# Ulan West Mine Expansion

# BSAL Verification Assessment

# Ulan Coal Mines Limited

Report Number 630.11114

November 2014

Version: FINAL

# Ulan West Mine Expansion

# BSAL Verification Assessment

# Ulan Coal Mines Limited

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**DOCUMENT CONTROL**

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| | | | | | |
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# 1 INTRODUCTION

## 1.1 Project Background

Ulan Coal Mines Limited (UCML) engaged SLR Consulting Australia Pty Ltd to undertake a Biophysical Strategic Agricultural Land (BSAL) Verification Assessment for the proposed Ulan West Mine Expansion Project (the Project), comprising a footprint of 275 hectares (ha).

UCML is proposing to modify Project Approval 08_0184 to allow for mine plan changes to Ulan West to ensure efficient and optimised extraction of the coal resource. The proposed modification includes extension of seven longwall mining panels in order to access additional resources, realignment of longwall panels to accommodate for previous modifications and changes to the associated surface infrastructure.

The proposed modification will produce approximately an additional 13 million tonnes of coal and extend the life of the UCML Complex by approximately 2 years. The currently approved Ulan West mining area covers approximately 3,060 ha. The proposed modification will extend this by approximately 275 ha.

This BSAL verification assessment is required to be submitted to OEH for a BSAL verification certificate. This report is intended to accompany the online BSAL verification certificate application. Murray Fraser undertook the BSAL Verification Assessment supervised by Clayton Richards (CPSS 2). Both Murray Fraser and Clayton Richards are responsible for the soil survey and interpretation of the field and laboratory results.

## 1.2 The Gateway Process and BSAL Background

The Strategic Regional Land Use Plans for the Upper Hunter and New England North West (SRLUP) was released by the NSW Government in September 2012; the BSAL mapping for the remainder of the State 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. An integral component of the plan is the introduction of the new decision making framework, known as the Gateway Process. This process involves the early assessment of potential impacts of mining and coal seam gas development on agricultural land and water resources.

As part of the new 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. Two categories of Strategic Agricultural Land have been identified: BSAL and critical industry clusters (CIC). 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 parameters:

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

The principal application of the strategic agricultural land mapping is a 'trigger' of the new Gateway process for new project development applications.

In April 2013, an Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land (Interim Protocol) was released by the NSW Government. This Interim Protocol outlines the process for seeking verification of whether or not land mapped as BSAL meets the BSAL criteria. This report is based on the criteria outlined in the Interim Protocol. The State Environment Planning Policy (mining, Petroleum Production and Extractive Industries) Amendment 2013 requires certain types of developments to verify whether the proposed site is on BSAL. The purpose of the protocol is to assist 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.

# 2 BSAL VERIFICATION

## 2.1 Defining BSAL

The Interim Protocol defines BSAL in three different ways:

1. General Commentary: 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 agricultural 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 Insert):

    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).

This report assesses BSAL according to the requirements of the third definition.

## 2.2 Methodology

The site verification and methodology reported in the following sections has been undertaken based on the Interim Protocol for Site Verification and Mapping of BSAL.

> **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 area of potential surface disturbance due to underground workings associated with the Project is 275 ha. In addition to this disturbance area, a 100 metre (m) buffer surrounding the Project Area is included within the assessment area, to account for minor changes in design in accordance with the BSAL protocol. The total Assessment Area is therefore 350 ha as shown in **Figure 1**.

**Figure 1**


LEGEND
Project Area
Project Area 100m Buffer
Track
SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
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F: 61 2 4037 3201
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Date: 14/11/2014
Drawn by: LH
Scale: 1:25,000
Sheet Size: A4
Projection: GDA 1994 MGA Zone 55
N
0 200 400 600 800
m
Ulan Coal Mines Limited
ULAN BSAL ASSESSMENT
Project Area
FIGURE 1

**Step 2: Confirm access to a reliable water supply**

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

Representative rainfall data for the area has been obtained from the Bureau of Meteorology (BOM) weather station at Ulan Water (Station 062036, BOM, 2014), which is considered to be a reliable; and representative dataset for the Project Area. Data shows that the area experiences an average rainfall of 643 millimetres (mm) per year. This rainfall is above the criteria threshold of 350 mm per year, and therefore the site has access to a reliable water supply.

**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 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 is designed to assess the simplest criteria first, to avoid more costly assessments if the site can be easily discounted as BSAL.*

The Proponent has reasonable access to the Project Area for the site verification of BSAL.

