West Muswellbrook Project

Gateway Application Supporting Document
Appendix B

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West Muswellbrook Project

Biophysical Strategic Agricultural Land (BSAL)

Site Verification Report

Report Number 630.11046

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Muswellbrook Coal Company Limited

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West Muswellbrook Project

Biophysical Strategic Agricultural Land (BSAL)

Site Verification Report

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Executive Summary

Muswellbrook Coal Company (MCC) is proposing to develop the West Muswellbrook Project, an open cut coal mine approximately 12 km north west of Muswellbrook in the Upper Hunter of NSW. This BSAL site verification report provides supporting documentation for the Gateway Application. The BSAL site verification program was undertaken over the 5,621 ha Project Application Area (PAA) at a survey intensity scale of 1:25,000 in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (OEH 2013)*.

The NSW regional scale BSAL mapping showed 206 ha of BSAL located in the West Muswellbrook PAA, consistent with the alluvial Hunter soil landscape as mapped at 1:250,000 scale by Lawrie and Kovac in 1991.

The BSAL site verification program excluded 2,830 ha based on slope greater than 10% and less than 20ha contiguous <10% slope. The 13 BSAL verification criteria were applied to 148 exposed soil profiles across the remainder of the PAA (2,791 ha). There were 14 soil types found across the site, dominated by Brown, Black and Red Vertosols, with smaller areas of Chromosols, Sodosols, Dermosols and Rudosols. Each soil profile was keyed out to the sub group or family level as part of the BSAL verification process.

There was a total of 204.6 ha of verified BSAL within the PAA, mainly situated in the Northern area near Rossgole Road. There was 136.24 ha of the verified BSAL located in proposed non disturbance areas, with 68.36 ha located within the proposed disturbance footprint, which will be impacted by mining.

The second component of this site verification report was the assessment of Land and Soil Capability (LSC) across the entire PAA in accordance with *The land and soil capability assessment scheme: second approximation (OEH 2012)*. This assessment applied the eight LSC criteria against the information obtained at each soil profile exposure in order to determine the limiting factor which dictates the LSC class for that site. A total of 141 soil profiles were assessed.

The Project disturbance area is dominated by LSC Class 4 (55%), followed by Class 6 (18%), and Class 5 (12%). Approximately 10% of the disturbance area (412 ha) is LSC Class 3 and 0.6% (26 ha) is considered LSC Class 2. There is also approximately 4% of the disturbance area LSC Class 7 which is considered not suitable for agriculture. The majority of the verified BSAL is located on LSC Class 2 and 3 land, which confirms the BSAL mapping also satisfies the LSC criteria.

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1 INTRODUCTION

1.1 Project Background

The Proponent for the West Muswellbrook Project (the Project) is Muswellbrook Coal Company Limited (MCC), a 100% owned subsidiary of Idemitsu Australia Resources Pty Ltd (IAR). The proposed Project is an open cut coal mine approximately 12 km north west of Muswellbrook in the Hunter Valley Coalfields of New South Wales (NSW). The Project is bordered by Bengalla and the proposed Mt Pleasant mine in the east, and Dartbrook underground mine in the North.

This report provides supporting documentation for the Gateway Application that is being prepared for the Project to assess impacts on Strategic Agricultural Land. This report, specifically addresses Biophysical Strategic Agricultural Land (BSAL), which is defined as land containing "a *rare combination of natural resources and is considered highly suitable for agriculture*" (DP&I, 2012). This report describes the BSAL verification program undertaken over the 5,621 ha Project Application Area (PAA). The verification program was undertaken in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* ((Office of Environment & Heritage (OEH) and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (DPI-OASFS), 2013)); hereafter referred to as the Interim Protocol.

The purpose of this report is to:

- Provide the results of the BSAL verification program conducted in accordance with the Interim Protocol. Including 1:25,000 scale maps showing extent and distribution of verified BSAL within the PAA; and
- Provide a detailed map of Land and Soil Capability (LSC) over the PAA.

The key personnel for this site verification program consisted of the following Consultants:

- Clayton Richards (CPSS 2 and Principal Consultant – SLR) was Project Manager and Author of this report and responsible for field and laboratory results interpretation;
- John Lawrie (CPSS 3) assisted with the fieldwork, soil descriptions and mapping;
- Murray Fraser (Senior Agronomist - SLR) assisted with the fieldwork, soil descriptions and mapping;
- Nathan Thompson (Principal GIS Consultant – SLR) responsible for figures and management of all GSI files associated with the program;
- Dr David McKenzie (CPSS 3) undertook the Phase 1 of this assessment and provided data for sites M1 to M34, including BSAL assessment, lab results, field sheets, LSC assessment and BSAL data cards.

1.2 The Gateway Process

The Strategic Regional Land Use Plans (SRLUP) for the Upper Hunter and New England North West were released by the NSW Government in September 2012. The BSAL mapping for the remainder of NSW was released in January 2014. The SRLUPs represent the Government's proposed framework to support growth, protect the environment and respond to competing land uses, whilst preserving key

regional values over the next 20 years. The Gateway Process is the first step in ensuring a rigorous and independent assessment of the potential impacts of a project on strategic agricultural land and associated water resources (including BSAL) prior to a development application being made.

As part of the Gateway Process, areas of particularly high agricultural values have been identified and mapped in consultation with key industry representatives and industry experts for the whole of NSW. These areas are referred to as Strategic Agricultural Land (SAL). Two categories of SAL have been identified:

1. Biophysical Strategic Agricultural Land (BSAL); and
2. Critical Industry Clusters (CIC):
    - Equine Cluster,
    - Viticulture Cluster.

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.

The criteria used to measure BSAL under the original SRLUP were based on three regional scale parameters:

1. Soil Fertility – based on the regional scale Draft Inherent General Fertility of NSW (OEH),
2. Land and Soil Capability – based on the regional scale Land and Soil Capability Mapping of NSW, and
3. Access to reliable water supply.

The application of the SAL mapping is to 'trigger' the new Gateway Process for new project development applications.

The Mining SEPP requires certain types of developments to verify whether the proposed development is on BSAL. The Interim Protocol assists proponents and landholders to understand what is required to identify the existence of BSAL and outlines the technical requirements for the on-site identification and mapping of BSAL.

1.3 Interim Protocol Checklist

Table 1 Interim Protocol Checklist

	Checklist Item	Addressed in Section of Report
	Ensure that:	
1.	a qualified soil scientist is overseeing the verification assessment and has signed off on the quality and extent of the work;	Section 1.1
2.	laboratories for soil samples are compliant with AS ISO/IEC17025;	Appendix 2
3.	results within 15 per cent of threshold levels are analysed in a laboratory;	Appendix 2
4.	all soil profile descriptions and observations are recorded and submitted to SALIS;	To be made available upon request by OEH
5.	laboratory data is supplied to OEH using their standard spreadsheet templates.	Electronic versions to be made available upon request by OEH
	The report supporting the BSAL site verification application must include:	
1.	reporting requirements for site verification criteria as described in Appendix 1;	**Table 5**
2.	three 1:25000 maps showing: base level information; soil types and BSAL;	Figures 2a, 2b, 4a, 4b, 5a and 5b
3.	GIS output files, and metadata statements; and	Electronic versions to be made available upon request
4.	Laboratory report.	Appendix 2

2 BSAL VERIFICATION

2.1 Defining BSAL

The Interim Protocol describes BSAL in three different ways:

1. 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. BSAL is able to be used sustainably for intensive purposes such as cultivation. Such land is inherently fertile and generally lacks significant biophysical constraints. (Interim Protocol: Section 3 Paragraph 1 on page 2).

2. On a regional scale, the maps of BSAL meet the three criteria outlined in the SRLUP (Interim Protocol: Section 3 text box):
    a. Access to reliable water supply;
    b. Inherent General Fertility; and
    c. Land and Soil Capability (LSC) as mapped for NSW by OEH.

3. On a property scale, the verification criteria include specific measurements of the following parameters: slope; rock outcrop; surface rock fragments; gilgai; soil fertility (based on soil type); effective rooting depth to a physical barrier; soil drainage; soil pH; salinity; and effective rooting depth to a chemical barrier. (Interim Protocol: Section 6 on page 5 and Figure 2). For Soil to be classified as BSAL it must meet all of these criteria. If any of the criteria are not met, the site is not BSAL and there is no need to continue the assessment. The minimum area for BSAL is 20 hectares. If the assessment area falls below 20 hectares at any point because the criteria are not met then the land is not BSAL and there is no need to continue the assessment

This report assesses' BSAL according to the requirements of the third description.

2.2 Methodology

The site verification and methodology reported in the following sections has been undertaken based on the Interim Protocol.

Step 1: Identify the project area which will be assessed for BSAL

The assessment area should include the entire project area and include at least a 100 m 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 assessment area is defined as:

- Mine Infrastructure Area,
- Out of Pit Emplacement Area,
- In Pit Emplacement Areas,
- Final Void, and
- Nil Disturbance.

For the purpose of this assessment, the proposed disturbance areas above include a 100m buffer surrounding the area to account for minor changes in design, in accordance with the BSAL protocol. The total assessment area is therefore 5,621 ha as shown in Figure 1 and is referred to in this report as the "PAA". The Lot and DPs for the areas comprising the site are listed in Appendix 4.

Step 2: Confirm access to a reliable water supply

BSAL lands must have access to a "reliable water supply".

As noted in the Upper Hunter SRLUP and the Interim Protocol (page 3), all areas covered by this SRLUP map satisfy the requirement for reliable water supply due to adequate rainfall or an underlying groundwater aquifer.

Step 3: Choose the appropriate approach to map the soils information

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 9.6 based on landscape characteristics using the information listed in Section 5 of the Interim Protocol.

It is important to note that for either approach, if any criteria indicate that the site is not BSAL, then no further assessment is necessary. The flow chart in Figure 2

(reproduced in this report as Figure 3) is designed to assess the simplest criteria first, to avoid more costly assessments if the site can be easily discounted as BSAL.

