



APPENDIX 6

Soils and Land Impact Assessment



ULAN COAL MINE MODIFICATION (MOD 6)

SOILS AND LAND IMPACT ASSESSMENT REPORT

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1. INTRODUCTION

Umwelt Australia Pty Ltd (Umwelt) engaged Minesoils Pty Ltd to undertake a Soils and Land Impact Assessment for the Ulan Coal Mine Modification (MOD 6). This assessment has been prepared as part of the Statement of Environmental Effects (SEE) required to accompany the modification application to the NSW Department of Planning and Environment (DPE) for development consent under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.1 OVERVIEW

1.1.1 PROPOSED DEVELOPMENT

The Ulan Coal Complex (UCC) is located approximately 38 kilometres north-north-east of Mudgee and 19 kilometres north-east of Gulgong in New South Wales. Operations at the UCC are located approximately 1.5 kilometres east of the village of Ulan and entirely within the Mid-Western Regional Council Local Government Area (LGA). Coal mining has been undertaken in the Ulan area since the 1920s.

Ulan Coal Mines Pty Limited (UCMPL) was granted Project Approval (PA) 08_0184 under Part 3A of the EP&A Act on 15 November 2010 for the Ulan Coal –Continued Operations Project (UCCO Project). Approved operations at the UCC consist of underground mining in the Ulan Underground and Ulan West areas as well as open cut mining, and associated coal handling and processing, and transport through to August 2033. The open cut operations have been in care and maintenance since 2016. Existing operations are shown in **Figure 1**.

UCMPL is proposing a modification to PA 08_0184 pursuant to section 4.55(2) of the EP&A Act to maximise resource recovery from the existing underground mining operations within existing mining lease and exploration lease areas (refer to **Figure 1**). In addition to identifying additional mineable resources within existing mining lease areas, UCMPL has determined that there is a valuable mineable resource within Exploration Lease (EL) 7542 and is seeking to modify PA 08_0184 to enable access to this coal resource by extending the currently approved longwall panels in these areas (refer to **Figure 1**).

The Proposed Modification will extend the life of the existing operations by two years until 2035 and allow for an additional approximately 25 Mt of extraction. The Proposed Modification generally comprises of:

- extension of Ulan Underground longwall (LW) panels LWW9 to LWW11 to the west
- widening of Ulan Underground LWW11 by approximately 30 metres
- extension of Ulan West LW9 to LW12 to the north.

There is an area within EL 7542 which may be accessed by either Ulan West or Ulan Underground depending on timing of operations and mining conditions. The area referred to as the ‘Longwall Option Area’. The Longwall Option Area will not change the maximum subsidence affectation area and therefore has no material impact on this assessment.

UCMPL is also proposing some minor changes to surface infrastructure to support underground mining activities including provision of:

- 3 ventilation shafts and associated infrastructure corridors
- 5 dewatering bores and associated infrastructure corridors
- an alternate access track
- an infrastructure corridor and service borehole (to deliver gravel and other construction materials and to provide access and power to the underground mine) to the south west of Ulan West.

A comparison between the approved development under PA 08_0184 and the Proposed Modification is provided in **Table 1**.

Table 1: Proposed Modification

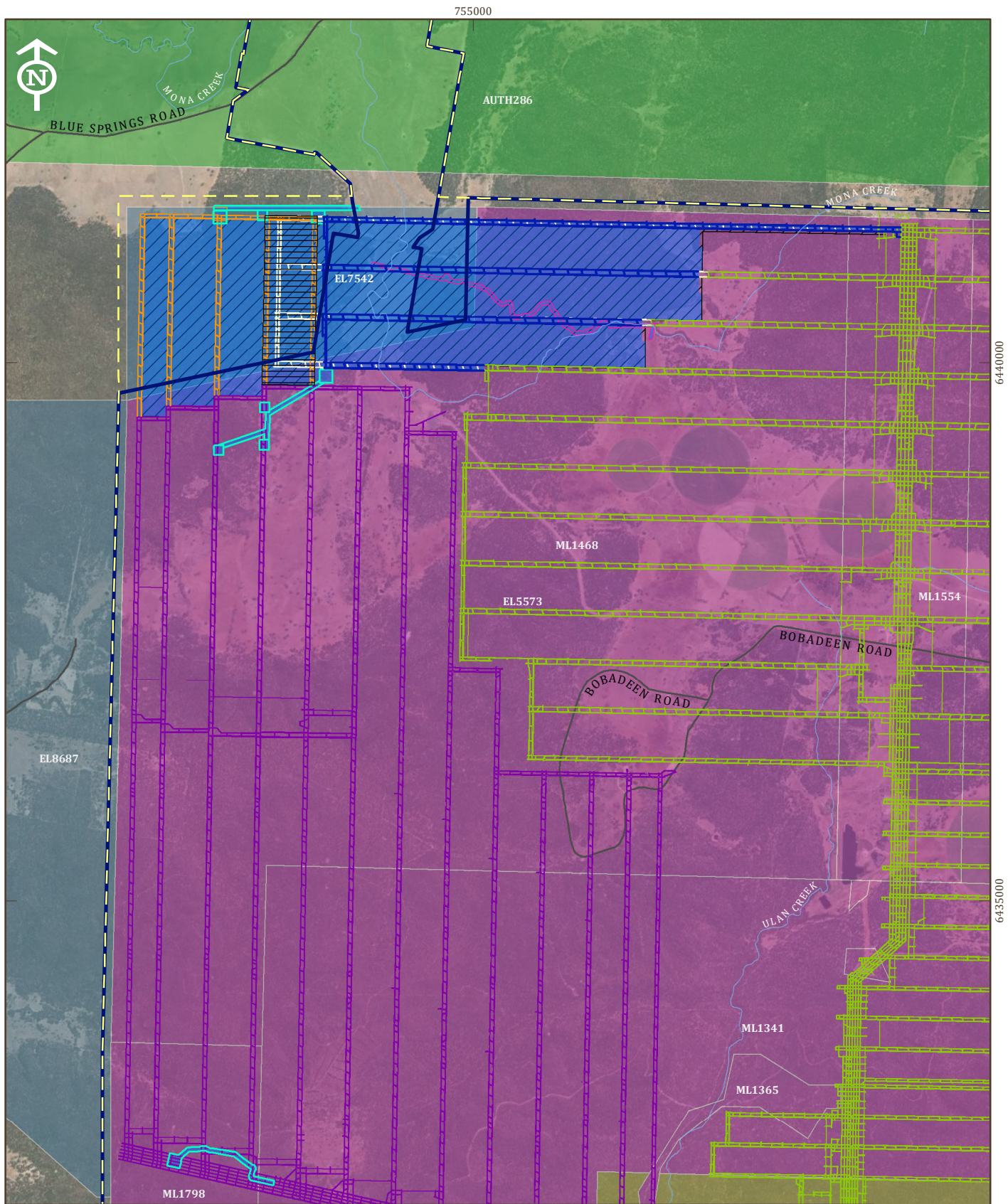
Project Component	Approved Operations	Consolidation Project
Mine life	Mining operations until 30 August 2033	Extension of life of mine until 30 August 2035 (an additional 2 years)
Limits of Extraction	20 million tonnes of coal per annum (including a maximum of 4.1 Mtpa ROM from the Open Cut)	No change Additional 25Mt from the Proposed Modification
Operating Hours	24 hours per day, 7 days per week	No change
Project boundary	As per PA 08_0184	Extension of Project Approval Boundary to include the northern part of EL 7542 (refer to Figure 1)
Mine plan	As per PA 08_0184	Extension of Ulan Underground LWW9 to LWW11, and Ulan West LW9 to LW12. Widening of Ulan Underground LWW11. Refer to Figure 1
Mining Method	Retreat longwall method	No change
Surface Infrastructure	As per PA 08_0184	Minor changes to infrastructure including dewatering bores, ventilation shafts and associated infrastructure to accommodate the proposed mine plan.
Coal Handling and Preparation Plant	As per PA 08_0184	No change
Coal Transportation	All coal transported from the site by rail. No more than 10 laden trains leave the site each day.	No change
Workforce	Approximately 931 people (Ulan Coal Complex)	No change

The Study Area subject to this assessment includes areas impacted by proposed longwall mining changes and proposed surface infrastructure, and covers an area of 780.0 ha (refer **Figure 2**). Proposed surface infrastructure and associated infrastructure corridors will cover an area of 27.4 ha within the Study Area, and will constitute the only direct soil resource disturbance.

1.1.2 APPROVAL PATHWAY

An application to DPE will be required for MOD 6. A referral has also been submitted for MOD 6 to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A Modification Report and associated technical assessments will be prepared for MOD 6.





Legend

- Study Area (780Ha)
- Proposed Extension Project Approval Boundary
- Ulan Project Approval Boundary
- Longwall Option Area
- Proposed Surface Infrastructure
- Proposed Access Track Corridor

- Proposed Ulan West Underground Modification
- Proposed Ulan Underground Modification
- Approved Ulan Underground
- Approved Ulan West Underground
- Proposed Modification Void Areas

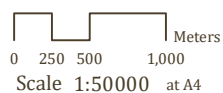
Existing Titles

- AUTH
- CCL
- EL
- ML
- MPL

MINE SOILS
LAND & REHABILITATION SPECIALISTS



GDA 1994 MGA Zone 55



Ulan Mod 6 SEE
Study Area

FIGURE 2

1.2 SOILS AND LAND IMPACT ASSESSMENT OBJECTIVES

The key objectives of the Soil and Land Impact Assessment undertaken by Minesoils are as follows:

Objective 1 Classify and determine the soil profile types within the Study Area using the Australian Soil Classification (ASC) system (Isbell, 2007), including a description and figure showing the distribution of each soil type.

Objective 2 Provide a description of, and figures showing, the land capability within the Study Area using The Land and Soil Capability Assessment Scheme: Second Approximation (Office of Environment and Heritage (OEH), 2013).

Objective 3 Provide recommendations to mitigate soil erosion and sedimentation associated with the infrastructure works and soil stockpiles using Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2E Mines and Quarries (Department of Environment and Climate Change, 2008).

Objective 4 Prepare an Agricultural Impact Assessment for the project developed in accordance with the *Strategic Land Use Policy Guideline for Agricultural Impact Statements* (NSW Department of Trade, Investment, Regional Infrastructure and Services [DTIRIS], 2012) and in consideration of the agricultural impact risk ranking methodology outlined in *Agricultural Impact Statement technical notes* (NSW Department of Primary Industries, 2013) to present a focussed assessment of potential impacts to agricultural resources and industries.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 1** Introduction – outlines the modification and presents the purpose of this report.
- Section 2** Existing Environment - outlines existing environmental information taken into account for the purposes of this assessment.
- Section 3** Soil Survey – describes the methodology of the soil field survey, its results, and describes potential impacts resulting from the proposed modification.
- Section 4** Land Capability Impact Assessment – describes the methodology of the land capability impact assessment, its results, and describes potential impacts resulting from the proposed modification.
- Section 5** Disturbance Management – provides a summary of the environmental mitigation and management recommendations
- Section 6** Conclusion
- Section 7** References
- Appendix A** Certificate of Analyses – Results of soil analyses from NATA accredited laboratory used to complete this Soils and Land Impact Assessment
- Appendix B** BSAL Verification Report and Site Verification Certificate



2 EXISTING ENVIRONMENT & REGIONAL MAPPING

2.1 CLIMATE

The Study Area is situated near the village of Ulan in the central west of NSW, approximately 38 kilometres north-north-east of Mudgee and 19 kilometres north-east of Gulgong. The Mudgee region has a warm, temperate climate with warm summers and cool to cold winters. The hottest month is January, with an average maximum of 31.1°C, while the coldest month is July, with an average minimum of 1.1°C (Bureau of Meteorology (BOM) station No. 062101, Mudgee Airport AWS, 2020).

The average annual rainfall is 650.2mm, with higher average rainfall in Summer and Spring. The wettest month is December, with 77.6mm of rain on average (Bureau of Meteorology (BOM) station No. 062101, Mudgee Airport AWS, 2020).

2.2 GEOLOGY AND GEOMORPHOLOGY

The Study Area lies within the Sydney Basin and the Regional Geology mapping indicates the majority of the site is located on the Narrabeen Group (TRn) Sandstones, with smaller areas of the Alluvium (Qa) – Silt, Clay, Sand and Gravel and the Purlawaugh Formation (Ju) – Sandstones, mudstones, claystones and coal (**Figure 3**). There were also minor basalt intrusion (Tb) - Basalt, tholeiite, observed on site but not in large enough areas to be mapped on a regional scale. The parent material underlying the soils are weathered in-situ and colluvial material derived from the parent rock listed above.

2.3 TOPOGRAPHY AND HYDROLOGY

The landform patterns within the Study Area consists of crests and plateaus with areas of rock outcrops above steep rocky slopes on maximal upper slopes to waning mid and lower slopes with rolling hills and low undulating hills flattening to low undulating rises and flats with open depressions. The drainage systems on site are moderately spaced erosional to alluvial stream development with fixed to slowly migrating integrated, convergent tributary patterns. Mona Creek drains from East to West across the site then flows north into the Talbragar River (**Figure 4**).

Slopes range from flat (1-2%) land to 20% on steep upper slopes. Local relief in the Study Area is approximately 90m with elevation ranging from approximately 440m AHD in the lower drainage channels and flats to 540m AHD.

2.4 SOIL LANDSCAPES

The Soil Landscape units are areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements. Murphy and Lawrie (1998) described the *Soil Landscapes of the Dubbo 1:250,000 Sheet* through a classification of landscape assemblages and their associated soil characteristics. The materials used to form the soil landscape definitions included cadastral data, geological, landform, soil, vegetation, and water resource studies. The classification also takes into account the limitations each unit poses that may restrict rural or urban development. The Soil Landscapes within the Study Area are presented in **Table 2** and **Figure 5** below and summarised in the following sections.

Table 2: Soil Landscapes within the Study Area

Soil Landscape	Abbreviation	Great Soil Group
Turill	ti	Earthy Sands
Ulan	ul	Yellow Podzolics & Soloths
Goonoo	gn	Earthy/Siliceous Sands & Earths
Lees Pinch	lp	Shallow Soils
Munghorn Plateau	mp	Yellow Earths & Yellow Podzolics

The Soil Landscape summary information is taken from the *Soil Landscapes of the Dubbo 1:250,000 Sheet* (Murphy, B.W. & Lawrie, J.W. 1998).

Turill

Undulating low hills with some sandstone outcrop. Narrabeen Sandstone, mudstone, and Jurassic shale and sandstone. Relief to 30 - 90 m; slopes 5 - 20%. Yellow and brown Earthy Sands (Uc5.11; Uc5.2) and Siliceous Sands (Uc4.2; Uc1.21) on upper and midslopes. Red Podzolic Soils (Dr3.21) on lower slopes and flats. Yellow and Grey Podzolic Soils (Dy3.21; Dy3.21; Dy3.81) along larger drainage lines. Grey duplex soils (grey Solodic Soils) (Dg1.33) were observed in isolated swampy areas. Lateritic-type soils form ridges with gravelly Red Earths near junction with Goonoo (gn) Soil Landscape.

Limitations include: Low fertility and water holding capacity; high to very erosion hazard under cultivation; some steep slopes. Salinity common on lower slopes and in depressions.



Ulan

Low undulating rises and flats. Shale, sandstone, conglomerate, chert, coal and torbanite seams. Relief 10 - 40 m; slopes 2 - 10%. Yellow Podzolic Soils (Dy2.41) on lower slopes and drainage lines with patches of yellow Solodic Soils/Solonetz in association with salt scalds. Yellow and Brown Earths (Gn2.2; Gn2.3; Gn2.4) on footslopes with minor areas of Earthy Sands (Uc4.2; Uc4.3) on low rises.

Limitations include: Low fertility; acid surface soils; low waterholding capacity; seasonal waterlogging; sodic subsoils.



Goonoo

Undulating rises and low hills on Pilliga sandstone with isolated rock outcrop. Relief 10 - 50 m; slopes 2 - 10%. Mainly Earthy Sands (Uc5.21) and Siliceous Sands (Uc1.22) on crests and upper slopes. Yellow Solodic Soils (Dy3.42; Dy5.42) on lower slopes and in depressions.

Limitations include: Very low fertility; low to very low available water holding capacity; rock outcrop; fragile light textured surface soils susceptible to degradation; loose sands with low bearing capacity when wet; acid surface soils and high erosion hazard especially in concentrated flows.



Lees Pinch

Rolling hills and low hills with steep rocky slopes and valley sides. Narrabeen sandstone, conglomerate sandstone, shale, conglomerate, mudstone, chert, coal and torbanite seams. Relief 60 - 240 m; slopes 15 - 40%. Shallow, sandy soils (Uc4.1; Uc1.43; Uc1; Uc2.21) with extensive rock outcrop, boulder debris slopes and sandstone cliffs. Other soils include grey or Yellow Earths (Gn2.84) and Yellow Podzolic Soils (Dy4.51) on lower slopes, shallow acid loams (Um5.51) on coal bearing strata, and Podzols (Uc2.22) on lower slopes.

Limitations include: Steep slopes; rock cliffs; very low fertility; very low water holding capacity; high permeability.



Munghorn Plateau

Low undulating hills on sandstone plateaus with much rock outcrop. Narrabeen sandstone. Relief 20 - 60 m; slopes 3 - 10%. Mainly Siliceous Sands (Uc1.22) and shallow soils (Uc4.1; Uc1) on crests and upper slopes. Yellow Earths (Gn2.21; Gn1.2) and Yellow Podzolic Soils (Dy2.41; Dy5.81) on lower slopes and in depressions. Some peats (U) may be present in depressions. Limitations include. Low fertility; low available waterholding capacity; rock outcrop; high permeability; loose sands with low bearing capacity when wet; acid surface soils.



2.5 LAND AND SOIL CAPABILITY

The NSW regional based maps of Land and Soil Capability (LSC) indicate the Study Area is limited to areas of Class 5 and 6 as shown in **Figure 6** and detailed in **Table 3** below. There is no 'High Capability' land according to this mapping. This regional mapping is based on the parameters to be used in future ground truthing assessments, as adopted from the NSW Soil Landscapes data, and detailed in 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 2** and their definition has been based on two considerations:

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



Table 3: 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)	
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.

* LSC class located within the Study Area based on regional mapping.

2.6 LAND USE

The majority of land within the Study Area is forested with high density woody vegetation. The areas of cleared land are currently used predominately for grazing. There is no evidence of cultivation and/or cropping within the Study Area. There are 2 private landholders and UCMPL owned land within the Study Area. These parcels of land are located predominantly on the RU1 Primary Production zone.

The NSW regional mapping information from Murphy and Lawrie (1998) described in the *Soil Landscapes of the Dubbo 1:250,000 Sheet* indicate compatible land uses associated with each soil landscape on site as detailed in Section 2.4. There are examples within NSW of rural land coexisting with underground mining operations, including the coastal coal mines in the Newcastle region, Hunter Valley Mines such as Beltana Underground, and Dartbrook. UCMPL has previously operated underground mining in conjunction with similar rural land zoning, therefore it is expected that similar constraints previously experienced, will be relevant to the Study Area.



2.7 STRATEGIC REGIONAL LAND USE PLAN - MAPPING

The NSW Government's Strategic Regional Land Use Policy defines and identifies strategic agricultural land across NSW. Strategic agricultural land includes land with unique natural resource characteristics, known as biophysical strategic agricultural land (BSAL), and clusters of significant agricultural industries known as critical industry clusters.

The nearest regionally mapped strategic agricultural land is approximately 2 km to the north of the Study Area along the alluvial flats of the Talbragar River (refer to **Figure 1: Regional Context**). Note this mapped BSAL has not undergone the site verification process and is mapped based on regional data.

The component of the Study Area not within an existing Mining Lease was assessed in accordance with the Interim Protocol for Site Verification of BSAL (OEH 2013). The results concluded the area was verified Non-BSAL. An application for a Site Verification Certificate (SVC) was made in May 2021 and the SVC 19199244 was received on 5th July 2021.

2.8 REGIONAL SOIL CLASSIFICATIONS

The NSW regional soil mapping indicates the dominant soils within the Study Area are Rudosols and Tenosols, with minor areas of Natric Kurosols along the drainage line and a very small area of shallow Ferrosol soil associated with the basalt intrusion in the North (**Figure 7**).

Rudosols

Soil with negligible (rudimentary) pedologic organisation apart from (a) minimal development of an A1 horizon or (b) the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or saprolite. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present.

Tenosols

The Tenosols will differ from Rudosols by virtue of having either a more than weakly developed A1 horizon, an A2, or a weakly developed B horizon. Tenosols do not fit the requirements of any other soil orders and generally have one or more of the following:

- I. A peaty horizon.
- II. A humose, melacic or melanic horizon, or conspicuously bleached A2 horizon, which overlies a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- III. A horizons which meet all the conditions for a peaty, humose, melacic or melanic horizon except the depth requirement, and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- IV. A1 horizons which have more than a weak development of structure and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- V. An A2 horizon which overlies a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials.
- VI. Either a tenic B horizon, or a B2 horizon with 15% clay (SL) or less¹, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material (including pedogenic carbonate).



- VII. A ferric or bauxitic horizon >0.2 m thick.
- VIII. A calcareous horizon >0.2 m thick.

Natric Kurosols

Soils other than Hydrosols with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is strongly acid (pH <5.5). The Natric Great Group means the major part of the upper 0.2 m of the B2 horizon is sodic (ESP >6%).

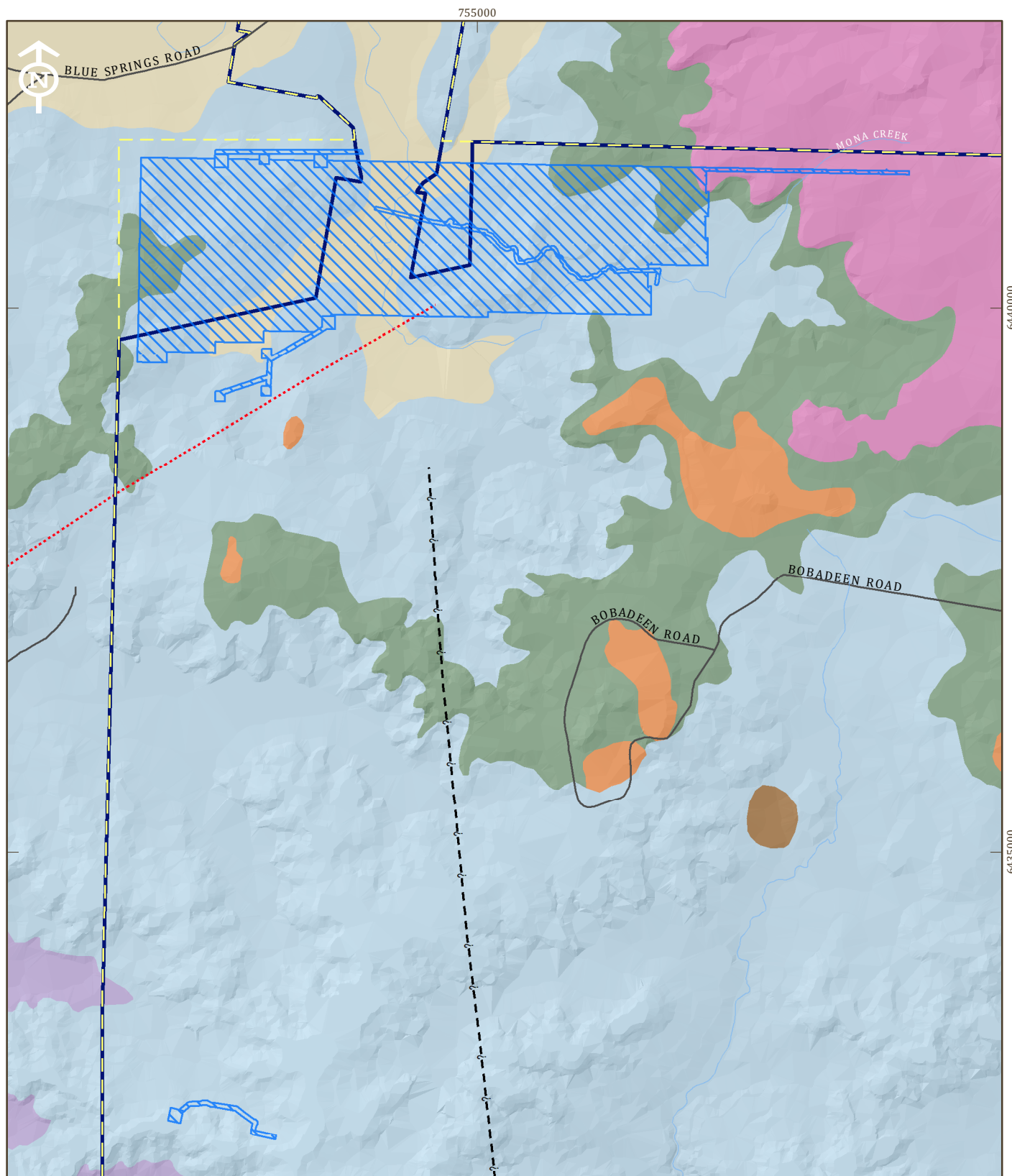
Ferrosols

Soils other than Vertosols, Hydrosols, and Calcarosols that:

- I. Have B2 horizons in which the major part has a free iron oxide¹ content greater than 5% Fe in the fine earth fraction (<2 mm), and
- II. Do not have clear or abrupt textural B horizons or a B2 horizon in which at least 0.3m has vertic properties.

These soils are almost entirely formed on either basic or ultrabasic igneous rocks.





