

KINGSDALE

Biophysical Strategic Agricultural Land Verification Assessment

Prepared for:
Ironstone Property

SLR Ref: 630.30409
Version No: v1.0
November 2022

SLR 

PREPARED BY

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BASIS OF REPORT

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

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.30409	November 2022	Murray Fraser	Rod Masters	Murray Fraser

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EXECUTIVE SUMMARY

SLR Consulting has been commissioned by Ironstone to complete a Biophysical Strategic Agricultural Land (BSAL) Verification Assessment. The land that will be subject to this application is referred to as the Study Area and comprises 51 hectares.

This BSAL Verification Assessment has been prepared in accordance with the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (the Interim Protocol) (OEH, 2013).

This BSAL Verification Assessment provides a detailed description of the fieldwork, laboratory results, as well as an assessment of each site for the presence of BSAL against the Interim Protocol BSAL assessment criteria. Two soil map units (SMUs) were identified in the Study Area, each were mapped according to the dominant Australian Soil Classification soil type using a combination of the soil survey and laboratory analysis results.

The identification of BSAL was based on the dominant soil type within each SMU. In accordance with the Interim Protocol, the outcomes of this BSAL Verification Assessment are as follows, and are summarised in **Table ES-1**:

- Land with greater than or equal to 10% slope (i.e., an exclusion area) accounted for 17 hectares of the Study Area and was excluded as potential BSAL.
- Land with slope less than 10%, but with less than 20 hectares of contiguous area (i.e. an exclusion area) accounted for 2 hectares of the Study Area and was excluded as potential BSAL.
- Land with greater than 30% rock outcrop (i.e. an exclusion area) accounted for less than one hectare of the Study Area and was excluded as potential BSAL.
- Two SMUs, an Epipedal Black Vertosol and a Grey-Brown Subnatric Sodosol, accounting for 32 hectares of the Study Area (i.e. outside of the exclusion areas), were verified as non-BSAL.

Table ES-1 BSAL Verification Assessment Summary

Soil Survey BSAL Verification Assessment	Hectares
Verified BSAL	Nil
Verified Non-BSAL	32
BSAL Exclusion Area	19
BSAL Verification Assessment Total	51

This BSAL Verification Assessment has verified that the entire Study Area of 51 hectares is non-BSAL.

1 Introduction

Ironstone Property Group is a privately owned real estate / property development company that focus on investment and delivery of quality projects within the regional town centers of NSW.

The proposed development site is located within the Goulburn Mulwaree LGA and has been identified as a logical housing expansion site nominated within the Urban and Fringe Housing Strategy. The Urban and Fringe Housing Strategy was endorsed and adopted by Goulburn Mulwaree Council on the 21st July 2020.

This Urban and Fringe Housing Strategy investigates and identifies areas suitable for the provision of additional housing to assist Goulburn Mulwaree Council meet the housing demands generated by expected continued population growth. The Strategy has been prepared in response to both the limited supply of residential land available to meet the short and medium term needs of the community and the directions of the South-East and Tablelands Regional Plan 2036.

The proposed development is approximately 2 kilometers north-west of the Goulburn town center and the site directly adjoins a small lot housing estate to the south-east. (**Figure 1** and **Figure 2**). The Study Area comprises 450 Crookwell Road Lot 70 DP1006688 and 457 Crookwell Road Lot 73 DP1006688, a total of 51 hectares.

Correspondence received from Goulburn Mulwaree City Council from the NSW Department of Primary Industries (OUT22/7138) on 6th June 2022 stated *“Assessing the BSAL status of the land, however, might be best addressed by undertaking a site verification as per the of the Interim protocol for site verification and mapping of biophysical strategic agricultural land (section 12, Appendix 1). Although the protocol for BSAL verification was developed to provide guidance to the mining industry, it can also be used to clarify the BSAL status of land for other developments.”* There is 24 hectares of regionally mapped BSAL within the Study Area (**Figure 2**).

SLR has been commissioned by Ironstone Property to complete a BSAL Verification Assessment to support the development. The land that will be subject to this application is referred to as the BSAL Verification Assessment Area.

This BSAL Verification Assessment provides an assessment of the Study Area in accordance with the Interim Protocol (OEH, 2013) and accompanies the application for the development.

1.1 Study Area

The Study Area is 51 hectares and is shown on **Figure 2**. A 100 metre buffer was not included in the BSAL Verification Assessment Area as this is not a mining application and does not require a Site Verification Certificate.

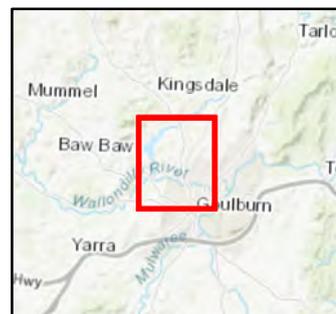


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- Roads
- Watercourse
- Study Area



KINGSDALE SOILS AND BSAL ASSESSMENT

**Locality and Site Verification
 Certificate Application Area**



Data Sources:
 NSW Spatial Information Exchange,
 Nearmap Imagery WMS (Sept 2022)

FIGURE 1

1.2 Legislation and Standards

1.2.1 Interim Protocol for Site Verification and Mapping of BSAL

The *State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013* (the 2013 Mining SEPP amendment) requires certain types of developments to verify whether the proposed site contains BSAL (OEH, 2013). The Interim Protocol outlines the process for seeking verification of whether or not land mapped as BSAL meets the established BSAL criteria.

BSAL 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 (OEH, 2013).

1.2.2 Assessment Standards

The key standards for this assessment include:

- The Interim Protocol;
- Australian Soil Classification (ASC) system (Isbell, 2002);
- Guidelines for Surveying Soil and Land Resources (National Committee on Soil and Terrain, 2008); and
- Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009).

2 Methodology

The BSAL verification methodology for the Study Area has been undertaken consistent with the process described within the Interim Protocol; including the following steps:

- Identify the area (i.e. the Study Area) which will be assessed for BSAL;
- Confirm access to a reliable water supply;
- Choose the appropriate approach to map the soils information;
- Undertake a risk assessment; and
- Undertake field soil surveys and BSAL verification assessment.

Each of these steps is described in further detail in the following subsections.

2.1 Step 1: Identify the Project which will be Assessed for BSAL

The Interim Protocol requires that *“the assessment area should include the entire project area and include at least a 100 metre buffer to take into account minor changes in design, surrounding disturbance and minor expansion. If BSAL is part of a larger contiguous mass of BSAL then the boundary of this area must also be identified.”*

The Study Area for the BSAL Verification Assessment is approximately 51 hectares and shown on **Figure 2**. The Study Area does not include a 100 metre buffer around the BSAL Verification Assessment Area.

2.2 Step 2: Confirm Access to a Reliable Water Supply

The Interim Protocol requires that *“BSAL lands must have access to a ‘reliable water supply’”,* which includes rainfall of 350 millimetres or more per annum in 9 out of 10 years.

The Study Area is located in Goulburn (NSW) with an average annual rainfall of 658 millimetres (BOM, 2022), and therefore has access to a “reliable water supply”.

2.3 Step 3: Choose the Appropriate Approach to Map the Soils Information

The Interim Protocol states *“access to the project area will define the level of investigation that the proponent can undertake. If the proponent has access to the land then the BSAL verification requirements for on-site soils assessment as described in sections 6 and 9 of the Interim Protocol should be met. If the proponent does not have access then the proponent should develop a model of soils distribution guided by sections 6 and 9 based on landscape characteristics using the information listed in Section 5 of the Interim Protocol.”*

Access was limited in some portions of the Study Area due to proximity to drainage lines and boggy/waterlogged ground. Some assessment sites were relocated away from these features in revised locations that were still be representative of the surrounding soil unit for mapping and assessment.

2.4 Step 4: Risk Assessment

The Interim Protocol states *“the proponent should undertake a risk assessment as this will influence the density of soil sampling required as explained in Section 9.6.1. The proposed activity on parts or all of the project area may be of low risk to agriculture and so may only require a sampling density of 1:100 000. Alternatively other areas may be at higher risk of impact and so should have a sampling density of 1:25 000.”*

A minimum inspection density of 1:25,000 has been conservatively adopted across the Study Area.

2.5 Step 5: Field Soil Survey and BSAL Verification Assessment

The field survey for the BSAL Verification Assessment was undertaken on the 2nd September 2022, by SLR’s Principal Agronomist Murray Fraser, and overseen by SLR’s Technical Director Rod Masters (CPSS-3).

During the week prior to the field survey (26th August – 1st September) 14.8 millimetres of rain was recorded at Goulburn TAFE (Bureau of Meteorology site 70263). Lands surrounding the Study Area were not able to be accessed at the time of the field survey.

2.6 Field Soil Survey Methodology

For soil to be classified as BSAL it must meet the criteria outlined in the flow chart shown in **Diagram 1**. If any criterion is not met (except for those outlined in step 5 or step 6), the site is not BSAL (OEH, 2013).

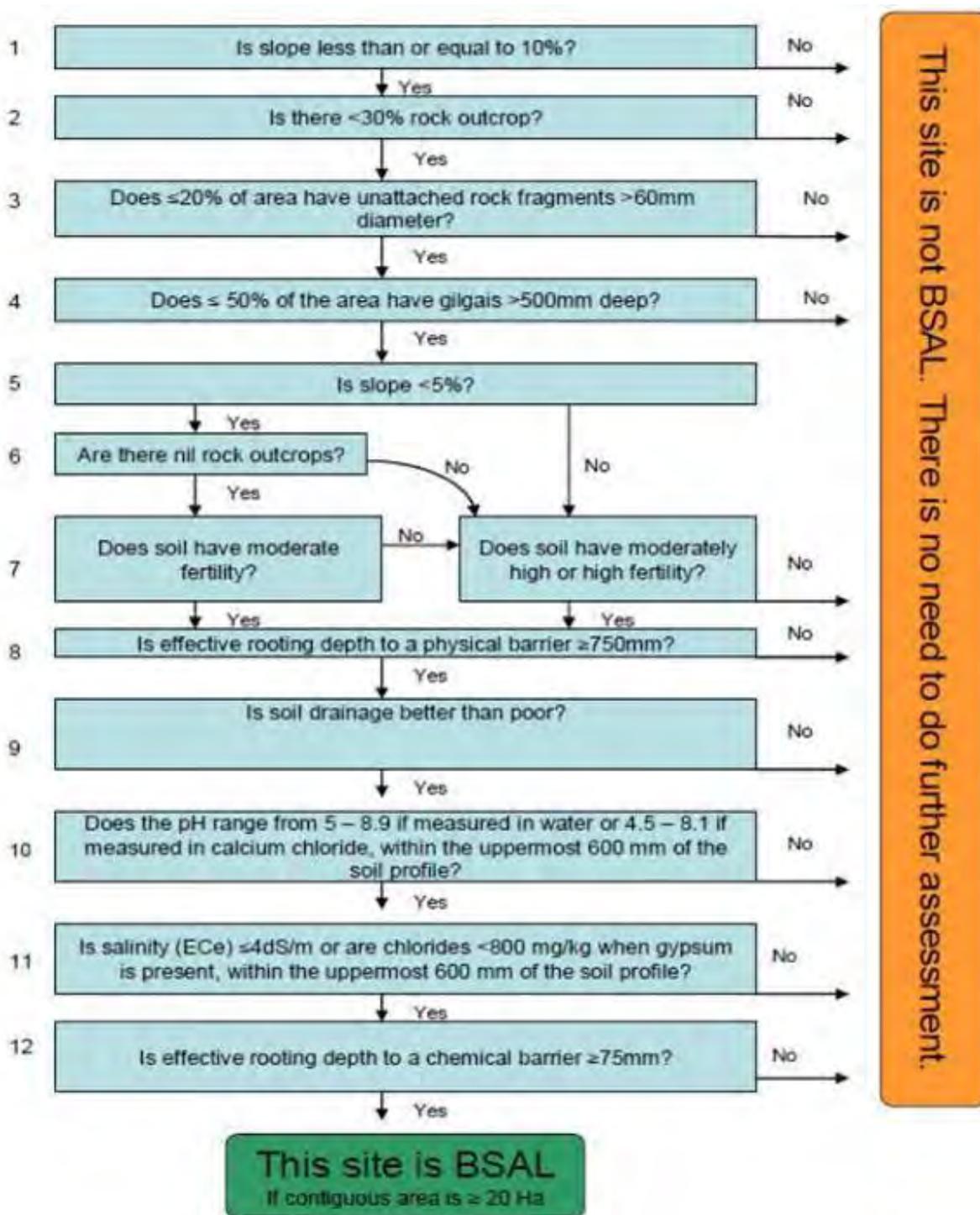
Section 6 of the Interim Protocol states *“slope is the upward or downward incline of the land surface, measured in per cent. BSAL soils must have a slope of less than or equal to 10 per cent. If any criteria are not met, the site is not BSAL and there is no need to continue the assessment”*.