MCC had access to the majority of properties within the PAA for on-ground verification of BSAL. However, three land holdings were not able to be accessed for BSAL verification by MCC as landholder access permissions were withheld. These land holdings are highlighted in **Figures 4a** and **4b** and listed in Appendix 4. The remainder of the PAA was accessible during the BSAL verification program. The assessment flowchart the Interim Protocol used to assess the accessible areas is shown in **Figure 3**.

Step 4: Risk assessment

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.

To identify the potential for the Project to impact on agricultural resources and the appropriate level of soil survey required, an evaluation of risk to agricultural resources and enterprises was undertaken. This risk assessment is taken from the Guideline for Agricultural Impact Statements at the Exploration Stage (DTIRIS, 2012) shown in **Table 2**, **Table 3** and **Table 4** below, and is based on the probability of occurrence and the consequence of the impact, as described in the Land Use Conflict Risk Assessment Guide (NSW DPI 2011). Depending on the risk, inspection densities can range from 1 site per 25-400 ha for low risk to 1 site per 5-25 ha for high risk (Gallant *et al*.2008).

Table 2 Agricultural Impact Risk Ranking Matrix

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

Source: DPI-OASFS, 2013

Table 3 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 4 Agricultural Impact Risk Ranking – Consequence Descriptors

Level: 1	Severe Consequences	Example of Implications
Description	Severe and/or permanent damage to agricultural resources, or industries Irreversible Severe impact on the community	Long term (eg 20 years) damage to soil or water resources Long term impacts (eg 20 years) on a cluster of agricultural industries or Important agricultural lands
Level: 2	**Major Consequences**	**Example of Implications**
Description	Significant and/or long-term impact to agricultural resources, or industries Long-term management implications Serious detrimental impact on the community	Water and / or soil impacted, possibly in the long term (eg 20 years) Long term (eg 20 years) displacement / serious impacts on agricultural industries
Level:3	**Moderate Consequences**	**Example of Implications**
Description	Moderate and/or medium-term impact to agricultural resources, or industries Some ongoing management implications Minor damage or impacts but over the long term.	Water and/ or soil known to be affected, probably in the short – medium term (eg 1-5 years) Management could include significant change of management needed to agricultural enterprises to continue.
Level: 4	**Minor Consequences**	**Example of Implications**
Description	Minor damage and/or short-term impact to agricultural resources, or industries Can be effectively managed as part of normal operations	Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated Minor erosion, compaction or water quality impacts that can be mitigated. For example, dust and noise impacts in a 12 month period on extensive grazing enterprises.
Level: 5	**Negligible Consequences**	**Example of Implications**
Description	Very minor damage or impact to agricultural resources, or industries Can be effectively managed as part of normal operations	No measurable or identifiable impact on the agricultural resource or industry

The Project's potential impacts on agriculture have been risk assessed as follows:

a. Consequence: Level 1 – Severe and/or permanent damage to agricultural resources, or industries. Irreversible. Severe impact on the community.
b. Probability: A – Almost Certain. Common or repeating occurrence.

The risk matrix result is A1 which is considered a high risk to agricultural activities. This area is therefore to have an inspection density of 1:25,000 which requires a minimum observation site every

25 ha. For the purpose of this survey the buffer land between, and surrounding the open cut pits, and the 100m buffer area is also considered to require an inspection density of 1:25,000. Of the total PAA of 5,621 ha, the exclusion area for greater than 10% slope and less than 20ha contiguous <10% slope totals 2,830 ha. Therefore the remaining area to be surveyed is 2,791 ha, which requires a minimum total of 112 inspection sites across the assessment area.

Step 5: Soils and landscape verification criteria

Ten site verification criteria are identified by the Interim Protocol (Section 6, page 5), with the easy to measure criteria assessed first. The assessment criteria are:

1. Slope;
2. Rock outcrop;
3. Surface rock fragments;
4. Gilgai;
5. Soil fertility (based on soil type);
6. Effective rooting depth to a physical barrier; soil drainage;
7. Soil pH;
8. Salinity;
9. Effective rooting depth to a chemical barrier; and
10. Contiguous area greater than 20ha

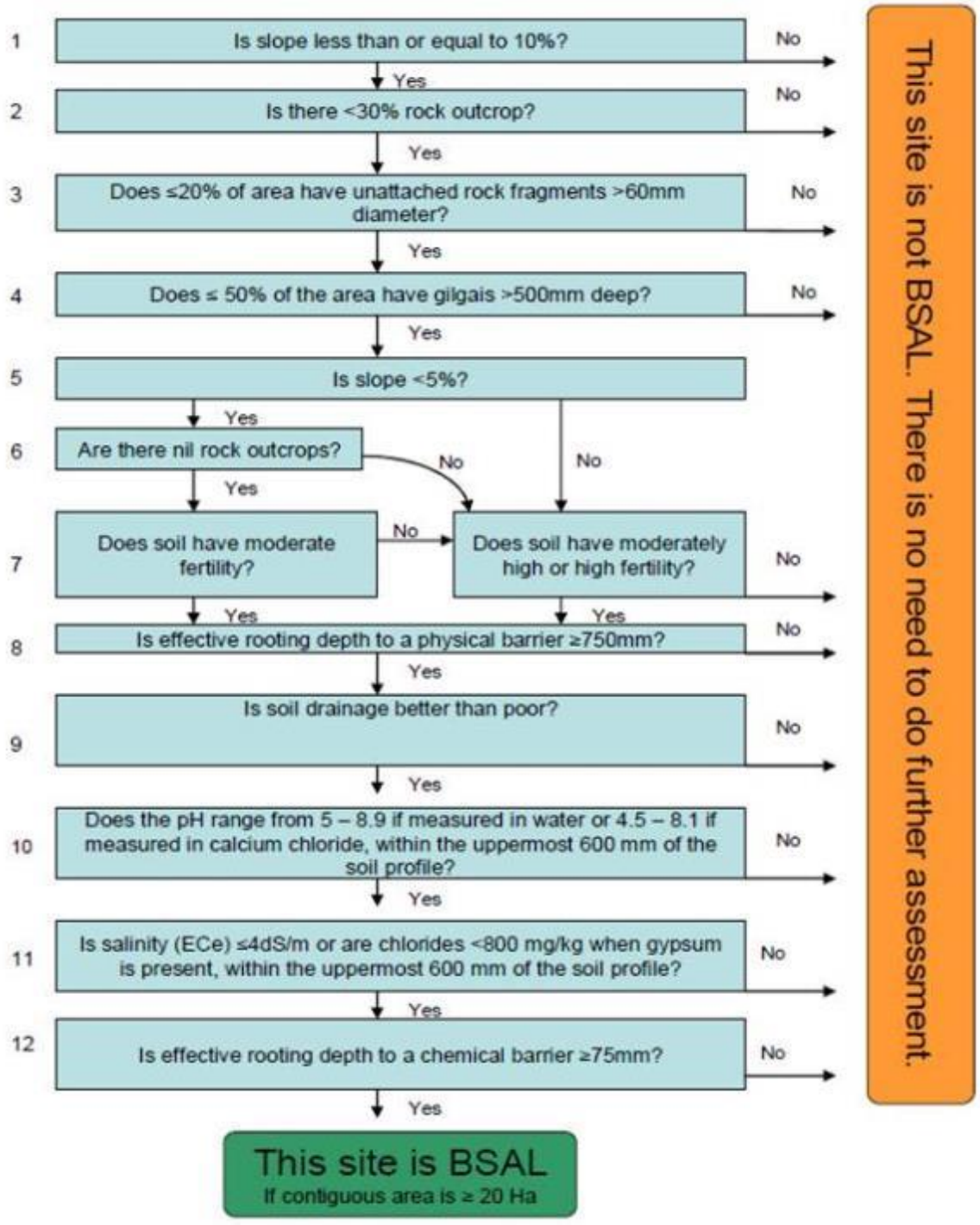
For soil to be classified as BSAL it must meet all the criteria outlined in the flow chart shown in **Figure 3**. If any criteria are not met, the site is not BSAL and there is no need to continue the assessment. The specific requirements for each parameter to be assessed are outlined in the Interim Protocol (Section 6).

Site assessment of slope gradients was undertaken using a digital elevation model and areas with gradients greater than 10% were considered exclusion sites and are shown in **Figure 4a** and **4b**. Areas of land with gradients less than 10% but less than 20ha contiguous were also excluded.

Existing soil landscape information was considered to provide a background understanding of the area and was used to assist in mapping the restricted access land holdings for this BSAL verification assessment.

The BSAL verification fieldwork was undertaken by McKenzie in June and July 2014, and SLR in September and October 2014. A total of 148 inspections at sites shown on **Figure 4a** and **4b** were undertaken, of which 75 were detailed test pits. This level of survey satisfies a 1:25,000 survey scale for the entire PAA. The survey intensity averages one inspection site every 18 ha across the PAA, which is above the minimum requirement for 1:25,000 ha of 1 inspection site every 25 ha (Gallant *et al* 2008). This level of survey was undertaken to ensure adequate representative sites were encountered as per the Interim Protocol requirements. The results of the verification work are detailed in **Section 2.3.**

Figure 3: Flow Chart for site assessment of BSAL



Source: Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (OEH 2013)

2.3 Results

The NSW government BSAL maps are based on the three regional scale criteria as outlined in the Interim protocol for site verification and mapping of BSAL (April 2013):

- Properties with access to a reliable water supply; and
- Land that falls under the soil fertility classes 'high' or 'moderately high' under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land and soil capability 1, 2 or 3 under the Land and Soil Capability Mapping of NSW (OEH); or
- Land that falls under the soil fertility classes 'moderate' under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land and soil capability 1 or 2 under the Land and Soil Capability Mapping of NSW (OEH);

The government fertility and land and soil capability mapping is largely based on the soil landscapes information which, in this case, was published in 1991 at a mapping scale of 1:250,000. The Government BSAL mapping aligns with the Hunter Soil Landscape which covers the floodplains of the Hunter River and its tributaries. The main soils are formed in alluvium. There were 206 ha of the Hunter soil landscape, and therefore government mapped BSAL, in the West Muswellbrook PAA.