Legend

- Study Area (780Ha)
- Proposed Extension Project
- Approval Boundary
- Ulan Project Approval Boundary
- ~ Watercourses

Western Coalfield Regional Geology (100k)

- Fault, concealed
- Hingeline, concealed

Geological Units

- Volcanic vent, breccia, crater sediments, minor basalt (J-Tc)
- Pilliga Sandstone - Course pebbly lithic-quartzose sandstone (Jp)
- Purlawaugh Formation - Sandstone, Mudstone, Claystone, Coal (Ju)
- Illawarra Coal Measures - Volcanic vent, breccia, crater sediments, minor bassalt (Pi)
- Alluvium - Silt, Clay, Sand, Gravel (Qa)
- Narrabeen Group - Sandstones (TRn)
- Extrusion & Intrusion - Bassalt, tholeiite (Tb)

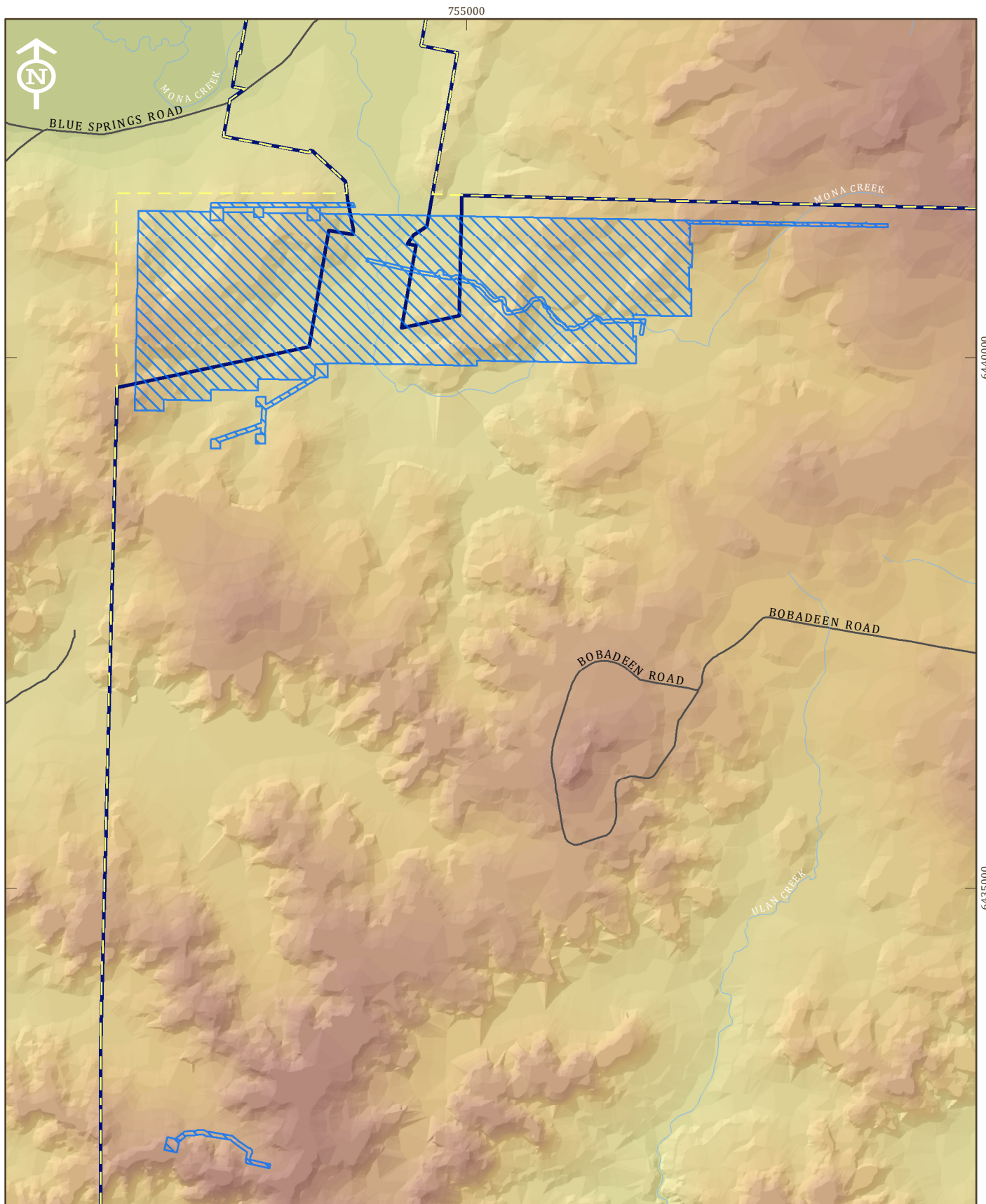
GDA 1994 MGA Zone 55

MINE SOILS
LAND & REHABILITATION SPECIALISTS

0 250 500 1,000 Meters
Scale 1:50000 at A4

Ulan Mod 5 SEE
Regional Geology

FIGURE 3



Legend

- ▨ Study Area (780Ha)
- ▭ Proposed Extension Project
- ▭ Approval Boundary
- ▭ Ulan Project Approval Boundary
- Watercourses

Elevation (m)

- 425 - 430
- 430 - 435
- 435 - 440
- 440 - 445

445 - 450	470 - 475	495 - 500	520 - 525	545 - 550
450 - 455	475 - 480	500 - 505	525 - 530	550 - 555
455 - 460	480 - 485	505 - 510	530 - 535	555 - 560
460 - 465	485 - 490	510 - 515	535 - 540	560 - 565
465 - 470	490 - 495	515 - 520	540 - 545	565 - 570

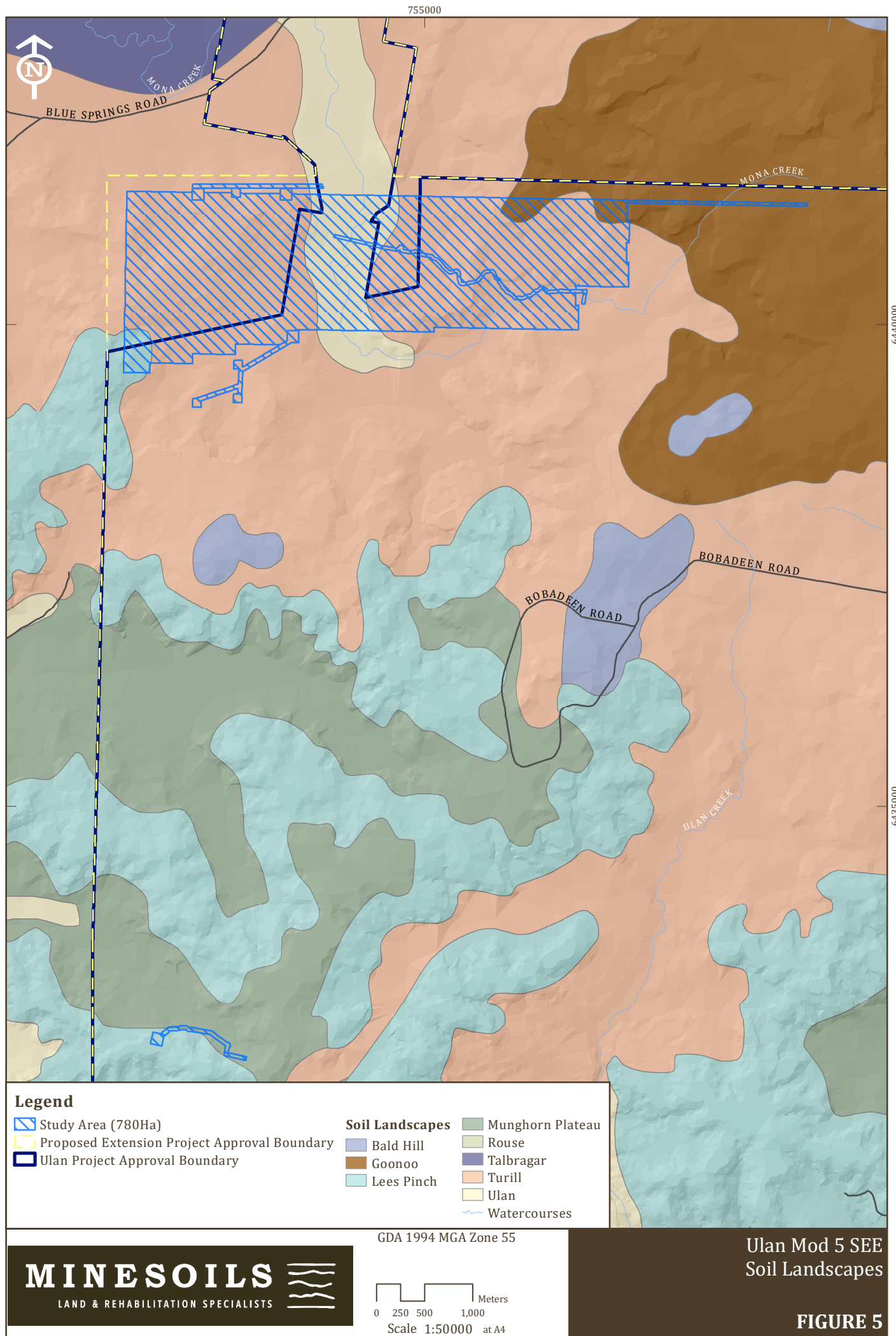
GDA 1994 MGA Zone 55

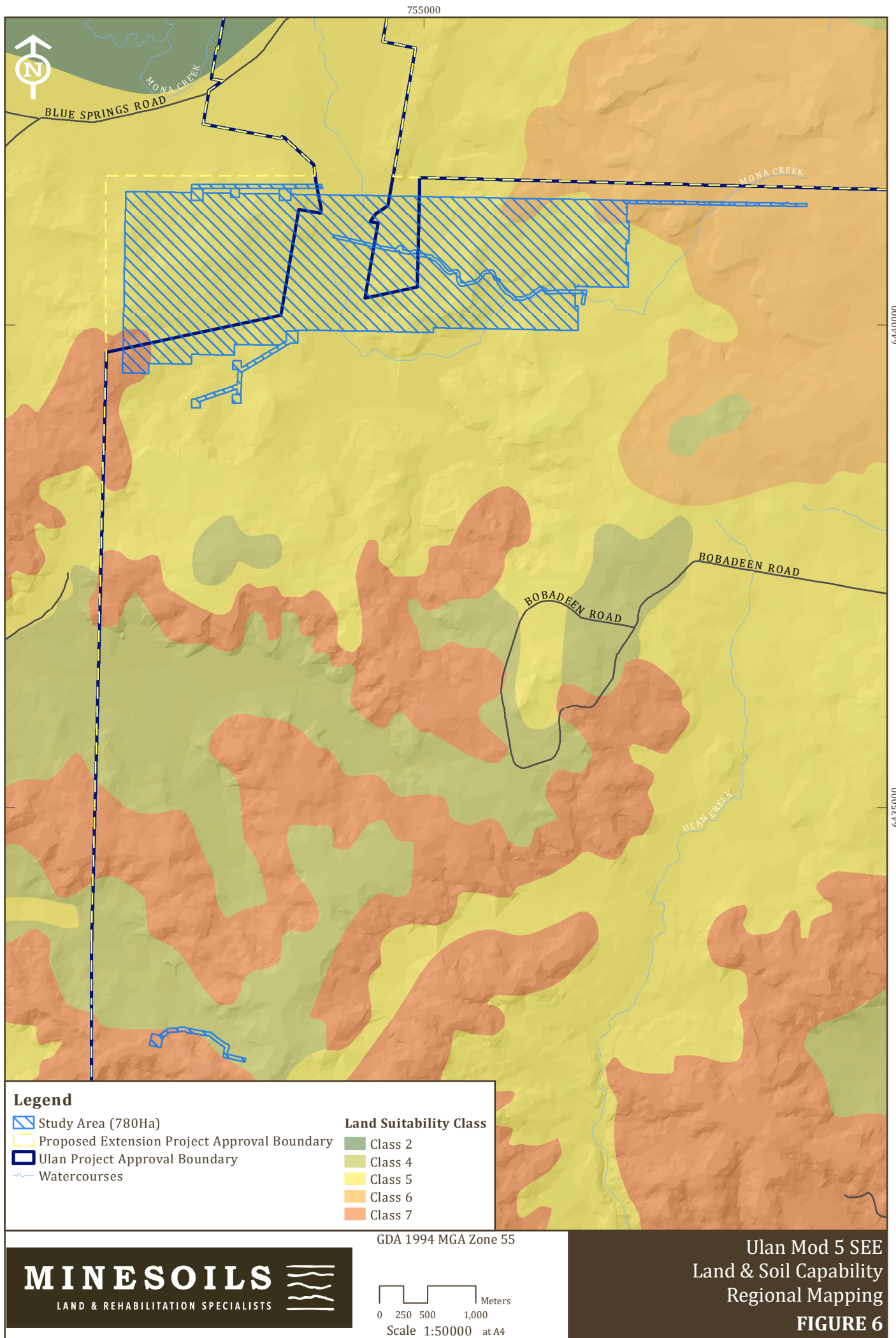
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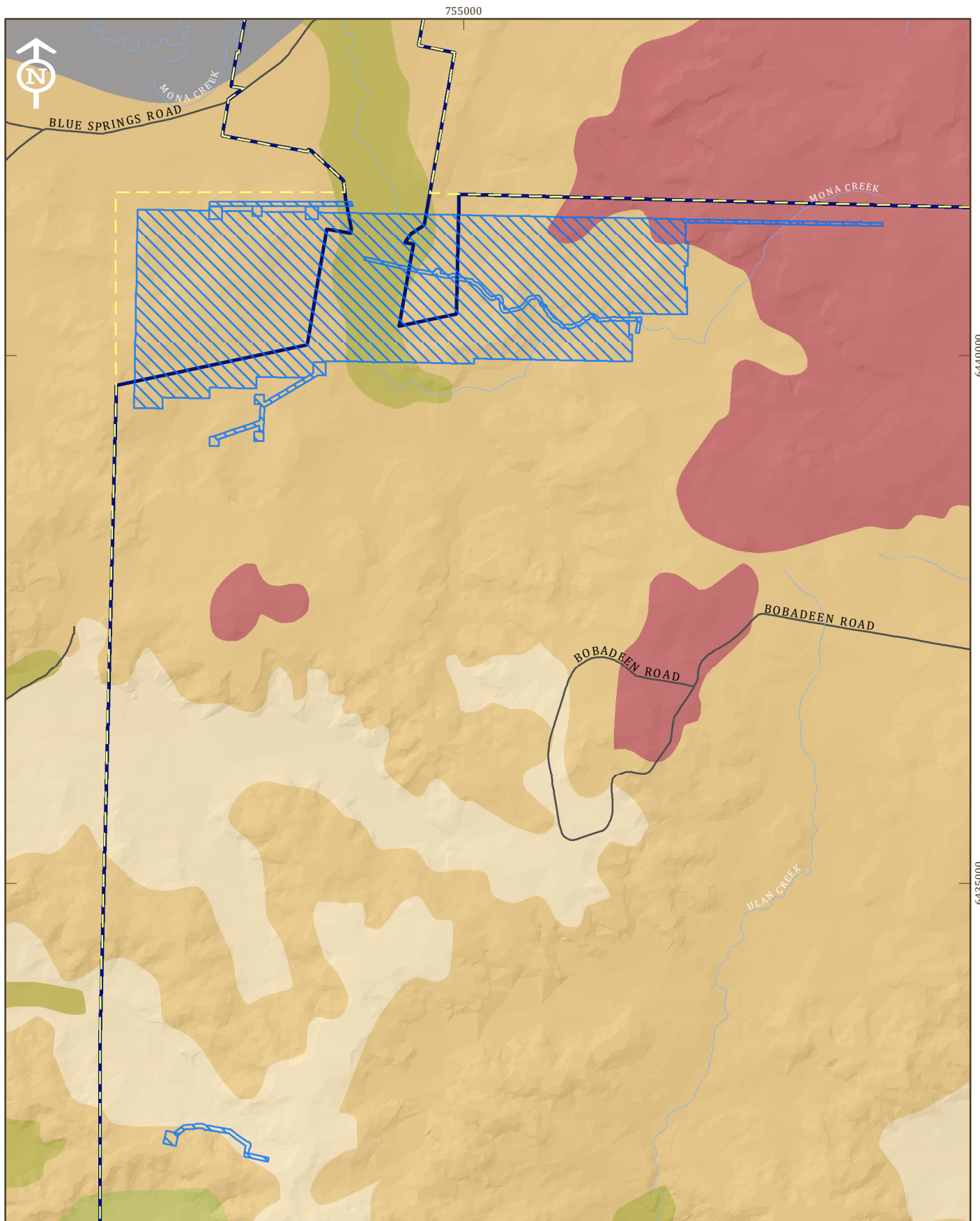
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Ulan Mod 5 SEE
Topography

FIGURE 4







Legend

- Study Area (780Ha)
- Proposed Extension Project Approval Boundary
- Ulan Project Approval Boundary
- Watercourses

Australian Soil Classification (ASC) - Order

- Ferrosols
- Kurosols, Natric

- Rudosols
- Rudosols and Tenosols
- Sodosols
- Vertosols

GDA 1994 MGA Zone 55

MINE SOILS
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0 250 500 1,000 Meters
Scale 1:50000 at A4

Ulan Mod 5 SEE
Australian Soil Classification
Regional Mapping
FIGURE 7

3 SOIL SURVEY

3.1 SOIL SURVEY METHODOLOGY

Minesoils undertook a soil and land resource assessment to satisfy the following tasks to be undertaken throughout the SEE process:

- Soil survey and assessment, identifying soil types, soil qualities and risks including erosion, acid sulfate soils risk and salinity;
- LSC Assessment;
- Management and mitigation measures for handling soil during construction, operations and rehabilitation.

The objective of Minesoils proposed fieldwork program is to satisfy the field assessment, sampling and testing requirements related to soil and land resources. The fieldwork plan outlined below was designed to satisfy the following requirements:

- Soil survey and mapping: This is recommended to be undertaken soil survey between a 1:25,000 and 1:50,000 survey intensity (1 site every 50 ha), and requires collection of landform pattern and element information, soil profile data, and taxonomic parameters to distinguish soil types according to the Australian Soil Classification criteria, within the Study Area.
- SEE LSC: The information required for the LSC assessment will be collected during both the desktop assessment and verified on the ground during the field program. The LSC system requires data on biophysical features from in situ measurements regional mapping.
- SEE soil qualities: Additional information will be recorded in the field on erosion and evidence of potentially erosive soils including tunnelling, rill, gully and sheet erosion, which may require specific handling and management techniques during construction. Observations were made on risks of ASS and salinity.

The field program was designed as an integrated free survey. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (NSCT, 2008). 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 gradual variation. Soil pits were excavated by a 3t tracked excavator to 1.2m. Site clearances and dial before you dig (DBYD) plans were provided as part of the excavation requirements.

The Study Area covers 780.0 ha; however, access was significantly restricted in uncleared areas with no access tracks, and soil investigation sites were limited in these areas. The number of soil investigation locations over the accessible areas was 24 sites and samples were collected and tested at all sites. Four samples were collected from each site and depths were typically at 0-10 cm, 20-30 cm, 40-50cm and 65-75 cm. The laboratory testing suite for these sites is detailed in the **Table 4** below.

Duplicate samples at every site were collected during the fieldwork and stored at Minesoils' office in Tamworth until the project is finalised. This duplication process offers insurance in the event of samples being lost in transit, laboratory accidents or inadequate soil volume for destructive tests and eliminates the need for additional site visits if any of the above occurs.

Soil profiles within the Study Area (refer to **Figure 8**) were assessed in accordance with the Australian Soil and Land Survey Field Handbook soil classification procedures (NCST, 2009). Detailed soil profile descriptions were recorded covering the major parameters specified in **Table 5** below. Soil profile logging was undertaken in the field using Minesoils soil data sheets, including GPS recordings and photographs of the landforms and soil profiles. Soils were keyed out in accordance with the Australian Soil Classification (ASC) Revised Edition (2008).



Table 4: Soil Sample Laboratory Analysis

Lab Analysis	
Analyte	Methodology
pH (1:5 water & CaCl)	Rayment & Lyons 2011-4A1
Electrical Conductivity (EC) and Chloride	Rayment & Lyons 2011-3A1
Cation Exchange Capacity (CEC) & ESP and Ca:Mg Ratio	Rayment & Lyons 2011-15J1
Particle Size Analysis (PSA) (Selected samples only)	ISSS Hydrometer plus 0.2 and 2.0 mm Sieving (CSIRO 'Yellow Book')

Table 5: Detailed soil profile description parameters

Detailed Field Assessment Parameters	
Horizon depth including distinctiveness and shape	Pan presence and form
Field texture grade	Permeability and drainage
Field colour (Munsell colour chart)	Field pH
Pedality structure, grade and consistence	Field moisture
Soil fabric and stickiness	Surface condition
Stones (abundance and size)	Landform pattern / element
Mottles (amount, size and distinctiveness)	Current land use and previous disturbance
Segregations (abundance, nature, form and size)	Vegetation



3.2 SOIL SURVEY RESULTS

The soil survey undertaken by Minesoils found the Study Area to contain three dominant soil map units: 1. Sodosol/Chromosol Complex, 2. Tenosols and 3. Dermosols (refer to **Figure 10**). A summary of the soil types is provided below with two representative soil profile descriptions shown in this section. All soil profile descriptions are reproduced in **Appendix 2**.

Sodosol/Chromosol Complex (10 sites) – 151.5 ha

The Sodosol/Chromosol complex consists of clear or abrupt texture contrast soils with varying degrees of sodicity in the subsoils. Typically, the higher sodic soils were found in the lower parts of the landforms such as the open drainage lines and flats. The Chromosol soils were typically found from the lower drainage lines to the med and upper slopes. This soil map unit included areas cleared for grazing with three sites located within dense bushland.

Tenosols - Light Textured (11 sites) – 589.8 ha

The Tenosol profiles found within this soil map unit were light textured, weak structured uniform soils, with deeper profiles typically located on the lower landforms whilst shallow soils overlies sandstone bedrock on upper slopes and crests.

Dermosols (3 sites) – 38.7 ha

The three Dermosol soil profiles had structured B2 horizons and were lacking strong texture contrast between the A and B horizons. These profiles were all eutrophic with two sites sodic. The sites were found in relation to two separate basalt intrusions which appear to have influenced the soil type in these small areas.



Table 6: Soil Map Units and Soil Types

Site #	Inspection Site Type	Soil Map Units		Soil Profile - Australian Soil Classification (ASC)	ASC Family Criteria
		#	Name		
B1	Detailed	1	Sodosol/Chromosol Complex	Eutrophic Subnatric Grey Sodosol	CFKMW
B2	Detailed	2	Tenosol (Light Textured)	Acidic Lithic Leptic Tenosol	AFLLU
B3	Detailed	2	Tenosol (Light Textured)	Acidic Paralithic Bleached Orthic Tenosol	CFLKV
B4	Detailed	1	Sodosol/Chromosol Complex	Mottled Eutrophic Brown Chromosol	CEKOW
B5	Detailed	2	Tenosol (Light Textured)	Basic Paralithic Brown-Orthic Tenosol	CEKKV
B6	Detailed	1	Sodosol/Chromosol Complex	Mottled-Sodic Eutrophic Brown Chromosol	CEKOW
B7	Detailed	1	Sodosol/Chromosol Complex	Eutrophic Mesonatric Grey Sodosol	CFLOV
B8	Detailed	2	Tenosol (Light Textured)	Basic Paralithic Brown-Orthic Tenosol	DFLKV
B9	Observation	Ex	Rock outcrop	Rock Outcrop Area	-
B10	Detailed	2	Tenosol (Light Textured)	Basic Paralithic Brown-Orthic Tenosol	CELLW
B11	Observation	Ex	Rock outcrop	Rock Outcrop Area	-
E1	Detailed	1	Sodosol/Chromosol Complex	Eutrophic Subnatric Brown Sodosol	BFLOW
E2	Detailed	2	Tenosol (Light Textured)	Acidic Paralithic Bleached Orthic Tenosol	BEKLW
E3	Detailed	3	Dermosol	Mottled-Sodic Eutrophic Grey Dermosol	BFMMW
E4	Detailed	2	Tenosol (Light Textured)	Acidic Paralithic Brown Orthic Tenosol	BEKLW
E5	Detailed	3	Dermosol	Sodic Eutrophic Brown Dermosol	AFOOW
E6	Detailed	2	Tenosol (Light Textured)	Manganic Paralithic Brown Orthic Tenosol	BEKLW
E7	Detailed	3	Dermosol	Haplic Eutrophic Black Dermosol	BFLLU
E8	Detailed	1	Sodosol/Chromosol Complex	Mottled Eutrophic Yellow Chromosol	CEKMW
E9	Detailed	1	Sodosol/Chromosol Complex	Sodic Eutrophic Yellow Chromosol	AHLOW
E10	Detailed	1	Sodosol/Chromosol Complex	Haplic Magnesic Red Chromosol	AHLOW
E11	Detailed	1	Sodosol/Chromosol Complex	Mottled Magnesic Red Chromosol	BGLOV
E12	Detailed	1	Sodosol/Chromosol Complex	Mottled Magnesic Grey Chromosol	DGKNW
E13	Detailed	2	Tenosol (Light Textured)	Acidic Paralithic Brown Orthic Tenosol	BGKLW

Representative sites shown below. All sites shown in **Appendix 2**.