**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) and is based on the probability of occurrence and the consequence of the impact, as described in the Land Use Conflict Risk Assessment Guide (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 1: Agricultural Impacts Risk Ranking Matrix**

| Consequence \ PROBABILITY | 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 operations | A5 low | B5 low | C5 low | D5 low | E5 low |

= low risk
= medium risk
= high risk

**Table 2: Agricultural Impact Risk Ranking – Probability Descriptors**

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

**Table 3: Agricultural Impact Risk Ranking – Consequence Descriptors**

| Level: 1 | Severe Consequences | Example of Implications |
|---|---|---|
| **Description** | Severe and/or permanent damage to agricultural resources, or industries<br>Irreversible<br>Severe impact on the community | Long term (eg 20 years) damage to soil or water resources<br>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<br>Long-term management implications<br>Serious detrimental impact on the community | Water and / or soil impacted, possibly in the long term (eg 20 years)<br>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<br>Some ongoing management implications<br>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)<br>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<br>Can be effectively managed as part of normal operations | Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated<br>Minor erosion, compaction or water quality impacts that can be mitigated.<br>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<br>Can be effectively managed as part of normal operations | No measurable or identifiable impact on the agricultural resource or industry |

The Project consists of an extension of workings from Ulan West's active mining area under 275 ha of leased Crown Land and a small area of privately owned land. The proposed underground mining operations will result in subsidence above the extracted longwall panels. The subsidence assessment completed for the proposed modification defined that the area affected by subsidence generally extends above and immediately adjacent to the underground mining footprints (SCT, 2014). The subsidence predictions provided as part of the subsidence assessment were found to be consistent with previous subsidence levels experienced at the UCML Complex. These predictions indicate that the Project will result in maximum predicted vertical subsidence within a typical range of 0.9 to 1.5 m, increasing in areas of lower overburden depth, up to about 1.8 m. These predictions were found to be consistent with previous subsidence predictions for the existing area and observed subsidence levels experienced at the UCML Complex.

The Project will require small areas of temporary surface disturbance including the re-positioning of previously approved de-watering boreholes and ventilation shafts, and the construction of three additional ventilation shafts.

Site inspection revealed there were small pockets of native pasture utilised for cattle grazing. As such the Project was determined to have a risk ranking of:

**Consequence: Level 5** – Very minor damage or impact to agricultural resources or industries. Can be effectively managed as part of normal operations.

**Probability: D** – Unlikely. Could occur in some circumstances but unlikely to occur

The risk matrix result is **D5** (**Table 1**) which is considered low risk to agricultural activities. For low risk activities the required inspection density is 1 site observation every 25 – 400 ha. For the purpose of this survey the 100 m buffer area is included in this inspection density.

**Step 4: Soils and landscape verification criteria**

Ten site verification criteria have been identified, with the easy to measure criteria assessed first. They are: 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. For soil to be classified as BSAL at each representative site it must meet all the criteria outlined in the flow chart shown in **Table 4**. If any criteria are not met, the site is not BSAL and there is no need to continue the assessment. The specific requirement for each parameter to be assessed is outlined in the Interim Protocol.