The design of the soil survey program was initially developed by desktop review of the Study Area against the BSAL methodology to identify any areas that could not meet the criteria (i.e. an exclusion area). Subsequently, the field survey program was developed to target the areas that were mapped as BSAL or could potentially meet BSAL criteria (i.e. non-exclusion areas).

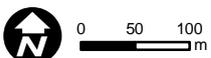
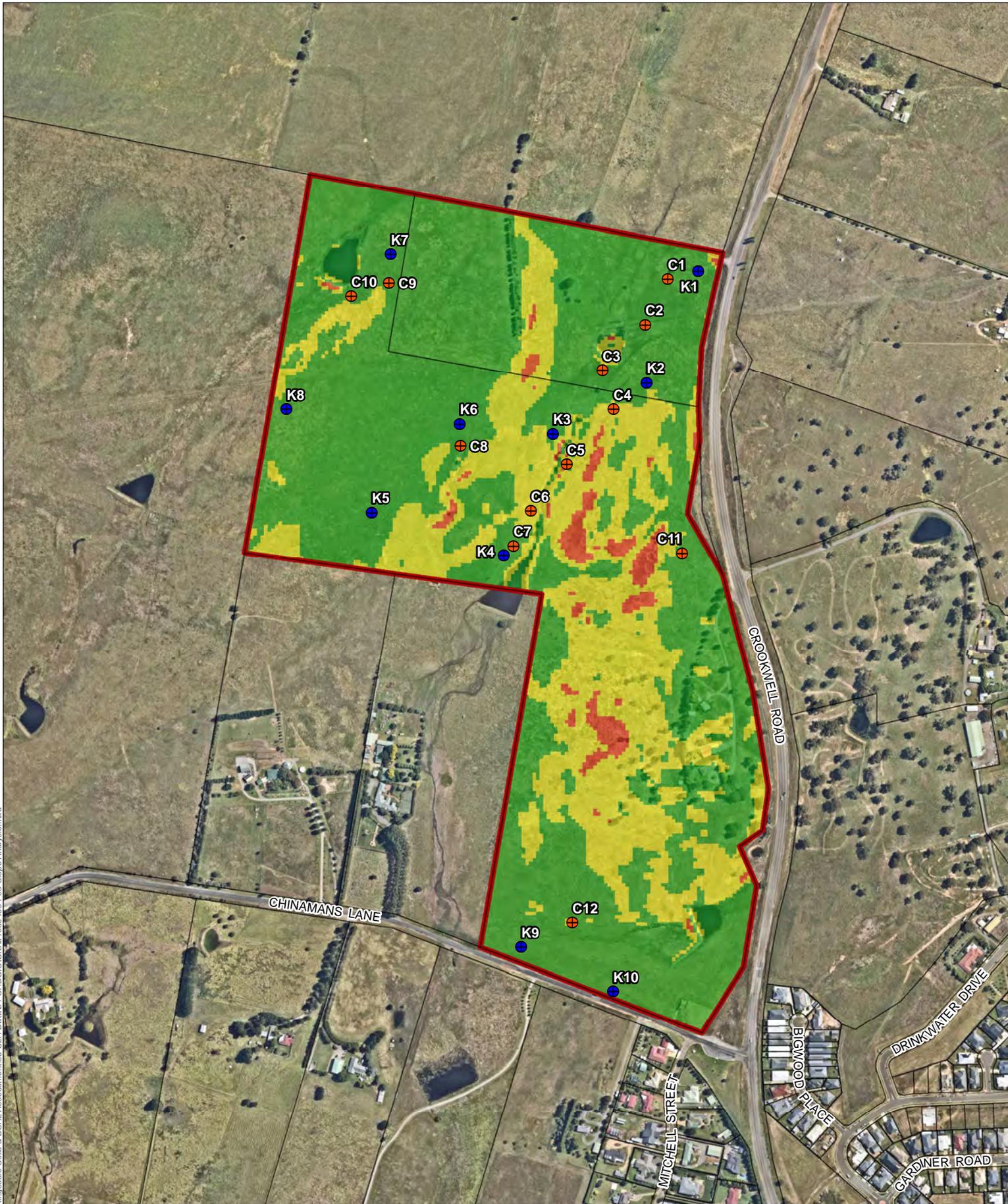
2.6.1.1 Exclusion Areas

Land greater than or equal to 10% slope within the Study Area was identified using topographical data derived from NSW Government data. Areas with greater than or equal to 10% slope were excluded from the soil survey program, along with any areas which were less than 10% slope and also less than 20 hectares in contiguous area. For the areas that were excluded because they were less than 10% slope and also less than 20 hectares in contiguous area, slope mapping outside of the Study Area was reviewed to confirm that these areas did not form part of a larger area greater than 20 hectares. In total, 17 hectares of the Study Area was determined not to meet the BSAL methodology Criteria 1, as shown in **Diagram 1** and on **Figure 3**. The slope analysis methodology is provided in **Appendix A**.

Diagram 1 Interim Protocol BSAL Criteria Flow Diagram



Note: In applying step 12 it was assumed that the effective rooting depth to a chemical barrier of ≥75 mm was incorrect as stated in Diagram 1, and instead a value of ≥750 mm was adopted as stated in Section 6.10 of the Interim Protocol. Where soil profiles fail BSAL criteria they are shown in red font in the detailed description.



Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:7,000 at A4
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- Check Sites
- Detailed Sites
- Study Area
- Cadastre

- Slope %**
- 0 - 10
 - 10 - 20
 - > 20

KINGSDALE SOILS AND BSAL ASSESSMENT

Slope Analysis



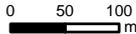
Data Sources:
 SLR IGIS field capture Soil Sites, Slope data derived from NSW Government Spatial Services - DFSI GOULBURN 1 metre resolution DEM, NSW Spatial Information Exchange, Nearmap Imagery WMS (Sept 2022)

FIGURE 3

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Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:7,000 at A4
 Project Number: 630.30409
 Date: 19-Oct-2022
 Drawn by: JG

-  Check Sites
-  Detailed Sites
-  Study Area
-  Cadastre
-  BSAL Exclusion Zone - Slope >10%
-  BSAL Exclusion Zone - <20 ha Contiguous

KINGSDALE SOILS AND BSAL ASSESSMENT

BSAL Exclusion Areas

Data Sources:
 Slope data derived from NSW Government Spatial Services - DFSI GOULBURN
 1 metre resolution DEM, NSW Spatial Information Exchange, Nearmap Imagery WMS (Sept 2022)



FIGURE 4

2.6.1.2 Soil Survey Density

To satisfy (and exceed) BSAL soil mapping requirements a total of 22 sites were assessed, comprising 10 detailed sites and 12 check/exclusion sites within the Study Area, as shown on **Figure 3**. A breakdown of the soil survey density, in accordance with the requirements of the Interim Protocol, is provided in **Table 1**.

Table 1 Assessment of Soil Survey Density

Category	Study Area
Total Study Area Hectares	51
BSAL Exclusion Zone (Greater Than 10% Slope) Hectares	17
BSAL Exclusion Zone (Less Than 20 Hectares Contiguous)	2
BSAL Exclusion Zone (Greater than 30% rock outcrop) Hectares	<1
BSAL Survey Area Hectares	32
Survey Density and Laboratory Analysis	BSAL Survey Area
1:25,000 Survey Area Hectares	32
1:25,000 Survey Density Target	Minimum 3 Required Sites
Actual Sites Surveyed	10 Detailed and 12 Check Sites
Laboratory Analysed Sites	8

2.6.1.3 Soil Survey Observation Types

Soil profiles were assessed at the 22 sites in accordance with the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). Each soil-profile exposure was excavated by a backhoe to either a depth of 1 metre, to equipment refusal, or to bedrock.

Detailed soil profile morphological descriptions were prepared at all sites to record the information specified in the Interim Protocol. Information was recorded for the major parameters specified in **Table 2**.

Global Positioning System (GPS) readings were taken for all sites with soil descriptions. Vegetation type, landform and aspect were also noted. Soil exposures from soil test pits were photographed during field operations.

A total of 22 sites were evaluated within the Study Area, giving one site observation per 1.5 hectares. Of the 22 sites, 10 were detailed sites (prefixed with K) and 12 were check sites (prefixed with C).

Check sites are mapping observations examined in sufficient detail to allocate the site to a specific soil type and map unit.

For detailed sites, soil was collected from each major soil horizon (soil layer). After assessment, soil test pits were backfilled with the remaining soil.

Table 2 Field Assessment Parameters

Descriptor	Application
Horizon depth	Weathering characteristics, soil development
Field colour	Permeability, susceptibility to dispersion/erosion
Field texture grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary distinctness and shape	Erosional/dispositional status, textural grade
Consistence force	Structural stability, dispersion, ped formation
Structure pedality grade	Soil structure, root penetration, permeability, aeration
Structure ped and size	Soil structure, root penetration, permeability, aeration
Stones – amount and size	Water holding capacity, weathering status, erosional/depositional character
Roots – amount and size	Effective rooting depth, vegetative sustainability
Ants, termites, worms etc.	Biological mixing depth

Soil samples from 8 detailed sites were utilised in the BSAL laboratory testing program. Samples were analysed in order to classify ASC (Isbell, 2002) soil taxonomic class and to enable BSAL verification.

Soil collected from each major soil horizon (soil layer) was sent to a National Association of Testing Authorities Australia accredited laboratory (Environmental Analysis Laboratory) for analysis. The selected physical and chemical laboratory analysis properties and their relevant application are listed in **Table 3**.

Table 3 Laboratory Analysis Parameters

Property	Application
Coarse Fragments (>2mm)	Soil workability; root development
Particle-Size Distribution (<2mm)	Determine fraction of clay, silt, fine sand and coarse sand; nutrient retention; exchange properties; erodibility; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Soil Reaction (pH)	Nutrient availability; nutrient fixation; toxicities (especially aluminium and manganese); liming; Sodicity; correlation with other soil properties
Electrical Conductivity (EC)	Appraisal of salinity hazard in soil substrates or groundwater; total soluble salts
Cation Exchange Capacity (CEC) & Exchangeable Cations	Nutrient status; calculation of exchangeable cations including sodium, calcium, magnesium, potassium and exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
Munsell Colour Chart (Munsell)	Drainage, oxidation, fertility, correlation with other physical, chemical and biological properties

Soil salinity in the samples from the detailed sites was determined through measurement of the EC of soil:water (1:5) suspensions. These values were converted to the EC of a saturated extract (EC_e) based on soil texture in accordance with the Interim Protocol.

3 Soil Assessment

Two soil map units (SMUs) were identified in the Study Area and were mapped according to the dominant ASC soil type (**Figure 4**) using a combination of the soil survey and laboratory analysis results. These two SMUs and the detailed and check sites associated with each SMU are shown below in **Table 4** and **Table 5**.