Site Description – Site B1						
Site Reference	B1	ASC Name	Eutrophic Subnatic Grey Sodosol (CFKMW)			
Average Slope	2%	Land Use	Grassland	Coordinates		
Site Morphology	Midslope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 752949		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6442107		




Plate 1 – Soil Profile (B1)




Plate 2 – Surface (B1)




Plate 3 – Landscape (B1)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (Munsell 10YR 2/2) Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.10 – 0.50	Brown to Grey (Munsell 7.5YR 5/3 to 10YR 6/1) Sand to Loamy Sand with apedal structure and weak consistence. Strongly acidic to slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and poorly drained. Clear boundary.
B2	0.50 – 0.75+	Light Reddish Grey (Munsell 2.5YR 7/1) Clay Loam with moderate pedality and firm consistence. Moderately acidic pH, non-saline and sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.9	Non-saline	5.39	Strongly acidic	4.4	Non-Sodic
0.20-0.30	0.3	Non-saline	5.29	Slightly acidic	3.2	Non-Sodic
0.40-0.50	0.4	Non-saline	6.39	Slightly acidic	4.8	Non-Sodic
0.65-0.75	0.3	Non-saline	5.80	Mod acidic	6.0	Sodic



Site Description – Site B3						
Site Reference	B3	ASC Name	Acidic Paralithic Bleached Orthic Tenosol (CFLKV)			
Average Slope	7%	Land Use	Grassland	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 753932		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6441383		




Plate 7 – Soil Profile (B3)




Plate 8 – Surface (B3)







Plate 9 – Landscape (B3)

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark brown to greyish brown (Munsell 10YR 3/3 to 5/2) Sandy Loam to Loamy Sand with weak pedality and weak consistence. Very strongly to strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.30 – 0.60	Brown (Munsell 10YR 5/3) Loamy Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary to C.
C	0.60+	Parent rock (weathered)

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	4.89	Very Strongly acidic	0.53	Non-Sodic
0.20-0.30	0.5	Non-saline	5.20	Strongly acidic	0.37	Non-Sodic
0.40-0.50	0.1	Non-saline	5.34	Strongly acidic	0.83	Non-Sodic



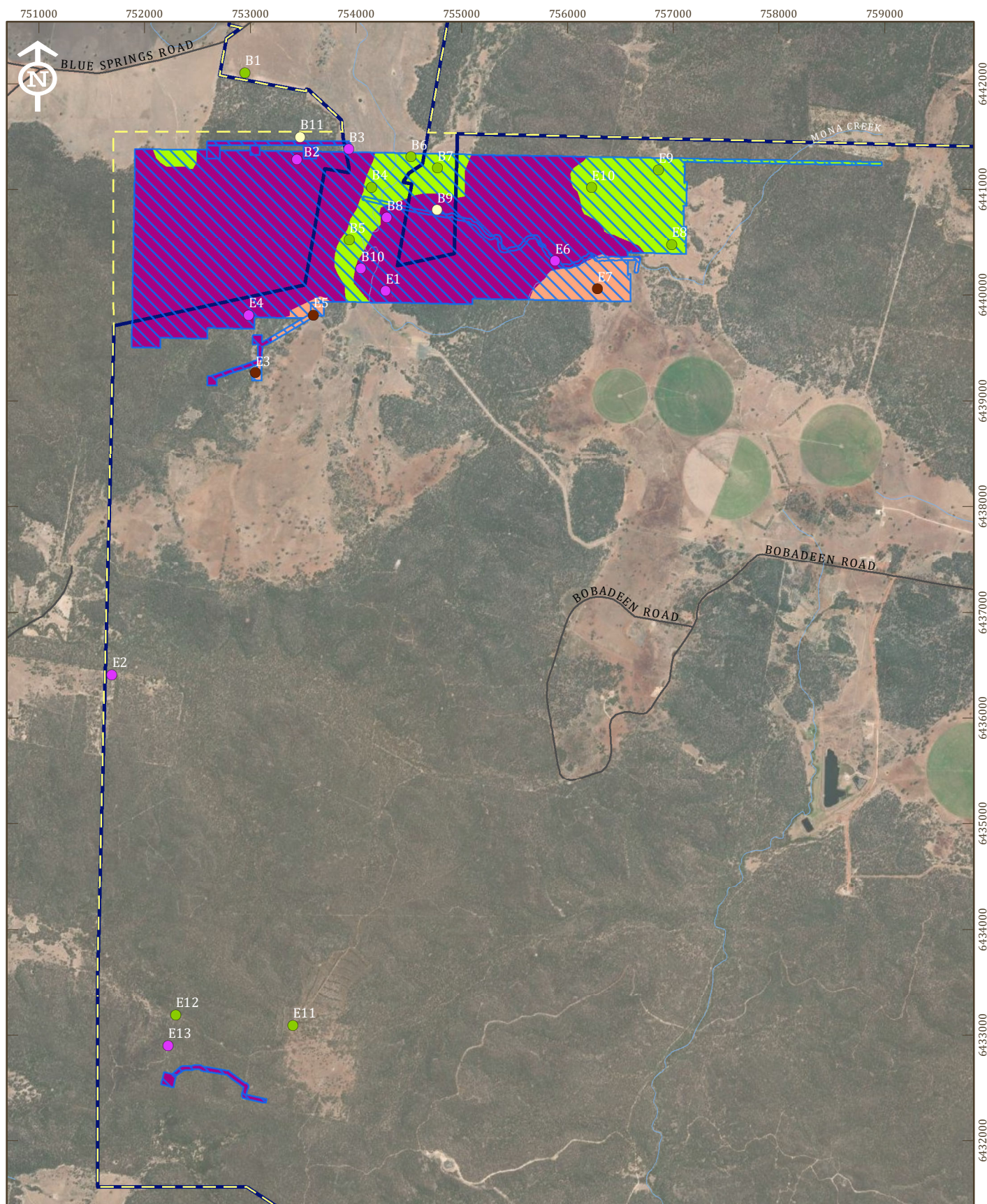
Site Description – Site E7						
Site Reference	E7	ASC Name	Haplic Eutrophic Black Dermosol (BFLU)			
Average Slope	9%	Land Use	Partially cleared for Grazing	Coordinates		
Site Morphology	Midslope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 756286		
Surface Condition	Firm	Mapped as BSAL	Not Applicable	Y: 6440060		

						
Plate 58 – Soil Profile (E7)			Plate 59 – Surface (E7)			
			Plate 60 – Landscape (E7)			

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark brown (Munsell 10YR 2/2) Loam with strong structure and moderate consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.20 – 0.30	Very dark greyish brown (Munsell 10YR 3/2) Sandy Loam with strong structure and moderate consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments. few fine roots and moderately drained. Clear boundary.
C	0.30 +	Weathered Basalt

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.1	Non-saline	6.38	Slightly Acidic	1.6	Non sodic
0.25-0.35	0.4	Non-saline	6.93	Neutral	3.9	Non sodic





Legend

- Study Area (780Ha)
- Proposed Extension Project Approval Boundary
- Ulan Project Approval Boundary

Soil Types

- Dermosol
- Rock Outcrop
- Sodosol / Chromosol Complex
- Tenosol / Rudosol Complex

Field Verified Soil Mapping

- Dermosol
- Sodosol / Chromosol Complex
- Tenosol / Rudosol Complex

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0 250 500 1,000 Meters
Scale 1:50000 at A4

Ulan Mod 5 SEE
Soil Mapping Units

FIGURE 8

4 LAND CAPABILITY IMPACT ASSESSMENT

4.1 LAND AND SOIL CAPABILITY ASSESSMENT

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 2012a) (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 4** in **Section 2.5**.

4.1.1 METHODOLOGY

Calculating 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 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 range from Low to High depending on the landform pattern and landform element in the proximity of the sites throughout the Study Area; and
- The average rainfall for the region is 640 mm (BOM 2021), and therefore the Study Area lies within the "greater than 500 mm 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 surface soil texture; surface soil pH and a regional mean annual rainfall range between 550mm and 700mm.

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The recharge potential for the site was determined based on an average annual rainfall of 640 mm, with annual evaporation of 1600-1800 mm (BOM 2021). This would suggest a low recharge potential and a low discharge potential.

The Study Area according to the Salt Store Map of NSW, is located in area of low salt store. However, due the current available scale of this mapping, laboratory tested EC values were used to determine salt store. The entire study area fell within non saline to slightly saline E_{Ce} results.

Hazard 6: Water Logging

Water logging was determined by the soil drainage characteristics, specifically field sample evidence of mottling, soil texture attributes as well as slope and climate. At the time of the field survey the low-lying areas were very wet with some waterlogging lasting for 1 to 2 weeks.

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.



4.1.2 RESULTS

The 24 soil test sites within the Study Area have been assessed and classified into the LSC Classes ranging from 4 to 7, as per **Table 7** below.

Table 7: LSC Parameters and Overall Class

		Hazard Criteria								Overall
		1	2	3	4	5	6	7	8	
Site	Soil Mapping Unit	Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Movement	Class
B1	1	2	6	1	5	1	2	1	1	6
B2	2	2	4	3	5	1	1	6	1	6
B3	2	3	3	3	5	1	1	4	1	5
B4	1	2	4	1	5	1	2	3	1	5
B5	2	3	4	1	5	1	2	4	1	5
B6	1	2	4	1	5	1	2	3	1	5
B7	1	2	2	4	3	1	2	3	1	4
B8	2	2	5	1	5	1	2	4	1	5
B9	-	3	5	1	-	1	1	7	1	7
B10	2	3	5	1	5	1	2	3	1	5
B11	-	3	5	1	-	1	1	7	1	7
E1	1	2	3	4	4	1	2	3	1	4
E2	2	2	5	1	5	1	1	3	1	5
E3	3	2	1	4	3	1	3	3	1	4
E4	2	2	4	1	5	1	3	3	1	5
E5	3	2	2	6	-	1	1	3	1	6
E6	2	2	4	1	5	1	3	3	1	5
E7	3	3	2	4	4	1	1	6	1	6
E8	1	3	5	1	5	1	1	3	1	5
E9	1	3	2	3	3	1	1	5	1	5
E10	1	3	1	4	3	1	1	6	1	6
E11	1	2	4	3	4	1	1	6	1	6
E12	1	3	4	1	5	1	2	3	1	5
E13	2	3	5	1	5	1	1	4	1	5

The limitations associated with each land Class are discussed below and the land area of each Pre-mining Class is shown in Figure 9.

Class 4 Land

There are three LSC Class 4 sites including two sites (B7 and E1) from the Chromosol/Sodosol complex soil map unit and one site (E3) from the Dermosol soil map unit. 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 constraints to this land class are soil structure and soil acidity. These sites are surrounded by poorer quality LSC classes and are therefore influenced by small scale of area considered LSC class 4.

Class 4 land covers an area of 25.6 ha.

Class 5 Land

Class 5 land includes sites from the Chromosol/Sodosol Complex and Tenosol soil map units. 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 soil acidity, wind erosion and shallow soil depth.

Class 5 land covers an area of 158.5 ha.

Class 6 Land

Class 6 land includes sites from all three soil map units. This classification indicates a low land capability, with very severe limitations for a wide range of land management use and few management practices are available to overcome these limitations. This land is generally only suitable for grazing with limitations and is not suitable for cultivation. The primary constraints to this land class are shallow soil depth, soil structure decline and wind erosion.

Class 6 land covers an area of 538.3 ha.

Class 7 Land

Class 7 land includes two sites mapped for rock outcrop areas. Whilst rock outcrop areas are a common feature in the steeper slopes of the Study Area, much of these areas were not accessible and were therefore not confirmed via ground truthing. This classification indicates the land has extremely severe limitations to most land uses. It is unsuitable for any type of cropping or grazing practices because of its limitations. The primary constraints to this land class are soil depth and rock outcrop.

Class 7 land covers an area of 57.6 ha.

4.2 IMPACT ASSESSMENT ON LSC

The subsidence impacts detailed in SCT (2021) for the proposed longwall panels indicates the predicted subsidence ranges from 2.1m over the shallower areas where overburden depth is 100m and 1.7m for the deeper areas where overburden depth is 250m. The impacts on LSC classes 5 to 7 at these depths is considered very low. The ability for the land to continue to be used for grazing with various limitations will remain throughout mining and post subsidence. It is predicted that minor repairs to surface infrastructure such as tracks, fencing and dams will be required, however this does not change the LSC classification.

The drainage lines located within the subsidence area are considered ephemeral and only flow following rainfall events before drying up. Whilst there will be impacts on ponding locations and speed of drying, as well as potential higher risk erosion sites due to the subsidence, these are not considered significant enough to impact the overall LSC categories for the subsidence impact zone.

The proposed surface infrastructure sites will require minor landform modification (leveling) and soil stripping, which will impact the LSC class for the proposed disturbance areas. The LSC classes within the proposed surface infrastructure areas that will be temporarily impacted consist of:

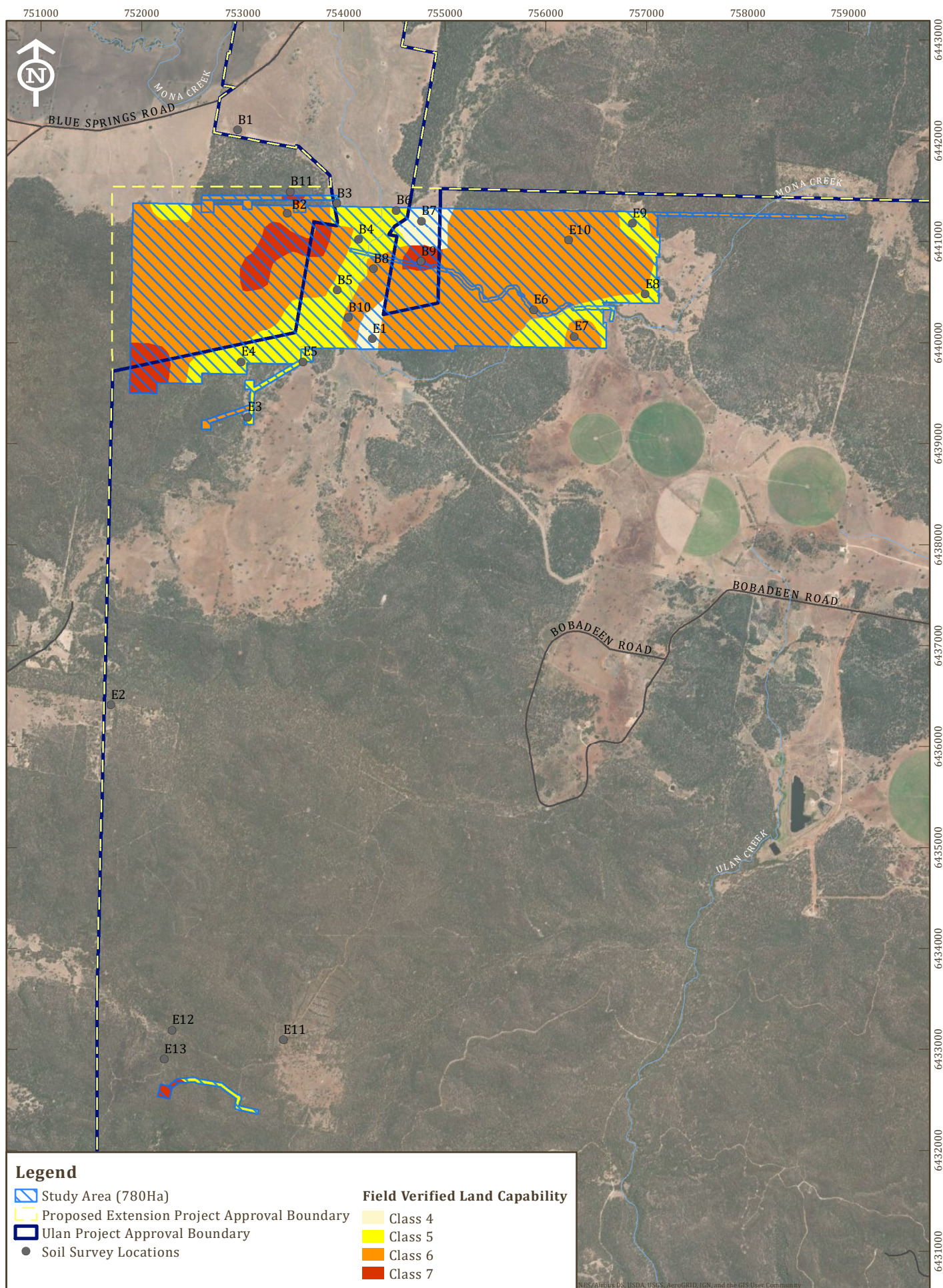
- 13.0 ha of LSC 5;
- 16.5 ha of LSC 6; and
- 4.4 ha of LSC 7.

These areas will be considered LSC class 8, not suitable for agriculture due to mining related facilities being operational. Following the end of life for these facilities, decommissioning, demolition and removal will allow for the disturbance areas to be re-graded (if required) and stored topsoil be placed over the area and rehabilitated with



either native vegetation or improved pastures depending on the surrounding land use. Therefore, long term LSC post decommissioning of surface infrastructure is expected to be unchanged from the pre-mining LSC class.





5 DISTURBANCE MANAGEMENT

5.1 DISTURBANCE MANAGEMENT FOR SURFACE INFRASTRUCTURE

This section addresses the methods for stripping and salvaging soil material for the construction of the various surface infrastructure required as part of this Modification, including; vent shafts, access tracks and dewatering bores. The process of soil handling for these surface infrastructure components will ensure the risk of erosion and sedimentation from disturbance areas is reduced, long term stockpiling is managed correctly and following decommissioning of the facility, there will be suitable soil material available for rehabilitation.

The following management and mitigation strategies are recommended to reduce the potential for degradation of soils within the proposed small disturbance areas for surface infrastructure. These recommendations are based on the assessment of the existing site conditions and apply to both topsoil and subsoil stripping where applicable;

- Plan and designate areas for long term soil stockpiles adjacent to the disturbance area or within a short haul distance for rehabilitation at a later date. Stockpiles should not be placed near drainage lines
- Strip material to the depths required for engineered stability of surface infrastructure, separating topsoil (generally up to 0.2m) and subsoil, subject to any further field investigations during construction activities.
- Soil should preferably be stripped in a slightly moist condition. Material should not be stripped in either an excessively dry or wet conditions. Whilst construction schedules dictate stripping times, consideration should be given to near term weather forecasts.
- The three main treatment options available for the amelioration of sodic soil is the application of gypsum, lime or organic matter, or a combination of these materials.
- The surface of long-term soil stockpiles should be slightly roughened to promote infiltration and minimise erosion until vegetation is established.
- As a general rule, maintain a maximum stockpile height of 3 m. Clayey soils should be stored in lower stockpiles for shorter periods of time compared to coarser textured sandy soils.
- Seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward provides sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.
- An inventory of available soil should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.
- Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be lightly contour ripped (after topsoil spreading) to create a “key” between the soil and the subsoil or compacted surface. Ripping should be undertaken on the contour. Best results will be obtained by ripping when soil is moderately moist to dry and when undertaken immediately prior to sowing. The respread topsoil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration.



5.2 DISTURBANCE MANAGEMENT FOR SUBSIDENCE AREA

The Subsidence Assessment for Proposed Modification (SCT 2021) detailed the surface impacts would be limited to landform changes with maximum between 1.7 and 2.1m of subsidence, temporary surface cracking, potential steps and potential erosion risks at downslope tension cracks along drainage lines. These surface disturbances are considered minor and easily reparable, and within the scope of impacts seen in previous subsidence areas at Ulan Coal Complex. There is no necessary land or soil preparations to be implemented prior to subsidence, however it is recommended that regular monitoring of active subsidence areas should be undertaken as per ongoing practices at Ulan Coal Complex. Repairs to surface cracks that interrupts drainage flow and has the risk of accelerating erosion should be addressed as a high priority.



6 AGRICULTURE IMPACT ASSESSMENT

6.1 INTRODUCTION

6.1.1 AGRICULTURAL CONTEXT

The Study Area landscape ranges from undulating low hills with occasional sandstone outcrops and small flats along creek lines, to rolling hills with steep rocky slopes and valley sides. Slopes range from 5% to 40%. As a result, a significant portion of land within the Study Area is forested with high density woody vegetation. Areas of cleared land are predominantly used for grazing activities. There is no evidence of sensitive agricultural activities (e.g. intensive plant or livestock agriculture, or livestock breeding) are being undertaken upon lands on which the Proposed Modification will occur.

There are examples within NSW of agricultural land coexisting with underground mining operations, including the coastal coal mines in the Newcastle region, Hunter Valley Mines such as Beltana Underground, and Dartbrook. UCMPL has previously operated underground mining over similar rural land zoning, therefore it is expected that similar constraints previously experienced will be relevant to the Study Area.

6.1.2 PURPOSE OF ASSESSMENT

This Agricultural Impact Statement (AIS) has been prepared to assess potential impacts to agricultural resources and enterprises/industries because of the Proposed Modification and to inform a Statement of Environmental Effects (SEE).

This AIS has been developed in accordance with the *Strategic Land Use Policy Guideline for Agricultural Impact Statements* (NSW Department of Trade, Investment, Regional Infrastructure and Services [DTIRIS], 2012) and in consideration of the agricultural impact risk ranking methodology outlined in *Agricultural Impact Statement technical notes* (NSW Department of Primary Industries, 2013) to present a focussed assessment of potential impacts to agricultural resources and industries.

The SEE (including this AIS) will be submitted to allow the NSW Department of Planning, Industry and Environment (DPIE) – Division of Resources and Geoscience (DRG) to assess the potential environmental impacts associated with the Program as required under Part 5 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).

6.1.3 AIS ASSESSMENT APPROACH

Requirements of the guidelines and technical notes are summarised in **Table 8**, which also identifies the relevant section of this AIS where the requirements have been addressed.



Table 8: AIS Requirements and Sections

AIS Technical Notes Assessment Requirements	AIS Technical Notes Section	Section Addressed in this AIS
Project overview and description	1	1
Detailed assessment of agricultural resources and production	2	6.2
-Soil information	2.1	6.2.1
-History of agriculture	2.2	6.2.5
-Land to be temporarily removed from agriculture	2.3	2.4.7
-Land to be returned to agriculture post project	2.4	2.5.8
-Land that will not be returned to agriculture	2.5	2.6.9
-Agricultural enterprises on any buffer and/or offset zones	2.6	2.7.10
Identification of Agricultural Resources	3	6.2/6.3
-Agricultural resources within the locality	3.1	6.2.5
-Current agricultural enterprises within surrounding locality	3.2	6.3.4
Assessment of Impacts	4	6.4
-Identification and assessment of impacts	4.1	6.4.1
-Physical movement of water	4.2	6.4.2
-Socio-economic impacts	4.3	6.4.3
Mitigation measures	5	6.5
-Project alternatives	5.1	6.5.1
-Monitoring programs to assess impacts	5.2	6.5.2
-Trigger Response Plans and trigger points	5.3	6.5.2
-Remedial actions	5.4	6.5.2
-Demonstrated capacity for rehabilitation	5.6	6.5.3
-Planning for progressive rehabilitation	5.7	6.5.3
Consultation	6	6.6

6.2 AGRICULTURAL RESOURCES OF THE STUDY AREA

6.2.1 SOIL CHARACTERISTICS

The Study Area lies within the Sydney Basin and the Regional Geology mapping indicates the majority of the site is located on the Narrabeen Group (TRn) Sandstones, with smaller areas of the Alluvium (Qa) – Silt, Clay, Sand and Gravel and the Purlawaugh Formation (Ju) – Sandstones, mudstones, claystones and coal (refer **Figure 3**). There are also minor basalt intrusion (Tb) - Basalt, tholeiite, observed on site but not in large enough areas to be mapped on a regional scale. The parent material underlying the soils are weathered in-situ and colluvial material derived from the parent rock listed above.

A soil assessment undertaken within the Study Area by Minesoils (2021) include the physical and chemical characterisation of two dominant units; 1. Tenosols, and 2. Chromosol/Sodosol Complex, and a minor soil map unit 3. Dermosols (refer **Figure 8**).

Tenosols are soils with generally only weak pedologic organisation apart from the A horizons. This soil type is present in the steeper, wooded areas of the Study Area, as well as in the lower lying alluvial zones.

Chromosols are soils with strong texture contrast between A horizons and B horizons. Chromosols with a sodic B horizon are defined as Sodosols. A complex between these two soil types exists within the Study Area as discussed in **Section 3.2**



6.2.2 SLOPE

Slopes within the Study Area range from 5% to 40%. The landform patterns within the Study Area consists of crests and plateaus with areas of rock outcrops above steep rocky slopes on maximal upper slopes to waning mid and lower slopes with rolling hills and low undulating hills flattening to low undulating rises and flats with open depressions. The drainage systems on site are moderately spaced erosional to alluvial stream development with fixed to slowly migrating integrated, convergent tributary patterns.

6.2.3 LAND AND SOIL CAPABILITY

Land and soil capability (LSC) is a classification system to describe the capacity or resilience of land and soil to withstand the known impacts of various land uses. Regional LSC mapping indicated the Study Area is dominated by LSC Class 5 and Class 7. The higher intensity soil survey LSC assessment undertaken as part of this study indicated the presence of LSC Classes 4, 5, 6 and 7 (refer **Figure 9**) as detailed in **Section 4**.

This range of LSC Classes indicates areas of varying capability from moderately capable for a range of land uses (LSC Class 4) to unsuitable for agriculture (LSC Class 7). These LSC classes reflect limitations that will restrict much of the land to minimal agricultural use, with large areas most appropriate for native vegetation cover with some light grazing or modified pasture. The limitations need to be carefully managed to prevent long-term degradation.