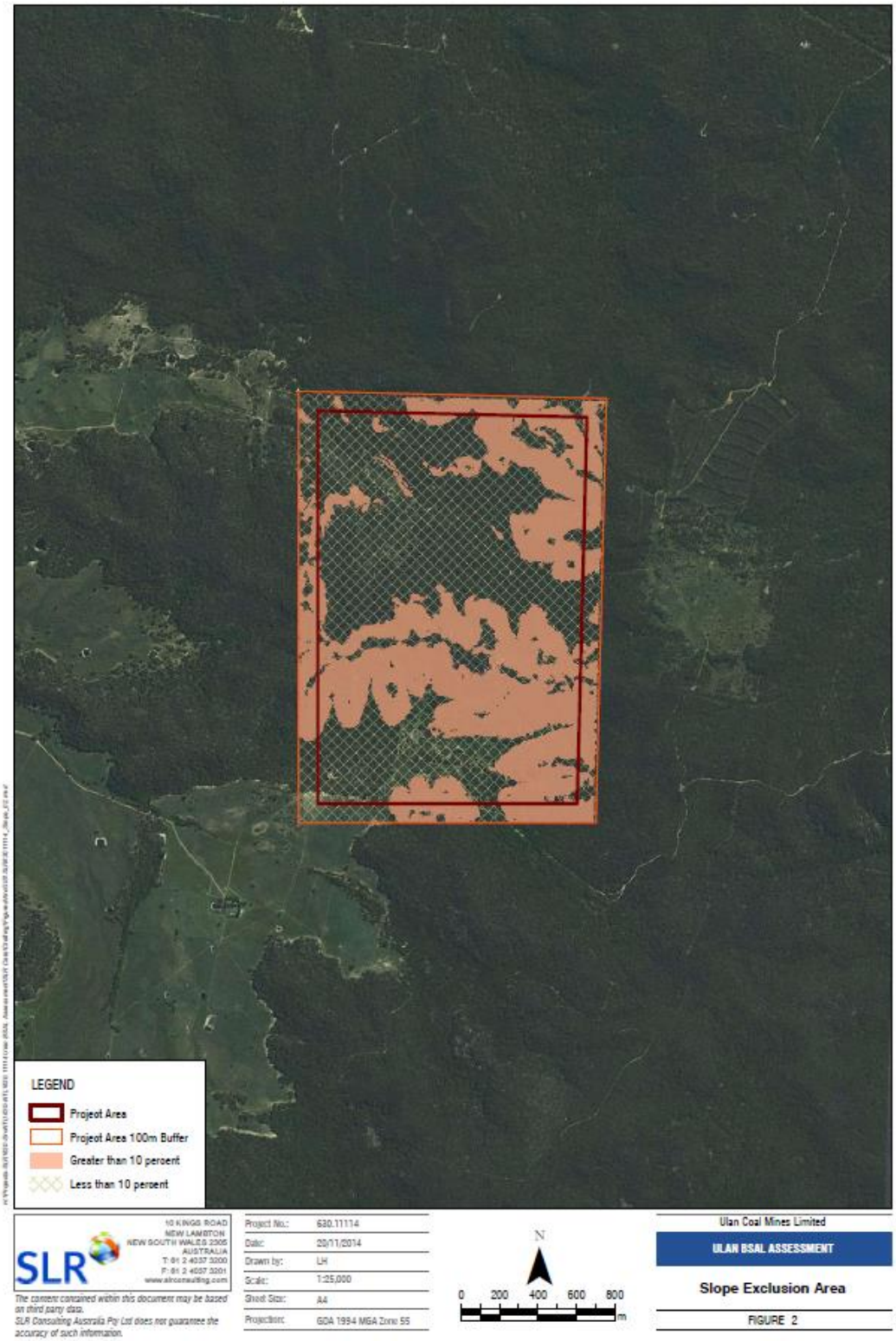
Using LIDAR, areas of greater than or equal to 10% slope were excluded from the BSAL site verification assessment area, as were areas of less than 10% slope which had a contiguous area of less than 20 ha. Two areas of less than 10% slope and greater than 20 ha contiguous area were identified using the LIDAR slope exclusion, and are shown in **Figure 2**:

**Northern Assessment Area**: Comprising 121 ha and assessed with Detailed Sites 1, 2 and 3 and Checked Sites 5, 6, 7 and 8.

**Southern Assessment Area**: Comprising 47 ha and assessed with Detailed Sites 4 and 5 and Checked Sites 1, 2, 3 and 9.

The BSAL verification fieldwork undertaken in October 2014 mapped 14 observations where access was possible within the Project Area, of which 5 were detailed soil pits and 9 were checked sites. This level of survey is greater than the required 1 – 5 observations required for a 1:100,000 survey scale.