Table 4 Soil Map Unit Summary

SMU	ASC Soil Type	Detailed Site	Check Site	Hectares
1	Epipedal Black Vertosol	K1, K2, K3, K4	C1, C2, C3, C4, C5, C6, C7, C8, C11	11
2	Grey-Brown Subnatric Sodosol	K5, K6, K7, K8, K9, K10	C9, C10, C12	21
Total				32

Table 5 ASC Soil Types within Study Area

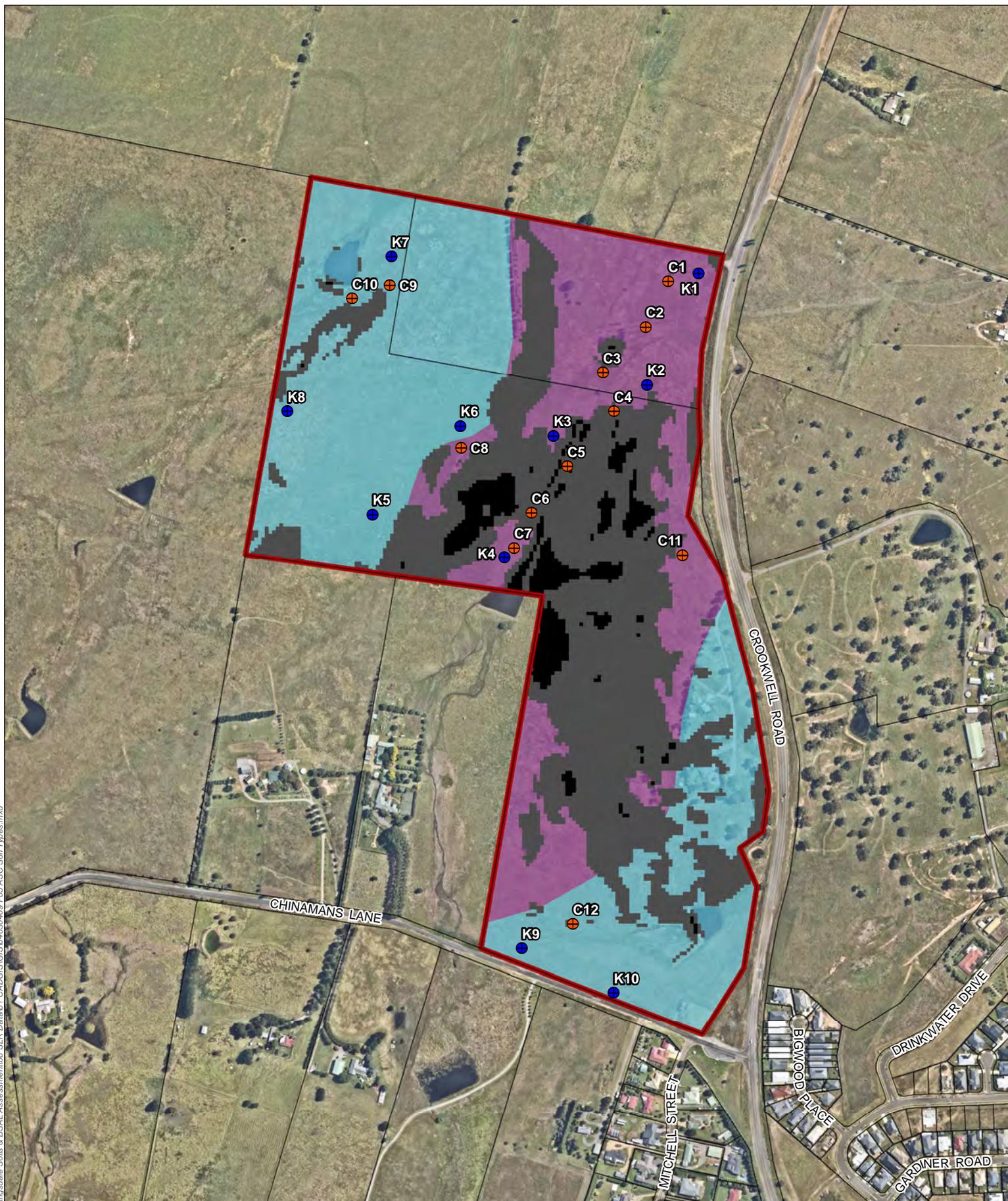
SMU	ASC Soil Type	Soil Type Group	Detailed Site	Check Site	Hectares
1	Epipedal Black Vertosol	Dominant	K1, K2, K3, K4	C1, C2, C3, C4, C5, C6, C7, C8, C11	11
2	Grey-Brown Subnatric Sodosol	Dominant	K5, K7, K8, K9	C9, C10, C12	21
	Mottled Brown Eutrophic Chromosol	Sub-Dominant	K6	Nil	
	Mottled Brown Mesotrophic Dermosol	Sub-Dominant	K10	Nil	
Total					32

Section 9.6.2 of the Interim Protocol states “All soil map units will have some soil variation. The dominant soil type upon which BSAL status is determined should comprise great [sic] than 70 per cent of a soil map unit.” Section 9.6.3 of the Interim Protocol further confirms “BSAL status is determined on the dominant soil type within a soil map unit.”

A description of one detailed representative site from each SMU follows **Figure 5**, with the remaining detailed soil profile descriptions shown in **Appendix B** and check site descriptions in **Appendix C**. Red font is used in the site summary tables to indicate the BSAL criteria which are not met for a particular site. Laboratory certificates of analysis are shown in **Appendix D**.

Drainage was observed to be generally poor across the site, given there was surface ponding of water on the flatter areas after only receiving 14.8 millimetres of rainfall in the week previous to undertaking the field survey.

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 Coordinate System: GDA 1994 MGA Zone 55
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-  Check Sites
-  Detailed Sites
-  Study Area
-  Cadastre

-  BSAL Exclusion Zone - Slope >10%
 -  BSAL Exclusion Zone - <20 ha Contiguous
- ASC Soil Types**
-  Epipedal Black Vertosol
 -  Subnatic Grey-Brown Sodosol

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ASC Soil Types

Data Sources:
 Soil data derived from SLR field observations, Slope data derived from NSW Government Spatial Services - DFSI GOULBURN 1 metre resolution DEM, NSW Spatial Information Exchange, Nearmap Imagery WMS (Sept 2022)



FIGURE 5

3.1 Soil Unit 1: Epipedal Black Vertosol

Vertosols are clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Vertosols must have 35% or more clay in the A1 horizon.

Table 6 Summary: Epipedal Black Vertosol (Site K2)

Overview	
Landscape Site K2	
	
ASC Name	Epipedal Black Vertosol
Representative Site	K2
Other Mapped Sites	K1, K3, K4
Survey Type	Detailed Lab
Dominant Topography	Midslope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	High
Slope (%)	4
Surrounding Slope (%)	>10
Aspect	West
Verified	Non-BSAL – Soil Depth

Table 7 Profile: Epipedal Black Vertisol (Site K2)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Very dark brown (10YR 2/2) silty clay, moderate structure of 5-15 mm crumb peds with a rough fabric and moderate consistence. Nil mottling; nil gravel content; nil segregations; well drained with a gradual and even boundary. Sampled 0.0 – 0.10.
	B21 0.20 – 0.50	Black (10YR 2/1) heavy clay, moderate structure of 10-20 mm blocky peds with a rough fabric and strong consistence. Nil mottling; nil gravel content; nil segregations; moderately well drained with a gradual and even boundary. Sampled 0.30 – 0.40.
	B2 0.50 – 0.70	Black (10YR 2/1) heavy clay, strong structure of 20-40 mm lenticular peds with a smooth fabric and strong consistence. 10% distinct grey mottling; 5% gravel content 5-10 mm; nil segregations; moderately well drained with an abrupt and even boundary. Sampled 0.60 – 0.70.
	BC +0.70	Weathered parent material with >60% gravel content 20-50 mm and nil roots beyond 0.70 m depth. Not sampled.

Table 8 Chemical Parameters: Epipedal Black Vertisol (Site K2)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.7	Moderately Acidic	0.7	Non-Sodic	0.7	Non-Saline	2.6	Ca Low
B21	7.1	Neutral	0.9	Non-Sodic	0.3	Non-Saline	1.5	Ca Low
B22	7.4	Mildly Alkaline	0.9	Non-Sodic	0.2	Non-Saline	1.5	Ca Low

3.2 Soil Unit 2: Subnatric Grey-Brown Sodosol

Sodosols are soils with a strong texture contrast between the A horizons and a sodic B horizon which are not strongly acidic (pH is greater than 5.5).

Table 9 Summary: Mottled-Subnatric Brown Sodosol (Site K7)

Overview	
Landscape Site K7	
	
ASC Name	Mottled-Subnatric Brown Sodosol
Representative Site	K7
Other Mapped Sites	K5, K6, K8, K9, K10
Survey Type	Detailed Lab
Dominant Topography	Midslope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately Low
Slope (%)	6
Surrounding Slope (%)	<10
Aspect	South-West
Verified	Non-BSAL – Inherent Fertility & Poor Drainage

Table 10 Profile: Mottled-Subnatric Brown Sodosol (Site K7)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Brown (10YR 4/3) clay loam, weak structure of 5-15 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 10% gravel content <10 mm; nil segregations; well drained with a gradual and even boundary. Sampled 0.0 – 0.10.
	A2 0.10 – 0.25	Brown (10YR 5/3) bleached clay loam, weak structure of 5-15 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 15% gravel content <10 mm; nil segregations; moderately well drained with a clear and even boundary. Sampled 0.10 – 0.20.
	B21 0.25 – 0.50	Yellowish-brown (10YR 5/6) heavy clay, strong structure of 15-40 mm blocky peds with a rough fabric and moderate consistence. 15% distinct red mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50.
	B22 +0.50	Dark yellowish-brown (10YR 4/6) heavy clay massive structure. 25% distinct red mottling; nil gravel content; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 11 Chemical Parameters: Mottled-Subnatric Brown Sodosol (Site K7)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.8	Moderately Acidic	2.3	Non-Sodic	0.4	Non-Saline	1.5	Ca Low
A2	6.2	Slightly Acidic	5.2	Non-Sodic	0.2	Non-Saline	1.1	Ca Low
B21	6.9	Neutral	9.7	Marginally Sodic	0.3	Non-Saline	0.3	Ca Deficient
B22	8.2	Moderately Alkaline	12.4	Sodic	0.8	Non-Saline	0.3	Ca Deficient

3.3 Biophysical Strategic Agricultural Land

This BSAL Verification Assessment has been conducted in accordance with the Interim Protocol, and the findings are:

- Land with greater than 10% slope (i.e. an exclusion area) accounted for 17 hectares of the Study Area and was excluded as potential BSAL.
- Land with slope less than 10%, but with less than 20 hectares of contiguous area (i.e. an exclusion area) accounted for 2 hectares of the Study Area and was excluded as potential BSAL.
- Land with greater than 30% rock outcrop (i.e. an exclusion area) accounted for less than 1 hectare of the Study Area and was excluded as potential BSAL.
- Two SMUs accounting for 32 hectares of the Study Area (i.e. outside of exclusion areas), were assessed for BSAL according to the Interim Protocol and verified as non-BSAL.