The BSAL verification protocol is based on 13 criteria as shown in Figure 3. The BSAL verification mapping is different from the Government BSAL map and the Site verification BSAL map for the following two reasons: Firstly, the BSAL verification criteria does not necessarily align with the three regional scale criteria used to produce the government BSAL maps. Secondly, the BSAL verification was also undertaken at a 1:25,000 inspection scale, which is significantly more detailed than the government mapping (1:250,000). These variations in criteria and mapping scale explains why the two maps are incongruent.

Figures 5a and **5b** show the dominant limiting factor for each soil type which fails the BSAL criteria. All soil profile sites have been keyed out to the sub group and family level according to the Australian Soil Classification (ASC), and are detailed below in **Table 5**. The BSAL assessment and status for each soil profile is also shown in **Table 6** with the first failed criteria highlighted.

Table 5 Results Site BSAL Verification Summary

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
M1	Detailed	McK	Basic, Stratic Rudosol	n/a	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✓	N/A	No	Rudosol - Moderately low fertility
M2	Detailed	McK	Endocalcareous, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	No	Ece = 6.2 dS/m
M3	Detailed	McK	Hypocalcic, Subnatric, Red Sodosol	n/a	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✗	N/A	No	Sodosol - Moderately low fertility
M4	Detailed	McK	Haplic, Epipedal, Red Vertosol	n/a	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	
M5	Detailed	McK	Sodic, Calcic, Brown Chromosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	SLR updated to BSAL
M6	Detailed	McK	Endocalcareous, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✓	N/A	No	Ece = 5.6 dS/m
M7	Detailed	McK	Epicalcareous, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	No	pH 8.2 (CaCl2)
M8	Detailed	McK	Sodic, Calcic, Red Chromosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	N/A	No	pH 8.2 (CaCl2)
M9	Detailed	McK	Endohypersodic, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	No	Ece = 5.3 dS/m
M10	Detailed	McK	Calcic, Subnatric, Brown Sodosol	n/a	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No	Sodosol - Moderately low fertility

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
M11	Detailed	McK	Endocalcareous, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✓	N/A	No	Ece = 4.1 dS/m
M12	Detailed	McK	Endocalcareous, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	N/A	No	pH 8.2 (CaCl2)
M13	Detailed	McK	Endohypersodic, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✓	✓	N/A	No	Drainage Poor (Waterlogging depth 0.48m)
M14	Detailed	McK	Mottled, Epipedal, Red Vertosol	n/a	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✓	✓	✓	N/A	No	Slope 12% - Greater than 10%
M15	Detailed	McK	Eutrophic, Mesonatric, Grey Sodosol	n/a	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✗	✓	N/A	No	Sodosol - Moderately low fertility
M16	Detailed	McK	Calcic, Subnatric, Black Sodosol	n/a	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✗	✗	N/A	No	Sodosol - Moderately low fertility
M17	Detailed	McK	Haplic, Self-mulching, Red Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
M18	Detailed	McK	Endohypersodic, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	No	Ece = 4.4 dS/m
M19	Detailed	McK	Endocalcareous-Endohypersodic, Self-Mulching, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	N/A	No	pH 8.4 (CaCl2)
M20	Detailed	McK	Haplic, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	SLR updated to BSAL
M21	Detailed	McK	Haplic, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
M22	Detailed	McK	Endocalcareous, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	No	pH 8.2 (CaCl2)

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
M23	Detailed	McK	Epicalcareous, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	
M24	Detailed	McK	Bleached-Mottled, Hypocalcic, Grey Chromosol	n/a	N/A	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	✓	N/A	No	Drainage Poor (Waterlogging depth 0.35m)
M25	Detailed	McK	Haplic, Epipedal, Red Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	
M26	Detailed	McK	Other soils, Regolithic, Hypocalcic Calcarosol	n/a	✓	✓	✓	✓	✘	✓	✘	✘	✓	✘	✓	✓	✓	N/A	No	Calcarosol - Moderately low fertility
M27	Detailed	McK	Endocalcareous, Epipedal, Grey Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	✓	N/A	No	pH 8.3 (CaCl2)
M28	Detailed	McK	Epicalcareous-Endohypersodic, Epipedal, Black Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	✓	N/A	No	pH 8.2 (CaCl2)
M29	Detailed	McK	Haplic, Calcic, Black Chromosol	n/a	✓	✓	✓	✓	✘	✓	✓	✓	✓	✘	✓	✓	✓	N/A	No	Drainage Poor (Waterlogging depth 0.50m)
M30	Detailed	McK	Calcareous, Stratic Rudosol	n/a	✓	✓	✓	✓	✓	✓	✘	✘	✓	✓	✘	✘	✘	N/A	No	(SLR updated - Rudosol - Moderately low fertility) pH 8.3 (CaCl2)
M31	Detailed	McK	Calcareous, Stratic Rudosol	n/a	✓	✓	✓	✓	✓	✓	✘	✘	✓	✓	✓	✓	✓	N/A	No	Rudosol - Moderately low fertility
M32	Detailed	McK	Endocalcareous, Epipedal, Red Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	N/A	No	pH 8.3 (CaCl2)
M33	Detailed	McK	Endocalcareous-Endohypersodic, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	N/A	No	Chemical Barrier (ESP 15.9 at 0.3m-0.6m layer)

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M34	Detailed	McK	Endocalcareous, Epipedal, Brown Vertosol	n/a	✓	✓	✓	✓	✘	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous
S-1	Check	MF & JL	Stratic Rudosol	HM	✓	✓	✓	✓	✓	✓	✘	✘	✘	✓	N/A	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-2	Check	MF & JL	Brown Vertosol	EQSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
S-3	Detailed	MF & JL	Haplic Eutrophic Red Chromosol	BELOV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	✓	✓	N/A	No	Physical Barrier C horizon at 0.60m
S-4	Check	MF & JL	Brown Chromosol	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
S-5	Detailed	MF & JL	Endocalcareous Self Mulching Brown Vertosol	FRSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✘	N/A	No	pH in water 9.3 at 0.50m
S-6	Detailed	MF & JL	Haplic Eutrophic Brown Dermosol	AFOOV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	N/A	No	pH in water 9.0 at 0.50m
S-7	Check	CR	Grey Chromosol	AELOU	✓	✓	✓	✓	✓	✓	N/A	N/A	✘	N/A	N/A	N/A	N/A	N/A	No	Shallow gravelly B/C horizon at 0.40m
S-8	Detailed	CR & JL	Endocalcareous Self Mulching Black Vertosol	FRSW	✓	✓	✓	✓	✘	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	
S-9	Detailed	CR & JL	Endocalcareous Self Mulching Brown Vertosol	ERSW	✓	✓	✓	✓	✘	✓	✓	✓	✓	✓	✓	✘	✓	N/A	No	Ece 6.4 dS/m at 0.60m
S-10	Detailed	MF & JL	Endocalcareous Self Mulching Black Vertosol	ESSV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous
S-11	Check	MF & JL	Haplic Self Mulching Brown Vertosol	EQSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.70m

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S-12	Check	MF & JL	Haplic Self Mulching Red Vertosol	FQRV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.55m
S-13	Detailed	MF & JL	Haplic Eutrophic Red Chromosol	BFMOV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	N/A	No	Physical Barrier B/C horizon at 0.65m
S-14	Check (Affiliate S9)	CR & JL	Red/Brown Vertosol	ERSW	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Weathered Rock (C Horizon) at 0.50m
S-14/15	Detailed	MF & JL	Endocalcareous-Endohypersodic Self Mulching Black Vertosol	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	No	Drainage Poor (Waterlogging at 0.45m)
S-15	Detailed	MF & JL	Haplic Self Mulching Black Vertosol	ERRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	No	Drainage Poor and pH 9.6 in water at 0.50m
S-16	Detailed	CR & JL	Endocalcareous Epipedal Black Vertosol	EQSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
S-17	Check	MF & JL	Mottled Self Mulching Brown Vertosol	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Gravel Layer (C horizon) at 0.70m
S-18	Check	MF & JL	Haplic Self Mulching Brown Vertosol	FQRU	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.30m
S-19	Check	MF & JL	Red Chromosol	BGMOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.55m
S-20	Detailed	MF & JL	Endohypersodic Self Mulching Black Vertosol	ERSW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	N/A	No	pH in water 9.1 at 0.40m
S-21	Check	CR & JL	Self Mulching Black Vertosol	ERSV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✗	N/A	N/A	N/A	No	Weathered Rock (C Horizon) at 0.65m
S-22	Check	CR & JL	Red Chromosol	BELOU	✗	✓	✓	✓	✗	✓	N/A	N/A	✗	N/A	N/A	N/A	N/A	N/A	No	Slope 13% measured

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S-23	Check	MF & JL	Haplic Self Mulching Brown Vertosol	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
S-24	Check	MF & JL	Haplic Self Mulching Brown Vertosol	EQRU	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.50m
S-25	Check	MF & JL	Haplic Self Mulching Brown Vertosol	ERSV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	N/A	N/A	N/A	✗	No	BSAL Area <20ha Contiguous
S-26	Check	MF & JL	Endocalcareous Self Mulching Black Vertosol	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Weathered Rock (C Horizon) at 0.70m
S-27	Detailed	MF & JL	Haplic Self Mulching Brown Vertosol	ERSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
S-28	Detailed	CR & JL	Endocalcareous Self Mulching Brown Vertosol	EQSW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✓	N/A	No	Ece 4.5 dS/m at 0.60m
S-29	Check	MF & JL	Endocalcareous Self Mulching Red Vertosol	HRRV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier - Gravel Layers
S-30	Check	MF & JL	Brown Sodosol	BGLOW	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	N/A	N/A	N/A	No	Sodosols have Moderately low fertility, Drainage is Poor
S-31	Check	MF & JL	Brown Sodosol	BGLOW	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	N/A	N/A	N/A	No	Gravel layers and Drainage is Poor
S-32	Detailed	CR & JL	Endocalcareous Self Mulching Brown Vertosol	EQSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	No	Ece 4.2 dS/m at 0.35m
S-33	Detailed	CR & JL	Eutrophic Subnatric Brown Sodosol	AEMOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No	Sodosols have Moderately low fertility
S-35	Check	MF & JL	Mottled Calcic Brown Chromosol	AGLOV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Gravel layer 0.10m and C horizon at 0.70m