## Figure 2


LEGEND
Project Area
Project Area 100m Buffer
Greater than 10 percent
Less than 10 percent
SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
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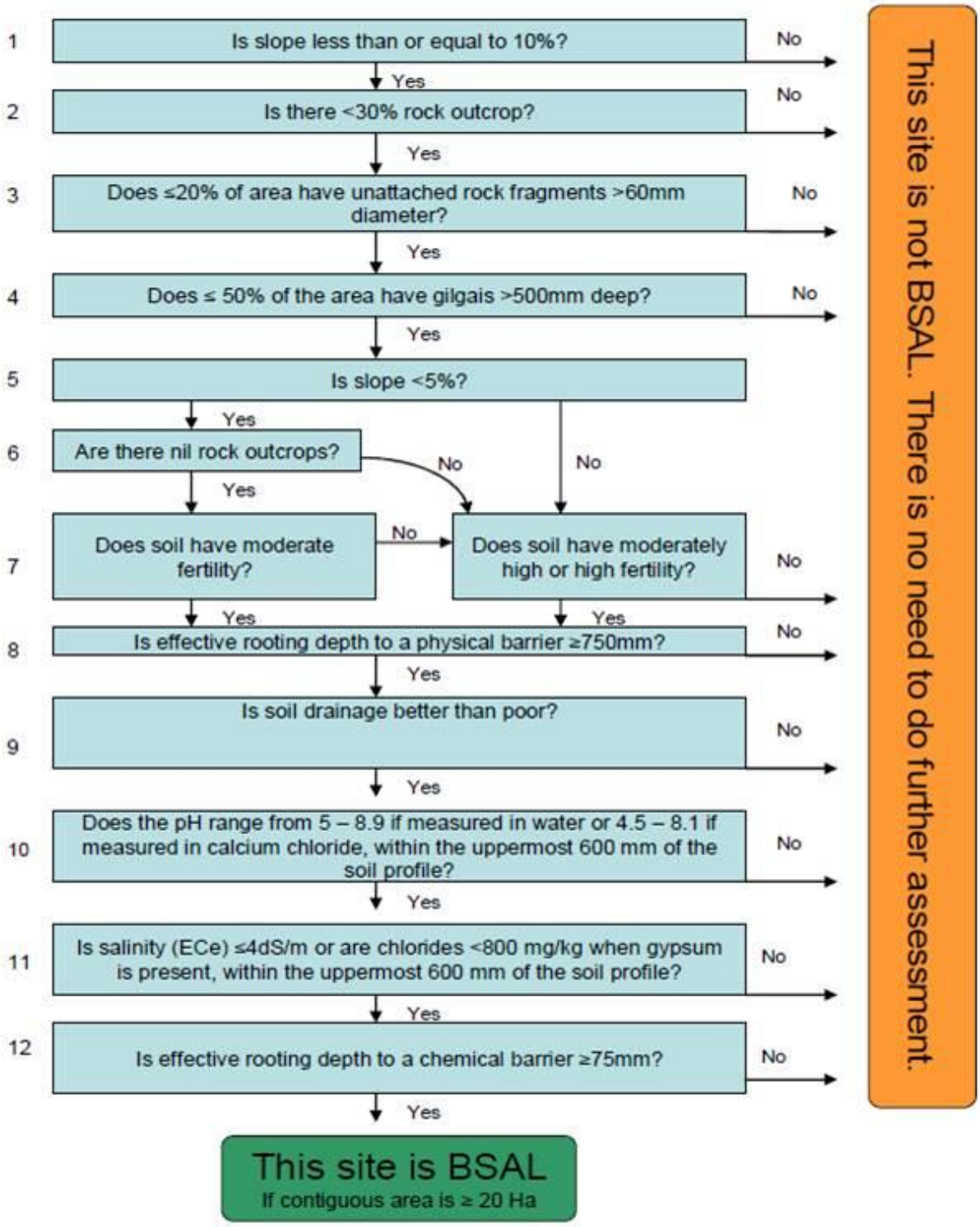
Project No.: 630.11114
Date: 20/11/2014
Drawn by: LH
Scale: 1:25,000
Sheet Size: A4
Projection: GDA 1994 MGA Zone 55
N
0 200 400 600 800
m
Ulan Coal Mines Limited
ULAN BSAL ASSESSMENT
Slope Exclusion Area
FIGURE 2

**Table 4: Flow Chart for site assessment of BSAL**



## 2.3 Results

The BSAL verification assessment resulted in no part of the Project Area satisfying all the BSAL criteria, therefore no BSAL was found. The assessment separated the Project Area according to exclusion areas and soil types into the following discrete areas:

1. There was 182 ha of exclusion area within the 350 ha assessment area based on two separate criteria:

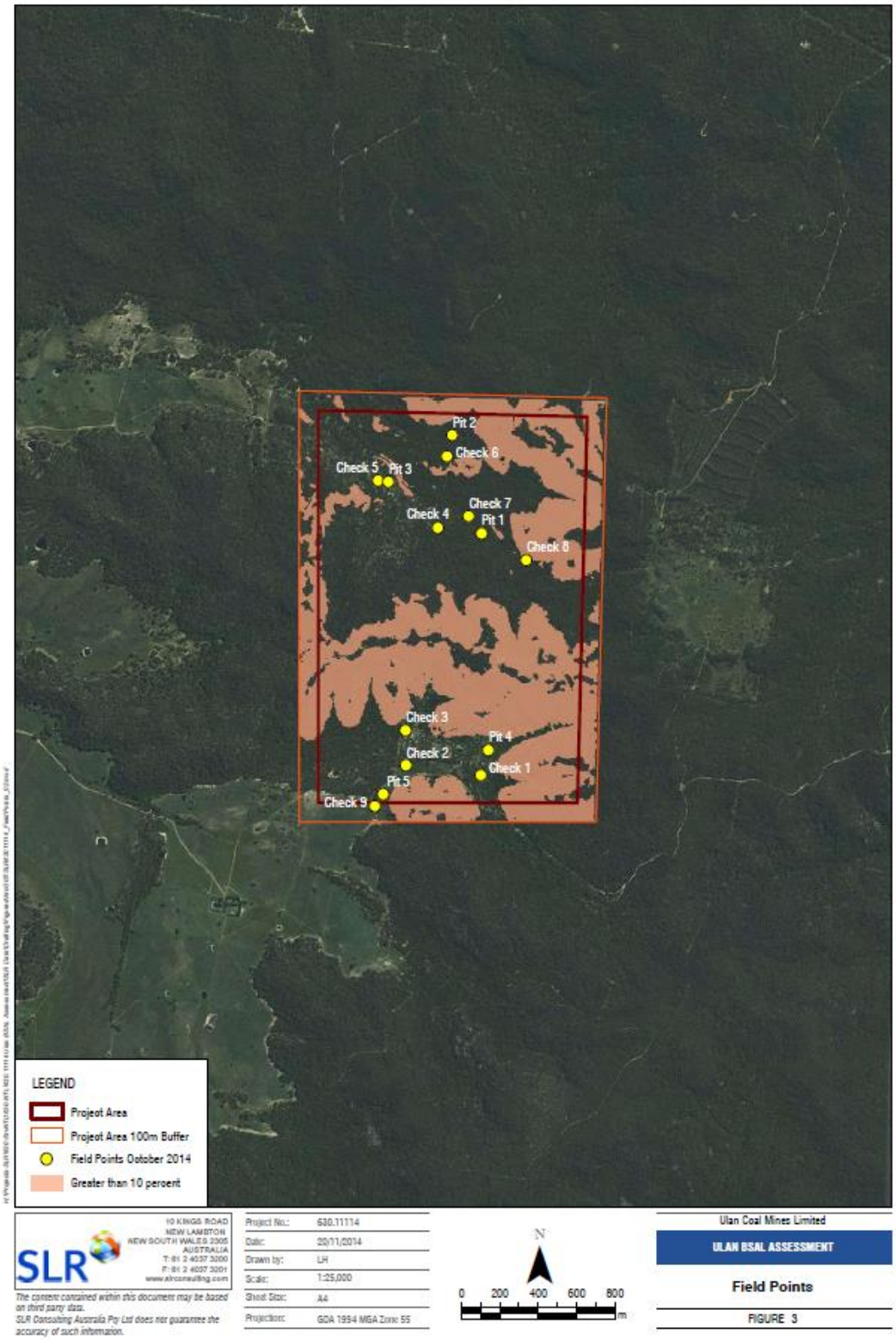
    a. Land with slope greater than or equal to 10%, comprising 157 ha.

    b. Land which had slope less than 10% but did not have a contiguous area greater than 20 ha, comprising 25 ha in total.

2. One soil type was found within the site assessed non-exclusion area, being a Tenosol, comprising the dominant soil type a Black-Orthic Tenosol and the minor soil type a Grey-Orthic Tenosol, corresponding to the field points shown in **Figure 3**. According to Table 6, Appendix 2 of the Interim Protocol, both a Black-Orthic Tenosol and a Grey-Orthic Tenosol of soil depth less than 1,000 mm which is sandy to sandy loam in texture has Moderately Low Inherent Fertility.

The findings of the on-site BSAL Assessment are summarised below and detailed in the BSAL Soil Data Cards attached in **Appendix A**. The accompanying laboratory data can be found in **Appendix B**. The methodology for the slope analysis is attached in **Appendix C**.