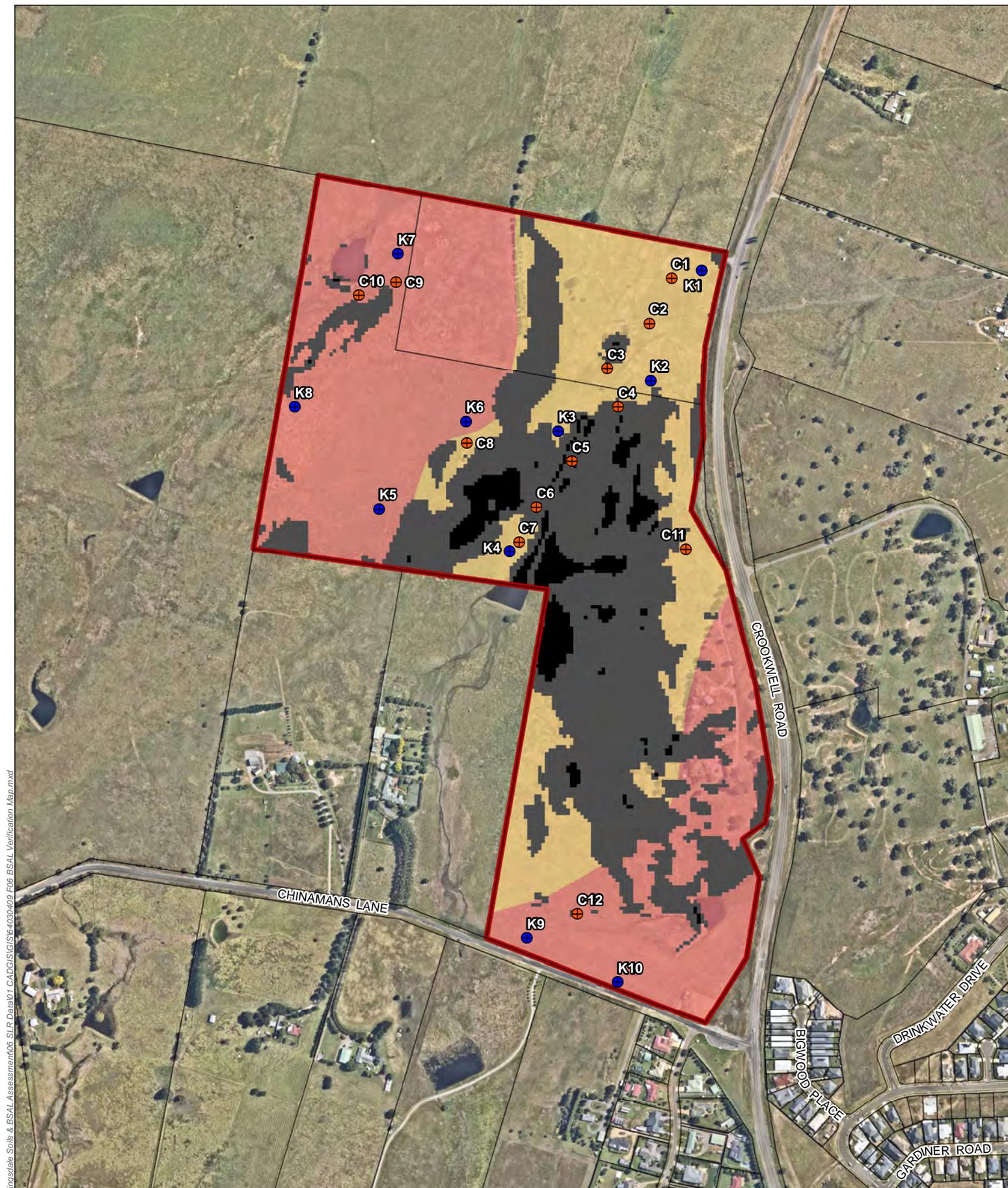
The BSAL Verification Assessment summary and limitations for each SMU and detailed site is provided in **Table 12** and **Table 13** and is shown on **Figure 6**.

Table 12 BSAL Verification Assessment Summary

Soil Survey BSAL Verification Assessment	Hectares
Verified BSAL	Nil
Verified Non-BSAL	32
Exclusion Area	19
BSAL Verification Assessment Total	51
Verified Non-BSAL	Hectares
Soil Type Verified Non-BSAL	32
Exclusion Greater Than 10% Slope	17
Exclusion Less Than 20 Hectares Contiguous Area	2
Exclusion Greater Than 3-% Rock Outcrop	<1
Verified Non-BSAL Total	51

Table 13 BSAL Verification Assessment

SMU	Site Number	Inspection Type	ASC Soil Type (Described to ASC Great Group for detailed sites)	1. Is slope < 10%?	2. Is there < 30% Rock Outcrop?	3. < 20% unattached Rock Fragments > 60mm?	4. Does < 50% have Gilgais >500mm deep?	5. Is Slope <5%?	6. Are there ml rock outcrops?	7a. Does soil have moderate fertility?	7b. Does soil have moderately high or high fertility?	8. Is ERD to a physical barrier >750mm?	9. Is drainage better than poor?	10. Is pH between 5.0 and 8.9 (water) and 4.5 and 8.1 (CaCl2)?	11. Is salinity (ECe) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Is the Site BSAL?	Is the Soil Map Unit BSAL?
1	K1	Detailed	Epipedal Black Vertosol	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	NLT	NLT	NLT	No	No
	K2	Detailed Lab	Epipedal Black Vertosol	✓	✓	✗	✓	✓	✗	✓	✓	✗	✗	✓	✓	✓	No	
	K3	Detailed Lab	Epipedal Black Vertosol	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✓	✓	✓	No	
	K4	Detailed Lab	Epipedal Black Vertosol	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✓	✓	✓	No	
2	K5	Detailed Lab	Mottled-Subnatric Brown Sodosol	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✓	No	No
	K6	Detailed Lab	Mottled Eutrophic Brown Chromosol	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✓	✓	✓	No	
	K7	Detailed Lab	Mottled-Subnatric Brown Sodosol	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗	✓	✓	✓	No	
	K8	Detailed	Mottled Brown Sodosol	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗	NLT	NLT	NLT	No	
	K9	Detailed Lab	Mottled-Subnatric Grey Sodosol	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓	✓	No	
	K10	Detailed Lab	Mottled Mesotrophic Yellow Dermosol	✓	✓	✓	✓	✗	✗	✓	✓	✓	✗	✓	✓	✓	No	
✓ = passes the BSAL criteria ✗ = fails the criteria but not excluded as BSAL ✗ = fails the BSAL criteria NLT – Not Laboratory Tested																		



H:\Projects\SLR\630-30409\630-30409_000000_Kingsdale Soils & BSAL Assessment\06_SIR_Data\01_CAD\GIS\630-30409_F06_BSAL_Verification_Map.mxd

 0 50 100 m
 Coordinate System: GDA 1994 MGA Zone 55
 Scale: 1:7,000 at A4
 Project Number: 630.30409
 Date: 19-Oct-2022
 Drawn by: JG

-  Check Sites
-  Detailed Sites
-  Study Area
-  Cadastre
-  BSAL Exclusion Zone - Slope >10%
-  BSAL Exclusion Zone - <20 ha Contiguous
- Areas of Verified Non-BSAL**
-  Soil Depth & Drainage
-  Inherent Fertility & Drainage

KINGSDALE SOILS AND BSAL ASSESSMENT

BSAL Verification Map

Data Sources:
 Soil data derived from SLR field observations, slope data derived from NSW Government Spatial Services - DFSI GOULBURN 1 metre resolution DEM, NSW Spatial Information Exchange, Nearmap Imagery WMS (Sept 2022)



FIGURE 6

4 Conclusion

The assessment has verified that the entire Study Area of 51 hectares is non-BSAL. This is consistent with the historical and prevailing land use in the Study Area (i.e. sheep grazing rather than more productive land uses such as cultivating crops), however this is not consistent with the NSW Government's regional BSAL mapping as there is no verified BSAL within the Study Area. This area should be removed from the regional BSAL mapping.

APPENDIX A

Slope Analysis Methodology



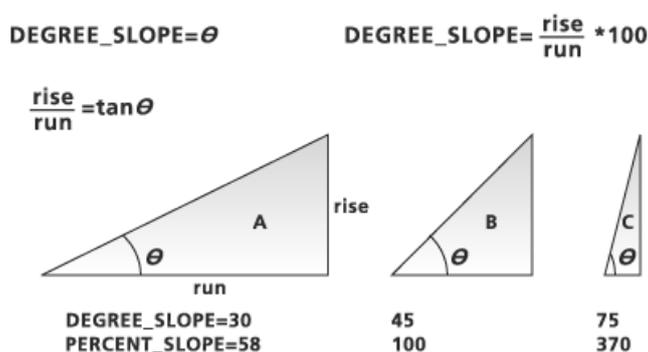
30th September 2022

Ironstone Property Kingsdale BSAL Verification Assessment SLR Slope Analysis Methodology

1. Acquire appropriate elevation information.
2. Load Contours into ArcMap 10.3
3. Using 3D Analyst Extension - Create a TIN Surface based on the contours
(http://resources.arcgis.com/en/help/main/10.1/index.html#/Create_TIN/00q90000001v000000/)
4. Using 3D Analyst Extension – Run the Surface Slope Tool
(<http://resources.arcgis.com/en/help/main/10.1/index.html#/00q900000076000000/>) using a custom Break File (attached).
5. Using a Spatial Join, correlate the Surface Slope at the Soil Survey coordinates.

The Surface Slope Tool

Surface Slope creates an output polygon feature class containing polygons that classify an input TIN or terrain dataset by slope. The slope is the angle of inclination between the surface and a horizontal plane, which may be analysed in degrees or percent. Slope in degrees is given by calculating the arctangent of the ratio of the change in height (dZ) to the change in horizontal distance (dS), or slope = $\text{Arctan}(dZ/dS)$. Percent slope is equal to the change in height divided by the change in horizontal distance multiplied by 100, or $(dZ/dX) * 100$.



The {**slope_field**} is the name of attribute field used to record the polygon aspect codes. Its default value is SlopeCode.

Each triangle is classified into a slope class. Contiguous triangles belonging to the same class are merged during the formation of output polygons. The {units} parameter can be set to use PERCENT or DEGREES. The default is PERCENT. The default percent slope class breaks are 1.00, 2.15, 4.64, 10.00, 21.50, 46.40, 100.00, 1000.00. Optionally, DEGREES may be used to classify slope. The default degree slope class breaks are 0.57, 1.43, 2.66, 5.71, 12.13, 24.89, 45.0, 90.0.

The {class_breaks_table} is used to define custom slope classes. The table can be either a TXT or DBF file for a Windows environment, and a DBF file in a UNIX environment. Each record in the table needs to contain two values that are used to represent the slope range of the class and its corresponding class code.