The LSC of the Study Area is expected to remain the same prior to, during and following the mining activities of the Proposed Modification.

6.2.4 BIOPHYSICAL STRATEGIC AGRICULTURAL LAND

Biophysical Strategic Agricultural Land is land with a rare combination of natural resources highly suitable for agriculture. These lands intrinsically have the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality.

The application of the Strategic Agricultural Land (SAL) mapping is to 'trigger' the Gateway Process for new project development applications. The *State Environmental Planning Policy (Mining, Petroleum Production and Extraction) 2007* (Mining SEPP) requires certain types of developments (i.e. mining or petroleum developments) to verify whether the proposed development is on BSAL.

There is no regionally mapped BSAL, or Critical Industry Cluster (CIC) within the Study Area (refer to **Figure 1**). The nearest trigger mapped BSAL is located approximately 1km to the North of the Study Area, and is associated with the Talbragar River alluvial soils unit.

A BSAL verification site investigation was undertaken by Minesoils (Clayton Richards CPSS - Director & Principal Soil Scientist) from 2nd to 5th November 2020. A total of 10 sites were inspected. All sites were subjected to detailed test pits, which included analytical data, with field assessment to confirm soil type and BSAL status. The BSAL site verification assessment resulted in no part of the Study Area satisfying all the BSAL criteria. The Site Verification Certificate (SVC 19199244) was received for the Study Area on the 5th July 2021 and is attached in **Appendix 3**

6.2.5 HISTORY OF AGRICULTURAL ENTERPRISE

While the majority of the Study Area remains original forested bushland the agricultural land use of cleared land within the Study Area covers an area of 87.6 ha and has been consistently used for cattle grazing (refer **Figure 10**). Based on aerial photography, site observation, soil and agricultural suitability, and anecdotal evidence, it is determined that land has historically not been capable of sustaining agriculture more advanced than low intensity grazing. Currently, cleared lands within the Study Area are used for cattle grazing for beef production on rain-fed unimproved pastures. Uncleared lands are not used for agricultural purposes.



Plate 1: Example of cleared land used for low intensity grazing



Plate 2: Example of uncleared land not used for agricultural purposes



Plate 3: Agricultural improvements such as fences are present on land with marginal productivity



Plate 4: Example of wooded bushland containing rocky outcrops and sustaining no agricultural enterprise

6.2.6 AGRICULTURAL PRODUCTIVITY

The NSW Department of Primary Industries (2019) Gross Margin Budget for ‘Inland Weaners’ provides an estimate of productivity of the grazing land within the Study Area. Estimated productivity is \$12,214.18 per annum, as summarised in **Table 9**.

Table 9: Estimated Productivity of Grazing Land within the Study Area

Enterprise	Estimated Gross Margin (\$/ha/year)	Grazing Land (ha)	Study Area Gross Margin (\$/year)
Inland Weaners	129.80	94.1	12,214.18

6.2.7 LAND TO BE TEMPORARILY REMOVED FROM AGRICULTURE

The surface infrastructure disturbance of the Proposed Modification will cover an area of 27.4ha. Of this area, 25.0 ha exists as marginal land not currently used for agriculture. The remaining 2.4 ha will occur on currently cleared grazing land and as a result will be made unsuitable for agriculture as a result of mining activities

6.2.8 LAND TO BE RETURNED TO AGRICULTURE POST MINING

The 2.4 ha removed from agriculture by the Proposed Modification will be returned to agriculture post mining.

6.2.9 LAND THAT WILL NOT BE RETURNED TO AGRICULTURE

There is no identified land within the Study Area that is currently in service for agriculture that will not be returning to an equivalent level of service following mining activities.

6.2.10 BUFFER ZONES AND OFFSET LANDS

There are no established buffer zones for the Study Area. Offset areas may be required for the Proposed Modification subject to confirmation of the Biodiversity Offset Strategy. It is not anticipated that any offset areas utilised for the Proposed Modification will have current agricultural land uses.



6.3 AGRICULTURAL RESOURCES AND ENTERPRISES IN PROJECT LOCALITY

6.3.1 CLIMATE CONDITIONS

The project locality has a warm, temperate climate with warm summers and cool to cold winters. The hottest month is January, with an average maximum of 31.1°C, while the coldest month is July, with an average minimum of 1.1°C. The average annual rainfall is 650.2mm, with higher average rainfall in Summer and Spring. The wettest month is December, with 77.6mm of rain on average (Bureau of Meteorology (BOM) station No. 062101, Mudgee Airport AWS, 2020).

6.3.2 TOPOGRAPHY AND WATER RESOURCES

The project locality straddles the Great Dividing Range and is located at the headwaters of the Goulburn River System (which drains to the East to the Hunter River Catchment) and the Talbragar River system (which drains west to the Macquarie River catchment). The project locality consists of eight sub-catchment areas, including Spring Gully, Ulan Creek, Bobadeen Creek, Curra Creek, Sportsmans Hollow Creek and Moolarben Creek catchments which flow into the Goulburn River system; and the Mona Creek and Cockbutta Creek catchments which flow into the Talbragar River system. All of these creeks are ephemeral (i.e. flow intermittently).

The topography of the locality is a combination of undulating valley floors to steeper slopes and rocky escarpments. The landforms of the locality can be characterized into three broad groups: broad valleys, transitional rocky uplands, and areas of elevation. The broad valleys have almost entirely been cleared for agricultural activity.

6.3.3 AGRICULTURAL SUPPORT INFRASTRUCTURE

The Mid-Western Regional LGA has a well-developed road network that connects the agricultural industry to markets, services and suppliers. Road services range from local unsealed and sealed roads, connecting to the Castlereagh Highway and the Golden Highway.

In addition, nearby agricultural service centres Gulgong (20km) and Mudgee (45km) allow access to businesses providing agricultural equipment and supplies, including animal fencing, animal vaccinations, livestock ID, stock supplements, seed, fertiliser and crop protection.

The closest regional livestock saleyards are located at the undercover Mudgee Saleyards and have been operating from their current site on Abattoirs Road since 2003.

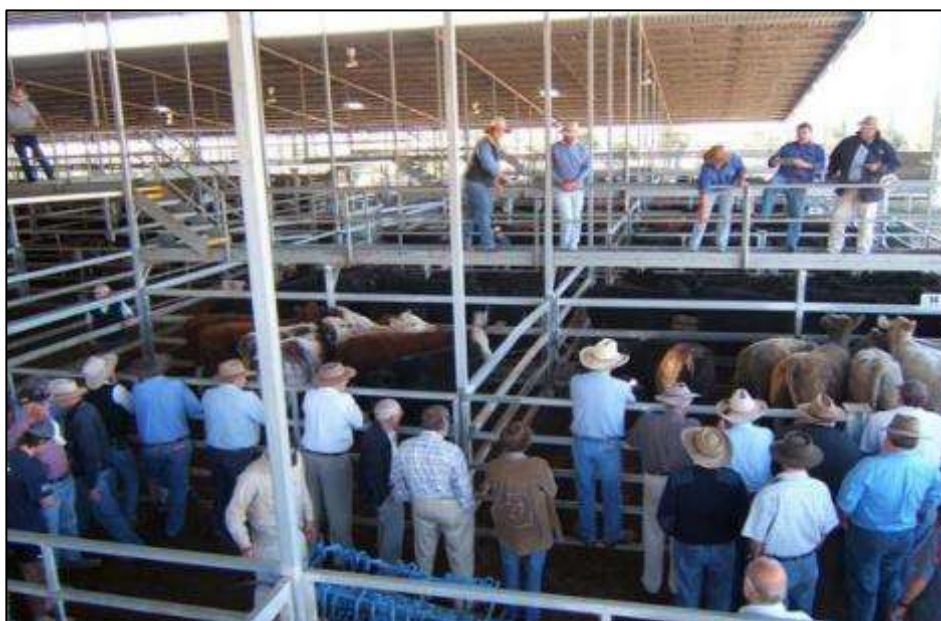


Plate 5: Cattle being sold at the Mudgee saleyards (Mid-Western Regional Council, 2021)

6.3.4 AGRICULTURE IN THE REGION

Agriculture is an important industry in the region. It is a large employer and produces a significant share of Mid-Western's total output. Agriculture, forestry and fishing is the fourth largest employer by industry in the Mid-Western Regional LGA, behind mining, retail and health care and social assistance (refer **Table 10**). Estimated output by industry is a gross measure of the total sales of each industry sector in Mid-Western Regional LGA. Table 11 highlights mining as the dominant industry for output in the region (primarily coal mining), with agriculture performing contributing 5.8% of the total output (Remplan, 2021, ABS 2016 Census Place of Work Employment (Scaled), ABS 2017 / 2018 National Input Output Tables, and ABS June 2020 Gross State Product).

Table 10: Employment by Industry for Mid-Western Regional LGA 2019 - 2020

Industry	Employed	%
Mining	1,831	18
Retail Trade	1,069	11
Health Care & Social Assistance	991	10
Agriculture, Forestry & Fishing	909	9
Construction	830	8
Accommodation & Food Services	815	8
Education & Training	764	8
Other Services	497	5
Public Administration & Safety	422	4
Manufacturing	400	4
Professional, Scientific & Technical Services	337	3
Administrative & Support Services	282	3
Transport, Postal & Warehousing	240	2
Wholesale Trade	187	2
Arts & Recreation Services	115	1
Rental, Hiring & Real Estate Services	111	1
Electricity, Gas, Water & Waste Services	107	1
Financial & Insurance Services	106	1
Information Media & Telecommunications	82	1
Total	10,095	100

Source: REMPLAN 2021, based on ABS 2016 Census Place of Work Employment (Scaled), ABS 2017 / 2018 National Input Output Tables, and ABS June 2021 Gross State Product.



Table 11: Estimated Output by Industry for Mid-Western Regional LGA 2019 - 2020

Industry	\$ Million	%
Mining	2,437.092	48.81
Retail Trade	416.659	8.34
Health Care & Social Assistance	314.686	6.30
Agriculture, Forestry & Fishing	288.198	5.77
Construction	262.973	5.27
Accommodation & Food Services	138.807	2.78
Education & Training	134.900	2.70
Other Services	132.006	2.64
Public Administration & Safety	111.025	2.22
Manufacturing	106.453	2.13
Professional, Scientific & Technical Services	100.344	2.01
Administrative & Support Services	88.217	1.77
Transport, Postal & Warehousing	82.500	1.65
Wholesale Trade	81.944	1.64
Arts & Recreation Services	79.935	1.60
Rental, Hiring & Real Estate Services	68.498	1.37
Electricity, Gas, Water & Waste Services	67.922	1.36
Financial & Insurance Services	61.017	1.22
Information Media & Telecommunications	20.321	0.41
Total	4,993.498	100.00

The 2015-16 Agricultural Census, run by the Australian Bureau of Statistics, calculated the total value of agricultural commodity values in Mid-Western Regional LGA was \$99m. The largest commodity produced was livestock slaughtering's, which accounted for 60 per cent of the Mid-Western Regional LGA's total agricultural output in value terms. Wool (15 per cent) and crops for cereal or hay (13 per cent and 10 per cent respectively) were also significant contributors, as shown in **Table 12**.



Table 12: Agricultural Commodity Value for Mid-Western Regional LGA 2020 - 2021

Commodity	Value (\$)	%
Livestock slaughtered	58,836,839	59.6
Wool	14,475,070	14.7
Broadacre crops	13,118,731	13.3
Hay	10,651,134	10.8
Fruit and nuts	1,233,056	1.2
Eggs	298,746	0.3
Vegetables	87,897	0.1
Milk	42,351	<0.1
Nurseries, cut flowers or cultivated turf	3,227	<0.1
Agriculture Total Value	98,747,051	100.0

Further analysis highlights that cattle and calves are the dominant regional enterprise, representing 66 per cent of the value of all livestock slaughtering's (refer **Table 13**) and 39 per cent of total agriculture commodity value. Sheep and lambs are also shown to be a significant enterprise, representing 34 per cent of the value of all livestock slaughtering's (Australian Bureau of Statistics, 2022).

Table 13: Agricultural Commodity Value for Livestock Slaughtering by Type for Mid-Western Regional LGA 2020 - 2021

Commodity	Value (\$)	%
Cattle and calves	38,721,373	65.8
Sheep and lambs	19,967,087	33.9
Poultry	86,870	0.1
Other	45,200	0.1
Pigs	16,310	0.0
Total Value	58,836,839	100.0



6.3.5 AGRICULTURAL ENTERPRISES OF LOCALITY

Large areas within the surrounding locality are owned by various mining companies and used for mining activities. Consistent with the agricultural enterprises of the wider region, the prevailing agricultural land use is cattle grazing. This is undertaken predominantly on areas cleared of vegetation as a result of historic agricultural use. However, the Project Locality also contains cropping enterprises. The Talbragar River alluvial floodplains located to the north of the Study Area are used for intensive cropping (refer **Plate 6**), and sporadic pockets of broad valleys to the south east sections of the Study Area but within the existing project approval boundary are subject to a pivoted irrigation (circular) cropping systems (refer **Plate 7** and **Figure 1**).



Plate 6: Evidence of cropping activity on Talbragar floodplain, 2km northeast of Study Area (2019).



Plate 7: Pivot irrigation cropping within approved project boundary <2 km southeast of the Study Area (2019).

General agricultural improvements (e.g. stock fences, livestock dams and existing access tracks) are in place throughout the cleared areas of the Project Locality, which reflects the historical and current development of the local lands for cropping and livestock grazing.

6.4 ASSESSMENT OF IMPACTS

6.4.1 AGRICULTURAL RESOURCES AND INDUSTRIES

Potential risks to agricultural production associated with the Proposed Modification could include:

- decreased productivity of agricultural land;
- changes to potential agricultural land uses;
- groundwater drawdown potential;
- contamination of water and land resources;
- dust generation;
- land compaction;
- noise generation;
- spread of weeds; and
- limited success of rehabilitation.

An assessment of the above potential risks to agriculture has been conducted in accordance with the Agricultural Impact Risk Ranking methodology described in the *Guideline for Agricultural Impact Statements*. **Table 14** and **Table 15** list the probability and consequence descriptors that were used in the Agricultural Impact Risk Ranking, as described by DTIRIS (2012a).

The level of risk was assessed according to the risk matrix presented in **Table 16** (DTIRIS, 2012a). The outcomes of the risk assessment are presented in **Table 17**.

Table 2: Agricultural Impact Risk Ranking – Probability Descriptors

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



Table 3: Agricultural Impact Risk Ranking – Consequence Descriptors

Level 1	Severe Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Severe and/or permanent damage to agricultural resources, or industries Irreversible Severe impact on the community 	<ul style="list-style-type: none"> Long-term (e.g. 20 years) damage to soil or water resources Long-term impacts (e.g. 20 years) on a cluster of agricultural industries or important agricultural lands
Level 2	Major Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Significant and/or long-term impact to agricultural resources, or industries Long-term management implications Serious detrimental impact on the community 	<ul style="list-style-type: none"> Water or soil impacted, possibly in the long-term (e.g. 20 years) Long-term (e.g. 20 years) displacement/serious impacts on agricultural industries
Level 3	Moderate Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Moderate and/or medium-term impact to agricultural resources, or industries Some ongoing management implications Minor damage or impacts but over the long-term 	<ul style="list-style-type: none"> Water or soil known to be affected, probably in the short to medium-term (e.g. 1-5 years) Management could include significant change of management needed for agricultural enterprises to continue
Level 4	Minor Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Minor damage and/or short-term impact to agricultural resources, or industries Can be effectively managed as part of normal operations 	<ul style="list-style-type: none"> Theoretically could affect the agricultural resource or industry in the short-term, but no impacts demonstrated Minor erosion, compaction or water quality impacts that can be mitigated For example, dust and noise impacts in a 12 month period on extensive grazing enterprises
Level 5	Negligible Consequences	Example of Implications
Description	<ul style="list-style-type: none"> Very minor damage or impact to agricultural resources, or industries Can be effectively managed as part of normal operation 	<ul style="list-style-type: none"> No measurable or identifiable impact on the agricultural resource or industry

Source: DTIRIS (2012a)



Table 16: Agricultural Risk Ranking – Matrix

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

Source: DTIRIS (2012a)

	High Risk
	Medium Risk
	Low Risk



Table 4: Agricultural Risk Ranking – Matrix

Risk	Control Measures	Risk Assessment		
		C	P	R
Decreased productivity of agricultural land	Monitoring of active operations and resulting subsidence and Trigger Action Response Plans in place	5	C	Low
	The Program activities are not located on or near strategic agricultural land.			
	Rehabilitation of subsidence impacted areas to a condition consistent with pre-disturbance land uses.			
	Water make up agreements and management plan triggered if impacts experienced			
Changes to potential agricultural land uses	Rehabilitation of subsidence impacted areas to a condition consistent with pre-disturbance land uses.	4	C	Low
	The soil and land characteristics will remain largely unchanged following subsidence.			
Groundwater drawdown potential	Water required for the Program will be sourced directly from the existing licensed water supply sources at the UCC.	5	E	Low
	Water make up agreements and management plan triggered if impacts experienced			
Contamination of water and land resources	Erosion and sediment control with micro rehabilitation of subsidence impacted areas to a pre mining condition and surface water runoff direction/ catchment flow consistent with pre-disturbance landform.	4	D	Low
	Environmental monitoring program already exists at UCC including Trigger Action Response Plans (TARPs).			
	Modelling of impacts consistent with those previously experienced on site.			
Dust generation	Enforcement of speed limits on all access tracks to reduce the dust generated.	5	C	Low
	Rehabilitation of disturbed areas to a condition consistent with pre-disturbance land uses.			
	Environmental Monitoring for air quality currently in place at UCC.			
Land compaction	Use of existing access tracks where possible and using shortest possible route to minimise environmental impacts for any new access tracks, if required.	4	D	Low
	Not expected to occur as modelling indicates consistent impacts as previously experienced on site at UCC.			
Noise generation	UCMPL will regularly consult with landholders and leasees throughout the Program.	4	C	Low
	Environmental Monitoring for noise currently in place at UCC.			
Spread of weeds	Use of existing access tracks where practicable.	4	C	Low
	Before being used on-site, all machinery will be inspected and cleaned where required to minimise the spread of weeds.			
Limited success of rehabilitation	Monitoring and prioritized response times for subsidence rehabilitation where surface water is expected to be impacted.	4	D	Low
	Monitoring and prioritized response times for subsidence rehabilitation where agricultural infrastructure such as fencing or roadways is impacted.			

As described above, it is anticipated that the Proposed Modification will have a low risk of impact to agricultural resources. Furthermore, the Proposed Modification is not anticipated to have any impact to the existing agricultural enterprises conducted within the Study Area or surrounding locality, including cropping enterprises as outlined in



Section 6.3.1. As such, it follows that impacts to agricultural industries in the locality and region would also be insignificant.

6.4.2 PRODUCTIVITY

Using the NSW Department of Primary Industries (2019) Gross Margin Budget for 'Inland Weaners' to estimate productivity, as per Section 6.2.6, lost agriculture value due to the removal of 2.4 ha of grazing land can be determined. Estimated lost productivity is \$311.52 per annum, as summarised in **Table 18**.

Table 18: Estimated Productivity of Grazing Land within the Study Area

Enterprise	Estimated Gross Margin (\$/ha/year)	Grazing Land (ha)	Study Area Gross Margin (\$/year)
Inland Weaners	129.80	2.4	311.52

Compared to the cost benefits of the Proposed Modification, this lost value is considered negligible.

6.4.3 AGRICULTURAL WATER RESOURCES

The Proposed Modification has been designed to minimise potential impacts to surface and groundwater sources by sourcing water required directly from existing licenced water supply sources at the UCC. In addition, the implementation of erosion and sediment control strategies, and targeted micro rehabilitation efforts, will minimise potential for increased surface water run-off or water diversion as a results of subsidence impacts. Catchment water capacities are expected to be consistent with the pre-mining landform.

Based on the above, the Proposed Modification will have no impact upon surface water or groundwater that currently contributes to agricultural enterprises within the Study Area or in the project locality.

6.4.4 SOCIO-ECONOMIC

Adverse socio-economic impacts associated with the Proposed Modification are anticipated to be negligible.

As there will be negligible impact to agriculture activity, impacts to supporting services, processing and value adding industries relevant to agricultural enterprises will be negligible. This means there will be no impact to critical mass thresholds of agricultural enterprises needed to attract and maintain investment in agricultural service industries and infrastructure

No other industries separate to agriculture and its support industries, such as tourism, have been identified as being at risk to be impacted by the Proposed Modification. As such, local and regional employment will not be affected.

Further potential agricultural related socio-economic impacts that have been limited by the nature and design of the Proposed Modification include negligible change in visual amenity and landscape value and no increase in traffic on local roads.

6.4.5 VISUAL AMENITY AND LANDSCAPE VALUES

The project will utilise existing facilities on site with the addition of three vent shafts and five dewatering bores. Existing access tracks will be used where possible, however additional tracks will be required to access the new surface infrastructure. The project is located within a landscape context of dense tree cover on ridges and slopes with high visual absorption capacity. Site inspection of the area did not identify agricultural enterprises reliant on visual amenity of the Study Area. On this basis the project is considered to have negligible impact on visual amenity and landscape values relied upon by local and regional agricultural enterprises.

6.4.6 TOURISM

The majority of the Mudgee wine/tourism industry is located within 10 to 15km of the city of Mudgee, which is approximately 40km from the Study Area and other existing Coal Mines of the Ulan area both underground and



open cut. The low impact of the project on surface characteristics is considered negligible impact on tourism in the area.

6.4.7 WEED MANAGEMENT AND PEST SPECIES

There is low risk from weed infestation during the construction and operational phases of the Project through vehicle movements on and off site. Weeds are currently managed within the frameworks of the UCMPL Environmental Management System, which includes issue-specific environmental management plans and monitoring programs. Continued inspection for weed germination will be conducted during the construction phase of the Project. Weeds are also actively managed as part of the grazing enterprises undertaken within and around the Study Area, given the continual monitoring and management required for farming enterprises.

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

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

Given the processes above, it is considered the Project is highly unlikely to represent an increased risk to the biosecurity of agricultural resources and enterprises within the region.

6.4.8 AIR QUALITY

There is potential for the Proposed Modification to generate dust primarily as a result of construction activities, mine ventilation and site rehabilitation. Minor disturbance of groundcover during the construction phase of the surface infrastructure and site commissioning, along with mobilisation of equipment to and between sites, has the potential to generate dust, with impacts dependent on road and weather conditions. Diesel emissions were also identified as a potential secondary air quality issue.

Modelling against EPA assessment criteria for PM_{2.5}, PM₁₀, TSP, deposited dust and NO₂ was undertaken at sensitive receptors as part of the Air Quality Impact Assessment for the Proposed Modification (Jacobs Group (Australia) Pty Limited, 2022). The assessment indicated that the Proposed Modification is unlikely to affect air quality beyond the range of historically measured fluctuations of key air quality indicators.

On this basis, it is concluded the Proposed Modification is unlikely to impact on air quality for agricultural resources and enterprises.

6.4.9 NOISE

Generally, agriculture is only impacted by noise when constantly high noise levels or sudden loud noise leads to a decrease in animal production through increased livestock stress.

Noise generated during construction and operation of the ancillary infrastructure associated with the Proposed Modification is predicted to be within relevant criteria at all receiver locations, with the exception of construction noise due to work that may be required outside of recommended standard work hours (Umwelt (Australia) Pty Limited, 2022).

With the implementation of management and mitigation measures (particularly for construction work outside of recommended standard work hours) it is considered that predicted noise levels for the Proposed Modification will have negligible impact on agricultural production within the area.

6.4.10 TRAFFIC

Agricultural enterprises can be impacted by increased traffic movements through an increase in noise and dust, and also through the cumulative impact of road transport being utilised by mining operations, leaving fewer transport options for agricultural enterprises.

There will be no change to traffic movements associated with the Proposed Modification. The transportation of coal extracted from the Study Area will be via the existing rail network and will therefore not result in increased road traffic.

On this basis the impact to agricultural resources and enterprises as a result of increased traffic movements associated with the Project is considered negligible.

6.4.11 UNCERTAINTY

There is a high level of certainty about the quality of agricultural resources in the Study Area, based on the detailed on-the-ground assessments and regional and local research carried out. There is a high level of certainty regarding the agricultural productivity in the Project Locality and the broader region. This impact assessment has been completed using good information regarding the agricultural use of the land and the limited anticipated impacts of the Proposed Modification. Therefore, there is low uncertainty regarding the predicted impacts of the Project on the agriculture in the locality and broader region, including indirect impacts.

6.5 MITIGATION MEASURES

The Proposed Modification includes a number of measures to prevent, minimise and manage adverse impacts on agricultural. This incorporates procedural mitigation measures along with a land management process that ensures the mining activity have negligible impact on agricultural resources and enterprise.

In addition to the specific measures described in this AIS and the SEE, all activities associated with the Program will be conducted in consideration of UCMPL's obligations and environmental management measures in the existing UCC environmental management plans.

6.5.1 PROJECT ALTERNATIVES

There are no practical cost-effective alternatives to the Proposed Modification given the nature of the longwall extensions and intended continuance of current extraction methodologies.

The proposed subsidence mitigation and rehabilitation measures are considered best practice and consistent with relevant policies and standards.

6.5.2 MONITORING PROGRAMS TO ASSESS IMPACTS

Monitoring programs are instituted to assess predicted verses actual impacts as the project progresses.

All current operations at the UCC are undertaken in accordance with approved Environmental Management Plans and Strategies. The management plans include detailed environmental monitoring programs. UCC continually monitors environmental performance and legislative compliance of the existing operations.