**Figure 3**


Pit 2
Check 6
Check 5
Pit 3
Check 7
Check 4
Pit 1
Check 8
Check 3
Pit 4
Check 2
Check 1
Pit 5
Check 9
LEGEND
Project Area
Project Area 100m Buffer
Field Points October 2014
Greater than 10 percent
SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
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N
0 200 400 600 800
m
Ulan Coal Mines Limited
ULAN BSAL ASSESSMENT
Field Points
FIGURE 3

**Table 5: Site BSAL Verification Summary**

| Site Number | Inspection Site Type | Australian Soil Classification (to ASC Great Group) | 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? | Is the Site BSAL? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pit 1 | Detailed | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| Pit 2 | Detailed | Grey-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| Pit 3 | Detailed | Grey-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| Pit 4 | Detailed | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| Pit 5 | Detailed | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 1 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 2 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 3 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 4 | Check | Grey-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 5 | Check | Grey-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 6 | Check | Grey-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 7 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 8 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |
| 9 | Check | Black-Orthic Tenosol | Yes | Yes | Yes | Yes | Yes | No | N/A | No | | | | | | **No** |

## On-Site BSAL Verification

### Soil Type –Tenosol

The soil type at three of the five detailed sample sites within the Project Area is a Black-Orthic Tenosol, whilst the remaining two detailed sites were a Grey-Orthic Tenosol. Tenosols comprise three major soil horizons and the profile is characterised by a sandy to sandy loam texture throughout. Soil pH ranges from very strongly acidic to slightly acidic. All sites are non-saline, non-sodic, with low to extremely low cation exchange capacity (CEC).

## Detailed Site 1 – Black-Orthic Tenosol

**Table 6: Site 1 – Black-Orthic Tenosol (Summary)**

| Site Description | |
|---|---|
|  **Plate 1 –** Profile Pit 1 |  **Plate 2 –** Landscape Looking North-East |
| **ASC Name** | Black-Orthic Tenosol |
| **Representative Check Sites** | 7, 8 |
| **Dominant Slope Association** | Gently to moderately inclined (3 – 5%) |
| **Land Use** | Native Forest |
| **Soil Fertility** | Moderately Low |
| **BSAL** | No |

**Table 7: Site 1 – Black-Orthic Tenosol (Analysis)**

| Horizon | Depth (m) | Description |
|---|---|---|
| A1 | 0.00 – 0.15 | Very dark grey apedal sand. Very strongly acidic, non-saline and non-sodic. Low CEC with <5% coarse fragments <10 mm. Rapidly drained with many coarse roots. Clear and even boundary. |
| A2 | 0.15 – 0.30 | Very dark greyish brown loamy sand with very weak pedality and consistence. Very strongly acidic and non-saline. Very low CEC with <5% coarse fragments <10 mm. Rapidly drained with many coarse roots. Clear and even boundary |
| B2 | 0.30 – 0.80 | Brown loamy sand with very weak pedality and consistence. Strongly acidic and non-saline. Very low CEC with <5% coarse fragments <10 mm. Rapidly drained with many coarse roots. Clear and even boundary |
| C | 80+ | Weathered sandstone (not laboratory tested) |

| Horizon | ECe | | Laboratory pH | |
|---|---|---|---|---|
| | dS/m | Rating | Value | Rating |
| A1 | 0.7 | Non-Saline | 4.3 | Very Strongly Acidic |
| A2 | 0.5 | Non-Saline | 4.7 | Very Strongly Acidic |
| B2 | 0.1 | Non-Saline | 5.3 | Strongly Acidic |
| C | N/A | N/A | N/A | N/A |

| Horizon | CEC | | ESP | |
|---|---|---|---|---|
| | cmol/kg | Rating | % | Rating |
| A1 | 7.4 | Low | 5.4 | Non-Sodic |
| A2 | <1.0 | Extremely Low | N.C* | N/A |
| B2 | <1.0 | Extremely Low | N.C* | N/A |
| C | N/A | N/A | N/A | N/A |

N.C* - Not calculated due to CEC <3.0 and/or Na <0.3 giving a false sodicity rating as per recommendation in *The Australian Soil Classification, Revised Edition* (Isbell, 2002).