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S-36	Check	MF & JL	Mottled Calcic Brown Chromosol	AGLOV	✓	✓	✓	✓	✗	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.65m
S-37	Check	MF & JL	Mottled Hypercalcic Brown Chromosol	AEMOV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✘	N/A	N/A	N/A	N/A	No	Drainage is Poor
S-38	Check	CR & JL	Red Sodosol (Buried)	BELOV	✓	✓	✓	✓	✓	✓	N/A	N/A	✘	✘	✓	N/A	N/A	N/A	No	Gravel Layer >20% at 0.65
S-43	Detailed	MF & JL	Mottled Self Mulching Grey Vertosol	FRSV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	✓	N/A	No	Drainage is Poor
S-44	Detailed	MF & JL	Haplic Self Mulching Grey Vertosol	ESSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	✘	✘	N/A	No	Physical Barrier - gravel layer at 0.70m
S-45	Check	MF & JL	Haplic Calcic Brown Chromosol	AGMOV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier - gravel layers and C horizon at 0.70m
S-46	Detailed	MF & JL	Endocalcareous Self Mulching Brown Vertosol	EQRV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	✓	N/A	No	pH in water 9.2 at 0.50m
S-47	Detailed	MF & JL	Eutrophic Subnatric Brown Sodosol	BELOV	✓	✓	✓	✓	✓	✓	✘	✘	✓	✘	✓	✘	✓	N/A	No	Sodosols have Moderately low fertility
S-48	Check	MF & JL	Haplic Self Mulching Brown Vertosol	EQRV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	N/A	N/A	N/A	✘	No	BSAL Area <20ha Contiguous
S-49H	Detailed	CR & JL	Haplic Self Mulching Black Vertosol (Hollow)	ERSV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous
S-49P	Detailed	CR & JL	Haplic Self Mulching Brown Vertosol (Puff)	ERSV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous
S-50	Check	MF & JL	Haplic Self Mulching Brown Vertosol	EQRV	✓	✓	✓	✓	✗	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Depth to B/C = 0.70m

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S-51	Detailed	MF & JL	Haplic Epipedal Brown Vertosol	EQSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	No	Ece is 6.7dS/m at 0.50m
S-52	Detailed	CR & JL	Self Mulching Black Vertosol	EQRW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	N/A	No	Chemical Barrier ESP 17.5 at 0.65m
S-54	Check	MF & JL	Mottled Self Mulching Brown Vertosol	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Depth to C = 0.65m
S-55	Check	MF & JL	Endocalcareous Self Mulching Black Vertosol	EQSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Depth to C = 0.60m
S-56	Detailed	MF & JL	Eutrophic Subnatric Brown Sodosol	AEMOV	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✓	✗	✗	N/A	No	Sodosols have Moderately low fertility
S-57	Check	CR & JL	Stratic Rudosol	EM	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-58	Check (Affiliated 65,67)	CR & JL	Sodic Eutrophic Brown Dermosol	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✓	✗	N/A	No	Fine Gravel 20% Layer B2
S-59	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	BEMNV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✗	✗	✓	N/A	No	Physical Barrier Depth to B/C = 0.50m
S-60	Check*	CR & MF	Brown Sodosol	TBC	✗	✓	✓	✓	✗	✓	✗	✗	✓	✓	N/A	N/A	N/A	N/A	No	Slope Greater than 10% = 12%
S-61	Detailed	CR & JL	Eutrophic Subnatric Black Sodosol	AEMOV	✗	✓	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	N/A	No	Slope Greater than 10% = 12%
S-62	Check	CR & JL	Brown Sodosol	AGKOU	✓	✓	✓	✓	✓	✓	✗	✗	✗	N/A	N/A	N/A	N/A	N/A	No	Physical Barrier Depth to B/C = 0.25m
S-63	Detailed	CR & JL	Eutrophic Subnatric Brown Sodosol	BFLMW	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No	Sodosols have Moderately low fertility

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S-64	Check	CR & JL	Stratic Rudosol	EM	✓	✓	✓	✓	✓	✓	✗	✗	✗	N/A	N/A	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-65	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	N/A	No	pH in water is 9 at 0.5m
S-66	Check	CR & JL	Stratic Rudosol	EM	✓	✓	✓	✓	✓	✓	✗	✗	✗	N/A	N/A	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-67	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	AEMOW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	No	ECe 5.5dS/m at 0.3m
S-68	Detailed	CR & JL	Endocalcareous Crusty Brown Vertosol	ESSV	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	N/A	No	Slope is 11% measured
S-69	Detailed	CR & JL	Endocalcareous Epipedal Brown Vertosol	ERSW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✓	✓	N/A	No	Drainage is Poor
S-70	Check (Affiliated 69)	CR & JL	Endocalcareous Epipedal Brown Vertosol	ERSW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	N/A	N/A	N/A	No	Drainage is Poor
S-71	Check	CR & JL	Brown Sodosol	BELOV	✗	✓	✓	✓	✗	✓	✗	✗	N/A	N/A	N/A	N/A	N/A	N/A	No	Slope 14% measured
S-72	Detailed	CR & JL	Eutrophic Subnatric Brown Sodosol	BELOV	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	N/A	No	Sodosols have Moderately low fertility
S-73	Check	CR & JL	Stratic Rudosol	EM	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-74	Check	CR & JL	Stratic Rudosol	EM	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	N/A	N/A	N/A	No	Stratic Rudosols have Moderately Low Fertility
S-75	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	AEOOV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	N/A	No	Physical Barrier Depth to C = 0.60m

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
S-76	Check (Affiliated 75)	CR & JL	Sodic Eutrophic Brown Dermosol	AEOOV	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	N/A	No	Slope 12% measured
S-77	Check (Affiliated 75)	CR & JL	Sodic Eutrophic Brown Dermosol	AEOOV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	N/A	No(a)	Affiliated with S-75 (High pH and Salinity)
S-78	Check	CR & JL	Red Chromosol	BELOV	✓	✓	✓	✓	✗	✓	N/A	N/A	✗	N/A	N/A	N/A	N/A	N/A	No	Weathered Rock at 0.60m
S-80	Check	CR & JL	Crusty Red Vertosol	ESSU	✓	✓	✓	✓	✓	✓	✓	✓	✗	N/A	N/A	N/A	N/A	N/A	No	Shallow B/C layer at 0.40m and Rock at +0.50m
S-81	Check	CR & JL	Epipedal Red Vertosol	ESSU	✓	✓	✓	✓	✓	✓	✓	✓	✗	N/A	N/A	N/A	N/A	N/A	No	Shallow B/C layer at 0.35m and Rock at +0.40m
S-82	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	AELOW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
S-83	Detailed	CR & JL	Endocalcareous Epipedal Black Vertosol (Buried)	EQRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	N/A	No	Chemical Barrier ESP 16.7 at 0.65m
S-84	Check	CR & JL	Red Chromosol	AELOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	N/A	N/A	N/A	No	Stone/Gravel layer at 0.40m
S-85	Detailed	CR & JL	Haplic Epipedal Black Vertosol (Buried)	EQRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
S-86	Detailed	CR & JL	Sodic Eutrophic Brown Dermosol	BEMOV	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	N/A	No	pH in water is 9.1 at 0.30m
S-87	Check	CR & JL	Self Mulching Brown Vertosol	ERSV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Weathered Rock (C Horizon) at 0.65m
S-88	Detailed	CR & JL	Haplic Eutrophic Brown Dermosol	BEMOV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✗	✓	✓	N/A	No	Physical Barrier Depth to C = 0.65m

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
B-5	Detailed	CR & MF	Eutrophic Subnatric Brown Sodosol	CFKOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✓	N/A	No	Sodosols have Moderately low fertility
B-6	Detailed	CR & MF	Endocalcareous Self Mulching Brown Vertosol	EQSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	No	BSAL Area <20ha Contiguous
B-7	Detailed	CR & MF	Endocalcareous Self Mulching Brown Vertosol	EQRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	No	pH in water is 9.1 at 0.40m
B-9	Detailed	CR & MF	Endocalcareous Self Mulching Brown Vertosol	EQRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	N/A	No	ECe 5.2dS/m at 0.00 to 0.05m (6.9dS/m at 0.40m)
C-1	Check	MF & JL	Brown Sodosol (Affiliate S-33)	AEMOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No(a)	Sodosols have Moderately low fertility
C-2	Check	MF & JL	Brown Sodosol (Affiliate S-33)	AEMOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No(a)	Sodosols have Moderately low fertility
C-3	Check	MF & JL	Brown Sodosol (Affiliate S-30)	BGLOW	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	N/A	N/A	N/A	No(a)	Sodosols have Moderately low fertility, Drainage is Poor
C-4	Check	MF & JL	Black Vertosol (Affiliate S-15)	ERRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	No	Drainage Poor and pH 9.6 in water at 0.50m
C-5	Check	MF & JL	Brown Sodosol (Affiliate S-47)	BELOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	✓	✗	✓	N/A	No(a)	Sodosols have Moderately low fertility
C-6	Check	MF & JL	Red Chromosol (Affiliate S-3)	BELOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	N/A	No	Physical Barrier C horizon at 0.60m
C-7	Check	MF & JL	Red Chromosol (Affiliate S-13)	BFMOV	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✓	N/A	No	Physical Barrier B/C horizon at 0.65m
C-8	Check	MF & JL	Red Vertosol (Affiliate S-12)	FQRV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.55m