Table example:

break, code

10.0, 11

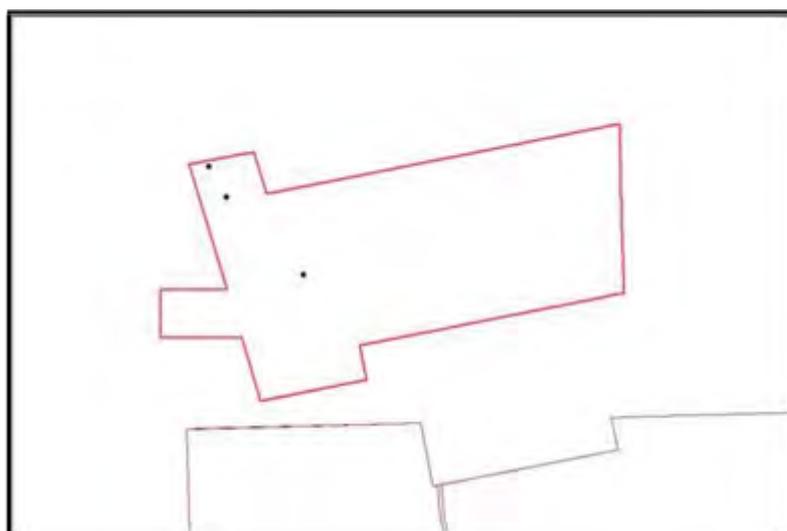
25.0, 22

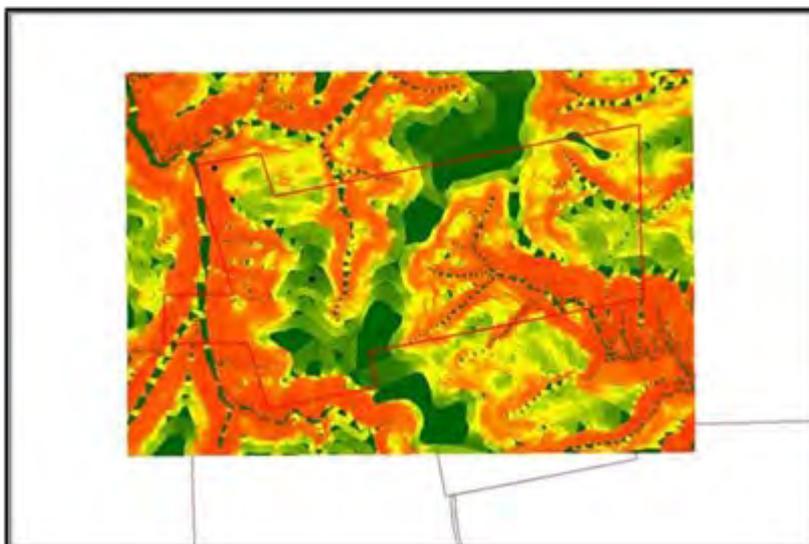
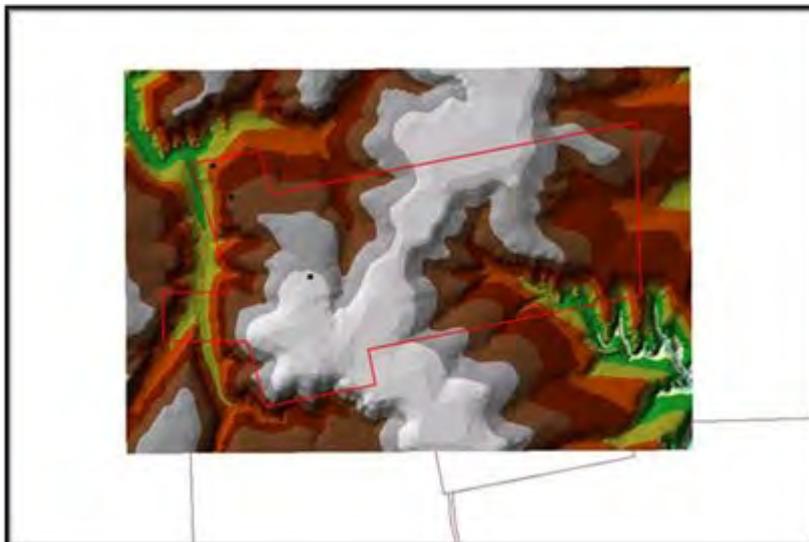
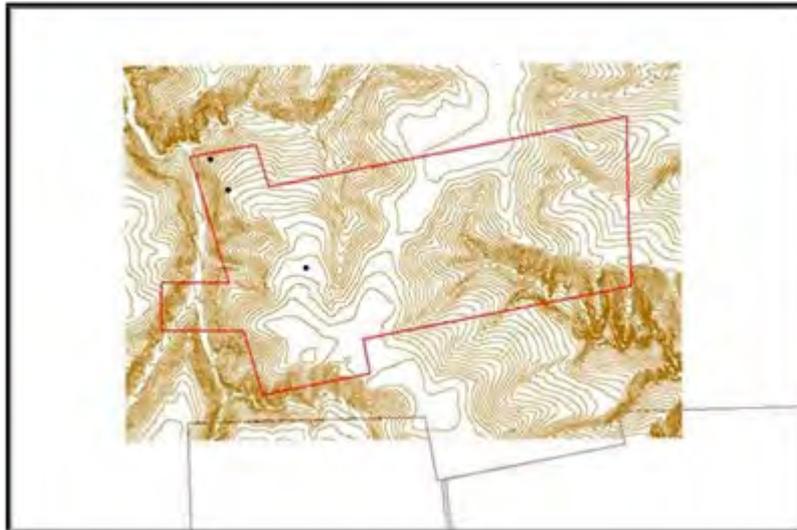
40.0, 33

70.0, 44

Note the comma delineation and use of decimals in the first field. Field names are needed but are ignored. The first field represents the breaks and values need to be decimal, the second field represents codes and values need to be integer. The units of the slope range are defined by the {units}. When this argument is not specified, the default classification is used.

And here is how we do it pictographically (example study shown):





APPENDIX B

Detailed Site Descriptions



Soil Unit 1: Epipedal Black Vertosol

Table 1 Summary: Epipedal Black Vertosol (Site K1)

Overview	
Landscape Site K1	
	
ASC Name	Epipedal Black Vertosol
Representative Site	K1
Other Mapped Sites	K2, K3, K4
Survey Type	Detailed
Dominant Topography	Upper Slope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	High
Slope (%)	4
Surrounding Slope (%)	<10
Aspect	South-West
Verified	Non-BSAL – Soil Depth

Table 2 Profile: Epipedal Black Vertisol (Site K1)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark brown (10YR 3/3) silty clay, moderate structure of 5-15 mm crumb peds with a rough fabric and moderate consistence. Nil mottling; <5% gravel content 5-10 mm; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10.
	B21 0.10 – 0.20	Very dark brown (10YR 2/2) light clay, moderate structure of 5-10 mm crumb peds with a rough fabric and moderate consistence. Nil mottling; <5% gravel content 5-10 mm; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.10 – 0.20.
	B22 0.20 – 0.40	Dark yellowish-brown (10YR 4/6) medium clay, strong structure of 20-40 mm blocky peds with a rough fabric and strong consistence. 5% distinct yellow mottling; 10% gravel content 5-10 mm; nil segregations; moderately well drained with an abrupt and wavy boundary. Sampled 0.30 – 0.40
	BC 0.40 – 0.50	Weather parent material with >70% gravel content 10-80 mm and few roots beyond 0.50m depth. Not sampled.
	C +0.50	Bedrock Not sampled.

Table 3 Field Parameters: Epipedal Black Vertisol (Site K1)

Layer	Field pH		Field Dispersion	Field Effervescence
	Unit	Rating	Rating	Rating
A1	6.0	Moderately Acidic	Nil	Nil
B21	6.5	Slightly Acidic	Slight	Moderate
B22	7.0	Neutral	Slight	Moderate

Soil Unit 1: Epipedal Black Vertosol

Table 4 Summary: Epipedal Black Vertosol (Site K3)

Overview	
Landscape Site K3	
	
ASC Name	Epipedal Black Vertosol
Representative Site	K3
Other Mapped Sites	K1, K2, K4
Survey Type	Detailed Lab
Dominant Topography	Midslope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	High
Slope (%)	6
Surrounding Slope (%)	<10
Aspect	West
Verified	Non-BSAL – Soil Depth & Poor Drainage

Table 5 Profile: Epipedal Black Vertisol (Site K3)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Dark yellowish-brown (10YR 3/4) heavy clay, moderate structure of 5-10 mm crumb peds with a rough fabric and strong consistence. 10% distinct yellow mottling; 15% gravel content <10 mm; nil segregations; well drained with a gradual and even boundary. Sampled 0.0 – 0.10.
	B21 0.20 – 0.50	Very dark greyish brown (10YR 3/2) medium clay, moderate structure of 10-20 mm blocky peds with a rough fabric and strong consistence. 10% distinct brown mottling; 5% gravel content <10 mm; nil segregations; moderately well drained with a gradual and even boundary. Sampled 0.30 – 0.40.
	B22 0.50 – 0.70	Brown (10YR 4/3) heavy clay, strong structure of 20-40 mm blocky peds with a smooth fabric and strong consistence. 25% distinct yellow mottling; 5% gravel content 5-10 mm; nil segregations; poorly drained with a clear and even boundary. Sampled 0.60 – 0.70.
	BC +0.70	Weathered parent material with >50% gravel content 10-60 mm and nil roots beyond 0.70 m depth. Not sampled.

Table 6 Chemical Parameters: Epipedal Black Vertisol (Site K3)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.6	Moderately Acidic	1.0	Non-Sodic	0.4	Non-Saline	1.6	Ca Low
B21	6.9	Neutral	0.9	Non-Sodic	0.2	Non-Saline	1.6	Ca Low
B22	7.5	Mildly Alkaline	1.1	Non-Sodic	0.2	Non-Saline	1.4	Ca Low

Soil Unit 1: Epipedal Black Vertosol

Table 7 Summary: Epipedal Black Vertosol (Site K4)

Overview	
Landscape Site K4	
	
ASC Name	Epipedal Black Vertosol
Representative Site	K4
Other Mapped Sites	K1, K2, K3
Survey Type	Detailed Lab
Dominant Topography	Lower slope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	High
Slope (%)	5
Surrounding Slope (%)	<10
Aspect	South-West
Verified	Non-BSAL –Poor Drainage

Table 8 Profile: Epipedal Black Vertisol (Site K4)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.30	Very dark brown (10YR 2/2) silty clay loam, moderate structure of 5-15 mm crumb peds with a sandy fabric and moderate consistence. Nil mottling; nil gravel content; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.0- 0.10 and 0.20 – 0.30.
	B21 0.30 – 0.50	Black (10YR 2/1) heavy clay, strong structure of 10-30 mm blocky peds with a sandy fabric and moderate consistence. 10% distinct brown mottling; nil gravel content; nil segregations; moderately well drained with a gradual and wavy boundary. Sampled 0.40 – 0.50.
	B22 +0.50	Very dark grey (10YR 3/1) heavy clay, massive structure. 30% distinct brown mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 9 Chemical Parameters: Epipedal Black Vertisol (Site K4)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.8	Moderately Acidic	0.8	Non-Sodic	0.6	Non-Saline	2.0	Ca Low
A1	7.0	Neutral	0.9	Non-Sodic	0.3	Non-Saline	1.5	Ca Low
B21	7.6	Mildly Alkaline	1.1	Non-Sodic	0.3	Non-Saline	1.1	Ca Low
B22	8.2	Moderately Alkaline	1.5	Non-Sodic	0.3	Non-Saline	1.0	Ca Deficient

Soil Unit 2: Mottled-Subnatric Grey-Brown Sodosol

Table 10 Summary: Mottled-Subnatric Brown Sodosol (Site K5)

Overview	
Landscape Site K5	
	
ASC Name	Mottled-Subnatric Brown Sodosol
Representative Site	K5
Other Mapped Sites	K6, K7, K8, K9, K10
Survey Type	Detailed Lab
Dominant Topography	Upper Slope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately Low
Slope (%)	1
Surrounding Slope (%)	<10
Aspect	West
Verified	Non-BSAL – Inherent Fertility & Poor Drainage

Table 11 Profile: Mottled-Subnatric Brown Sodosol (Site K5)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark yellowish-brown (10YR 4/4) clay loam, weak structure of 5-10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 15% gravel content <5 mm; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10.
	A2 0.10 – 0.30	Dark grey (10YR 4/1) clay loam, weak structure of 5-10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 15% gravel content <5 mm; nil segregations; well drained with a clear and wavy boundary. Sampled 0.20 – 0.30.
	B21 0.30 – 0.60	Yellowish-brown (10YR 5/6) heavy clay, massive structure. 20% distinct red mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50.
	B22 +0.60	Light olive brown (2.5Y 5/6) heavy clay, massive structure. 30% distinct orange mottling; nil gravel content nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 12 Chemical Parameters: Mottled-Subnatric Brown Sodosol (Site K5)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.8	Moderately Acidic	2.5	Non-Sodic	0.4	Non-Saline	1.9	Ca Low
A2	6.0	Moderately Acidic	3.0	Non-Sodic	0.2	Non-Saline	2.3	Ca Low
B21	8.1	Moderately Alkaline	6.0	Marginally Sodic	0.4	Non-Saline	0.5	Ca Deficient
B22	8.5	Strongly Alkaline	6.6	Marginally Sodic	0.9	Non-Saline	0.5	Ca Deficient