## Detailed Site 2 –Grey-Orthic Tenosol

### Table 8: Site 2 – Grey-Orthic Tenosol (Summary)

| Site Description | |
|---|---|
|  |  |
| **Plate 3 –** Profile Pit 2 | **Plate 4** – Landscape looking West |
| **ASC Name** | Grey-Orthic Tenosol |
| **Representative Check Sites** | 4, 6 |
| **Dominant Slope Association** | Flat to gently inclined (1 – 3%) |
| **Land Use** | Native Forest |
| **Soil Fertility** | Moderately Low |
| **BSAL** | No |

**Table 9: Site 2 – Grey-Orthic Tenosol (Analysis)**

| Horizon | Depth (m) | Description |
|---|---|---|
| A1 | 0.00 – 0.10 | Very dark grey loamy sand with very weak pedality and consistence. Strongly acidic and non-saline. Extremely low CEC with <5% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary. |
| A2 | 0.10 – 0.20 | Dark brown loamy sand with very weak pedality and consistence. Moderately acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| B2 | 0.20 – 0.60 | Dark greyish-brown loamy sand with very weak pedality and consistence. Moderately acidic and non-saline. Very low CEC with <5% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| C | 0.60+ | Weathered sandstone (not laboratory tested) |

| Horizon | ECe | | Laboratory pH | |
|---|---|---|---|---|
| | dS/m | Rating | Value | Rating |
| A1 | 0.7 | Non-Saline | 5.4 | Strongly Acidic |
| A2 | 0.5 | Non-Saline | 5.6 | Moderately Acidic |
| B2 | 0.2 | Non-Saline | 5.9 | Moderately Acidic |
| C | N/A | N/A | N/A | N/A |

| Horizon | CEC | | ESP | |
|---|---|---|---|---|
| | cmol/kg | Rating | % | Rating |
| A1 | <1.0 | Extremely Low | N.C* | N/A |
| B1 | <1.0 | Extremely Low | N.C* | N/A |
| B2 | 1.4 | Very Low | N.C* | N/A |
| C | N/A | N/A | N/A | N/A |

N.C* - Not calculated due to CEC <3.0 and/or Na <0.3 giving a false sodicity rating as per recommendation in *The Australian Soil Classification, Revised Edition* (Isbell, 2002).

## Detailed Site 3 – Grey-Orthic Tenosol

### Table 10: Site 3 – Grey-Orthic Tenosol (Summary)

| Site Description | |
|---|---|
|  |  |
| **Plate 5 –** Profile Pit 3 | **Plate 6 –** Landscape looking North-East |
| **ASC Name** | Grey-Orthic Tenosol |
| **Representative Check Sites** | 4, 5 |
| **Dominant Slope Association** | Flat to Gently inclined (1 – 3%) |
| **Land Use** | Cattle grazing |
| **Soil Fertility** | Moderately Low |
| **BSAL** | No |

**Table 11: Site 3 – Grey-Orthic Tenosol (Analysis)**

| Horizon | Depth (m) | Description |
|---|---|---|
| A1 | 0.00 – 0.15 | Dark brown loamy sand with very weak pedality and consistence. Strongly acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary. |
| A2 | 0.15 – 0.30 | Dark greyish-brown loamy sand with very weak pedality and consistence. Strongly acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| B2 | 0.30 – 0.65 | Brown loamy sand with very weak pedality and consistence. Strongly acidic and non-saline. Extremely low CEC with >40% coarse fragments 10-20 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| C | 0.65+ | Weathered sandstone (not laboratory tested) |

| Horizon | ECe | | Laboratory pH | |
|---|---|---|---|---|
| | dS/m | Rating | Value | Rating |
| A1 | 0.1 | Non-Saline | 5.3 | Strongly Acidic |
| A2 | 0.1 | Non-Saline | 5.2 | Strongly Acidic |
| B2 | 0.1 | Non-Saline | 5.4 | Strongly Acidic |
| C | N/A | N/A | N/A | N/A |

| Horizon | CEC | | ESP | |
|---|---|---|---|---|
| | cmol/kg | Rating | % | Rating |
| A1 | <1.0 | Extremely Low | N.C* | N/A |
| B1 | <1.0 | Extremely Low | N.C* | N/A |
| B2 | <1.0 | Extremely Low | N.C* | N/A |
| C | N/A | N/A | N/A | N/A |

N.C* - Not calculated due to CEC <3.0 and/or Na <0.3 giving a false sodicity rating as per recommendation in *The Australian Soil Classification, Revised Edition* (Isbell, 2002).