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
C-9	Check	MF & JL	Brown Dermosol (Affiliate S-6)	AFOOV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	✓	N/A	No(a)	pH in water 9.0 at 0.50m
C-10	Check	MF & JL	Brown Vertosol (Affiliate S-11)	EQSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.70m
C-11	Check	MF & JL	Black Vertosol (Affiliate S-10)	ESSV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous
C-12	Check	MF & JL	Brown Vertosol (Affiliate S-23)	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
C-13	Check	MF & JL	Brown Vertosol (Affiliate S-17)	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier Gravel Layer (C horizon) at 0.70m
C-14	Check	MF & JL	Brown Vertosol (Affiliate S-24)	EQRU	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.50m
C-15	Check	MF & JL	Brown Vertosol (Affiliate S-24)	EQRU	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.50m
C-16	Check	MF & JL	Brown Vertosol (Affiliate S-18)	FQRU	✓	✓	✓	✓	✘	✓	✓	✓	✘	✘	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.30m
C-17	Check	MF & JL	Brown Vertosol (Affiliate S-32)	EQSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	N/A	No	Ece greater than 4dS/m in affiliate site
C-18	Check	MF & JL	Red Chromosol (Affiliate S-19)	BGMOV	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.55m
C-19	Check	MF & JL	Black Vertosol (Affiliate S-14/15)	ERSV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	✘	✓	✘	N/A	No	Drainage Poor (Waterlogging at 0.45m)
C-20	Check	MF & JL	Brown Vertosol (Affiliate S-27)	ERSW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✘	No	BSAL Area <20ha Contiguous

Site #	Inspection Site Type	Assessor	Australian Soil Classification to ASC Sub Order (for check sites) and Sub Group (for Detailed or Affiliated sites))	ASC Family Criteria	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 nil 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?	11. Is salinity (Ece) < 4 dS/m	12. Is ERD to a chemical barrier >750mm?	Does this soil cover greater than 20ha?	Is the Site and Area BSAL?	First Limiting Factor
C-21	Check	MF & JL	Brown Sodosol (Affiliate S-33)	AEMOV	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	N/A	No(a)	Sodosols have Moderately low fertility
C-22	Check	MF & JL	Black Vertosol (Affiliate S-20)	ERSW	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	N/A	No(a)	pH greater than 8.9 in affiliate site
C-23	Check	MF & JL	Black Vertosol (Affiliate S-15)	ERRW	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗	N/A	No	Drainage Poor and pH 9.6 in water at 0.50m
C-24	Check	MF & JL	Brown Chromosol (Affiliate S-4)	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
C-25	Check	MF & JL	Stratic Rudosol (Affiliate S-1)	HM	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	N/A	N/A	N/A	N/A	No(a)	Stratic Rudosols have Moderately Low Fertility
C-26	Check	MF & JL	Brown Vertosol (Affiliate S-2)	EQSV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	N/A	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
C-27	Check	MF & JL	Brown Chromosol (Affiliate S-4)	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m
C-28	Check	MF & JL	Brown Chromosol (Affiliate S-4)	BEMOV	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	N/A	N/A	N/A	No	Physical Barrier C horizon at 0.60m

2.4 BSAL Conclusion

The BSAL verification assessment resulted in 14 soil units located within the PAA, grouped to the sub order level. **Figure 5a and 5b** separates the PAA according to exclusion areas and soil types within the site into the following discrete areas:

1. There was 2,830 ha of land with slope greater than 10% or areas less than 20ha bordered by slopes greater than 10%: These areas were located on the sideslopes of the ridgelines, as shown in **Figure 4a** and **4b**. These areas are considered exclusion areas and therefore not BSAL.

2. Within the remaining 2,791 ha of the PAA, there were 14 soil units found as detailed in **Table 5** and shown in **Figure 5a** and **5b**.

3. There was a total of **204.6 ha** of verified BSAL in the PAA according to the requirements within the Interim Protocol. The remaining areas are segregated into the dominant limiting factor ruling out each soil type from being verified BSAL. The BSAL areas are shown on **Figure 5a and 5b.** The breakdown of the 204.6 ha of verified BSAL is as follows:
    - Mine infrustracture area – 8.54 ha;
    - Out of pit emplacement area – 58.87 ha
    - In pit emplacement area – 0.95 ha
    - Nil disturbance area – 136.24 ha

In conclusion, a total of 204.6 ha of verified BSAL is present within the West Muswellbrook PAA. A total 68.36 ha of BSAL lies within the proposed mine disturbance areas.

3 SOIL TYPES SUMMARY

3.1 Vertosols

3.1.1 Vertosols Summary

The BSAL Verification Program identified 80 soil profiles as Vertosols, dominated by black, brown or red sub orders, self mulching or epipedal great groups, and endocalcareous or haplic sub groups. These soils were located on various landform positions ranging from ridge lines to lower slopes and flats across the entire assessment area.

A total of 18 Vertosol soil profiles were identified as fulfilling the soil profile criteria for BSAL, as detailed in **Table 5**. The majority of Vertosols failed either Criteria 8: *Is effective rooting depth to a physical barrier >750mm?* or Criteria 9: *Is soil drainage better than poor?* and therefore were verified non-BSAL.

Three representative soil profiles are described below to illustrate the typical physical and chemical characteristics of the Vertosols found within the PAA.

Note that site M26 was keyed out by McKenzie as a Regolithic, Hypocalcic Calcarasol. However this soil type was not found elsewhere within the PAA and, on its own, is too small in area to map separately. Therefore, this site has been included within the Black Vertosol mapping unit, consistent with surrounding soil profiles.

3.1.2 Endocalcareous Epipedal Black Vertosol

These soils varied in topsoil (A horizon) depth from 0.08m to 0.15m, with a gradual boundary to the subsoil (B horizon). Linear gilgai was common on these soils. Alkalinity was generally moderate to strong, with sodicity increasing with depth to sodic and strongly sodic. Salinity generally increased with depth to moderate to highly saline. **Table 6** and **Table 7** provide a summary and analysis of this soil type.

Table 6 Endocalcareous Epipedal Black Vertosol (Site S-16) (Summary)

Site Description	
 **Plate 1 –** Profile (Site S-16)	 **Plate 2 –** Landscape (Site S-16)
ASC Name	Endocalcareous Epipedal Black Vertosol
Dominant Slope Association	Mid to Lower slopes and flats (1 to 10% slope)
Land Use	Cleared Grazing
Soil Fertility	High
BSAL	S-16 - Yes

Table 7 Endocalcareous Epipedal Black Vertosol (Site S-16) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.08	Very dark greyish brown (10YR 3/2) silty clay loam with moderate pedality and consistence. Neutral pH and non-sodic. Non Saline with high cation exchange capacity. No coarse fragments at site S-16. Many fine roots and well drained. Gradual boundary.
B21	0.08 – 0.40	Very dark greyish brown (10YR 3/2) heavy clay with Strong pedality and moderate consistence. Moderately alkaline and sodic. Non saline with very high cation exchange capacity. No coarse fragments at site S-16. Common roots and well drained. Gradual boundary.
B22	0.40 – 0.75	Very dark greyish brown (10YR 3/2) heavy clay with Strong pedality and strong consistence. Strongly alkaline and sodic. Slightly saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate present from 0.40m at 10%. Few roots and well drained. Gradual boundary.
B23	0.75 – 1.00+	Very dark greyish brown (10YR 3/2) heavy clay with Strong pedality and moderate consistence. Strongly alkaline and sodic. Moderately saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate present from at 15%. Few roots and moderately drained. Layer continues.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	1.6	Non-saline	7	Neutral
B21	0.9	Non-saline	8.4	Moderately Alkaline
B22	3.1	Slightly saline	8.8	Strongly Alkaline
B23	6.1	Moderately saline	8.6	Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	37.2	High	3.2	Non sodic
B21	51.3	Very High	7.8	Sodic
B22	51.4	Very High	12.8	Sodic
B23	52.4	Very High	13.7	Sodic

3.1.3 Endocalcareous Self Mulching Brown Vertosol (Site S-32)

These soils varied in topsoil depth from 0.10m to 0.15m, with a gradual boundary to the subsoil. Linear gilgai was common on these soils. Alkalinity was generally moderate to strong, with sodicity increasing with depth to sodic and strongly sodic. Salinity generally increased with depth to moderate to highly saline. **Table 8** and **Table 9** provide a summary and analysis of this soil type.

Table 8 Endocalcareous Self Mulching Brown Vertosol (Site S-32) (Summary)

Site Description	
	
Plate 3 – Profile (Site S-32)	**Plate 4 –** Landscape (Site S-32)
ASC Name	Endocalcareous Self Mulching Brown Vertosol
Dominant Slope Association	Lower slopes and flats (1 to 5% slope)
Land Use	Cleared Grazing
Soil Fertility	High
BSAL	S-32 - No

Table 9 Endocalcareous Self Mulching Brown Vertosol (Site S-32) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Very dark greyish brown (10YR 3/3) clay loam with moderate pedality and consistence. Slightly acidic and non-sodic. Non saline with high cation exchange capacity. No coarse fragments. Many fine roots and well drained. Gradual boundary.
B21	0.10 – 0.30	Dark brown (10YR 3/3) heavy clay with strong pedality and consistence. Moderately alkaline and sodic. Non saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate present from 0.15m at 5%. Many fine roots and moderately drained. Gradual boundary.
B22	0.30 – 0.50	Brown (7.5YR 4/3) heavy clay with strong pedality and consistence. Strongly alkaline and sodic. Moderately saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate present at 15%. Few fine roots and moderately drained. Gradual boundary.
B23	0.50 – 1.00+	Strong Brown (7.5YR 4/4) heavy clay with strong pedality and consistence. Strongly alkaline and strongly sodic. Moderately saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate present at 15%. Few fine roots and imperfectly drained.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.8	Non-saline	6.4	Slightly Acidic
B21	1.5	Non-saline	7.9	Moderately Alkaline
B22	4.2	Moderately saline	8.8	Strongly Alkaline
B23	7.8	Moderately saline	8.7	Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	33.4	High	3.9	Non sodic
B21	49.8	Very High	8.6	Sodic
B22	51.4	Very High	13.8	Sodic
B23	49.7	Very High	15.5	Strongly Sodic

3.1.4 Haplic Self Mulching Red Vertosol (Site M-17)

These soils varied in topsoil depth from 0.05m to 0.20m, with a gradual boundary to the subsoil. Linear gilgai was common on these soils, whilst soil depth was generally less than 0.75m. pH was generally neutral to moderately alkaline, with sodicity increasing with depth to sodic. Salinity generally increased with depth to moderately saline. **Table 10** and **Table 11** provide a summary and analysis of this soil type.