Mining operations are managed through the existing Environmental Management System (EMS) to minimise impacts on the surrounding environment and community. The EMS provides for the monitoring and reporting of all key environmental aspects of the current operations.

Key management plans currently in effect that assist in managing impacts on agricultural land include:

- Subsidence Management Plan;
- Erosion and Sediment Control Plan;
- Flora and Fauna Management Plan;
- Land Management Plan;



- Noise Management Plan;
- Air Quality Management Plan;
- Waste Management Plan;
- Water Management Plan; and
- Rehabilitation Management Plan.

These management plans will be reviewed and revised where necessary to incorporate the requirements associated with the Proposed Modification prior to commencement. A key component of this revision will be the development of trigger levels and Trigger Response Action Plans, in consultation with stakeholders. The environmental monitoring program and data collected listed in Table 18 below will form the basis in this regard.

In addition, an Annual Review will be prepared for the Project. This document will summarise Project activities and performance in the areas of health, safety, environment and community and will be made publicly available. All management plans and monitoring data will also be made publicly available on the UCC website.

Table 19: Proposed Monitoring Programs and Management Plans

Parameter	Management Plan	Monitoring	Frequency
Subsidence	Subsidence Management Plan Rehabilitation Management Plan Land Management Plan	<ul style="list-style-type: none"> - Visual assessment of subsidence - Geotechnical stability - Visual assessment of pasture performance - Ground cover (%) - Surface water and groundwater monitoring 	Quarterly
Meteorological Conditions	Air Quality Management Plan	<ul style="list-style-type: none"> - Rainfall - Temperature - Windspeed - Wind direction - Sigma Theta - Solar radiation 	Daily
Surface Water	Water Management Plan	<ul style="list-style-type: none"> - Run-off water quality - Sediment dam water quality - Surface water flows 	Monthly
Groundwater	Water Management Plan	<ul style="list-style-type: none"> - Seepage/leachate - Groundwater levels - Water quality 	Monthly
Air Quality	Air Quality Management Plan	<ul style="list-style-type: none"> - Predictive meteorological forecasting - PM10 and PM2.5 monitoring - Dust deposition - Total Suspected Particulate (TSP) - Regional reference site monitoring 	Monthly
Blasting	Blast Management Plan	<ul style="list-style-type: none"> - Air blast overpressure (dB(Linear Peak)) 	As required
Noise	Noise Management Plan	<ul style="list-style-type: none"> - Predictive meteorological forecasting - Real-time noise monitoring for day to day planning - (Supplementary attended monitoring) 	Daily (Quarterly)
Traffic	Traffic Management Plan	<ul style="list-style-type: none"> - Traffic volume surveys - Review records of date, time and material transported from site 	Annually
Waste	Waste Management Plan	<ul style="list-style-type: none"> - Quantities of waste - Waste streams 	Biannually



6.5.3 REHABILITATION

During operations, rehabilitation will consist of small scale, targeted efforts in areas of subsidence. Following operations, rehabilitation will focus on areas disturbed for surface infrastructure. Rehabilitation of these areas will be to a condition consistent with pre-disturbance land use.

UCC has a demonstrated capacity for the rehabilitation of disturbed lands where impacts have been significant compared to those of the Proposed Modification. I

UCMPL rehabilitation relinquishment was successfully completed and approved in 2020. 50.4ha of rehabilitation located adjacent to the East Pit was submitted to the Resource Regulator. It has successfully become a representative native woodland community, with the Resource Regulator signing off on the area on the 5th March 2020. The rehabilitated area was progressively completed during the mid-1980's through to 1997. Surveys have identified 55 flora species, 45 of which are from the surrounding area and 130 fauna species, including 12 threatened species.

This is an indication that rehabilitated areas can meet criteria for a self-sustaining landform which includes flora, fauna richness and land stability

6.6 CONSULTATION

Consultation in relation to the Project was undertaken using a range of mechanisms which included meetings, presentations, information sessions, newsletters, face to face interviews, phone discussions and other forms of personal communication (e.g. emails). Identification of relevant stakeholders for the Project was based on regulatory requirements for the Project, and in particular the DGRs relating to consultation. The DGRs required consultation with the following stakeholders:

- Office of Environment and Heritage;
- NSW Office of Water;
- DTIRIS – Mineral Resources and Energy;
- Department of Primary Industries;
- Roads and Maritime Services;
- Mid-Western Shire Council; and
- Relevant Aboriginal Groups.

Direct consultation to inform the AIS was undertaken with land operators regarding current management of land and agricultural practices on the Study Area and its surrounds.

Relevant findings from the stakeholder consultation undertaken for the Project were considered in the preparation of this AIS and are discussed further in the EIS.

As part of the ongoing operation of UCC, a community and external relations procedure has been developed to help manage all community and stakeholder consultation activities. All stakeholder engagement activities as part of the program have been undertaken in accordance with the existing procedure.



7 CONCLUSION

The landform within the proposed subsidence area is dominated by crests and plateaus with areas of rock outcrops above steep rocky slopes on maximal upper slopes to waning mid and lower slopes with rolling hills and low undulating hills flattening to low undulating rises and flats with open depressions. The drainage systems on site are moderately spaced erosional to alluvial stream development with fixed to slowly migrating integrated, convergent tributary patterns. Mona Creek drains from east to west across the site then flows north into the Talbragar River. There are three dominant soil map units consisting of: 1. Sodosol/Chromosol Complex, 2. Light Textured Tenosols and 3. Dermosols. The LSC for the area ranges from Class 4 through to Class 7 and is generally limited to being suitable for grazing or bushland. There is no high-quality cropping land or Biophysical Strategic Agricultural Land within the Study Area.

There is negligible risk of LSC classes being impacted long term with subsidence predictions being within the parameters of those previously experienced at Ulan Coal Complex. There are minor impacts predicted for dams, drainage lines and tracks as active mining progresses, however these impacts are predicted to be easily repairable and similar to previous maintenance level repairs undertaken at Ulan Coal Complex as a result of subsidence.

Given the limited surface impacts on the agricultural resources of the Study Area, and the low level of agricultural productivity of the Study Area, the agricultural impacts of the Proposed Modification are expected to be negligible.



8 REFERENCES

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Appendix 1

Laboratory Results



GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

46 soil samples supplied by Minesoils Pty Ltd on 23 November, 2020 - Lab Job No. K0894.

Analysis requested by Clayton Richards. Your project: MS-033 EIS.

PO Box 11034 TAMWORTH NSW 2340

SAMPLE ID	Lab Code	EMMERSON AGGREGATE CLASS	MOISTURE CONTENT (% of water in air- dry sample)	TOTAL GRAVEL > 2 mm (% of total oven- dry equivalent)	GRAVEL > 4.75 mm (% of total oven-dry equivalent)	GRAVEL 2.00-4.75 mm (% of total oven- dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven- dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven- dry equivalent)	SILT 2-20 µm ISSS (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)	Total soil fractions (incl. Gravel)
E1 0-10	K0894/1	..	23.3%	3.0%	0.0%	3.0%	31.3%	30.1%	20.5%	15.0%	100.0%
E1 20-30	K0894/2	..	15.6%	12.3%	0.0%	12.3%	34.1%	27.0%	15.5%	11.1%	100.0%
E1 40-50	K0894/3	2	12.7%	1.3%	0.0%	1.3%	33.9%	15.9%	16.1%	32.8%	100.0%
E1 65-75	K0894/4	2	14.5%	0.9%	0.0%	0.9%	9.5%	31.1%	14.4%	44.1%	100.0%
E2 0-10	K0894/5	..	14.1%	1.7%	0.0%	1.7%	71.8%	20.5%	0.2%	5.7%	100.0%
E2 20-30	K0894/6	..	8.0%	4.1%	0.0%	4.1%	68.3%	19.9%	5.4%	2.4%	100.0%
E2 40-50	K0894/7	2	7.6%	6.5%	0.0%	6.5%	58.7%	20.2%	8.7%	5.8%	100.0%
E2 65-75	K0894/8	2	8.6%	8.6%	0.0%	8.6%	44.6%	23.0%	6.1%	17.8%	100.0%
E3 0-10	K0894/9	..	27.3%	2.4%	0.0%	2.4%	14.3%	31.6%	23.2%	28.5%	100.0%
E3 20-30	K0894/10	2	16.7%	20.8%	0.0%	20.8%	10.1%	28.2%	24.0%	17.0%	100.0%
E3 40-50	K0894/11	2	16.7%	1.4%	0.0%	1.4%	11.5%	28.0%	25.9%	33.2%	100.0%
E3 65-75	K0894/12	2	14.5%	0.2%	0.0%	0.2%	30.8%	33.6%	6.3%	29.1%	100.0%
E4 0-10	K0894/13	..	8.4%	0.4%	0.0%	0.4%	60.9%	27.9%	6.9%	4.0%	100.0%
E4 20-30	K0894/14	..	9.4%	1.1%	0.0%	1.1%	58.4%	29.5%	6.8%	4.2%	100.0%
E4 40-50	K0894/15	..	10.3%	6.4%	0.9%	5.5%	55.5%	27.8%	4.8%	5.4%	100.0%
E4 65-75	K0894/16	..	9.8%	19.2%	7.6%	11.5%	45.5%	25.6%	5.3%	4.4%	100.0%
E4 85-95	K0894/17	2	11.0%	3.5%	1.7%	1.8%	40.8%	28.8%	9.5%	17.4%	100.0%
E5 0-10	K0894/18	..	12.3%	6.9%	0.0%	6.9%	34.7%	15.4%	10.9%	32.1%	100.0%
E5 20-30	K0894/19	2	19.4%	2.6%	0.0%	2.6%	27.9%	14.8%	4.9%	49.8%	100.0%
E6 0-10	K0894/20	..	10.1%	2.0%	0.0%	2.0%	54.0%	33.4%	6.9%	3.7%	100.0%
E6 25-35	K0894/21	..	11.3%	1.6%	0.0%	1.6%	60.1%	27.6%	7.7%	3.1%	100.0%
E6 60-70	K0894/22	2	12.7%	4.1%	0.0%	4.1%	41.6%	25.2%	12.1%	17.0%	100.0%
E7 0-10	K0894/23	..	22.2%	2.1%	0.0%	2.1%	25.9%	34.5%	18.9%	18.6%	100.0%
E7 20-30	K0894/24	3	11.0%	28.8%	19.7%	9.0%	22.1%	31.5%	6.7%	11.0%	100.0%
E8 0-10	K0894/25	..	14.2%	1.5%	0.0%	1.5%	59.8%	26.3%	7.9%	4.5%	100.0%
E8 20-30	K0894/26	..	10.2%	4.1%	0.0%	4.1%	58.5%	23.8%	8.9%	4.8%	100.0%
E8 40-50	K0894/27	..	6.6%	6.1%	0.7%	5.4%	54.9%	26.4%	7.9%	4.7%	100.0%
E8 65-75	K0894/28	2	17.5%	18.0%	8.1%	9.9%	41.2%	15.0%	3.8%	22.0%	100.0%
E9 0-10	K0894/29	..	18.4%	21.3%	13.7%	7.7%	23.7%	28.4%	14.5%	12.0%	100.0%
E9 20-30	K0894/30	..	16.9%	1.0%	0.0%	1.0%	10.0%	24.8%	11.0%	53.1%	100.0%
E9 40-50	K0894/31	2	17.5%	0.4%	0.0%	0.4%	9.2%	18.8%	8.3%	63.4%	100.0%
E9 65-75	K0894/32	2	13.7%	0.2%	0.0%	0.2%	7.1%	23.0%	18.7%	51.0%	100.0%
E10 0-10	K0894/33	..	23.6%	26.7%	8.7%	18.0%	19.6%	31.9%	10.5%	11.3%	100.0%
E10 20-30	K0894/34	2	15.5%	1.8%	0.0%	1.8%	4.3%	33.3%	16.3%	44.2%	100.0%
E11 0-10	K0894/35	..	13.4%	11.1%	0.0%	11.1%	38.1%	31.3%	9.8%	9.7%	100.0%
E11 20-30	K0894/36	3	10.1%	67.8%	38.6%	29.2%	10.1%	12.9%	4.1%	5.1%	100.0%
E11 40-50	K0894/37	2	18.9%	1.0%	0.0%	1.0%	9.7%	18.5%	6.9%	63.8%	100.0%
E11 65-75	K0894/38	2	15.2%	5.4%	0.0%	5.4%	9.9%	18.4%	7.6%	58.7%	100.0%
E12 0-10	K0894/39	..	12.7%	12.3%	0.0%	12.3%	75.5%	8.2%	1.3%	2.6%	100.0%
E12 20-30	K0894/40	..	11.8%	8.3%	0.0%	8.3%	76.0%	10.5%	2.0%	3.2%	100.0%
E12 40-50	K0894/41	..	11.2%	6.3%	0.0%	6.3%	76.1%	11.4%	3.4%	2.8%	100.0%
E12 65-75	K0894/42	2	10.2%	8.6%	0.0%	8.6%	54.8%	17.0%	2.5%	17.1%	100.0%
E13 0-10	K0894/43	..	5.0%	13.9%	0.0%	13.9%	67.8%	9.7%	1.6%	7.0%	100.0%
E13 20-30	K0894/44	..	7.8%	7.2%	0.0%	7.2%	64.9%	13.2%	4.3%	10.4%	100.0%
E13 40-50	K0894/45	..	7.7%	8.8%	2.6%	6.2%	68.8%	13.5%	2.5%	6.3%	100.0%
E13 65-75	K0894/46	3	8.5%	12.1%	0.0%	12.1%	59.6%	13.4%	4.3%	10.6%	100.0%

Note:

- 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.
- Australian Standard 1289.3.8.1-1997 (see attached)
- '..' denotes not analysed
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full. Results only relate to the item tested.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).
- This report was issued on 07/12/2020.

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

33 soil samples supplied by Minesoils Pty Ltd on 23 November, 2020 - Lab Job No. K0895

Analysis requested by Clayton Richards. Your project: MS-033 BSAL.

PO Box 11034 TAMWORTH NSW 2340

SAMPLE ID	Lab Code	EMMERSON AGGREGATE CLASS	MOISTURE CONTENT (% of water in air- dry sample)	TOTAL GRAVEL > 2 mm (% of total oven- dry equivalent)	GRAVEL > 4.75 mm (% of total oven-dry equivalent)	GRAVEL 2.00-4.75 mm (% of total oven- dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven- dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven-dry equivalent)	SILT 2-20 µm ISSS (% of total oven- dry equivalent)	CLAY < 2 µm (% of total oven- dry equivalent)	Total soil fractions (incl. Gravel)
B1 0-10	K0895/1	..	26.2%	2.1%	0.0%	2.1%	73.4%	15.6%	1.8%	7.1%	100.0%
B1 20-30	K0895/2	..	8.6%	4.6%	0.0%	4.6%	67.1%	21.6%	5.4%	1.3%	100.0%
B1 40-50	K0895/3	..	8.0%	3.8%	0.0%	3.8%	58.4%	25.0%	6.3%	6.6%	100.0%
B1 65-75	K0895/4	2	13.8%	4.3%	0.0%	4.3%	42.1%	17.9%	8.4%	27.3%	100.0%
B2 0-10	K0895/5	..	7.7%	3.3%	0.0%	3.3%	55.3%	26.2%	3.7%	11.5%	100.0%
B2 20-30	K0895/6	..	8.7%	8.5%	4.6%	3.9%	50.9%	25.6%	3.2%	11.8%	100.0%
B3 0-10	K0895/7	..	8.7%	2.5%	0.0%	2.5%	60.3%	21.5%	6.6%	9.0%	100.0%
B3 20-30	K0895/8	..	6.1%	4.2%	0.0%	4.2%	61.9%	20.9%	4.7%	8.4%	100.0%
B3 40-50	K0895/9	..	6.4%	3.6%	0.0%	3.6%	63.7%	20.6%	4.0%	8.1%	100.0%
B4 0-10	K0895/10	..	13.8%	1.2%	0.0%	1.2%	42.7%	37.3%	10.1%	8.7%	100.0%
B4 20-30	K0895/11	..	12.4%	5.5%	0.0%	5.5%	33.1%	38.9%	10.6%	11.9%	100.0%
B4 40-50	K0895/12	..	13.4%	2.1%	0.0%	2.1%	23.2%	30.1%	6.0%	38.7%	100.0%
B4 65-75	K0895/13	2	15.3%	0.4%	0.0%	0.4%	28.5%	32.5%	5.5%	33.1%	100.0%
B5 0-10	K0895/14	..	10.1%	0.7%	0.0%	0.7%	57.8%	26.8%	7.1%	7.6%	100.0%
B5 20-30	K0895/15	..	9.1%	0.7%	0.0%	0.7%	73.9%	15.1%	5.0%	5.2%	100.0%
B5 40-50	K0895/16	..	10.7%	1.8%	0.0%	1.8%	75.2%	13.3%	4.3%	5.5%	100.0%
B5 65-75	K0895/17	..	11.2%	14.5%	0.0%	14.5%	61.2%	12.9%	5.2%	6.1%	100.0%
B6 0-10	K0895/18	..	14.1%	1.3%	0.0%	1.3%	46.0%	29.4%	14.2%	9.0%	100.0%
B6 20-30	K0895/19	..	7.9%	3.0%	0.0%	3.0%	47.5%	32.5%	12.9%	4.1%	100.0%
B6 40-50	K0895/20	2	15.7%	0.7%	0.0%	0.7%	16.2%	14.5%	6.4%	62.2%	100.0%
B6 65-75	K0895/21	2	12.0%	1.9%	0.0%	1.9%	30.1%	26.6%	15.4%	26.0%	100.0%
B7 0-10	K0895/22	..	17.8%	2.9%	0.0%	2.9%	33.7%	26.9%	16.5%	19.9%	100.0%
B7 20-30	K0895/23	..	14.5%	8.4%	0.0%	8.4%	36.8%	27.8%	12.9%	14.0%	100.0%
B7 40-50	K0895/24	2	9.8%	3.0%	0.0%	3.0%	45.9%	20.9%	7.7%	22.5%	100.0%
B7 65-75	K0895/25	2	6.4%	6.4%	0.0%	6.4%	58.4%	21.3%	6.5%	7.4%	100.0%
B8 0-10	K0895/26	..	13.1%	2.6%	0.0%	2.6%	58.3%	27.2%	6.7%	5.2%	100.0%
B8 20-30	K0895/27	..	9.1%	2.7%	0.0%	2.7%	66.3%	21.4%	4.0%	5.7%	100.0%
B8 40-50	K0895/28	..	12.6%	4.6%	0.0%	4.6%	65.1%	23.5%	2.2%	4.6%	100.0%
B8 65-75	K0895/29	2	7.9%	14.8%	0.0%	14.8%	49.1%	16.9%	5.2%	14.0%	100.0%
B10 0-10	K0895/30	..	8.8%	0.9%	0.0%	0.9%	65.4%	21.7%	6.1%	5.9%	100.0%
B10 20-30	K0895/31	..	9.9%	1.7%	0.0%	1.7%	60.5%	22.4%	6.1%	9.2%	100.0%
B10 40-50	K0895/32	..	10.8%	4.5%	0.0%	4.5%	57.5%	18.4%	6.7%	12.8%	100.0%
B10 65-75	K0895/33	..	10.9%	5.1%	0.0%	5.1%	56.6%	17.6%	4.6%	16.1%	100.0%

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: Australian Standard 1289.3.8.1-1997 (see attached)
- 3: '..' denotes not analysed
- 4: Analysis conducted between sample arrival date and reporting date.
- 5: This report is not to be reproduced except in full. Results only relate to the item tested.
- 6: All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).
- 7: This report was issued on 07/12/2020.

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340			Sample ID:	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
			E1 0-10	E1 20-30	E1 40-50	E1 65-75	E2 0-10	E2 20-30	
			Soil	Soil	Soil	Soil	Soil	Soil	
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	
	Parameter	Method reference	K0894/1	K0894/2	K0894/3	K0894/4	K0894/5	K0894/6	
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.29	4.84	6.13	6.04	5.85	5.08	
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.034	0.043	0.009	0.030	0.111	0.034	
	Exchangeable Calcium	(cmol./kg)	0.31	1.8	3.9	4.9	0.07	0.08	
		(kg/ha)	141	814	1,755	2,219	29	35	
		(mg/kg)	63	363	783	991	13	16	
	Exchangeable Magnesium	(cmol./kg)	0.12	0.77	5.0	7.4	0.07	0.11	
		(kg/ha)	32	211	1,354	2,023	19	30	
		(mg/kg)	14	94	605	903	8.5	13	
	Exchangeable Potassium	(cmol./kg)	<0.12	<0.12	0.13	0.18	<0.12	<0.12	
		(kg/ha)	<112	<112	<112	154	<112	<112	
		(mg/kg)	<50	<50	<50	69	<50	<50	
	Exchangeable Sodium	(cmol./kg)	<0.065	0.07	0.55	1.2	<0.065	<0.065	
		(kg/ha)	<33	37	286	638	<33	<33	
		(mg/kg)	<15	16	128	285	<15	<15	
Exchangeable Aluminium	(cmol./kg)	1.2	0.05	0.27	0.24	0.44	0.03		
	(kg/ha)	245	9.5	55	48	88	5.9		
	(mg/kg)	109	4.2	24	21	39	2.6		
Exchangeable Hydrogen	(cmol./kg)	0.98	0.16	0.53	0.55	0.48	0.09		
	(kg/ha)	22	3.6	12	12	11	2.1		
	(mg/kg)	9.8	1.6	5.3	5.5	4.8	<1		
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	2.7	2.9	10	15	1.1	0.38		
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	12	62	38	34	5.9	21		
Magnesium (%)		4.4	26	48	51	6.3	29		
Potassium (%)		1.2	2.3	1.2	1.2	0.81	1.9		
Sodium - ESP (%)		1.2	2.4	5.3	8.5	4.1	17		
Aluminium (%)		45	1.6	2.6	1.6	40	7.7		
Hydrogen (%)		37	5.4	5.1	3.8	43	24		
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	2.7	2.3	0.79	0.67	0.94	0.71		
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 2.5/2	10 YR 4/3	10 YR 5/3	10 YR 5/4	10 YR 3/3	7.5 YR 7/3	
			Very Dark Brown	Brown	Brown	Yellowish Brown	Dark Brown	Pink	
	Mottles Munsell Colour		..	..	10YR 6/6 Brownish Yellow	..	..	..
	Degree of Mottling (%)		..	..	70	..	..	..