Soil Unit 2: Subnatric Grey-Brown Sodosol

Sub-Dominant Soil Type: Mottled Eutrophic Brown Chromosol

Table 13 Summary: Mottled Eutrophic Brown Chromosol (Site K6)

Overview	
Landscape Site K6	
	
ASC Name	Mottled Eutrophic Brown Chromosol
Representative Site	K6
Other Mapped Sites	K5, K7, K8, K9, K10
Survey Type	Detailed Lab
Dominant Topography	Upper Slope Plateau
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately High
Slope (%)	6
Surrounding Slope (%)	<10
Aspect	South
Verified	Non-BSAL – Poor Drainage

Table 14 Profile: Mottled Eutrophic Brown Chromsol (Site K6)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark brown (10YR 3/3) clay loam, weak structure of 5-15 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 5% gravel content 5-10 mm; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10.
	A2 0.10 – 0.30	Brown (10YR 4/3) clay loam, weak structure of 5-10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 15% gravel content 5-10 mm; nil segregations; well drained with a clear and wavy boundary. Sampled 0.20 – 0.30.
	B21 0.30 – 0.50	Brown (10YR 5/3) heavy clay, strong structure of 20-40 mm blocky peds with a rough fabric and strong consistence. 15% distinct yellow mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50.
	B22 +0.50	Yellowish brown (10Y 5/4) heavy clay, strong structure of 40-50 mm blocky peds with a rough fabric and strong consistence. 20% distinct brown mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 15 Field Parameters: Mottled Eutrophic Brown Chromsol (Site K6)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	6.2	Slightly Acidic	0.9	Non-Sodic	0.7	Non-Saline	2.0	Ca Low
A2	6.3	Slightly Acidic	0.6	Non-Sodic	0.3	Non-Saline	1.8	Ca Low
B21	7.7	Mildly Alkaline	1.1	Non-Sodic	0.3	Non-Saline	1.1	Ca Low
B22	7.6	Mildly Alkaline	1.1	Non-Sodic	0.4	Non-Saline	1.1	Ca Low

Soil Unit 2: Subnatric Grey-Brown Sodosol

Table 16 Summary: Mottled Brown Sodosol (Site K8)

Overview	
Landscape Site K8	
	
ASC Name	Mottled Brown Sodosol
Representative Site	K8
Other Mapped Sites	K5, K6, K7, K9, K10
Survey Type	Detailed
Dominant Topography	Midslope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately Low
Slope (%)	7
Surrounding Slope (%)	<10
Aspect	West
Verified	Non-BSAL – Inherent Fertility & Poor Drainage

Table 17 Profile: Mottled Brown Sodosol (Site K8)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Brown (10YR 4/3) clay loam, weak structure of 5-10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 5% gravel content 5-10 mm; nil segregations; well drained with a gradual and even boundary. Sampled 0.0 – 0.10.
	A2 0.10 – 0.30	Light yellowish-brown (10YR 6/4) bleached clay loam, weak structure of <10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 20% gravel content <10 mm; nil segregations; moderately well drained with an abrupt and wavy boundary. Sampled 0.20 – 0.30.
	B21 0.30 – 0.60	Yellowish brown (10YR 5/6) medium clay, strong structure of 15-30 mm blocky peds with a rough fabric and strong consistence. 40% distinct red mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained , with a gradual and even boundary Sampled 0.40 – 0.50.
	B22 +0.60	Yellowish brown (10YR 5/8) heavy clay, strong structure of 20-40 mm blocky peds with a rough fabric and strong consistence. 30% distinct red mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 18 Field Parameters: Mottled Brown Sodosol (Site K8)

Layer	Field pH		Field Dispersion	Field Effervescence
	Unit	Rating	Rating	Rating
A1	5.5	Strongly Acidic	Nil	Nil
A2	6.0	Moderately Acidic	Slight	Nil
B21	6.0	Moderately Acidic	High	Nil
B22	6.5	Slightly Acidic	High	Nil

Soil Unit 2: Subnatric Grey-Brown Sodosol

Table 19 Summary: Mottled-Subnatric Grey Sodosol (Site K9)

Overview	
Landscape Site K9	
	
ASC Name	Mottled-Subnatric Grey Sodosol
Representative Site	K9
Other Mapped Sites	K5, K6, K7, K8, K10
Survey Type	Detailed Lab
Dominant Topography	Lower Slope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately Low
Slope (%)	4
Surrounding Slope (%)	<10
Aspect	West
Verified	Non-BSAL – Inherent Fertility & Poor Drainage

Table 20 Profile: Mottled-Subnatric Grey Sodosol (Site K9)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Dark yellowish-brown (10YR 4/4) clay loam, weak structure of 5-15 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; nil gravel content; nil segregations; well drained with a gradual and even boundary. Sampled 0.0- 0.10.
	A21 0.10 – 0.30	Brown (10YR 4/3) clay loam, weak structure of 5-10 mm crumb peds with a sandy fabric and weak consistence. Nil mottling; 15% gravel content 5-10 mm; nil segregations; moderately well drained with a gradual and even boundary. Sampled 0.20 – 0.30.
	A22 0.30 – 0.50	Brown (10YR 5/3) silty clay loam, moderate structure of 10-30 mm blocky peds with a rough fabric and weak consistence. 20% distinct yellow mottling; <5% gravel content 5-10 mm; nil segregations; poorly drained with an abrupt and even boundary. Sampled 0.40 – 0.50.
	B22 +0.50	Dark greyish-brown (10YR 4/2) heavy clay, massive structure. 15% distinct yellow mottling; nil gravel content 5-10 mm; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 21 Chemical Parameters: Mottled-Subnatric Grey Sodosol (Site K9)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.1	Strongly Acidic	2.8	Non-Sodic	0.3	Non-Saline	1.7	Ca Low
A21	6.0	Slightly Acidic	2.6	Non-Sodic	0.2	Non-Saline	1.8	Ca Low
A22	7.1	Neutral	7.1	Marginally Sodic	0.3	Non-Saline	0.6	Ca Deficient
B22	8.3	Moderately Alkaline	8.0	Marginally Sodic	0.4	Non-Saline	0.5	Ca Deficient

Soil Unit 2: Subnatric Grey-Brown Sodosol

Sub-Dominant Soil Type: Mottled Eutrophic Brown Dermosol

Table 22 Summary: Eutrophic Brown Dermosol (Site K10)

Overview	
Landscape Site K10	
	
ASC Name	Eutrophic Brown Dermosol
Representative Site	K10
Other Mapped Sites	K5, K6, K7, K8, K9
Survey Type	Detailed Lab
Dominant Topography	Mid Slope
Dominant Land Use	Sheep Grazing
Vegetation	Grass Pasture
Inherent Soil Fertility	Moderately High
Slope (%)	9
Surrounding Slope (%)	<10
Aspect	West
Verified	Non-BSAL –Poor Drainage

Table 23 Profile: Mottled Eutrophic Brown Dermosol (Site K10)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark yellowish-brown (10YR 4/4) clay loam, moderate structure of 5-10 mm crumb peds with a sandy fabric and moderate consistence. Nil mottling; <5% gravel content <5 mm; nil segregations; well drained with a gradual and wavy boundary. Sampled 0.0 – 0.10.
	B21 0.10 – 0.30	Brown (10YR 4/3) silty clay loam moderate structure of 5-15 mm blocky peds with a sandy fabric and moderate consistence. Nil mottling; <5% gravel content <5 mm; nil segregations; moderately well drained with a gradual and even boundary. Sampled 0.20 – 0.30.
	B22 0.30 – 0.50	Light yellowish-brown (10YR 6/4) light clay, moderate structure of 20-40 mm blocky peds with a rough fabric and strong consistence. 10% distinct yellow mottling; 15% gravel content 5-10 mm; nil segregations; poorly drained with a gradual and wavy boundary. Sampled 0.40 – 0.50.
	B23 +0.50	Brown (10YR 4/3) medium clay, massive structure. 30% distinct yellow mottling; 15% gravel content 5-10 mm; nil segregations; poorly drained . Sampled 0.65 – 0.75. Layer continues beyond sampling depth.

Table 24 Chemical Parameters: Mottled Eutrophic Brown Dermosol (Site K10)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.6	Moderately Acidic	3.1	Non-Sodic	0.3	Non-Saline	1.8	Ca Low
B21	6.3	Slightly Acidic	4.4	Non-Sodic	0.2	Non-Saline	2.1	Ca Low
B22	6.4	Slightly Acidic	4.9	Non-Sodic	0.2	Non-Saline	1.0	Ca Deficient
B23	6.4	Slightly Acidic	4.9	Non-Sodic	0.2	Non-Saline	0.5	Ca Deficient

APPENDIX C

Check Site Descriptions



Soil Unit 1: Epipedal Black Vertosol

Table 1 Site C1 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Very dark brown (10YR 2/2) silty clay
	Surface water ponding in cattle hoof prints, associated with poor drainage in the B2 horizon of Soil Unit 1: Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C1	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Midslope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	4	
Aspect	South-West	

Soil Unit 1: Epipedal Black Vertosol

Table 2 Site C2 Black Vertosol

Profile	Horizon / Depth (m)	Description
	<p>A1 0.0 – 0.10</p>	<p>Black (10YR 3/1) silty clay</p>
	<p>Surface water ponding in cattle hoof prints, associated with poor drainage in the B2 horizon of Soil Unit 1: Soil Unit 1: Epipedal Black Vertosol</p>	
<p>ASC Name</p>	<p>Black Vertosol</p>	
<p>Representative Site</p>	<p>Site C2</p>	
<p>Other Mapped Detailed Sites</p>	<p>K1, K2, K3, K4</p>	
<p>Survey Type</p>	<p>Check Site</p>	
<p>Dominant Topography</p>	<p>Lower Slope</p>	
<p>Dominant Land Use</p>	<p>Grass Pasture</p>	
<p>Vegetation</p>	<p>Sheep Grazing</p>	
<p>Inherent Soil Fertility</p>	<p>High</p>	
<p>Slope (%)</p>	<p>3</p>	
<p>Aspect</p>	<p>South</p>	

Soil Unit 1: Epipedal Black Vertosol

Table 3 Site C3 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Very dark brown (10YR 2/2) silty clay
	Surface water ponding, associated with poor drainage in the B2 horizon of Soil Unit1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C3	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Lower Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	1	
Aspect	South-West	

Soil Unit 1: Epipedal Black Vertosol

Table 4 Site C4 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Black (10YR 3/1) silty clay loam
	Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C4	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Midslope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	13	
Aspect	West	

Soil Unit 1: Epipedal Black Vertosol

Table 5 Site C5 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark brown (10YR 3/3) silty clay
	Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C5	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Drainage Line	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	11	
Aspect	South	

Soil Unit 1: Epipedal Black Vertosol

Table 6 Site C6 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Black (10YR 2/1) light clay
	Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C6	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Mid Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	13	
Aspect	South	

Soil Unit 1: Epipedal Black Vertosol

Table 7 Site C7 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Dark yellowish-brown (10YR 3/4) silty clay
	Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C7	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Lower Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	7	
Aspect	South-West	

Soil Unit 1: Epipedal Black Vertosol

Table 8 Site C8 Black Vertosol

Profile	Horizon / Depth (m)	Description
	<p>A1 0.0 – 0.10</p>	<p>Very dark brown (10YR 2/2) light clay</p>
	<p>Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol</p>	
ASC Name	Black Vertosol	
Representative Site	Site C8	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Upper Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	6	
Aspect	West	