Table 10 Haplic Self Mulching Red Vertosol (Site M-17) (Summary)

Site Description	
	
Plate 5 – Profile (Site M-17)	**Plate 6 –** Landscape (Site M-17)
ASC Name	Haplic Self Mulching Red Vertosol
Dominant Slope Association	Mid to upper slopes (1 to 10% slope)
Land Use	Cleared Grazing
Soil Fertility	High
BSAL	M-17 - No

Table 11 Haplic Self Mulching Red Vertosol (Site M-17) (Analysis)

Horizon	Depth (m)	Description
A11	0.00 – 0.10	Dark brown (7.5YR 3/2) light clay with strong pedality and strong consistence. Slightly acidic and non-sodic. Non Saline with moderate cation exchange capacity. No coarse fragments. Many fine roots and well drained. Gradual boundary.
A12	0.10 – 0.20	Dark reddish brown (5YR 3/3) light clay with strong pedality and strong consistence. Neutral pH and non sodic. Non Saline with high cation exchange capacity. No coarse fragments. Many fine roots and moderately drained. Gradual boundary.
B2	0.20 – 0.47	Dark reddish brown (2.5YR 3/4) medium clay with moderate pedality and moderate consistence. Mildly alkaline and non sodic. Non Saline with high cation exchange capacity. No coarse fragments. Few fine roots and moderately drained. Gradual boundary.
B3	0.47 – 0.80	Dark reddish brown (2.5YR 3/4) Light clay with moderate pedality and strong consistence. Moderately alkaline and non sodic. No coarse fragments. Few roots.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A11	0.7	Non Saline	6.2	Slightly Acidic
A12	0.4	Non Saline	7.2	Neutral
B2	0.6	Non Saline	7.6	Mildly Alkaline
B3	5.9	Moderately Saline	7.9	Moderately Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A11	22	Moderate	0.6	Non Sodic
A12	34	High	0.8	Non Sodic
B2	38	High	1.1	Non Sodic
B3	35	High	1.2	Non Sodic

3.2 Chromosols

3.2.1 Chromosols Summary

The BSAL Verification Program identified 23 soil profiles as Chromosols, dominated by red or brown sub orders, Calcic or Eutrophic great groups, and mottled, haplic or sodic sub groups.

One Chromosol soil profile was identified as BSAL, that being site M5 – Sodic, Calcic, Brown Chromosol (McKenzie 2014). The majority of Chromosols failed either Criteria 8: *Is effective rooting depth to a physical barrier >750mm?* or Criteria 9: *Is soil drainage better than poor?* and therefore were verified non BSAL.

Two representative soil profiles are described below to illustrate the typical physical and chemical characteristics of the Chromosol order within Project Study Area.

3.2.2 Haplic Eutrophic Red Chromosol (Site S-3)

These soils varied in topsoil depth from 0.1m to 0.3m, with an abrupt to clear boundary to the clay subsoil. For the purposes of the BSAL verification assessment these soils typically failed on the basis of soil depth given many of the chromosols were less than 0.75m deep. **Table 12** and **Table 13** provide a summary and analysis of this soil type.

Table 12 Haplic Eutrophic Red Chromosol (Site S-3) (Summary)

Site Description	
 **Plate 7 –** Profile (Site S-3)	 **Plate 8 –** Landscape (Site S-3)
ASC Name	Haplic Eutrophic Red Chromosol
Dominant Slope Association	Mid to upper slopes (1 to 10% slope)
Land Use	Cleared Grazing and timbered
Soil Fertility	Moderate
BSAL	S-3 - No

Table 13 Haplic Eutrophic Red Chromosol (Site S-3) (Analysis)

Horizon	Depth (m)	Description		
A2	0.00 – 0.20	Dark yellow brown (10YR 3/4) loam with weak pedality and consistence. Moderately acidic and non-sodic. Non Saline with low cation exchange capacity. No coarse fragments. abundant fine roots and well drained. Clear boundary.		
B2	0.20 – 0.60	Yellowish red (5YR 4/6) medium clay with moderate pedality and consistence. Neutral to mildly alkaline and sodic. Non Saline with moderate cation exchange capacity. No coarse fragments. Common fine roots and moderately drained. Gradual boundary.		
B/C	0.60 – 0.90	Strong brown (7.5YR 5/6) clay loam with massive structure. Strongly alkaline and non sodic. Non Saline with moderate cation exchange capacity. Weathered rock. No roots and poorly drained. Layer continues.		
Horizon	**ECe**		**Laboratory pH**	
	dS/m	Rating	Value	Rating
A2	0.7	Non-saline	5.6	Moderately Acidic
B2	0.3	Non-saline	7.2	Neutral
B2	0.4	Non-saline	7.8	Mildly Alkaline
B/C	1.0	Non-saline	8.6	Strongly Alkaline
Horizon	**CEC**		**ESP**	
	cmol/kg	Rating	%	Rating
A2	10.8	Low	0.9	Non sodic
B2	19.1	Moderate	1.0	Non sodic
B2	23.6	Moderate	1.7	Non sodic
B/C	18.9	Moderate	1.1	Non sodic

3.2.3 Sodic Calcic Brown Chromosol (Site M-5)

These soils varied in topsoil depth from 0.1m to 0.2m, with an abrupt to clear boundary to the clay subsoil. For the purposes of the BSAL verification assessment these soils failed the soil depth criteria. **Table 14** and **Table 15** provide a summary and analysis of this soil type.

Table 14 Sodic Calcic Brown Chromosol (Site M-5) (Summary)

Site Description	
	
Plate 9 – Profile (Site M-5)	**Plate 10 –** Landscape (Site M-5)
ASC Name	Sodic Calcic Brown Chromosol
Dominant Slope Association	Mid to Upper slopes (1 to 10% slope)
Land Use	Cleared Grazing
Soil Fertility	Moderately High
BSAL	M-5 - No

Table 15 Sodic Calcic Brown Chromosol (Site M-5) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Brown (7.5YR 4/2) clay loam with moderate pedality and weak consistence. Slightly acidic and non-sodic. Non Saline with low cation exchange capacity. No coarse fragments. Many fine roots and well drained. Clear boundary.
B21	0.10 – 0.30	Brown (7.5YR 4/3) medium/heavy clay with strong pedality and moderate consistence. Neutral pH and non sodic. Non Saline with moderate cation exchange capacity. No coarse fragments. Few roots and moderately drained. Gradual boundary.
B22	0.30 – 0.60	Brown (7.5YR 4/3) medium/heavy clay with weak pedality and strong consistence. Strongly alkaline and sodic. Slightly saline with high cation exchange capacity. No coarse fragments. Few roots and moderately drained. Gradual boundary.
B31	0.60 – 0.90	Brown (7.5YR 4/4) medium clay with weak pedality and strong consistence. Strongly alkaline and strongly sodic. Moderately saline with very high cation exchange capacity. No coarse fragments. No roots and imperfectly drained.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.69	Non Saline	6.3	Slightly Acidic
B21	0.54	Non Saline	6.9	Neutral
B22	3.95	Slightly Saline	8.6	Strongly Alkaline
B23	7.58	Moderately Saline	8.8	Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	14.03	Low	2.35	Non Sodic
B21	22.16	Moderate	5.87	Non Sodic
B22	39.30	High	12.21	Sodic
B23	42.07	Very High	15.45	Strongly Sodic

3.3 Sodosols

3.3.1 Sodosols Summary

The BSAL Verification Program identified 18 soil profiles as Sodosols, dominated by brown sub order, subnatric great group, and eutrophic sub group. These soils were located on the creeklines, flats and lower slopes.

No Sodosol soil profiles were identified as BSAL. All the Sodosol profiles failed Criteria 7: *Does soil have moderate fertility*? and therefore were verified non BSAL.

One representative soil profile is described below to illustrate the typical physical and chemical characteristics of the Sodosol order within Project Study Area.

3.3.2 Eutrophic Subnatric Brown Sodosol (Site S-33)

These soils varied in topsoil depth from 0.1m to 0.2m, with an abrupt to clear boundary to the clay subsoil. Sodicity within the upper section of the subsoil was greater than ESP 6. For the purposes of the BSAL verification assessment these soils failed the fertility criteria given the soil type. **Table 16** and **Table 17** provide a summary and analysis of this soil type.

Table 16 Eutrophic Subnatric Brown Sodosol (Site S-33) (Summary)

Site Description	
	
Plate 11 – Profile (Site S-33)	**Plate 12 –** Landscape (Site S-33)
ASC Name	Subnatric Brown Sodosol
Dominant Slope Association	Flat to lower slopes (1 to 5% slope)
Land Use	Cleared grazing and creeklines
Soil Fertility	Moderately Low
BSAL	No

Table 17 Eutrophic Subnatric Brown Sodosol (Site S-33) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.10	Dark Brown (7.5YR 3/3) clay loam with moderate pedality and consistence. Slightly acidic and non-sodic. Non Saline with high cation exchange capacity. No coarse fragments. Many fine roots and well drained. Clear boundary.
A2	0.10 – 0.20	Dark Brown (7.5YR 3/3) clay loam with weak pedality and consistence. Neutral pH and non sodic. Non Saline with moderate cation exchange capacity. No coarse fragments. Common roots and moderately drained. Clear boundary.
B2	0.20 – 0.75	Dark Yellowish Brown (10YR 4/6) light medium clay with strong pedality and consistence. Moderate to strongly alkaline and sodic. Non saline to slightly saline with high cation exchange capacity. No coarse fragments, 15% grey mottles. Few roots and poorly drained. Layer continues.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.8	Non-saline	6.4	Slightly Acidic
A2	0.3	Non-saline	7.1	Neutral
B2	0.9	Non-saline	8.4	Moderately Alkaline
B2	3.7	Slightly saline	8.5	Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	27.9	High	1.4	Non sodic
A2	19.2	Moderate	1.6	Non sodic
B2	29.3	High	5.8	Non sodic
B2	31.8	High	12.9	Sodic

3.4 Dermosols

3.4.1 Dermosols Summary

The BSAL Verification Program identified 13 soil profiles as Dermosols, dominated by Brown sub order, Eutrophic great group, and sodic sub group.