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Sample ID:	E1 0-10	E1 20-30	E1 40-50	E1 65-75	E2 0-10	E2 20-30
Crop:	Soil	Soil	Soil	Soil	Soil	Soil
Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference					
		K0894/1	K0894/2	K0894/3	K0894/4	K0894/5
						K0894/6

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
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- This report was issued on 04/12/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richard, Tel: 0800 696 696 EIR

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
		Crop:	E2 40-50	E2 65-75	E3 0-10	E3 20-30	E3 40-50	E3 65-75
		Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K0894/7	K0894/8	K0894/9	K0894/10	K0894/11	K0894/12
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.35	7.44	7.69	5.51	6.27	6.13
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.007	0.027	0.053	0.022	0.023	0.025
	Exchangeable Calcium	(cmol./kg)	0.10	0.05	3.7	0.77	0.60	0.52
		(kg/ha)	45	24	1,671	344	270	233
		(mg/kg)	20	11	746	154	121	104
	Exchangeable Magnesium	(cmol./kg)	1.6	4.9	3.4	2.3	5.8	6.2
		(kg/ha)	435	1,339	938	622	1,568	1,685
		(mg/kg)	194	598	419	278	700	752
	Exchangeable Potassium	(cmol./kg)	<0.12	<0.12	0.14	<0.12	<0.12	<0.12
		(kg/ha)	<112	<112	125	<112	<112	<112
		(mg/kg)	<50	<50	56	<50	<50	<50
	Exchangeable Sodium	(cmol./kg)	0.52	1.7	0.35	0.22	0.57	0.76
		(kg/ha)	270	883	181	115	294	392
		(mg/kg)	120	394	81	51	131	175
Exchangeable Aluminium	(cmol./kg)	0.01	0.01	0.50	0.14	0.21	0.40	
	(kg/ha)	**Inhouse S37 (KCl)	2.6	2.2	100	28	42	81
	(mg/kg)		1.2	<1	45	13	19	36
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1	0.09	<0.01	<0.01	0.27	0.46	0.62
	(kg/ha)	(Acidity Titration)	1.9	<1	<1	6.1	10	14
	(mg/kg)		<1	<1	<1	2.7	4.6	6.2
Effective Cation Exchange Capacity (ECEC) (cmol./kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	2.3	6.7	8.2	3.7	7.7	8.6
Calcium (%)		**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	4.3	0.80	46	21	7.9	6.1
Magnesium (%)			68	73	42	61	75	72
Potassium (%)			0.59	0.64	1.8	1.1	0.73	0.69
Sodium - ESP (%)			22	25	4.3	6.0	7.5	8.9
Aluminium (%)			0.55	0.16	6.1	3.7	2.7	4.7
Hydrogen (%)			3.7	0.00	0.00	7.3	6.0	7.3
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol./kg)	0.06	0.01	1.1	0.34	0.10	0.08
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 6/3	10 YR 6/2	10 YR 2/2	2.5 Y 5/1	10 YR 6/1	10 YR 6/1
			Pale Brown	Light Brownish Gray	Very Dark Brown	Gray	Gray	Gray
	Mottles Munsell Colour		10 YR 6/6 Brownish Yellow	7.5 YR 5/8 Strong Brown	.. ..	.. ..	10 YR 5/6 Yellowish Brown	7.5 YR 5/8 Strong Brown
			Degree of Mottling (%)	10	60	10	25

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340		Sample ID:	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	
			E2 40-50	E2 65-75	E3 0-10	E3 20-30	E3 40-50	E3 65-75	
			Crop:	Soil	Soil	Soil	Soil	Soil	Soil
			Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K0894/7	K0894/8	K0894/9	K0894/10	K0894/11	K0894/12	

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate.
- ** NATA accreditation does not cover the performance of this service.
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- This report was issued on 04/12/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richards. Your test will cost £10

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18	
		Crop:	E4 0-10	E4 20-30	E4 40-50	E4 65-75	E4 85-95	E5 0-10	
		Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	
	Parameter	Method reference	K0894/13	K0894/14	K0894/15	K0894/16	K0894/17	K0894/18	
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.40	5.59	5.65	6.22	6.69	5.37	
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.014	0.005	0.006	0.010	0.027	0.090	
	Exchangeable Calcium (cmol./kg) (kg/ha) (mg/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.68	0.48	0.16	0.06	<0.05	1.6	
			303	216	74	25	<22	715	
			135	97	33	11	<10	319	
	Exchangeable Magnesium (cmol./kg) (kg/ha) (mg/kg)		0.29	0.22	0.75	1.3	5.2	4.1	
			78	60	204	347	1,412	1,108	
			35	27	91	155	631	495	
	Exchangeable Potassium (cmol./kg) (kg/ha) (mg/kg)		<0.12	<0.12	<0.12	<0.12	<0.12	0.27	
			<112	<112	<112	<112	<112	235	
			<50	<50	<50	<50	<50	105	
	Exchangeable Sodium (cmol./kg) (kg/ha) (mg/kg)		<0.065	<0.065	<0.065	0.08	0.83	0.66	
			<33	<33	<33	41	425	342	
			<15	<15	<15	18	190	153	
	Exchangeable Aluminium (cmol./kg) (kg/ha) (mg/kg)		**Inhouse S37 (KCl)	0.25	0.20	0.14	0.02	0.03	0.49
				51	41	28	3.3	6.0	99
				23	18	12	1.5	2.7	44
Exchangeable Hydrogen (cmol./kg) (kg/ha) (mg/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.32	0.19	0.19	0.05	<0.01	0.40		
		7.1	4.3	4.3	1.1	<1	8.9		
		3.2	1.9	1.9	<1	<1	4.0		
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	1.7	1.2	1.3	1.5	6.2	7.5		
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	40	41	13	3.7	0.74	21		
Magnesium (%)		17	19	57	85	84	54		
Potassium (%)		5.0	2.2	1.7	2.1	1.1	3.6		
Sodium - ESP (%)		3.6	4.5	3.9	5.2	13	8.9		
Aluminium (%)		15	17	10	1.1	0.48	6.6		
Hydrogen (%)		19	16	14	3.2	0.00	5.3		
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	2.4	2.2	0.22	0.04	0.01	0.39		
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 3/3	10 YR 4/4	10 YR 5/4	10 YR 6/4	2.5 Y 7/1	10 YR 3/3	
			Dark Brown	Dark Yellowish Brown	Yellowish Brown	Light Yellowish Brown	Light Gray	Dark Brown	
	Mottles Munsell Colour		..	..	..	..	7.5 YR 5/8	..
	Degree of Mottling (%)		..	..	..	..	Strong Brown	..
			..	..	..	..	20	..

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
	Crop:	E4 0-10	E4 20-30	E4 40-50	E4 65-75	E4 85-95	E5 0-10
	Client:	Soil	Soil	Soil	Soil	Soil	Soil
		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/13	K0894/14	K0894/15	K0894/16	K0894/17	K0894/18

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
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- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate.
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Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

Analysis requested by Clayton Richards, Year 600, WIS 000 210

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
		Crop:	E5 20-30	E6 0-10	E6 25-35	E6 60-70	E7 0-10	E7 20-30
		Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K0894/19	K0894/20	K0894/21	K0894/22	K0894/23	K0894/24
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.52	6.38	6.93	6.91	5.17	5.87
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.088	0.046	0.018	0.023	0.072	0.021
	Exchangeable Calcium	(cmol./kg)	0.66	3.1	0.83	1.6	1.3	0.19
		(kg/ha)	295	1,372	375	728	589	87
		(mg/kg)	132	612	167	325	263	39
	Exchangeable Magnesium	(cmol./kg)	12	0.85	0.45	1.6	1.7	1.4
		(kg/ha)	3,262	232	124	448	466	379
		(mg/kg)	1,456	104	55	200	208	169
	Exchangeable Potassium	(cmol./kg)	<0.12	0.17	0.16	0.41	0.35	<0.12
		(kg/ha)	<112	145	144	357	307	<112
		(mg/kg)	<50	65	64	159	137	<50
	Exchangeable Sodium	(cmol./kg)	1.6	0.07	<0.065	0.11	0.27	0.21
		(kg/ha)	818	35	<33	56	138	110
		(mg/kg)	365	15	<15	25	62	49
Exchangeable Aluminium	(cmol./kg)	0.03	0.02	0.01	0.02	1.1	0.70	
	(kg/ha)	**Inhouse S37 (KCl)	6.7	3.1	2.0	3.0	229	142
	(mg/kg)		3.0	1.4	<1	1.4	102	63
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1	<0.01	0.04	<0.01	<0.01	0.76	0.49
	(kg/ha)	(Acidity Titration)	<1	<1	<1	<1	17	11
	(mg/kg)		<1	<1	<1	<1	7.6	4.9
	Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	14	4.2	1.5	3.8	5.5	3.0
	Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	4.6	73	55	43	24	6.4
	Magnesium (%)		83	20	30	43	31	46
	Potassium (%)		0.81	3.9	11	11	6.3	1.5
	Sodium - ESP (%)		11	1.6	3.9	2.9	4.8	7.0
	Aluminium (%)		0.23	0.37	0.66	0.40	21	23
	Hydrogen (%)		0.00	0.99	0.00	0.00	14	16
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	0.05	3.6	1.8	0.99	0.77	0.14
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 5/6	10 YR 4/4	10 YR 5/3	10 YR 5/6	10 YR 2/2	10 YR 3/2
			Yellowish Brown	Dark Yellowish Brown	Brown	Yellowish Brown	Very Dark Brown	Very Dark Grayish Brown
	Mottles Munsell Colour		..	..	..	..	..	..
	Degree of Mottling (%)		..	..	..	..	..	..

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
		E5 20-30	E6 0-10	E6 25-35	E6 60-70	E7 0-10	E7 20-30
	Crop:	Soil	Soil	Soil	Soil	Soil	Soil
	Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/19	K0894/20	K0894/21	K0894/22	K0894/23	K0894/24

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
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- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate.
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Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340			Sample ID:	Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
			E8 0-10	E8 20-30	E8 40-50	E8 65-75	E9 0-10	E9 20-30	
			Soil	Soil	Soil	Soil	Soil	Soil	
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	
	Parameter	Method reference	K0894/25	K0894/26	K0894/27	K0894/28	K0894/29	K0894/30	
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.43	6.16	6.48	5.70	6.22	7.91	
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.065	0.007	0.007	0.025	0.100	0.041	
	Exchangeable Calcium	(cmol./kg)	1.6	0.60	0.61	1.4	7.7	7.1	
		(kg/ha)	732	269	273	613	3,449	3,192	
		(mg/kg)	327	120	122	274	1,540	1,425	
	Exchangeable Magnesium	(cmol./kg)	0.40	0.31	0.27	4.0	2.1	8.3	
		(kg/ha)	109	84	73	1,096	561	2,251	
		(mg/kg)	49	37	33	489	251	1,005	
	Exchangeable Potassium	(cmol./kg)	0.27	<0.12	<0.12	0.16	0.88	0.19	
		(kg/ha)	234	<112	<112	138	775	168	
		(mg/kg)	105	<50	<50	62	346	75	
	Exchangeable Sodium	(cmol./kg)	<0.065	<0.065	<0.065	0.14	0.11	0.34	
		(kg/ha)	<33	<33	<33	71	56	176	
		(mg/kg)	<15	<15	<15	32	25	79	
Exchangeable Aluminium	(cmol./kg)	0.12	0.05	0.01	0.09	0.02	0.01		
	(kg/ha)	23	9.9	2.8	18	3.4	2.9		
	(mg/kg)	10	4.4	1.3	8.0	1.5	1.3		
Exchangeable Hydrogen	(cmol./kg)	0.14	0.06	0.02	0.17	0.06	<0.01		
	(kg/ha)	3.2	1.5	<1	3.9	1.3	<1		
	(mg/kg)	1.4	<1	<1	1.7	<1	<1		
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	2.6	1.1	1.0	6.0	11	16		
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	63	53	60	23	71	45		
Magnesium (%)		15	27	27	68	19	52		
Potassium (%)		10	6.8	4.9	2.7	8.2	1.2		
Sodium - ESP (%)		1.6	3.3	5.1	2.3	1.00	2.1		
Aluminium (%)		4.4	4.3	1.4	1.5	0.16	0.09		
Hydrogen (%)		5.4	5.7	2.1	2.9	0.54	0.00		
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	4.1	1.9	2.3	0.34	3.7	0.86		
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 3/3	10 YR 5/4	10 YR 6/4	10 YR 6/6	10 YR 2/2	10 YR 5/8		
		Dark Brown	Yellowish Brown	Light Yellowish Brown	Brownish Yellow	Very Dark Brown	Yellowish Brown		
			
			
Mottles Munsell Colour		..	..	..	..	..	..
Degree of Mottling (%)		..	..	..	..	..	..

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
	Crop:	E8 0-10	E8 20-30	E8 40-50	E8 65-75	E9 0-10	E9 20-30
	Client:	Soil	Soil	Soil	Soil	Soil	Soil
		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/25	K0894/26	K0894/27	K0894/28	K0894/29	K0894/30

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
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- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
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AGRICULTURAL SOIL ANALYSIS REPORT

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Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340		Sample ID:	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
		Crop:	E9 40-50	E9 65-75	E10 0-10	E10 20-30	E11 0-10	E11 20-30
		Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K0894/31	K0894/32	K0894/33	K0894/34	K0894/35	K0894/36
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.01	8.14	5.68	5.75	5.58	5.79
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.074	0.123	0.069	0.033	0.029	0.011
	Exchangeable Calcium	(cmol./kg)	3.6	2.4	1.5	0.09	1.6	0.35
		(kg/ha)	1,613	1,099	680	38	721	158
		(mg/kg)	720	491	304	17	322	71
	Exchangeable Magnesium	(cmol./kg)	10	13	2.0	4.5	0.86	0.96
		(kg/ha)	2,854	3,618	544	1,230	233	262
		(mg/kg)	1,274	1,615	243	549	104	117
	Exchangeable Potassium	(cmol./kg)	0.19	0.16	0.38	0.25	0.39	0.16
		(kg/ha)	166	142	335	221	338	144
		(mg/kg)	74	64	150	99	151	64
	Exchangeable Sodium	(cmol./kg)	0.71	1.3	0.29	0.41	<0.065	<0.065
		(kg/ha)	364	653	147	210	<33	<33
		(mg/kg)	163	292	66	94	<15	<15
Exchangeable Aluminium	(cmol./kg)	0.02	0.01	0.53	1.5	0.42	0.40	
	(kg/ha)	3.4	2.2	107	296	84	81	
	(mg/kg)	1.5	<1	48	132	37	36	
Exchangeable Hydrogen	(cmol./kg)	<0.01	<0.01	0.34	0.81	0.28	0.33	
	(kg/ha)	<1	<1	7.5	18	6.2	7.4	
	(mg/kg)	<1	<1	3.4	8.1	2.8	3.3	
Effective Cation Exchange Capacity (ECEC) (cmol./kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	15	17	5.0	7.5	3.6	2.3
Calcium (%)		**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	24	14	30	1.1	45	15
Magnesium (%)			70	77	40	60	24	42
Potassium (%)			1.3	0.95	7.6	3.3	11	7.2
Sodium - ESP (%)			4.7	7.4	5.7	5.4	1.4	2.8
Aluminium (%)			0.11	0.06	10	19	12	18
Hydrogen (%)			0.00	0.00	6.6	11	7.8	15
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol./kg)	0.34	0.18	0.76	0.02	1.9	0.37
Moist Munsell Colour		**Inhouse Munsell Soil Colour Classification	10 YR 6/8	7.5 YR 6/8	10 YR 3/3	5 YR 5/8	7.5 YR 3/3	7.5 YR 4/6
			Brownish Yellow	Reddish Yellow	Dark Brown	Yellowish Red	Dark Brown	Strong Brown
Mottles Munsell Colour			..	..	..	7.5 YR 3/1	..	..
Degree of Mottling (%)			Very Dark Gray
			10

AGRICULTURAL SOIL ANALYSIS REPORT

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PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
		E9 40-50	E9 65-75	E10 0-10	E10 20-30	E11 0-10	E11 20-30
	Crop:	Soil	Soil	Soil	Soil	Soil	Soil
	Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/31	K0894/32	K0894/33	K0894/34	K0894/35	K0894/36

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340		Sample ID:	Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
		E11 40-50	E11 65-75	E12 0-10	E12 20-30	E12 40-50	E12 65-75	
		Soil	Soil	Soil	Soil	Soil	Soil	
		Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	
	Parameter	Method reference	K0894/37	K0894/38	K0894/39	K0894/40	K0894/41	K0894/42
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.27	6.08	4.95	5.44	5.74	5.55
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.019	0.024	0.018	0.009	0.011	0.014
	Exchangeable Calcium	(cmol./kg)	0.12	0.16	0.20	0.06	<0.05	0.09
		(kg/ha)	56	70	88	27	<22	41
		(mg/kg)	25	31	39	12	<10	19
	Exchangeable Magnesium	(cmol./kg)	6.9	7.8	0.25	0.15	0.17	1.2
		(kg/ha)	1,873	2,115	69	41	47	315
		(mg/kg)	836	944	31	18	21	140
	Exchangeable Potassium	(cmol./kg)	0.28	0.32	<0.12	<0.12	<0.12	<0.12
		(kg/ha)	249	279	<112	<112	<112	<112
		(mg/kg)	111	125	<50	<50	<50	<50
	Exchangeable Sodium	(cmol./kg)	0.45	0.37	<0.065	<0.065	<0.065	0.18
		(kg/ha)	231	191	<33	<33	<33	94
		(mg/kg)	103	85	<15	<15	<15	42
Exchangeable Aluminium	(cmol./kg)	0.45	0.16	0.34	0.29	0.17	1.2	
	(kg/ha)	91	32	69	58	35	233	
	(mg/kg)	40	14	31	26	16	104	
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1	0.38	0.27	0.69	0.40	0.17	0.68
	(kg/ha)	(Acidity Titration)	8.6	6.0	15	8.9	3.7	15
	(mg/kg)		3.8	2.7	6.9	4.0	1.7	6.8
Effective Cation Exchange Capacity (ECEC) (cmol./kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	8.6	9.0	1.6	0.96	0.59	3.3
Calcium (%)		**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	1.4	1.7	12	6.3	5.6	2.8
Magnesium (%)			80	86	16	16	29	35
Potassium (%)			3.3	3.5	2.2	2.5	2.1	0.93
Sodium - ESP (%)			5.2	4.1	3.8	3.9	5.6	5.5
Aluminium (%)			5.2	1.7	22	30	29	35
Hydrogen (%)			4.5	3.0	44	42	28	21
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol./kg)	0.02	0.02	0.77	0.39	0.19	0.08
Moist Munsell Colour		**Inhouse Munsell Soil Colour Classification	5 YR 5/8	7.5 YR 6/6	10 YR 3/2	10 YR 5/2	10 YR 5/2	10 YR 7/1
			Yellowish Red	Reddish Yellow	Very Dark Grayish Brown	Grayish Brown	Grayish Brown	Light Gray
Mottles Munsell Colour			..	7.5 YR 5/8	..	..	..	7.5 YR 7/6
			..	Strong Brown	..	..	..	Reddish Yellow
Degree of Mottling (%)			..	80	..	..	..	60

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894

Analysis requested by Clayton Richards. Your Job: MS-033 EIS

PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
		E11 40-50	E11 65-75	E12 0-10	E12 20-30	E12 40-50	E12 65-75
	Crop:	Soil	Soil	Soil	Soil	Soil	Soil
	Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/37	K0894/38	K0894/39	K0894/40	K0894/41	K0894/42

Notes:

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 Analysis requested by Clayton Richards. Your Job: MS-033 EIS
 PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340			Sample ID:	Sample 43	Sample 44	Sample 45	Sample 46
			Crop:	E13 0-10	E13 20-30	E13 40-50	E13 65-75
			Client:	Soil	Soil	Soil	Soil
				Umwelt	Umwelt	Umwelt	Umwelt
	Parameter	Method reference		K0894/43	K0894/44	K0894/45	K0894/46
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		4.91	4.75	4.75	5.94
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.012	0.013	0.011	1.103
	Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.21	0.05	<0.05	<0.05
		(kg/ha)		95	22	<22	<22
		(mg/kg)		42	10	<10	<10
	Exchangeable Magnesium	(cmol./kg)		0.08	0.04	0.05	0.32
		(kg/ha)		23	9.8	14	87
		(mg/kg)		10	4.4	6.1	39
	Exchangeable Potassium	(cmol./kg)		<0.12	<0.12	<0.12	<0.12
		(kg/ha)		<112	<112	<112	<112
		(mg/kg)		<50	<50	<50	<50
	Exchangeable Sodium	(cmol./kg)		<0.065	<0.065	<0.065	<0.065
		(kg/ha)		<33	<33	<33	<33
		(mg/kg)		<15	<15	<15	<15
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	1.3	1.6	1.7	1.4	
	(kg/ha)		257	321	338	287	
	(mg/kg)		115	143	151	128	
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.54	0.96	1.0	1.0	
	(kg/ha)		12	21	23	23	
	(mg/kg)		5.4	9.6	10	10	
Effective Cation Exchange Capacity (ECEC) (cmol./kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		2.2	2.7	2.9	2.8
	Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	9.8	1.9	1.7	1.5	
	Magnesium (%)		3.9	1.3	1.8	11	
	Potassium (%)		1.3	0.67	0.71	0.62	
	Sodium - ESP (%)		0.87	0.60	0.41	0.60	
	Aluminium (%)		59	60	59	50	
	Hydrogen (%)		25	36	37	36	
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol./kg)		2.5	1.4	0.99	0.14
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 3/3	10 YR 3/4	10 YR 4/4	10 YR 4/4	
			Dark Brown	Dark Yellowish Brown	Dark Yellowish Brown	Dark Yellowish Brown	
	Mottles Munsell Colour		
	Degree of Mottling (%)		

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 Analysis requested by Clayton Richards. Your Job: MS-033 EIS
 PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 43	Sample 44	Sample 45	Sample 46
		E13 0-10	E13 20-30	E13 40-50	E13 65-75
	Crop:	Soil	Soil	Soil	Soil
	Client:	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0894/43	K0894/44	K0894/45	K0894/46

Notes:

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 Analysis requested by Clayton Richards. Your Job: MS-033 EIS
 PO BOX 11034 TAMWORTH NSW 2340

PO BOX 11034 TAMWORTH NSW 2340			Sample ID:	Heavy Soil	Medium Soil	Light Soil	Sandy Soil	
			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)	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)	0.6	0.5	0.4	0.2			
	(kg/ha)	121	101	73	30			
	(mg/kg)	54	45	32	14			
Exchangeable Hydrogen	(cmol./kg)	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		
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	..					
	Mottles Munsell Colour		..					
	Degree of Mottling (%)		..					
			..					

AGRICULTURAL SOIL ANALYSIS REPORT

46 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0894
 Analysis requested by Clayton Richards. Your Job: MS-033 EIS
 PO BOX 11034 TAMWORTH NSW 2340

Sample ID: Crop: Client:	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
	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: 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_e/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.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer to website).
17. This report was issued on 04/12/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895
Analysis requested by Clayton Richards. Your Job: MS-033 BSAL
PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
		Crop:	B1 0-10	B1 20-30	B1 40-50	B1 65-75	B2 0-10
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/1	K0895/2	K0895/3	K0895/4	K0895/5
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		5.39	5.29	6.39	5.80	5.01
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.041	0.015	0.015	0.041	0.024
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.85	0.13	0.36	0.58	0.09
	(kg/ha)		382	58	163	262	39
	(mg/kg)		170	26	73	117	18
Exchangeable Magnesium	(cmol _e /kg)		0.31	0.07	0.74	7.1	0.42
	(kg/ha)		84	20	201	1,922	115
	(mg/kg)		38	8.9	90	858	51
Exchangeable Potassium	(cmol _e /kg)		<0.12	<0.12	<0.12	0.63	<0.12
	(kg/ha)		<112	<112	<112	549	<112
	(mg/kg)		<50	<50	<50	245	<50
Exchangeable Sodium	(cmol _e /kg)		0.08	<0.065	<0.065	0.60	<0.065
	(kg/ha)		39	<33	<33	311	<33
	(mg/kg)		18	<15	<15	139	<15
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	0.32	0.26	0.03	0.69	1.6
	(kg/ha)		65	52	5.2	139	327
	(mg/kg)		29	23	2.3	62	146
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.08	0.05	0.02	0.44	0.44
	(kg/ha)		1.8	1.1	<1	9.9	9.8
	(mg/kg)		<1	<1	<1	4.4	4.4
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		1.8	0.59	1.3	10	2.7
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100		48	22	28	5.8	3.2
Magnesium (%)			18	12	56	71	16
Potassium (%)			6.4	10	8.3	6.3	3.3
Sodium - ESP (%)			4.4	3.2	4.8	6.0	2.1
Aluminium (%)			18	44	1.9	6.9	60
Hydrogen (%)			4.7	8.0	1.3	4.4	16
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		2.7	1.8	0.49	0.08	0.21
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	..	2	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		10 YR 2/2 Very Dark Brown	7.5 YR 5/3 Brown	10 YR 6/1 Gray	2.5 Y 7/1 Light Gray	7.5 YR 3/4 Dark Brown
Mottles Munsell Colour			..	..	7.5 YR 6/6 Reddish Yellow	7.5 YR 5/8 Strong Brown	..
Degree of Mottling (%)			..	..	7	40	..
		

AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895

Analysis requested by Clayton Richards. Your Job: MS-033 BSAL

PO BOX 11034 TAMWORTH NSW 2340

Sample ID:	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	B1 0-10	B1 20-30	B1 40-50	B1 65-75	B2 0-10
Crop:	soil	soil	soil	soil	soil
Client:	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt

Parameter	Method reference	K0895/1	K0895/2	K0895/3	K0895/4	K0895/5
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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_e/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.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).
17. This report was issued on 2/12/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895

Analysis requested by Clayton Richards. Your Job: MS-033 BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Crop:	B2 20-30	B3 0-10	B3 20-30	B3 40-50	B4 0-10
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/6	K0895/7	K0895/8	K0895/9	K0895/10
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		5.59	4.86	5.20	5.34	5.64
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.009	0.037	0.020	0.006	0.021
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	<0.05	0.75	0.44	0.32	1.5
	(kg/ha)		<22	336	196	145	671
	(mg/kg)		<10	150	88	65	299
Exchangeable Magnesium	(cmol _e /kg)		0.88	0.27	0.19	0.21	0.51
	(kg/ha)		240	73	51	58	138
	(mg/kg)		107	33	23	26	61
Exchangeable Potassium	(cmol _e /kg)		<0.12	<0.12	<0.12	<0.12	0.31
	(kg/ha)		<112	<112	<112	<112	275
	(mg/kg)		<50	<50	<50	<50	123
Exchangeable Sodium	(cmol _e /kg)		<0.065	<0.065	<0.065	<0.065	<0.065
	(kg/ha)		<33	<33	<33	<33	<33
	(mg/kg)		<15	<15	<15	<15	<15
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	0.86	1.0	0.60	0.52	0.18
	(kg/ha)		174	208	121	104	36
	(mg/kg)		77	93	54	47	16
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.26	0.32	0.07	<0.01	0.63
	(kg/ha)		5.9	7.2	1.7	<1	14
	(mg/kg)		2.6	3.2	<1	<1	6.3
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		2.1	2.4	1.3	1.1	3.1
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100		1.3	31	33	29	48
Magnesium (%)			42	11	14	19	16
Potassium (%)			2.0	2.4	2.8	3.1	10
Sodium - ESP (%)			2.0	0.53	0.37	0.83	0.33
Aluminium (%)			41	42	45	47	5.7
Hydrogen (%)			12	13	5.5	0.00	20
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		0.03	2.8	2.3	1.5	3.0
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	..	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 5/2 Strong Brown	10 YR 3/3 Dark Brown	10 YR 5/2 Grayish Brown	10 YR 5/3 Brown	5 YR 3/2 Dark Reddish Brown
Mottles Munsell Colour			..	..	..	..	..
Degree of Mottling (%)			..	..	..	..	..
		

AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895
 Analysis requested by Clayton Richards. Your Job: MS-033 BSAL
 PO BOX 11034 TAMWORTH NSW 2340

Sample ID:	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
Crop:	B2 20-30	B3 0-10	B3 20-30	B3 40-50	B4 0-10
Client:	soil	soil	soil	soil	soil
	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	K0895/6	K0895/7	K0895/8	K0895/9	K0895/10

Parameter	Method reference
Notes:	

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- ** NATA accreditation does not cover the performance of this service.
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- This report was issued on 2/12/2020.

Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895
Analysis requested by Clayton Richards. Your Job: MS-033 BSAL
PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
		Crop:	B4 20-30	B4 40-50	B4 65-75	B5 0-10	B5 20-30
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/11	K0895/12	K0895/13	K0895/14	K0895/15
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.68	7.09	7.46	5.61	6.47
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.006	0.015	0.017	0.022	0.006
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.3	3.6	3.2	1.9	1.2
	(kg/ha)		580	1,626	1,430	856	525
	(mg/kg)		259	726	638	382	234
Exchangeable Magnesium	(cmol _e /kg)		0.68	4.1	5.2	0.47	0.36
	(kg/ha)		184	1,121	1,423	127	98
	(mg/kg)		82	500	635	57	44
Exchangeable Potassium	(cmol _e /kg)		0.19	0.32	0.44	0.20	<0.12
	(kg/ha)		171	281	381	177	<112
	(mg/kg)		76	126	170	79	<50
Exchangeable Sodium	(cmol _e /kg)		<0.065	<0.065	0.14	<0.065	<0.065
	(kg/ha)		<33	<33	71	<33	<33
	(mg/kg)		<15	<15	32	<15	<15
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	0.04	<0.01
	(kg/ha)		1.8	1.3	1.1	8.9	1.5
	(mg/kg)		<1	<1	<1	4.0	<1
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	0.04	0.02
	(kg/ha)		<1	<1	<1	<1	<1
	(mg/kg)		<1	<1	<1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		2.2	8.1	9.0	2.7	1.7
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / CEC x 100		59	45	35	71	70
Magnesium (%)			31	51	58	18	22
Potassium (%)			8.9	4.0	4.8	7.6	5.8
Sodium - ESP (%)			0.33	0.75	1.5	0.30	0.51
Aluminium (%)			0.42	0.08	0.06	1.7	0.45
Hydrogen (%)			0.00	0.00	0.00	1.5	1.3
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		1.9	0.88	0.61	4.1	3.3
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	2	..	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 5/4	10 YR 5/6	10 YR 6/1	5 YR 2.5/2	7.5 YR 3/4
			Brown	Yellowish Brown	Gray	Dark Reddish Brown	Dark Brown
Mottles Munsell Colour			..	..	7.5 YR 5/8	..	..
			..	..	Strong Brown	..	..
Degree of Mottling (%)			..	..	20	..	..

AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895

Analysis requested by Clayton Richards. Your Job: MS-033 BSAL

PO BOX 11034 TAMWORTH NSW 2340

Sample ID:	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
Crop:	B4 20-30	B4 40-50	B4 65-75	B5 0-10	B5 20-30
Client:	soil	soil	soil	soil	soil
	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	K0895/11	K0895/12	K0895/13	K0895/14	K0895/15

Parameter	Method reference
Notes:	

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
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Quality Checked: Kris Saville
 Agricultural Co-Ordinator

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AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895

Analysis requested by Clayton Richards. Your Job: MS-033 BSAL

PO BOX 11034 TAMWORTH NSW 2340

		Sample ID:	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
		Crop:	B5 40-50	B5 65-75	B6 0-10	B6 20-30	B6 40-50
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/16	K0895/17	K0895/18	K0895/19	K0895/20
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		6.70	7.23	5.00	5.57	6.87
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.005	0.006	0.057	0.006	0.047
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.91	1.2	1.1	0.38	3.3
	(kg/ha)		410	547	495	171	1,486
	(mg/kg)		183	244	221	76	663
Exchangeable Magnesium	(cmol _e /kg)		0.22	0.26	0.38	0.21	10
	(kg/ha)		60	72	104	58	2,753
	(mg/kg)		27	32	47	26	1,229
Exchangeable Potassium	(cmol _e /kg)		<0.12	<0.12	0.12	<0.12	0.22
	(kg/ha)		<112	<112	<112	<112	194
	(mg/kg)		<50	<50	<50	<50	87
Exchangeable Sodium	(cmol _e /kg)		<0.065	<0.065	<0.065	<0.065	0.85
	(kg/ha)		<33	<33	<33	<33	438
	(mg/kg)		<15	<15	<15	<15	196
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	<0.01	<0.01	0.25	0.12	0.02
	(kg/ha)		<1	1.2	50	24	3.6
	(mg/kg)		<1	<1	22	11	1.6
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.12	0.03	<0.01
	(kg/ha)		<1	<1	2.7	<1	<1
	(mg/kg)		<1	<1	1.2	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		1.2	1.6	2.0	0.84	15
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100		76	78	54	46	23
Magnesium (%)			18	17	19	26	70
Potassium (%)			4.1	2.9	6.1	7.0	1.5
Sodium - ESP (%)			0.74	1.7	2.3	5.0	5.9
Aluminium (%)			0.33	0.37	12	14	0.12
Hydrogen (%)			0.00	0.00	6.0	3.0	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		4.2	4.6	2.9	1.8	0.33
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	..	..	2
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		7.5 YR 4/6 Strong Brown	10 YR 5/6 Yellowish Brown	7.5 YR 3/3 Dark Brown	10 YR 5/4 Yellowish Brown	10 YR 5/3 Brown
Mottles Munsell Colour			..	..	..	..	7.5 YR 5/6 Strong Brown
Degree of Mottling (%)			..	..	..	..	40
		

AGRICULTURAL SOIL ANALYSIS REPORT

33 samples supplied by Minesoils Pty. Ltd. on 23/11/2020. Lab Job No.K0895
 Analysis requested by Clayton Richards. Your Job: MS-033 BSAL
 PO BOX 11034 TAMWORTH NSW 2340

Sample ID:	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
Crop:	B5 40-50	B5 65-75	B6 0-10	B6 20-30	B6 40-50
Client:	soil	soil	soil	soil	soil
	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	K0895/16	K0895/17	K0895/18	K0895/19	K0895/20

Parameter	Method reference
Notes:	

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
- The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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Analysis requested by Clayton Richards. Your Job: MS-033 BSAL

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		Sample ID:	Sample 21	Sample 22	Sample 23	Sample 24	Sample 25
		Crop:	B6 65-75	B7 0-10	B7 20-30	B7 40-50	B7 65-75
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/21	K0895/22	K0895/23	K0895/24	K0895/25
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		8.02	5.63	6.32	7.35	8.37
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.113	0.026	0.021	0.046	0.044
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	1.6	1.0	0.62	0.29	0.14
	(kg/ha)		723	470	279	131	65
	(mg/kg)		323	210	125	59	29
Exchangeable Magnesium	(cmol _e /kg)		7.4	1.6	1.3	2.9	1.5
	(kg/ha)		2,005	426	363	778	399
	(mg/kg)		895	190	162	347	178
Exchangeable Potassium	(cmol _e /kg)		0.12	0.21	<0.12	<0.12	<0.12
	(kg/ha)		<112	182	<112	<112	<112
	(mg/kg)		<50	81	<50	<50	<50
Exchangeable Sodium	(cmol _e /kg)		1.2	0.18	0.23	0.70	0.58
	(kg/ha)		629	91	118	360	296
	(mg/kg)		281	41	53	161	132
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	<0.01	0.94	0.23	0.02	<0.01
	(kg/ha)		1.1	189	47	4.0	1.2
	(mg/kg)		<1	84	21	1.8	<1
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.34	0.13	<0.01	<0.01
	(kg/ha)		<1	7.6	2.9	<1	<1
	(mg/kg)		<1	3.4	1.3	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		10	4.3	2.6	3.9	2.2
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100		16	25	24	7.5	6.5
Magnesium (%)			71	37	52	73	66
Potassium (%)			1.2	4.9	1.3	1.2	1.3
Sodium - ESP (%)			12	4.1	8.9	18	26
Aluminium (%)			0.05	22	9.0	0.51	0.27
Hydrogen (%)			0.00	7.9	5.1	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		0.22	0.67	0.47	0.10	0.10
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		2	..	..	2	2
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		2.5 Y 7/1 Light Gray	7.5 YR 3/3 Dark Brown	10 YR 4/3 Brown	10 YR 6/1 Gray	10 YR 3/4 Dark Yellowish Brown
Mottles Munsell Colour			7.5 YR 6/8 Reddish Yellow	10 YR 5/8 Yellowish Brown	..
Degree of Mottling (%)			70	30	..

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Sample ID:	Sample 21	Sample 22	Sample 23	Sample 24	Sample 25
Crop:	B6 65-75	B7 0-10	B7 20-30	B7 40-50	B7 65-75
Client:	soil	soil	soil	soil	soil
	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	K0895/21	K0895/22	K0895/23	K0895/24	K0895/25

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
- Conversions for 1 cmol_e/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
- Conversions to kg/ha = mg/kg x 2.24
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		Sample ID:	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Crop:	B8 0-10	B8 20-30	B8 40-50	B8 65-75	B10 0-10
		Client:	soil	soil	soil	soil	soil
			Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
Parameter	Method reference		K0895/26	K0895/27	K0895/28	K0895/29	K0895/30
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		5.37	5.79	6.63	7.63	5.71
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.013	0.006	0.003	0.015	0.015
Exchangeable Calcium	(cmol _e /kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.33	0.33	0.31	1.2	0.67
	(kg/ha)		146	146	137	559	302
	(mg/kg)		65	65	61	250	135
Exchangeable Magnesium	(cmol _e /kg)		0.13	0.14	0.13	2.1	0.36
	(kg/ha)		34	39	34	585	98
	(mg/kg)		15	18	15	261	44
Exchangeable Potassium	(cmol _e /kg)		<0.12	<0.12	<0.12	<0.12	0.13
	(kg/ha)		<112	<112	<112	<112	116
	(mg/kg)		<50	<50	<50	<50	52
Exchangeable Sodium	(cmol _e /kg)		<0.065	<0.065	<0.065	0.19	<0.065
	(kg/ha)		<33	<33	<33	97	<33
	(mg/kg)		<15	<15	<15	43	<15
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	0.34	0.17	<0.01	<0.01	0.08
	(kg/ha)		69	35	1.2	<1	16
	(mg/kg)		31	15	<1	<1	7.1
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.23	0.03	<0.01	<0.01	0.03
	(kg/ha)		5.1	<1	<1	<1	<1
	(mg/kg)		2.3	<1	<1	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)		1.1	0.76	0.47	3.7	1.3
Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100		29	43	65	34	52
Magnesium (%)			11	19	26	59	28
Potassium (%)			7.6	10	6.6	1.7	10
Sodium - ESP (%)			1.3	1.5	1.1	5.2	1.5
Aluminium (%)			31	23	1.2	0.13	6.1
Hydrogen (%)			20	3.6	0.00	0.00	2.2
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol _e /kg)		2.6	2.3	2.4	0.58	1.9
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		..	..	..	2	..
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		10 YR 4/4 Dark Yellowish Brown	2.5 Y 6/2 Light Brownish Gray	10 YR 5/3 Brown	2.5 Y 7/1 Light Gray	7.5 YR 2.5/3 Very Dark Brown
Mottles Munsell Colour			..	10 YR 6/6 Brownish Yellow	..	7.5 YR 5/8 Strong Brown	..
Degree of Mottling (%)			..	10	..	40	..
		

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 PO BOX 11034 TAMWORTH NSW 2340

Sample ID:	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
Crop:	B8 0-10	B8 20-30	B8 40-50	B8 65-75	B10 0-10
Client:	soil	soil	soil	soil	soil
	Umwelt	Umwelt	Umwelt	Umwelt	Umwelt
	K0895/26	K0895/27	K0895/28	K0895/29	K0895/30

Parameter	Method reference
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. <i>Soil Chemical Methods - Australasia</i> . 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 _e /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	
13. ** NATA accreditation does not cover the performance of this service.	
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PO BOX 11034 TAMWORTH NSW 2340			Sample 31	Sample 32	Sample 33
Sample ID:			B10 20-30	B10 40-50	B10 65-75
Crop:			soil	soil	soil
Client:			Umwelt	Umwelt	Umwelt
	Parameter	Method reference	K0895/31	K0895/32	K0895/33
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.28	6.45	5.69
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.008	0.013	0.015
	Exchangeable Calcium	(cmol _e /kg)	0.91	1.1	0.82
		(kg/ha)	408	472	368
		(mg/kg)	182	211	164
	Exchangeable Magnesium	(cmol _e /kg)	0.54	0.68	1.3
		(kg/ha)	146	185	352
		(mg/kg)	65	83	157
	Exchangeable Potassium	(cmol _e /kg)	<0.12	<0.12	<0.12
		(kg/ha)	<112	<112	<112
		(mg/kg)	<50	<50	<50
	Exchangeable Sodium	(cmol _e /kg)	<0.065	<0.065	<0.065
		(kg/ha)	<33	<33	<33
		(mg/kg)	<15	<15	<15
Exchangeable Aluminium	(cmol _e /kg)	**Inhouse S37 (KCl)	0.01	<0.01	0.08
	(kg/ha)		2.5	1.7	16
	(mg/kg)		1.1	<1	7.0
Exchangeable Hydrogen	(cmol _e /kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.02	<0.01	0.02
	(kg/ha)		<1	<1	<1
	(mg/kg)		<1	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol _e /kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol _e /kg)	1.5	1.8	2.3
	Calcium (%)	**Base Saturation Calculations - Cation cmol _e /kg / ECEC x 100	59	58	35
	Magnesium (%)		35	37	55
	Potassium (%)		3.8	2.9	2.5
Sodium - ESP (%)	0.58		1.1	2.6	
Aluminium (%)	0.79		0.46	3.3	
Hydrogen (%)	1.1		0.32	0.93	
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol _e /kg)	1.7	1.5	0.63
Emerson Aggregate Test (EAT)		**AS1289.3.8.1-2017	..	..	..
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	7.5 YR 5/6 Strong Brown	7.5 YR 4/6 Strong Brown	7.5 Y 5/8 Strong Brown
	Mottles Munsell Colour	
	Degree of Motting (%)	
		

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 PO BOX 11034 TAMWORTH NSW 2340

	Sample ID:	Sample 31	Sample 32	Sample 33
	Crop:	B10 20-30	B10 40-50	B10 65-75
	Client:	soil	soil	soil
		Umwelt	Umwelt	Umwelt
Parameter	Method reference	K0895/31	K0895/32	K0895/33

Notes:

- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
- Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
- 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- Guidelines for phosphorus have been reduced for Australian soils.
- Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- Total Acid Extractable Nutrients indicate a store of nutrients.
- 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.
- Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
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		Sample ID:	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
		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)	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)	0.6	0.5	0.4	0.2	
	(kg/ha)	121	101	73	30	
	(mg/kg)	54	45	32	14	
Exchangeable Hydrogen	(cmol./kg)	0.6	0.5	0.4	0.2	
	(kg/ha)	13	11	8	3	
	(mg/kg)	6	5	4	2	
Effective Cation Exchange Capacity (CEC) (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 / CEC 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	
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	Class 3-8				
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	..				
Mottles Munsell Colour		..				
Degree of Mottling (%)		..				
		..				

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Sample ID:	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
	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).
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.
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Appendix 2

Soil Profile Descriptions



Site Description – Site B1						
Site Reference	B1	ASC Name	Eutrophic Subnatic Grey Sodosol (CFKMW)			
Average Slope	2%	Land Use	Grassland	Coordinates		
Site Morphology	Midslope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 752949		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6442107		

						
Plate 1 – Soil Profile (B1)			Plate 2 – Surface (B1)			
			Plate 3 – Landscape (B1)			

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (Munsell 10YR 2/2) Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.10 – 0.50	Brown to Grey (Munsell 7.5YR 5/3 to 10YR 6/1) Sand to Loamy Sand with apedal structure and weak consistence. Strongly acidic to slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and poorly drained. Clear boundary.
B2	0.50 – 0.75+	Light Reddish Grey (Munsell 2.5YR 7/1) Clay Loam with moderate pedality and firm consistence. Moderately acidic pH, non-saline and sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.9	Non-saline	5.39	Strongly acidic	4.4	Non-Sodic
0.20-0.30	0.3	Non-saline	5.29	Slightly acidic	3.2	Non-Sodic
0.40-0.50	0.4	Non-saline	6.39	Slightly acidic	4.8	Non-Sodic
0.65-0.75	0.3	Non-saline	5.80	Mod acidic	6.0	Sodic



Site Description – Site B2						
Site Reference	B2	ASC Name	Acidic Lithic Leptic Tenosol (AFLLU)			
Average Slope	1%	Land Use	Native Vegetation (unused)	Coordinates		
Site Morphology	Crest	Soil Fertility	Low	MGA 55		
Landform Element	Hillcrest	BSAL Site Status	Verified Non BSAL	X: 753441		
Surface Condition	Soft/Sandy	Mapped as BSAL	No	Y: 6441284		




Plate 4 – Soil Profile (B2)




Plate 5 – Surface (B2)




Plate 6 – Landscape (B2)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 7.5YR 3/4) Sandy Loam with apedal structure and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.10 – 0.40	Brown (Munsell 7.5YR 5/2) Sandy Loam with apedal structure and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and well drained. Clear boundary.
C	0.40+	Parent rock.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	5.01	Strongly acidic	2.1	Non-Sodic
0.20-0.30	0.1	Non-saline	5.59	Moderately acidic	2.0	Non-Sodic



Site Description – Site B3						
Site Reference	B3	ASC Name	Acidic Paralithic Bleached Orthic Tenosol (CFLKV)			
Average Slope	7%	Land Use	Grassland	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 753932		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6441383		




Plate 7 – Soil Profile (B3)




Plate 8 – Surface (B3)




Plate 9 – Landscape (B3)

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark brown to Greyish brown(Munsell 10YR 3/3 to 5/2) Sandy Loam to Loamy Sand with weak pedality and weak consistence. Very strongly to strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.30 – 0.60	Brown (Munsell 10YR 5/3) Loamy Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary to C.
C	0.60+	Parent rock (weathered)

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	4.89	Very Strongly acidic	0.53	Non-Sodic
0.20-0.30	0.5	Non-saline	5.20	Strongly acidic	0.37	Non-Sodic
0.40-0.50	0.1	Non-saline	5.34	Strongly acidic	0.83	Non-Sodic



Site Description – Site B4						
Site Reference	B4	ASC Name	Mottled Eutrophic Brown Chromosol (CEKOW)			
Average Slope	1%	Land Use	Grassland	Coordinates		
Site Morphology	Drainage Plain	Soil Fertility	Moderately High	MGA 55		
Landform Element	Plain	BSAL Site Status	Verified Non BSAL	X: 754149		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6441023		




Plate 10 – Soil Profile (B4)




Plate 11 – Surface (B4)




Plate 12 – Landscape (B4)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark reddish brown (Munsell 5YR 3/2) Loamy Sand with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.20 – 0.35	Brown (Munsell 7.5YR 5/4) Sandy Loam with weak pedality and weak consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary.
B2	0.35 – 0.75+	Yellowish-brown to Grey (Munsell 10YR 5/6 to 6/1) Light Clay with strong pedality and firm consistence. Neutral to mildly alkaline pH, non-saline and sodic. Nil coarse fragments. Trace roots and poorly drained with distinct grey & orange mottles.

Sample Depth	ECe		pH _(1:5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	5.64	Moderately acidic	0.33	Non-Sodic
0.20-0.30	0.1	Non-saline	6.68	Neutral	0.33	Non-Sodic
0.40-0.50	0.1	Non-saline	7.09	Neutral	0.75	Non-Sodic
0.65-0.75	0.1	Non-saline	7.46	Mildly alkaline	1.50	Non-Sodic



Site Description – Site B5				
Site Reference	B5	ASC Name	Basic Paralithic Brown-Orthic Tenosol (CEKKV)	
Average Slope	3%	Land Use	Grassland	Coordinates
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 753937
Surface Condition	Soft	Mapped as BSAL	No	Y: 6440523



Plate 13 – Soil Profile (B5)



Plate 14 – Surface (B5)



Plate 15 – Landscape (B5)

Horizon	Depth (m)	Description				
A1	0.00 – 0.15	Dark reddish brown (Munsell 5YR 2.5/5) Loamy Sand with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.				
A2	0.15 – 0.60	Dark brown to Strong brown (Munsell 7.5YR 5/4 to 4/6) Loamy Sand to Sand with apedal structure and weak consistence. Slightly acidic to neutral pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and well drained. Gradual boundary to weathered C.				
C	0.60+	Parent rock (weathered) – Yellowish Brown (Munsell 10YR 5/6) Gravelly Loamy Sand. Neutral pH, non-saline and non-sodic. 50% stones from parent material.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	5.61	Moderately acidic	0.30	Non-Sodic
0.20-0.30	0.1	Non-saline	6.47	Slightly acidic	0.51	Non-Sodic
0.40-0.50	0.1	Non-saline	6.70	Neutral	0.74	Non-Sodic
0.65-0.75	0.1	Non-saline	7.23	Neutral	1.70	Non-Sodic



Site Description – Site B6				
Site Reference	B6	ASC Name	Mottled-Sodic Eutrophic Brown Chromosol (CEKOW)	
Average Slope	1%	Land Use	Grassland	Coordinates
Site Morphology	Lower slope	Soil Fertility	Moderately High	MGA 55
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 754521
Surface Condition	Soft	Mapped as BSAL	No	Y: 6441314



Plate 16 – Soil Profile (B6)



Plate 17 – Surface (B6)



Plate 18 – Landscape (B6)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 7.5YR 3/3) Loamy Sand with weak pedality and weak consistence. Very strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.10 – 0.35	Yellowish brown (Munsell 10YR 5/4) Loamy Sand with apedal structure and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary.
B2	0.35 – 0.75+	Brown to Light Reddish Grey (Munsell 10YR 5/3 to 2.5YR 7/1) Heavy Clay to Clay Loam with strong pedality and firm consistence. Neutral to moderately alkaline pH, non-saline and marginally sodic to strongly sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.3	Non-saline	5.00	Very strongly acidic	2.3	Non-Sodic
0.20-0.30	0.1	Non-saline	5.57	Moderately acidic	5.0	Marg-Sodic
0.40-0.50	0.3	Non-saline	6.87	Neutral	5.9	Marg-Sodic
0.65-0.75	1.0	Non-saline	8.02	Moderately alkaline	12.0	Strongly Sodic



Site Description – Site B7						
Site Reference	B7	ASC Name	Eutrophic Mesonatric Grey Sodosol (CFLOV)			
Average Slope	1%	Land Use	Grassland	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 754769		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6441205		

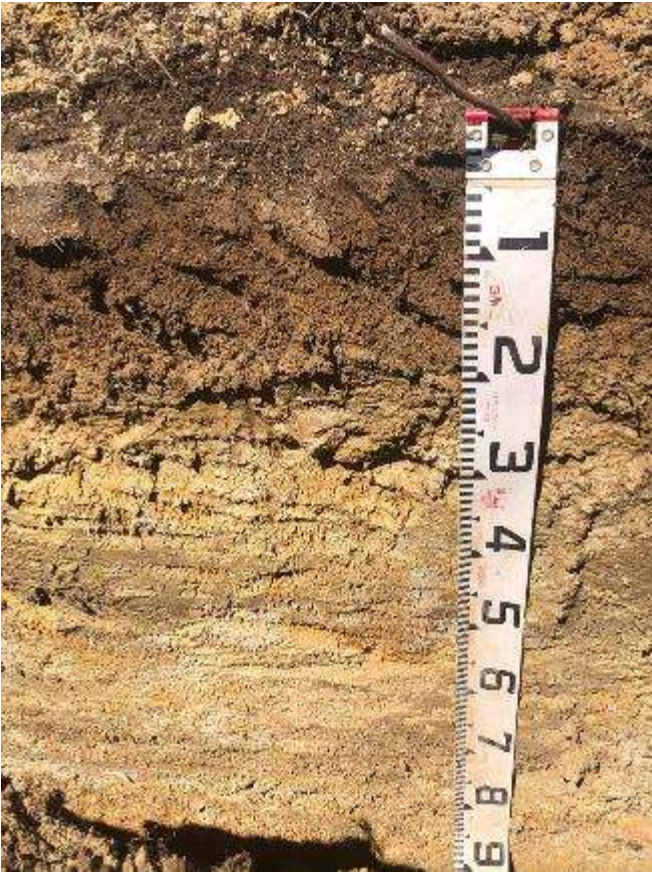


Plate 19 – Soil Profile (B7)




Plate 20 – Surface (B7)




Plate 21 – Landscape (B7)

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (Munsell 7.5YR 3/3) Loam with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
A2	0.15 – 0.30	Brown (Munsell 10YR 4/3) Loamy Sand with apedal structure and weak consistence. Slightly acidic pH, non-saline and sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary.
B2	0.30 – 0.75+	Grey to Dark yellowish brown (Munsell 10YR 6/1 to 3/4) Light Clay with moderate pedality and firm consistence. Mildly to moderately alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.2	Non-saline	5.63	Moderately acidic	4.1	Non-Sodic
0.20-0.30	0.2	Non-saline	6.32	Slightly acidic	8.9	Sodic
0.40-0.50	0.4	Non-saline	7.35	Mildly alkaline	18.0	Strongly Sodic
0.65-0.75	1.0	Non-saline	8.37	Moderately alkaline	26.0	Strongly Sodic



Site Description – Site B8				
Site Reference	B8	ASC Name	Basic Paralithic Brown-Orthic Tenosol (DFLKV)	
Average Slope	2%	Land Use	Grassland	Coordinates
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 754293
Surface Condition	Soft	Mapped as BSAL	No	Y: 6440737



Plate 22 – Soil Profile (B8)



Plate 23 – Surface (B8)



Plate 24 – Landscape (B8)