Soil Unit 2: Subnatric Grey-Brown Sodosol

Table 9 Site C9 Brown Sodosol

Profile	Horizon / Depth (m)	Description
	<p>A1 0.0 – 0.10</p>	<p>Brown (10YR 4/3) clay loam</p>
	<p>Surface water ponding in cattle hoof prints, associated with poor drainage in the B2 horizon of Soil Unit 2: Subnatric Grey-Brown Sodosol</p>	
ASC Name	Brown Sodosol	
Representative Site	Site C9	
Other Mapped Detailed Sites	K5, K6, K7, K8, K9, K10	
Survey Type	Check Site	
Dominant Topography	Midslope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	Moderately Low	
Slope (%)	8	
Aspect	South-West	

Soil Unit 2: Subnatric Grey-Brown Sodosol

Table 10 Site C10 Brown Sodosol

Profile	Horizon / Depth (m)	Description
	<p>A1 0.0 – 0.10</p>	<p>Dark yellowish-brown (10YR 4/4) clay loam</p>
	<p>Surface water ponding in cattle hoof prints, associated with poor drainage in the B2 horizon of Soil Unit 2: Subnatric Grey-Brown Sodosol</p>	
<p>ASC Name</p>	<p>Brown Sodosol</p>	
<p>Representative Site</p>	<p>Site C10</p>	
<p>Other Mapped Detailed Sites</p>	<p>K5, K6, K7, K8, K9, K10</p>	
<p>Survey Type</p>	<p>Check Site</p>	
<p>Dominant Topography</p>	<p>Lower Slope</p>	
<p>Dominant Land Use</p>	<p>Sheep Grazing</p>	
<p>Vegetation</p>	<p>Grass Pasture</p>	
<p>Inherent Soil Fertility</p>	<p>Moderately Low</p>	
<p>Slope (%)</p>	<p>9</p>	
<p>Aspect</p>	<p>South</p>	

Soil Unit 1: Epipedal Black Vertosol

Table 11 Site C11 Black Vertosol

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Very dark greyish brown (10YR 3/2) light clay
	Basalt rock outcrop associated with Soil Unit 1: Epipedal Black Vertosol	
ASC Name	Black Vertosol	
Representative Site	Site C11	
Other Mapped Detailed Sites	K1, K2, K3, K4	
Survey Type	Check Site	
Dominant Topography	Upper Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	High	
Slope (%)	2	
Aspect	West	

Soil Unit 2: Subnatric Grey-Brown Sodosol

Table 12 Site C12 Brown Sodosol

Profile	Horizon / Depth (m)	Description
	<p>A1 0.0 – 0.10</p>	<p>Dark yellowish-brown (10YR 4/4) clay loam</p>
	<p>Granite rock outcrop associated with Soil Unit 2: Subnatric Grey-Brown Sodosol</p>	
ASC Name	Brown Sodosol	
Representative Site	Site C12	
Other Mapped Detailed Sites	K5, K6, K7, K8, K9, K10	
Survey Type	Check Site	
Dominant Topography	Lower Slope	
Dominant Land Use	Sheep Grazing	
Vegetation	Grass Pasture	
Inherent Soil Fertility	Moderately Low	
Slope (%)	6	
Aspect	South	

APPENDIX D

Laboratory Certificates of Analysis



AGRICULTURAL SOIL ANALYSIS REPORT

30 samples supplied by SLR Consulting Australia Pty Ltd on 8/09/2022. Lab Job No. N2530.
 Analysis requested by Murray Fraser. Your Job: SLR 630.30409 Kingsdale BSAL
 10 Kings Road NEW LAMBTON NSW 2305

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Sample ID:		K2 0-10	K2 30-40	K2 60-70	K3 0-10	K3 30-40	K3 60-70
Crop:		Soil	Soil	Soil	Soil	Soil	Soil
Client:		Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone
Parameter	Method reference	N2530/1	N2530/2	N2530/3	N2530/4	N2530/5	N2530/6
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.66	7.05	7.40	5.56	6.93	7.48
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.083	0.049	0.042	0.061	0.030	0.034
Exchangeable Calcium	(cmol./kg)	17	27	27	11	17	22
	(kg/ha)	7,500	12,072	11,912	4,899	7,425	9,685
	(mg/kg)	3,348	5,389	5,318	2,187	3,315	4,324
Exchangeable Magnesium	(cmol./kg)	6.5	17	17	6.7	10	16
	(kg/ha)	1,759	4,746	4,735	1,822	2,759	4,295
	(mg/kg)	785	2,119	2,114	813	1,232	1,918
Exchangeable Potassium	(cmol./kg)	0.35	0.56	0.54	0.49	0.35	0.42
	(kg/ha)	307	493	473	426	304	368
	(mg/kg)	137	220	211	190	136	164
Exchangeable Sodium	(cmol./kg)	0.16	0.40	0.42	0.19	0.25	0.41
	(kg/ha)	81	206	216	99	127	212
	(mg/kg)	36	92	97	44	57	95
Exchangeable Aluminium	(cmol./kg)	0.03	<0.01	<0.01	<0.01	0.09	0.01
	(kg/ha)	5.2	1.2	1.1	1.5	18	2.3
	(mg/kg)	2.3	<1	<1	<1	7.9	1.0
Exchangeable Hydrogen	(cmol./kg)	0.15	<0.01	<0.01	0.11	<0.01	<0.01
	(kg/ha)	3.3	<1	<1	2.6	<1	<1
	(mg/kg)	1.5	<1	<1	1.1	<1	<1
Effective Cation Exchange Capacity (CEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	24	45	45	18	27	38
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	70	59	59	59	60	56
Magnesium (%)		27	38	39	36	37	41
Potassium (%)		1.5	1.2	1.2	2.6	1.3	1.1
Sodium - ESP (%)		0.66	0.88	0.94	1.0	0.90	1.1
Aluminium (%)		0.11	0.01	0.01	0.04	0.32	0.03
Hydrogen (%)		0.62	0.00	0.00	0.62	0.00	0.00
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	2.6	1.5	1.5	1.6	1.6	1.4
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)	5.2	6.6	6.8	5.1	6.2	6.6
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	4	4	4	4	4	4
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10YR 2/2	10YR 2/1	10YR 2/1	10YR 3/4	10YR 3/2	10YR 4/3
		Very Brown	Black	Black	Dark Yellowish Brown	Very Dark Grayish Brown	Brown
Mottles Munsell Colour		10YR 7/6	5YR 4/4	10YR 5/4
..		Yellow	Reddish Brown	Yellowish Brown	
Degree of Mottling (%)		15	5	15

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 10 Kings Road NEW LAMBTON NSW 2305

		Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Sample ID:		K4 0-10	K4 20-30	K4 40-50	K4 65-75	K5 0-10	K5 20-30
Crop:		Soil	Soil	Soil	Soil	Soil	Soil
Client:		Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone
Parameter	Method reference	N2530/7	N2530/8	N2530/9	N2530/10	N2530/11	N2530/12
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.77	6.97	7.62	8.16	5.79	5.98
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.071	0.034	0.045	0.054	0.050	0.027
Exchangeable Calcium	(cmol./kg)	16	19	26	22	5.3	5.3
	(kg/ha)	7,215	8,486	11,832	9,666	2,394	2,401
	(mg/kg)	3,221	3,788	5,282	4,315	1,069	1,072
Exchangeable Magnesium	(cmol./kg)	8.1	12	24	22	2.9	2.3
	(kg/ha)	2,195	3,323	6,562	5,982	776	627
	(mg/kg)	980	1,484	2,930	2,671	347	280
Exchangeable Potassium	(cmol./kg)	0.31	0.36	0.72	0.57	0.24	0.15
	(kg/ha)	272	311	627	495	213	129
	(mg/kg)	122	139	280	221	95	57
Exchangeable Sodium	(cmol./kg)	0.21	0.28	0.55	0.69	0.23	0.25
	(kg/ha)	106	146	284	356	117	127
	(mg/kg)	47	65	127	159	52	57
Exchangeable Aluminium	(cmol./kg)	0.02	<0.01	0.01	0.01	0.10	0.07
	(kg/ha)	4.7	1.7	2.3	2.1	20	14
	(mg/kg)	2.1	<1	1.0	<1	9.0	6.4
Exchangeable Hydrogen	(cmol./kg)	0.13	<0.01	<0.01	<0.01	0.20	0.13
	(kg/ha)	3.0	<1	<1	<1	4.6	2.9
	(mg/kg)	1.3	<1	<1	<1	2.0	1.3
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	25	32	52	45	9.0	8.2
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	65	60	51	48	60	65
Magnesium (%)		33	38	47	49	32	28
Potassium (%)		1.3	1.1	1.4	1.3	2.7	1.8
Sodium - ESP (%)		0.83	0.90	1.1	1.5	2.5	3.0
Aluminium (%)		0.09	0.03	0.02	0.02	1.1	0.86
Hydrogen (%)		0.54	0.00	0.00	0.00	2.3	1.6
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	2.0	1.5	1.1	0.98	1.9	2.3
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)	5.2	6.1	6.7	7.2	5.1	5.4
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	4	3	3	4	3	3
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10YR 2/2	10YR 3/1	10YR 2/1	10YR 3/1	10YR 4/4	10YR 4/1
		Very Brown	Very Dark Gray	Black	Very Dark Gray	Dark Yellowish Brown	Dark Gray
Mottles Munsell Colour		10YR 4/4
Degree of Mottling (%)		Dark Yellowish Brown
		20
		

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		Sample ID:	Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
		Crop:	K5 40-50	K5 65-75	K6 0-10	K6 20-30	K6 40-50	K6 65-75
		Client:	Soil	Soil	Soil	Soil	Soil	Soil
			Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone
Parameter	Method reference		N2530/13	N2530/14	N2530/15	N2530/16	N2530/17	N2530/18
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		8.06	8.50	6.20	6.34	7.68	7.55
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.065	0.156	0.082	0.036	0.053	0.045
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	9.7	11	9.1	12	24	26
	(kg/ha)		4,341	5,148	4,080	5,317	10,807	11,889
	(mg/kg)		1,938	2,298	1,822	2,374	4,825	5,308
Exchangeable Magnesium	(cmol./kg)		21	24	4.6	6.6	22	24
	(kg/ha)		5,832	6,556	1,256	1,806	5,937	6,585
	(mg/kg)		2,604	2,927	561	806	2,651	2,940
Exchangeable Potassium	(cmol./kg)	0.46	0.48	1.5	0.53	0.52	0.44	
	(kg/ha)	407	423	1,354	461	458	389	
	(mg/kg)	182	189	605	206	205	174	
Exchangeable Sodium	(cmol./kg)	2.0	2.5	0.13	0.12	0.51	0.59	
	(kg/ha)	1,011	1,311	68	64	265	302	
	(mg/kg)	451	585	30	29	118	135	
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.02	0.02	0.02	0.05	0.02	0.02
	(kg/ha)		3.8	3.7	4.6	9.1	3.4	3.2
	(mg/kg)		1.7	1.6	2.1	4.1	1.5	1.4
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.12	0.15	<0.01	<0.01
	(kg/ha)		<1	<1	2.6	3.3	<1	<1
	(mg/kg)		<1	<1	1.2	1.5	<1	<1
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		34	39	16	19	47	52
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100		29	30	59	61	51	51
Magnesium (%)		64	62	30	34	46	47	
Potassium (%)		1.4	1.3	10.0	2.7	1.1	0.86	
Sodium - ESP (%)		5.9	6.6	0.85	0.64	1.1	1.1	
Aluminium (%)		0.06	0.05	0.15	0.23	0.04	0.03	
Hydrogen (%)		0.00	0.00	0.75	0.76	0.00	0.00	
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		0.45	0.48	2.0	1.8	1.1	1.1
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)		7.0	7.6	5.6	5.9	6.9	7.0
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		3	3	4	4	4	4
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification		10YR 5/6	2.5Y 5/6	10YR 3/3	10YR 4/3	10YR 5/3	10YR 5/4
		Yellowish Brown	Light Olive Brown	Dark Brown	Brown	Brown	Yellowish Brown	
Mottles Munsell Colour		10R 4/6	10YR 5/6	7.5YR 5/6	
		Red	Yellowish Brown	Strong Brown	
Degree of Mottling (%)			2	5	2