One Dermosol soil profile was identified as BSAL, that being site S-82 – Sodic Eutrophic Brown Dermosol. The majority of Dermosols failed either Criteria 8: *Is effective rooting depth to a physical barrier >750mm?* or Criteria 10: Does pH range from 5 to 8.9 in water or 4.5 to 8.1 in CaCl2 within 0.60m, *Criteria 11: Is Salinity (ECe) < or = 4dS/m in 0.60m or Criteria 12: Is ERD to a chemical barrier > or + 750mm,* and therefore were verified non BSAL.

One representative soil profile is described below to illustrate the typical physical and chemical characteristics of the Dermosol order within Project Study Area.

3.4.2 Sodic Eutrophic Brown Dermosol (Site S-65)

These soils varied in topsoil depth from 0.1m to 0.3m, with a gradual boundary to the clay subsoil. For the purposes of the BSAL verification assessment these soils failed a variety of criteria including soil depth to a physical or chemical barrier, or high pH. **Table 18** and **Table 19** provide a summary and analysis of this soil type.

Table 18 Sodic Eutrophic Brown Dermosol (Site S-65) (Summary)

Site Description	
 **Plate 13 –** Profile (Site 17)	 **Plate 14 –** Landscape (Site 17)
ASC Name	Sodic Eutrophic Brown Dermosol
Dominant Slope Association	Lower slopes and flats (1 to 5% slope)
Land Use	Cleared grazing
Soil Fertility	Moderately High to High
BSAL	No

Table 19 Sodic Eutrophic Brown Dermosol (Site S-65) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.12	Very dark greyish brown (10YR 3/2) clay loam with moderate pedality and consistence. Slightly acidic and non-sodic. Non Saline with high cation exchange capacity. No coarse fragments. Many roots and well drained. Clear boundary.
A2	0.12 – 0.30	Very dark greyish brown (10YR 3/2) silty clay loam with strong pedality and moderate consistence. Mildly alkaline and non sodic. Non Saline with high cation exchange capacity. No coarse fragments. Common roots and moderately drained. Gradual boundary.
B1	0.30 – 0.70	Very dark greyish brown (10YR 4/2) silty clay with strong pedality and consistence. Strongly alkaline and sodic. Non Saline with high cation exchange capacity. No coarse fragments. Common roots and moderately drained. Gradual boundary.
B2	0.70 – 1.00	Brown (7.5YR 5/3) heavy clay with strong pedality and consistence. Very strongly alkaline and strongly sodic. slightly saline with very high cation exchange capacity. No coarse fragments. Calcium Carbonate 10% at 0.70m. Few fine roots and imperfectly drained.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.3	Non-saline	6.3	Slightly Acidic
A2	0.3	Non-saline	7.5	Mildly Alkaline
B1	1.0	Non-saline	9	Strongly Alkaline
B2	2.9	Slightly saline	9.3	Very Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	28.3	High	1.1	Non sodic
A2	31.5	High	1.9	Non sodic
B1	32.8	High	10.4	Sodic
B2	42.2	Very High	17.3	Strongly Sodic

3.5 Rudosols

3.5.1 Rudosols Summary

The BSAL Verification Program identified 10 soil profiles as Stratic Rudosols. These soils were located on the creeklines and flats.

No Rudosol soil profiles were identified as BSAL. All Rudosols failed Criteria 7: Does soil have a moderate fertility? And majority failed Criteria 8: *Is effective rooting depth to a physical barrier >750mm?* and therefore were verified non BSAL.

One representative soil profile is described below to illustrate the typical physical and chemical characteristics of the Rudosol order within Project Study Area.

3.5.2 Stratic Rudosol (Site M-1)

These soils varied in topsoil depth due to the depositional layers, however often included grave layers within the upper profile. For the purposes of the BSAL verification assessment these soils failed the fertility criteria given the soil type. **Table 20** and **Table 21** provide a summary and analysis of this soil type.

Table 20 Static Rudosol (Site M-1) (Summary)

Site Description	
 **Plate 15 –** Profile (Site 17)	 **Plate 16 –** Landscape (Site 17)
ASC Name	Stratic Rudosol
Dominant Slope Association	Mid to Lower slopes and flats (1 to 10% slope)
Land Use	Grazing
Soil Fertility	Moderately Low
BSAL	No

Table 21 Stratic Rudosol (Site M-1) (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark greyish brown (10YR 3/2) loam with moderate pedality and consistence. Slightly acidic (pH 6.1) and non-sodic (ESP 2.0). Non Saline with moderate cation exchange capacity. No coarse fragments at site 17. Many fine roots and well drained. Clear boundary.
B21	0.20 – 0.40	Dark brown (10YR 3/3) medium clay with moderate pedality and consistence. Mildly alkaline (pH 7.5) and sodic (ESP 7.8). Non Saline with moderate cation exchange capacity. No coarse fragments at site 17. Few fine roots and moderately drained. Clear boundary.
B22	0.40 – 0.60	Brown (10YR 4/3) heavy clay with strong pedality and consistence. Moderately alkaline (pH 8.3) and sodic (ESP 7). Non Saline with moderate cation exchange capacity. No coarse fragments at site 17. Few fine roots and moderately drained. Clear boundary.
B23	0.60 – 0.90	Strong Brown (7.5YR 5/6) light clay with strong pedality and consistence. Strongly alkaline (pH 9.0) and sodic (ESP 7.0). Moderately saline (ECe 6.8) with moderate cation exchange capacity. No coarse fragments at site 17. Few fine roots and imperfectly drained.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.40	Non Saline	6.0	Moderately Acidic
B21	0.90	Non Saline	7.4	Mildly Alkaline
B22	1.9	Non Saline	8.3	Moderately Alkaline
B23	6.8	Moderately Saline	9.0	Strongly Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A1	13	Moderate	2.0	Non Sodic
B21	24	Moderate	7.5	Sodic
B22	23	Moderate	7.8	Sodic
B23	20	Moderate	7.0	Sodic

4 LAND AND SOIL CAPABILITY (LSC)

4.1 Methodology

The Land and Soil Capability (LSC) assessment scheme has been developed for NSW: *The land and soil capability assessment scheme: second approximation – A general rural land evaluation system for NSW* (OEH, 2012; hereafter referred to as the LSC Guideline). The LSC scheme builds on the former *Rural Land Capability* system (Emery, 1986). The LSC scheme retains the eight class system but places additional emphasis on specific soil limitations and their management.

The LSC classes from the LSC Guideline are reproduced in **Table 22** and are based on two main considerations:

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

Table 22 Land and Soil Capability Descriptions

LSC Class	General Definition	
Land capable of a wide variety of land uses (cropping, grazing, horticulture forestry, conservation, nature conservation)		
1	*Extremely high capability land* No limitations	No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land Slight limitations	Limitations 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* Moderate limitations	Is capable of sustaining high-impact land uses, such as cropping with cultivation using more intensive and widely accepted management practices. However careful management of the 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* Moderate to high limitations for high-impact land uses	Limitations 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* High limitations for high-impact land uses	Limitations will 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 of a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	*Low capability land* Very high limitations for high-impact land uses	Land 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.

LSC Class	General Definition	
Land generally incapable of agricultural land use (selective forestry and nature conservation)		
7	*Very low capability land* Severe limitations that restrict most land uses	Limitations generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations are 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.

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 dependent on the slope percentage of the land and presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess the wind erosion hazard for each soil unit:

- Wind erosive power - has been mapped in the Study Area as ‘Low’ (Figure 6 in the LSC Guideline);
- Capacity of the land to maintain surface cover - determined by the average rainfall. For the Scone locality the average annual rainfall is 646.5 mm and therefore the Study Area lies within the “greater than 500 mm rainfall” (Table 6 of the LSC Guideline).

- Erodibility of the soil to wind - determined by surface texture in accordance with Table 5 of the LSC Guideline; and

- Exposure of the land to wind - determined by site inspection of location and exposure within the PAA.

Hazard 3: Soil Structure Decline

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

Hazard 4: Soil Acidification

The soil acidification hazard is assessed using three criteria, being soil buffering capacity, pH and mean annual rainfall. In this assessment, soil buffering capacity was based on soil type, surface soil pH and a regional mean annual rainfall range of 550-700 mm.

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The overall recharge potential for the site was determined based on an average annual rainfall (Scone) of 646.5 mm (BOM, 2014). This suggests low recharge potential, however, recharge potential also relates to landform position with elevated sites having a high recharge potential.

Based on the annual rainfall data and an average annual evapotranspiration of 600-700 mm minor discharge potential for the site is likely. As above, discharge potential also relates to landform position with sites low in the landscape position having a greater potential to discharge.

The PAA, according to the Salt Store Map of NSW (Figure 7 in the LSC Guideline) is located in an area of low-moderate salt store. Due to the current available scale of this mapping, laboratory tested EC values were used to determine salt store.

Hazard 6: Water Logging

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

Hazard 7: Shallow Soils and Rockiness

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

Hazard 8: Mass Movement

The mass movement hazard is assessed through a combination of three criteria; mean annual rainfall, presence of mass movement and slope class. The mean annual rainfall is greater than 500 mm.

4.2 Assessment Results

The LSC class was determined for each soil profile site with adequate data. The detailed and lab tested sites contained all required information whilst the check sites contained six of the eight criteria, omitting soil acidity and salinity. Subjective assessment was used for these sites by reviewing surrounding sites and results of similar soil profiles within the same soil type.