Horizon	Depth (m)	Description				
A1	0.00 – 0.20	Dark yellowish brown (Munsell 10YR 4/4) Loamy Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.				
A2	0.20 – 0.65	Pale red to Brown (Munsell 2.5YR 6/2 to 10YR 5/3) Sand with apedal structure and weak consistence. Moderately acidic to neutral pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary to C.				
C	0.65+	Parent rock (weathered) Light Grey (Munsell 2.5Y 7/1) Gravelly Sandy Loam. Mildly alkaline pH, non-saline and non-sodic. 60% stones from parent material.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	5.37	Strongly acidic	1.3	Non-Sodic
0.20-0.30	0.1	Non-saline	5.79	Moderately acidic	1.5	Non-Sodic
0.40-0.50	0.1	Non-saline	6.63	Neutral	1.1	Non-Sodic
0.65-0.75	0.2	Non-saline	7.63	Mildly alkaline	5.2	Non-Sodic



Site Description – Site B9				
Site Reference	B9	ASC Name	Rock outcrop area	
Average Slope	4%	Land Use	Native vegetation	Coordinates
Site Morphology	Midslope	Soil Fertility	Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL (exclusion)	X: 754767
Surface Condition	Loose/Rocky	Mapped as BSAL	No	Y: 6440807

 <p>Plate 25 – Surface (B9)</p>	 <p>Plate 26 – Surface (B9)</p>
 <p>Plate 27 – Surface (B9)</p>	 <p>Plate 28 – Surface (B9)</p>
 <p>Plate 29 – Surface (B9)</p>	 <p>Plate 30 – Surface (B9)</p>

Site Description – Site B10						
Site Reference	B10	ASC Name	Basic Paralithic Brown-Orthic Tenosol (CELLW)			
Average Slope	7%	Land Use	Grassland	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL	X: 754046		
Surface Condition	Soft	Mapped as BSAL	No	Y: 6440253		




Plate 31 – Soil Profile (B10)




Plate 32 – Surface (B10)




Plate 33 – Landscape (B10)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark brown (Munsell 7.5YR 2.5/3) Loamy Sand with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.20 – 0.60	Strong brown (Munsell 7.5YR 5/6 to 4/6) Sandy Loam with weak pedality and weak consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and well drained. Gradual boundary.
A3	0.60-0.75+	Strong Brown (Munsell 7.5YR 5/8) Sandy Loam with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and well drained. Layer continues.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	5.71	Moderately acidic	1.50	Non-Sodic
0.20-0.30	0.1	Non-saline	6.28	Slightly acidic	0.58	Non-Sodic
0.40-0.50	0.2	Non-saline	6.45	Slightly acidic	1.10	Non-Sodic
0.65-0.75	0.2	Non-saline	5.69	Moderately acidic	2.60	Non-Sodic



Site Description – Exclusion Areas Rock Outcrop				
Site Reference	B11 Exclusion Area	ASC Name	Rock outcrop area	
Average Slope	2-10%	Land Use	Native vegetation	Coordinates
Site Morphology	Mid-Upper slope	Soil Fertility	Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Verified Non BSAL (exclusion)	X: 753469
Surface Condition	Loose/Rocky	Mapped as BSAL	No	Y: 6441498

 <p>Plate 34 – Surface (Exclusion))</p>	 <p>Plate 35 – Surface (Exclusion))</p>
 <p>Plate 36 – Surface (Exclusion))</p>	 <p>Plate 37 – Surface (Exclusion))</p>
 <p>Plate 38 – Surface (Exclusion))</p>	 <p>Plate 39 – Surface (Exclusion))</p>

Site Description – Site E1				
Site Reference	E1	ASC Name	Eutrophic Subnatic Brown Sodosol (BFLOW)	
Average Slope	2%	Land Use	Grassland	Coordinates
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 754281
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6440042



Plate 40 – Soil Profile (E1)



Plate 41 – Surface (E1)



Plate 42 – Landscape (E1)

Horizon	Depth (m)	Description				
A1	0.00 – 0.15	Very dark brown (Munsell 7.5YR 2.5/2) Loam with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.				
A2	0.15 – 0.50	Brown (Munsell 10YR 4/3 to 5/3) Loam to Clay Loam with weak structure and weak consistence. Very strongly to slightly acidic pH, non-saline and sodic. Nil coarse fragments. Few fine roots and poorly drained. Clear boundary.				
B2	0.50 – 1.00+	Yellowish brown (Munsell 10YR 5/4) Light-medium Clay with moderate pedality and firm consistence. slightly acidic pH, non-saline and sodic. Nil coarse fragments. Trace roots and moderately drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	5.29	Strongly acidic	1.2	Non-Sodic
0.20-0.30	0.4	Non-saline	4.84	Very strongly acidic	2.4	Non-Sodic
0.40-0.50	0.1	Non-saline	6.13	Slightly acidic	5.3	Non-Sodic
0.65-0.75	0.3	Non-saline	6.04	Slightly acidic	8.5	Sodic



Site Description – Site E2				
Site Reference	E2	ASC Name	Acidic Paralithic Bleached Orthic Tenosol (BEKLW)	
Average Slope	2%	Land Use	Native Bush	Coordinates
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 751691
Surface Condition	Loose Sand	Mapped as BSAL	Not Applicable	Y: 6436409



Plate 43 – Soil Profile (E2)



Plate 44 – Surface (E2)



Plate 45 – Landscape (E2)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 10YR 3/3) Sand with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.10 – 0.40	Pink (Munsell 7.5YR 7/3) Sand with apedal structure and very weak consistence. Strongly acidic pH, non-saline and strongly sodic. Nil coarse fragments. Few fine roots and moderately drained. Gradual boundary.
B	0.40 – 0.80+	Pale brown to light brownish grey (Munsell 10YR 6/3 to 6/2) Loamy Sand to Sandy Loam with apedal structure and very weak consistence. Slightly acidic to mildly alkaline pH, non-saline and strongly sodic. Nil coarse fragments. Few fine roots and moderately drained. Layer continues.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	2.6	Non-saline	5.85	Moderately Acidic	4.1	Non sodic
0.20-0.30	0.8	Non-saline	5.08	Strongly Acidic	17	Strongly Sodic
0.40-0.50	0.2	Non-saline	6.35	Slightly Acidic	22	Strongly Sodic
0.65-0.75	0.4	Non-saline	7.44	Mildly Alkaline	25	Strongly Sodic



Site Description – Site E3				
Site Reference	E3	ASC Name	Mottled-Sodic Eutrophic Grey Dermosol (BFMMW)	
Average Slope	1%	Land Use	Grassland (Near Dam Spillway)	Coordinates
Site Morphology	Drainage Line	Soil Fertility	Moderately Low	MGA 55
Landform Element	Open Depression	BSAL Site Status	Not Applicable	X: 753046
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6439265



Plate 46 – Soil Profile (E3)



Plate 47 – Surface (E3)



Plate 48 – Landscape (E3)

Horizon	Depth (m)	Description				
A1	0.00 – 0.10	Very dark brown (Munsell 10YR 2/2) Clay Loam with strong pedality and moderate consistence. Mildly alkaline pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.				
A2	0.10 – 0.30	Grey (Munsell 2.5YR 5/1) Silty Loam with moderate structure and moderate consistence. Moderately acidic pH, non-saline and sodic. Nil coarse fragments. Few fine roots and poorly drained. Gradual boundary.				
B2	0.30 – 0.80+	Grey (Munsell 10YR 6/1) Silty Clay Loam to Sandy Clay Loam with moderate pedality and firm consistence. slightly acidic pH, non-saline and sodic. Nil coarse fragments. Trace roots and poorly drained.				
Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	7.69	Mildly Alkaline	4.3	Non sodic
0.20-0.30	0.2	Non-saline	5.51	Moderately Acidic	6.0	Sodic
0.40-0.50	0.2	Non-saline	6.27	Slightly Acidic	7.5	Sodic
0.65-0.75	0.6	Non-saline	6.13	Slightly Acidic	8.9	Sodic



Site Description – Site E4						
Site Reference	E4	ASC Name	Acidic Paralithic Brown Orthic Tenosol (BEKLW)			
Average Slope	1%	Land Use	Partial Cleared Native Bush	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 752984		
Surface Condition	Soft/Sandy	Mapped as BSAL	Not Applicable	Y: 6439813		




Plate 49 – Soil Profile (E4)




Plate 50 – Surface (E4)




Plate 51 – Landscape (E4)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 7.5YR 3/3) Loamy Sand with apedal structure and very weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
A2	0.10 – 0.75	Dark yellowish brown to Light yellowish brown (Munsell 10YR 4/4 to 6/4) Loamy Sand with apedal structure and very weak consistence. Moderately acidic to slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. few fine roots and moderately drained. Clear boundary.
B2	0.75 – 1.00+	Light grey (Munsell 2.5Y 7/1) Sandy Loam with moderate pedality and firm consistence. Neutral pH, non-saline and sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	5.40	Strongly Acidic	3.6	Non sodic
0.20-0.30	0.1	Non-saline	5.59	Moderately Acidic	4.5	Non sodic
0.40-0.50	0.1	Non-saline	5.65	Moderately Acidic	3.9	Non sodic
0.65-0.75	0.2	Non-saline	6.22	Slightly Acidic	5.2	Non sodic
0.85-0.95	0.4	Non-saline	6.69	Neutral	13	Sodic



Site Description – Site E5					
Site Reference	E5 (Check site)	ASC Name	Sodic Eutrophic Brown Dermosol (AFOOW)		
Average Slope	2%	Land Use	Grassland (previously Cultivated)	Coordinates	
Site Morphology	Mid Slope	Soil Fertility	Moderate	MGA 55	
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 753598	
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6439813	



Plate 52 – Soil Profile (E5)



Plate 53 – Surface (E5)




Plate 54 – Landscape (E3)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 10YR 3/3) Light Clay with strong pedality and moderate consistence. Strongly acidic pH, slightly saline and sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
B2	0.10 – 0.30+	Yellowish brown (Munsell 10YR 5/6) Heavy Clay with moderate pedality and firm consistence. Neutral pH, slightly saline and sodic. Nil coarse fragments. Trace roots and moderately drained.

Sample Depth	ECe		pH(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	2.1	Slightly saline	5.37	Strongly Acidic	8.9	Sodic
0.20-0.30	2.0	Slightly saline	6.52	Neutral	11	Sodic



Site Description – Site E6						
Site Reference	E6	ASC Name	Manganic Paralithic Brown Orthic Tenosol (BEKLW)			
Average Slope	1%	Land Use	Native Bush	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 755882		
Surface Condition	Soft/Sandy	Mapped as BSAL	Not Applicable	Y: 6440327		




Plate 55 – Soil Profile (E6)




Plate 56 – Surface (E6)




Plate 57 – Landscape (E6)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark yellowish brown (Munsell 10YR 4/4) Loamy Sand with weak structure and weak consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
A2	0.20 – 0.55	Brown (Munsell 10YR 5/3) Loamy Sand with apedal structure and very weak consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments. few fine roots and poorly drained. Gradual boundary.
B2	0.55 – 1.00+	Yellowish brown (Munsell 10Y 5/6) Loam with moderate pedality and moderate consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments, 5% Manganese nodules. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1:5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.1	Non-saline	6.38	Slightly Acidic	1.6	Non sodic
0.25-0.35	0.4	Non-saline	6.93	Neutral	3.9	Non sodic
0.60-0.70	0.2	Non-saline	6.91	Neutral	2.9	Non sodic



Site Description – Site E7						
Site Reference	E7	ASC Name	Haplic Eutrophic Black Dermosol (BFLU)			
Average Slope	9%	Land Use	Partially cleared for Grazing	Coordinates		
Site Morphology	Midslope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 756286		
Surface Condition	Firm	Mapped as BSAL	Not Applicable	Y: 6440060		




Plate 58 – Soil Profile (E7)




Plate 59 – Surface (E7)




Plate 60 – Landscape (E7)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark brown (Munsell 10YR 2/2) Loam with strong structure and moderate consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.20 – 0.30	Very dark greyish brown (Munsell 10YR 3/2) Sandy Loam with strong structure and moderate consistence. Neutral pH, non-saline and non-sodic. Nil coarse fragments. few fine roots and moderately drained. Clear boundary.
C	0.30 +	Weathered Basalt

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.1	Non-saline	6.38	Slightly Acidic	1.6	Non sodic
0.25-0.35	0.4	Non-saline	6.93	Neutral	3.9	Non sodic



Site Description – Site E8						
Site Reference	E8	ASC Name	Mottled Eutrophic Yellow Chromosol (CEKMW)			
Average Slope	3%	Land Use	Grassland	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 756987		
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6440481		




Plate 61 – Soil Profile (E8)




Plate 62 – Surface (E8)




Plate 63 – Landscape (E8)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 10YR 3/3) Loamy Sand with weak pedality and weak consistence. Strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.10 – 0.60	Yellowish brown to Light yellowish brown (Munsell 10YR 5/4 to 6/4) Loamy Sand with apedal structure and very weak consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and poorly drained. Clear boundary.
B2	0.60 – 1.00+	Brownish yellow (Munsell 10YR 6/6) Sandy Clay Loam with moderate pedality and firm consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.5	Non-saline	5.43	Strongly Acidic	1.6	Non sodic
0.20-0.30	0.2	Non-saline	6.16	Slightly Acidic	3.3	Non sodic
0.40-0.50	0.2	Non-saline	6.48	Slightly Acidic	5.1	Non sodic
0.65-0.75	0.2	Non-saline	5.70	Moderately Acidic	2.3	Non sodic



Site Description – Site E9					
Site Reference	E9	ASC Name	Sodic Eutrophic Yellow Chromosol (AHL0W)		
Average Slope	7%	Land Use	Grassland	Coordinates	
Site Morphology	Mid slope	Soil Fertility	Moderate	MGA 55	
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 756859	
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6441184	




Plate 64 – Soil Profile (E9)




Plate 65 – Surface (E9)







Plate 66 – Landscape (E9)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark brown (Munsell 10YR 2/2) Loam with moderate pedality and moderate consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Some surface rocks. Many fine roots and moderately drained. Sharp boundary.
B2	0.10 – 0.80+	Brownish yellow (Munsell 10YR 6/8) Heavy Clay with strong pedality and firm consistence. Moderately alkaline to neutral pH, non-saline and non-sodic to sodic at depth. Nil coarse fragments. Trace roots and moderately drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.0	Non-saline	6.22	Slightly Acidic	1.0	Non sodic
0.20-0.30	0.2	Non-saline	7.91	Moderately Alkaline	2.1	Non sodic
0.40-0.50	0.4	Non-saline	7.01	Neutral	4.7	Non sodic
0.65-0.75	2.8	Slightly saline	8.14	Moderately Alkaline	7.4	Sodic



Site Description – Site E10						
Site Reference	E10	ASC Name	Haplic Magnesic Red Chromosol (AHLOW)			
Average Slope	4%	Land Use	Native Bush	Coordinates		
Site Morphology	Mid slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 756230		
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6441019		




						
<p>Plate 67 – Soil Profile (E10)</p>			<p>Plate 68 – Surface (E10)</p>			
			<p>Plate 69 – Landscape (E10)</p>			

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark brown (Munsell 10YR 3/3) Loam with moderate pedality and moderate consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Some surface rocks. Many fine roots and moderately drained. Clear boundary.
B2	0.10 – 0.30+	Yellowish red (Munsell 5YR 5/8) Medium Clay with strong pedality and firm consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Trace roots and moderately drained.

Sample Depth	ECe		pH _(1-5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.6	Non-saline	5.68	Moderately Acidic	5.7	Non sodic
0.20-0.30	0.8	Non-saline	5.75	Moderately Acidic	5.4	Non sodic



Site Description – Site E11						
Site Reference	E11	ASC Name	Mottled Magnesic Red Chromosol (BGLOV)			
Average Slope	1%	Land Use	Cleared Native Bush	Coordinates		
Site Morphology	Crest	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillcrest	BSAL Site Status	Not Applicable	X: 753401		
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6433093		

						
Plate 70 – Soil Profile (E11)			Plate 71 – Surface (E11)			
						
Plate 72 – Landscape (E11)						

Horizon	Depth (m)	Description
A1	0.00 – 0.15	Dark brown (Munsell 7.5YR 3/3) Sandy Loam with weak pedality and weak consistence. Moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Clear boundary.
A2	0.15 – 0.30	Strong brown (Munsell 7.5YR 4/6) Gravelly Loam with apedal structure and very weak consistence. Moderately acidic pH, non-saline and non-sodic. 70% coarse fragments (10mm). Few fine roots and moderately drained. Clear boundary.
B2	0.30 – 0.70	Yellowish red to reddish yellow (Munsell 5YR 5/8 to 7.5YR 6/6) Heavy Clay with strong pedality and firm consistence. Slightly acidic pH, non-saline and non-sodic. Nil coarse fragments. Trace roots and moderately drained.
C	0.70+	Weathered Sandstone

Sample Depth	ECe		pH _(1:5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.4	Non-saline	5.58	Moderately Acidic	1.4	Non sodic
0.20-0.30	0.1	Non-saline	5.79	Moderately Acidic	2.8	Non sodic
0.40-0.50	0.1	Non-saline	6.27	Slightly Acidic	5.2	Non sodic
0.65-0.75	0.1	Non-saline	6.08	Slightly Acidic	4.1	Non sodic



Site Description – Site E12						
Site Reference	E12	ASC Name	Mottled Magnesian Grey Chromosol (DGKNW)			
Average Slope	2%	Land Use	Native Bush	Coordinates		
Site Morphology	Lower slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 752296		
Surface Condition	Soft	Mapped as BSAL	Not Applicable	Y: 6433191		




Plate 73 – Soil Profile (E12)




Plate 74 – Surface (E12)




Plate 75 – Landscape (E12)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark greyish brown (Munsell 10YR 3/2) Sand with weak pedality and weak consistence. Very strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and well drained. Gradual boundary.
A2	0.20 – 0.80	Greyish brown (Munsell 10YR 5/2) Sand with apedal structure and very weak consistence. Strongly to moderately acidic pH, non-saline and non-sodic. Nil coarse fragments. Few fine roots and moderately drained. Clear boundary.
B2	0.80 – 1.00+	Light Grey (Munsell 10YR 7/1) Sandy Clay Loam with moderate pedality and firm consistence. Moderately acidic pH, non-saline and non-sodic. 20% coarse fragments 10-20mm. Trace roots and poorly drained.

Sample Depth	ECe		pH _(1:5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.4	Non-saline	4.95	Very Strongly Acidic	3.8	Non sodic
0.20-0.30	0.2	Non-saline	5.44	Strongly Acidic	3.9	Non sodic
0.40-0.50	0.2	Non-saline	5.74	Moderately Acidic	5.6	Non sodic
0.80-0.90	0.3	Non-saline	5.55	Moderately Acidic	5.5	Non sodic



Site Description – Site E13						
Site Reference	E13	ASC Name	Acidic Paralithic Brown Orthic Tenosol (BGKLW)			
Average Slope	4%	Land Use	Native Bush	Coordinates		
Site Morphology	Mid slope	Soil Fertility	Moderately Low	MGA 55		
Landform Element	Hillslope	BSAL Site Status	Not Applicable	X: 752222		
Surface Condition	Loose/Sandy	Mapped as BSAL	Not Applicable	Y: 6432903		




Plate 76 – Soil Profile (E13)




Plate 77 – Surface (E13)




Plate 78 – Landscape (E13)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark brown (Munsell 10YR 3/3) Sand with weak structure and weak consistence. Very strongly acidic pH, non-saline and non-sodic. Nil coarse fragments. Many fine roots and moderately drained. Gradual boundary.
A2	0.20 – 0.90	Dark yellowish brown (Munsell 10YR 4/4) Sandy Loam to Sand with apedal structure and very weak consistence. Very strongly acidic to moderately acidic pH, non-saline to highly saline and non-sodic. Nil coarse fragments. few fine roots and moderately drained. Layer continues.

Sample Depth	ECe		pH _(1.5water)		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.3	Non-saline	4.91	Very Strongly Acidic	0.87	Non sodic
0.20-0.30	0.1	Non-saline	4.75	Very Strongly Acidic	0.60	Non sodic
0.40-0.50	0.3	Non-saline	4.75	Very Strongly Acidic	0.41	Non sodic
0.65-0.75	15.4	Highly saline	5.94	Moderately Acidic	0.60	Non sodic



Appendix 3

Site Verification Certificate (SVC 19199244)



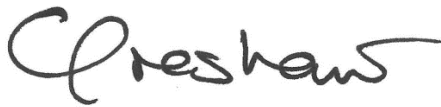
Site Verification Certificate
Ulan Coal Mine Expansion – Modification 6 (SVC 19199244)

Part 4AA, Division 3 of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*

Pursuant to clause 17C(1) of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*, I determine the application made by Ulan Coal Mines Pty Ltd by issuing this certificate.

I certify that in my opinion, having regard to the criteria in the *Interim Protocol for site verification and mapping of biophysical strategic agricultural land*, the land specified in Schedule 1 identified as “BSAL Project Application Area” is not Biophysical Strategic Agricultural Land.

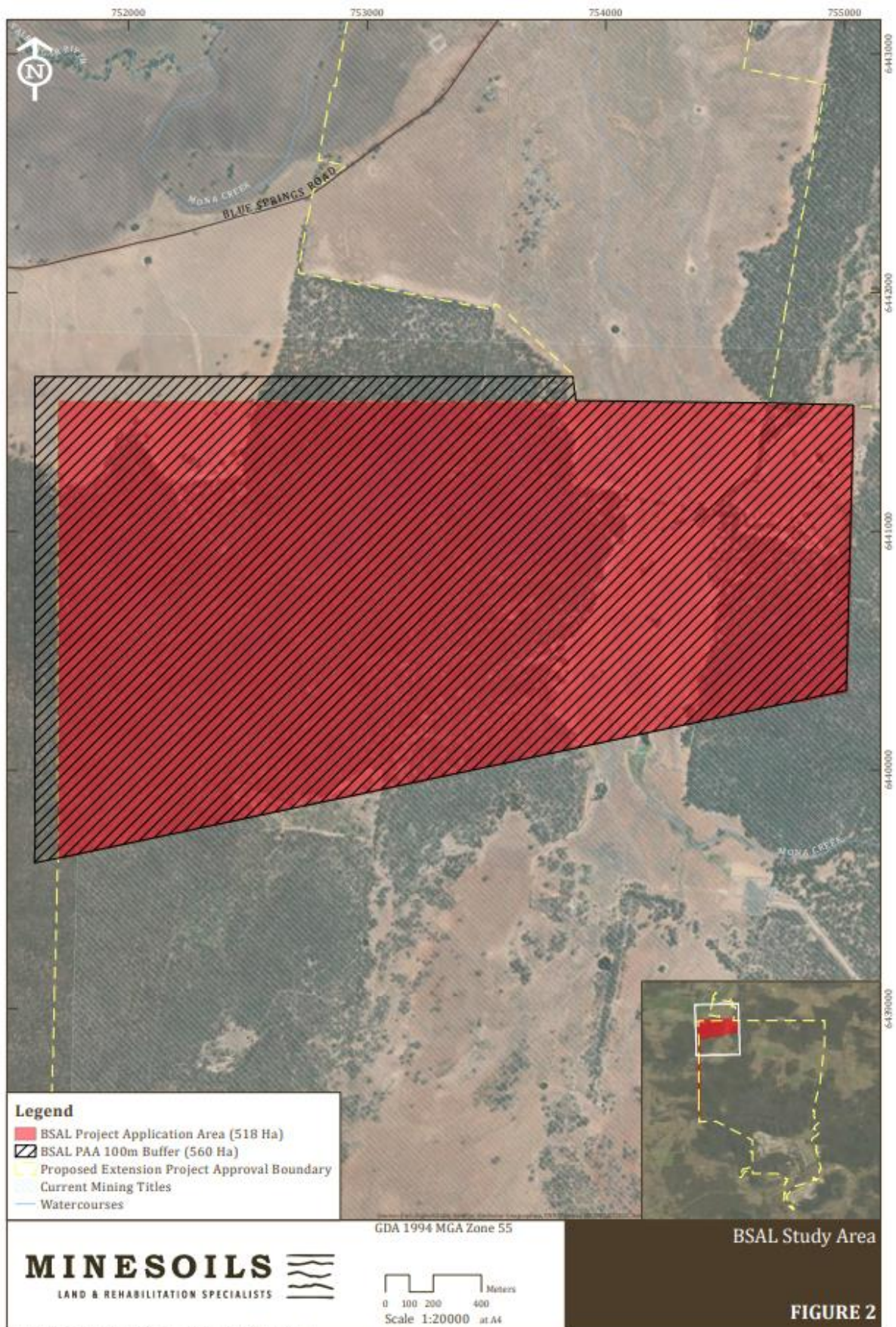
The reasons for forming the opinion on each of the relevant criteria are contained in Schedule 2.



Clay Preshaw
Executive Director Energy, Resources and Industry Assessments
as delegate for the Planning Secretary

Date certificate issued: 05/07/2021

SCHEDULE 1



SCHEDULE 2

Relevant criteria	Consideration
Slope >10 %	Around 106 hectares of the application area includes slopes > 10% and a further 8.6 hectares (ha) were areas surrounded by steep slopes but less than 20 ha contiguous.
Soil types	<p>No areas within the application area qualified as BSAL due to insufficient soil fertility, drainage, rock outcrops and/or depth to physical or chemical (sodicity) barriers.</p> <p>The Department's soil science experts confirmed that the soil data provided was consistent with the protocol and with its soil survey data for the area, and that the application area was not likely to contain BSAL.</p>