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 10 Kings Road NEW LAMBTON NSW 2305

		Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
Sample ID:		K7 0-10	K7 10-20	K7 40-50	K7 65-75	K9 0-10	K9 20-30
Crop:		Soil	Soil	Soil	Soil	Soil	Soil
Client:		Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone
Parameter	Method reference	N2530/19	N2530/20	N2530/21	N2530/22	N2530/23	N2530/24
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.75	6.19	6.92	8.23	5.07	6.02
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.043	0.022	0.044	0.145	0.031	0.021
Exchangeable Calcium	(cmol./kg)	2.0	1.6	2.8	6.4	1.5	2.8
	(kg/ha)	900	713	1,249	2,860	663	1,241
	(mg/kg)	402	318	558	1,277	296	554
Exchangeable Magnesium	(cmol./kg)	1.4	1.4	11	19	0.86	1.5
	(kg/ha)	370	379	2,920	5,301	233	411
	(mg/kg)	165	169	1,304	2,367	104	183
Exchangeable Potassium	(cmol./kg)	0.46	0.18	0.35	0.60	0.28	0.26
	(kg/ha)	404	159	302	527	249	226
	(mg/kg)	180	71	135	235	111	101
Exchangeable Sodium	(cmol./kg)	0.10	0.18	1.5	3.7	0.12	0.13
	(kg/ha)	50	94	771	1,930	60	64
	(mg/kg)	22	42	344	862	27	29
Exchangeable Aluminium	(cmol./kg)	0.09	0.02	0.02	0.02	0.70	0.06
	(kg/ha)	18	4.2	3.7	4.1	141	13
	(mg/kg)	7.9	1.9	1.7	1.8	63	5.8
Exchangeable Hydrogen	(cmol./kg)	0.19	0.13	<0.01	<0.01	0.66	0.11
	(kg/ha)	4.3	2.8	<1	<1	15	2.4
	(mg/kg)	1.9	1.3	<1	<1	6.6	1.1
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	4.2	3.5	15	30	4.1	4.8
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100	48	45	18	21	36	57
Magnesium (%)		32	40	70	64	21	31
Potassium (%)		11	5.2	2.2	2.0	6.9	5.3
Sodium - ESP (%)		2.3	5.2	9.7	12	2.8	2.6
Aluminium (%)		2.1	0.60	0.12	0.07	17	1.3
Hydrogen (%)		4.5	3.6	0.00	0.00	16	2.3
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)	1.5	1.1	0.26	0.33	1.7	1.8
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)	5.7	6.1	6.3	7.3	4.9	5.8
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017	4	3	4	2	4	3
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 4/3	10 YR 5/3	10 YR 5/6	10 YR 4/6	10 YR 4/4	10 YR 4/3
		Brown	Brown	Yellowish Brown	Dark Yellowish Brown	Dark Yellowish Brown	Brown
Mottles Munsell Colour		..	..	2.5 YR 4/8	..	..	..
..		..	Red	..	..	..
Degree of Mottling (%)		..	..	5	..	..	..

AGRICULTURAL SOIL ANALYSIS REPORT

30 samples supplied by SLR Consulting Australia Pty Ltd on 8/09/2022. Lab Job No. N2530.
 Analysis requested by Murray Fraser. Your Job: SLR 630.30409 Kingsdale BSAL
 10 Kings Road NEW LAMBTON NSW 2305

		Sample ID:	Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Crop:	K9 40-50	K9 65-75	K10 0-10	K10 20-30	K10 40-50	K10 65-75
		Client:	Soil	Soil	Soil	Soil	Soil	Soil
			Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone
Parameter	Method reference		N2530/25	N2530/26	N2530/27	N2530/28	N2530/29	N2530/30
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)		7.08	8.26	5.59	6.33	6.44	6.36
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.039	0.070	0.036	0.024	0.026	0.028
Exchangeable Calcium	(cmol./kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	6.0	8.7	2.1	2.8	2.1	1.8
	(kg/ha)		2,690	3,916	962	1,238	964	811
	(mg/kg)		1,201	1,748	429	553	430	362
Exchangeable Magnesium	(cmol./kg)		10	18	1.2	1.3	2.2	3.4
	(kg/ha)		2,844	4,876	319	366	608	919
	(mg/kg)		1,270	2,177	143	163	272	410
Exchangeable Potassium	(cmol./kg)	0.52	0.74	0.29	0.18	0.17	0.20	
	(kg/ha)	452	646	253	156	152	176	
	(mg/kg)	202	288	113	70	68	78	
Exchangeable Sodium	(cmol./kg)	1.3	2.4	0.13	0.20	0.24	0.29	
	(kg/ha)	665	1,223	67	104	124	149	
	(mg/kg)	297	546	30	46	55	66	
Exchangeable Aluminium	(cmol./kg)	**Inhouse S37 (KCl)	0.02	0.01	0.25	0.02	0.03	0.02
	(kg/ha)		3.1	2.7	50	4.6	5.6	4.8
	(mg/kg)		1.4	1.2	22	2.0	2.5	2.2
Exchangeable Hydrogen	(cmol./kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.30	0.11	0.11	0.13
	(kg/ha)		<1	<1	6.7	2.4	2.5	3.0
	(mg/kg)		<1	<1	3.0	1.1	1.1	1.3
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)		18	30	4.3	4.6	4.9	5.8
Calcium (%)	**Base Saturation Calculations - Cation cmol./kg / ECEC x 100		33	29	50	60	44	31
Magnesium (%)		57	60	27	29	45	58	
Potassium (%)		2.8	2.5	6.8	3.9	3.5	3.4	
Sodium - ESP (%)		7.1	8.0	3.1	4.4	4.9	4.9	
Aluminium (%)		0.08	0.04	5.8	0.49	0.57	0.41	
Hydrogen (%)		0.00	0.00	7.0	2.3	2.2	2.3	
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol./kg)		0.57	0.49	1.8	2.1	0.96	0.54
pH	**Rayment & Lyons 2011 - 4B4 (CaCl ₂)		6.2	7.0	5.3	5.9	6.0	6.0
Emerson Aggregate Test (EAT)	**AS1289.3.8.1-2017		3	2	3	3	3	2
Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10 YR 5/3	10 YR 4/2	10 YR 4/4	10 YR 4/3	10 YR	10 YR	
		Brown	Dark Grayish Brown	Dark Yellowish Brown	Brown	Brown	Light Yellowish Brown	
5 YR 4/6		10 YR 2/1	..	..	..	..
Yellowish Red		Black	..	..	..	..
		Yellowish Brown	..	..	..	..
		5	5	..	..	..
Degree of Mottling (%)		15	5	..	..	..	..

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

30 samples supplied by SLR Consulting Australia Pty Ltd on 8/09/2022. Lab Job No. N2530

Analysis requested by Murray Fraser. Your Job: SLR 630.30409 Kingsdale BSAL

10 Kings Road NEW LAMBTON NSW 2305

SAMPLE ID	Lab Code	MOISTURE CONTENT	TOTAL GRAVEL > 2 mm	GRAVEL > 4.75 mm	GRAVEL 2.00-4.75 mm	COARSE SAND 200-2000 µm (0.2-2.0 mm)	FINE SAND 20-200 µm (0.02-0.2 mm)	SILT 2-20 µm	CLAY < 2 µm
		(% of water in sample)	(% of total oven-dry equivalent)	(% of total oven-dry equivalent)	(% of total oven-dry equivalent)	(% of total oven-dry equivalent)			
K2 0-10	N2530/1	30.9%	0.0%	0.0%	0.0%	4.7%	9.9%	36.3%	49.1%
K2 30-40	N2530/2	24.6%	0.1%	0.0%	0.1%	8.7%	17.5%	14.3%	59.4%
K2 60-70	N2530/3	20.2%	4.2%	0.0%	4.2%	16.4%	15.7%	15.4%	48.2%
K3 0-10	N2530/4	29.4%	15.9%	10.1%	5.8%	11.9%	5.3%	17.7%	49.2%
K3 30-40	N2530/5	18.4%	3.5%	1.4%	2.2%	14.2%	21.6%	16.0%	44.7%
K3 60-70	N2530/6	20.1%	4.9%	2.5%	2.4%	17.4%	11.6%	15.5%	50.7%
K4 0-10	N2530/7	28.7%	0.1%	0.0%	0.1%	4.3%	31.5%	29.0%	35.0%
K4 20-30	N2530/8	23.7%	0.7%	0.0%	0.7%	8.4%	17.7%	28.4%	44.8%
K4 40-50	N2530/9	27.1%	0.4%	0.0%	0.4%	5.2%	11.8%	17.4%	65.2%
K4 65-75	N2530/10	19.3%	2.9%	0.0%	2.9%	11.4%	13.8%	21.4%	50.6%
K5 0-10	N2530/11	22.4%	15.2%	3.0%	12.2%	18.0%	27.0%	11.7%	28.1%
K5 20-30	N2530/12	18.6%	12.8%	2.7%	10.1%	20.2%	25.5%	17.6%	23.9%
K5 40-50	N2530/13	26.3%	2.6%	0.0%	2.6%	6.5%	12.6%	6.1%	72.2%
K5 65-75	N2530/14	25.1%	1.2%	0.0%	1.2%	7.6%	16.4%	6.9%	67.8%
K6 0-10	N2530/15	27.8%	6.4%	0.0%	6.4%	20.6%	26.1%	15.8%	31.1%
K6 20-30	N2530/16	22.0%	13.7%	7.1%	6.6%	21.8%	18.2%	11.0%	35.2%
K6 40-50	N2530/17	25.6%	1.1%	0.0%	1.1%	12.0%	12.9%	17.4%	56.6%
K6 65-75	N2530/18	22.7%	4.3%	2.0%	2.3%	21.3%	19.2%	14.5%	40.8%
K7 0-10	N2530/19	23.2%	7.9%	1.1%	6.8%	12.9%	40.4%	16.7%	22.1%
K7 10-20	N2530/20	12.1%	13.7%	2.6%	11.2%	15.7%	28.2%	16.9%	25.4%
K7 40-50	N2530/21	19.5%	1.7%	0.0%	1.7%	6.8%	22.0%	13.2%	56.2%
K7 65-75	N2530/22	23.4%	1.0%	0.0%	1.0%	3.4%	10.0%	6.8%	78.7%
K9 0-10	N2530/23	21.1%	0.7%	0.0%	0.7%	8.8%	39.7%	19.6%	31.2%
K9 20-30	N2530/24	17.3%	13.6%	3.0%	10.6%	12.3%	34.5%	14.4%	25.2%
K9 40-50	N2530/25	22.5%	1.8%	0.6%	1.2%	6.9%	20.5%	37.7%	33.1%
K9 65-75	N2530/26	22.0%	0.9%	0.0%	0.9%	4.6%	15.8%	13.4%	65.3%
K10 0-10	N2530/27	18.2%	2.1%	0.0%	2.1%	12.6%	36.3%	21.2%	27.8%
K10 20-30	N2530/28	16.6%	3.0%	1.0%	2.0%	12.0%	32.7%	26.9%	25.4%
K10 40-50	N2530/29	15.7%	16.8%	10.0%	6.9%	10.0%	22.2%	18.5%	32.4%
K10 65-75	N2530/30	19.2%	16.0%	7.1%	8.9%	7.5%	20.2%	17.9%	38.3%

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)
- 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 28/09/2022.

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