Table 23 LSC Site Assessment

Site ID	*Water erosion*	*Wind erosion*	*Soil structural decline*	*Soil acidity*	*Salinity*	*Water logging*	*Rockiness & Soil Depth*	*Mass movement*	LSC Class
M1	1	2	1	3	1	6	1	1	6
M2	2	2	2	2	4	1	1	1	4
M3	2	2	1	3	4	1	1	1	4
M4	3	2	2	2	2	1	1	1	3
M5	2	2	2	3	4	1	1	1	4
M6	3	2	1	2	4	1	1	1	4
M7	3	2	1	2	4	1	1	1	4
M8	3	2	1	3	5	1	1	1	5
M9	2	2	2	2	4	1	1	1	4
M10	3	2	1	3	4	1	1	1	4
M11	3	2	1	2	5	1	1	1	5
M12	3	2	2	2	5	1	1	1	5
M13	3	2	2	2	3	6	1	1	6
M14	4	2	1	2	n/a	1	4	1	4
M15	3	2	2	3	4	6	1	1	6
M16	2	2	1	2	4	1	1	1	4
M17	2	2	1	1	1	1	3	1	3
M18	3	2	1	2	4	3	1	1	4
M19	3	2	1	1	5	1	1	1	5
M20	2	2	1	2	2	1	1	1	2
M21	1	2	1	2	2	1	1	1	2
M22	3	2	2	2	4	1	1	1	4
M23	2	2	2	2	2	3	1	1	3
M24	1	2	2	2	2	6	1	1	6
M25	3	2	2	n/a	3	3	1	1	3
M26	3	2	2	3	3	6	1	1	6
M27	3	2	2	2	5	1	1	1	5
M28	2	2	1	2	5	1	1	1	5
M29	3	2	1	3	n/a	4	2	1	4
M30	2	2	4	2	7	1	1	1	7
M31	2	2	2	4	5	1	1	1	5
M32	4	2	4	2	3	1	1	1	4
M33	2	2	2	2	4	2	1	1	4

Site ID	*Water erosion*	*Wind erosion*	*Soil structural decline*	*Soil acidity*	*Salinity*	*Water logging*	*Rockiness & Soil Depth*	*Mass movement*	**LSC Class**
M34	3	2	2	2	4	1	1	1	4
S-1	1	2	1	n/a	n/a	3	1	1	2
S-2	2	2	2	n/a	n/a	3	1	1	2
S-3	3	2	3	3	1	3	4	1	4
S-4	2	2	3	n/a	n/a	3	4	1	4
S-5	2	2	1	1	3	3	1	1	3
S-6	n/a	2	2	2	3	3	4	1	4
S-7	2	2	3	n/a	n/a	3	1	1	3
S-8	3	2	1	1	3	3	1	1	3
S-9	3	2	1	1	4	3	1	1	4
S-10	2	2	1	1	2	3	3	1	3
S-11	2	2	2	n/a	n/a	3	3	1	3
S-12	n/a	2	1	n/a	n/a	3	4	1	4
S-13	3	2	3	3	1	3	4	1	4
S-14	3	2	4	n/a	n/a	3	4	1	4
S-14/15	3	2	1	1	3	3	3	1	3
S-15	3	2	1	1	3	3	1	1	3
S-16	2	2	1	3	3	3	1	1	3
S-17	3	2	1	n/a	n/a	3	3	1	3
S-18	3	2	1	n/a	n/a	3	6	1	6
S-19	2	2	3	n/a	n/a	3	4	1	4
S-20	3	2	1	1	4	3	1	1	4
S-21	3	2	1	n/a	n/a	3	4	1	4
S-22	5	2	3	n/a	n/a	3	4	1	4
S-23	3	2	1	n/a	n/a	3	4	1	4
S-24	3	2	1	n/a	n/a	3	6	1	6
S-25	3	2	1	n/a	n/a	3	1	1	3
S-26	3	2	1	n/a	n/a	3	4	1	4
S-27	2	2	1	1	2	3	1	1	3
S-28	3	2	1	3	4	3	1	1	4
S-29	3	2	1	n/a	n/a	3	4	1	4
S-30	3	2	3	n/a	n/a	3	1	1	3
S-31	3	2	3	n/a	n/a	3	1	1	3
S-32	2	2	1	3	4	3	1	1	4
S-33	1	2	3	3	3	4	3	1	4
S-35	3	2	3	n/a	n/a	3	4	1	4
S-36	n/a	2	3	n/a	n/a	3	4	1	4
S-37	3	2	3	n/a	n/a	3	3	1	3
S-38	1	2	3	n/a	n/a	3	1	1	3
S-43	3	2	1	1	4	3	3	1	4

Site ID	*Water erosion*	*Wind erosion*	*Soil structural decline*	*Soil acidity*	*Salinity*	*Water logging*	*Rockiness & Soil Depth*	*Mass movement*	**LSC Class**
S-44	1	2	2	1	4	4	3	1	4
S-45	2	2	3	n/a	n/a	3	4	1	4
S-46	2	2	2	1	4	3	3	1	4
S-47	2	2	3	3	4	3	3	1	4
S-48	3	2	1	n/a	n/a	3	1	1	3
S-49H	3	2	1	1	4	3	1	1	4
S-49P		2	1	1	3	3	1	1	
S-50	3	2	1	n/a	n/a	3	4	1	4
S-51	3	2	1	3	4	3	1	1	4
S-52	3	2	1	3	4	3	1	1	4
S-54	2	2	2	n/a	n/a	3	4	1	4
S-55	2	2	1	n/a	n/a	3	4	1	4
S-56	3	2	1	3	4	3	1	1	4
S-57	2	2	3	n/a	n/a	3	1	1	3
S-58	2	2	3	n/a	n/a	3	1	1	3
S-59	3	2	3	3	5	3	3	1	5
S-60	5	2	3	3	3	3	4	1	4
S-61	5	2	1	3	4	2	3	1	5
S-62	3	2	3	n/a	n/a	3	6	1	6
S-63	2	2	3	3	3	3	1	1	3
S-64	1	2	3	n/a	n/a	3	6	1	6
S-65	1	2	1	3	2	3	1	1	3
S-66	1	2	3	n/a	n/a	3	6	1	6
S-67	1	2	1	3	4	3	1	1	4
S-68	4	2	3	1	4	3	3	1	4
S-69	3	2	2	1	3	3	1	1	3
S-71	5	2	3	n/a	n/a	3	3	1	5
S-72	3	2	3	3	5	3	4	1	5
S-73	1	2	3	n/a	n/a	3	3	1	3
S-74	2	2	3	n/a	n/a	3	1	1	3
S-75	3	2	3	2	4	3	4	1	4
S-76	5	2	3	n/a	n/a	3	3	1	5
S-77	3	2	3	n/a	n/a	3	1	1	3
S-78	3	2	3	n/a	n/a	3	4	1	4
S-80	2	2	2	n/a	n/a	3	6	1	6
S-81	3	2	2	n/a	n/a	3	6	1	6
S-82	3	2	3	3	3	3	1	1	3
S-83	2	2	1	3	4	3	1	1	4
S-84	3	2	3	n/a	n/a	3	3	1	3
S-85	2	2	1	3	2	3	1	1	3

Site ID	*Water erosion*	*Wind erosion*	*Soil structural decline*	*Soil acidity*	*Salinity*	*Water logging*	*Rockiness & Soil Depth*	*Mass movement*	**LSC Class**
S-86	3	2	3	3	5	3	3	1	5
S-87	3	2	1	n/a	n/a	3	4	1	4
S-88	3	2	3	3	3	3	4	1	4
B-5	2	5	3	4	3	4	1	1	4
B-6	1	2	1	1	3	3	1	1	3
B-7	1	2	1	3	3	3	1	1	3
B-8	2	2	4	3	4	3	1	1	4
E1	4	2	3	3	n/a	2	6	1	6
E2	6	2	3	3	2	2	6	1	6
E3	4	2	1	3	n/a	2	6	1	6
E4	4	2	1	1	2	2	2	1	4
E5	5	2	3	3	2	2	4	1	5
E6	6	2	3	3	n/a	2	4	1	6
E7	6	2	3	3	n/a	2	6	1	6
E8	4	2	3	3	1	2	6	1	6
E9	6	2	2	1	3	2	4	1	6
E10	3	2	1	1	n/a	3	3	1	3
E11	4	2	1	1	2	2	2	1	4
E12	4	2	1	1	3	2	3	1	4
E13	4	2	1	1	2	2	4	1	4
E14	3	2	1	3	4	3	2	1	4
E15	4	2	1	1	n/a	2	4	1	4
E16	4	2	3	3	n/a	2	6	1	6
E17	4	2	1	1	n/a	2	4	1	4
E18	2	2	1	3	4	2	3	1	4
E19	3	2	1	1	n/a	2	3	1	3
E20	4	2	1	3	3	2	2	1	4
E21	3	2	1	3	n/a	2	6	1	6

Note: Shaded Site ID boxes are detailed and lab tested sites.

4.3 LSC Conclusion

The overall LSC classes for the Study Area ranged from 2 to 7 as illustrated in **Figure 6a and 6b.** The key findings from the LSC assessment include:

- The Project disturbance area is dominated by LSC Class 4 (55%), followed by Class 6 (18%), and Class 5 (12%). Approximately 10% of the disturbance area is LSC Class 3 and 0.5% is considered LSC Class 2. There is also approximately 4% of the disturbance area LSC Class 7 which is considered not suitable for agriculture.

- The majority of the verified BSAL is located on LSC Class 2 and 3 land, which confirms the BSAL mapping also satisfies the LSC criteria.

Table 24 summarises the LSC classes in the PAA Disturbance Areas below.

Table 24 – Land and Soil Capability Class Summary for Disturbance Areas

PAA disturbance type	LSC Class						Extent of disturbance (ha)
	2	3	4	5	6	7	
Mine infrastructure area	0.00	8.87	160.92	0.00	0.00	0.00	169.79
Out-of-pit emplacement area	21.23	157.97	366.39	58.56	5.47	0.00	609.62
In pit emplacement	0.00	236.23	1580.91	349.90	579.31	77.31	2823.65
Final void	0.00	6.47	74.54	53.77	138.57	69.04	342.40
Total Disturbance Area	**21.23**	**409.54**	**2182.76**	**462.23**	**723.35**	**146.35**	**3945.46**
Not disturbed	39.06	235.99	594.13	66.46	507.37	232.61	1675.62
TOTAL PAA	**60.29**	**645.53**	**2776.89**	**528.69**	**1230.72**	**378.96**	**5,621.00**

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