## Detailed Site 4 – Black-Orthic Tenosol

### Table 11: Site 4 –Black-Orthic Tenosol (Summary)

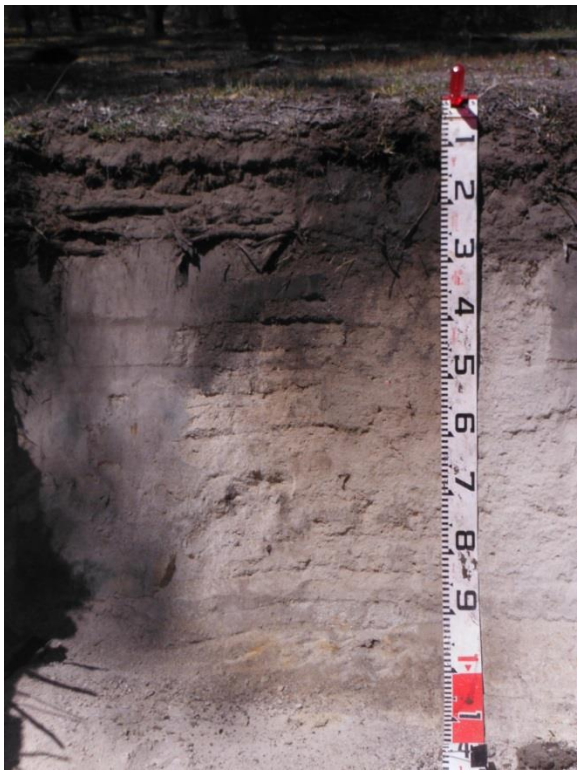
| Site Description | |
|---|---|
|  |  |
| **Plate 7 –** Profile Pit 4 | **Plate 8 –** Landscape looking North |
| **ASC Name** | Black-Orthic Tenosol |
| **Representative Check Sites** | 1, 3 |
| **Dominant Slope Association** | Flat (0 – 1%) |
| **Land Use** | Cattle grazing |
| **Soil Fertility** | Moderately Low |
| **BSAL** | No |

**Table 13: Site 4 – Black-Orthic Tenosol (Analysis)**

| Horizon | Depth (m) | Description |
|---|---|---|
| A1 | 0.00 – 0.08 | Very dark grey loamy sand with very weak pedality and consistence. Moderately acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary. |
| A2 | 0.08 – 0.30 | Very dark greyish-brown loamy sand with very weak pedality and consistence. Moderately acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| B2 | 0.30 – 0.80 | Pinkish-grey loamy sand with very weak pedality and consistence. Slightly acidic and non-saline. Extremely low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| C | 0.80+ | Weathered sandstone (not laboratory tested) |

| Horizon | ECe | | Laboratory pH | |
|---|---|---|---|---|
| | dS/m | Rating | Value | Rating |
| A1 | 0.2 | Non-Saline | 5.7 | Moderately Acidic |
| A2 | 0.5 | Non-Saline | 5.8 | Moderately Acidic |
| B2 | 0.1 | Non-Saline | 6.3 | Slightly Acidic |
| C | N/A | N/A | N/A | N/A |

| Horizon | CEC | | ESP | |
|---|---|---|---|---|
| | cmol/kg | Rating | % | Rating |
| A1 | <1.0 | Extremely Low | N.C* | N/A |
| B1 | <1.0 | Extremely Low | N.C* | N/A |
| B2 | 2.5 | Very Low | 4.0 | Non-Sodic |
| C | N/A | N/A | N/A | N/A |

N.C* - Not calculated due to CEC <3.0 and/or Na <0.3 giving a false sodicity rating as per recommendation in *The Australian Soil Classification, Revised Edition* (Isbell, 2002).

## Detailed Site 5 – Black-Orthic Tenosol

### Table 14: Site 5 – Black-Orthic Tenosol (Summary)

| Site Description | |
|---|---|
|  |  |
| **Plate 9 –** Profile Pit 5 | **Plate 10 –** Landscape Looking North-East |
| **ASC Name** | Black-Orthic Tenosol |
| **Representative Check Sites** | 2, 9 |
| **Dominant Slope Association** | Flat to gently inclined (1 – 3%) |
| **Land Use** | Cattle grazing |
| **Soil Fertility** | Moderately Low |
| **BSAL** | No |

**Table 15: Site 5 – Black Orthic Tenosol (Analysis)**

| Horizon | Depth (m) | Description |
|---|---|---|
| A1 | 0.00 – 0.12 | Dark brown loamy sand with very weak pedality and consistence. Moderately acidic, non-sodic and non-saline. Very low CEC with <10% coarse fragments <10 mm. Rapidly drained with coarse roots common. Clear and even boundary. |
| A2 | 0.12 – 0.30 | Very dark greyish-brown sandy loam with very weak pedality and consistence. Slightly acidic and non-saline. Very low CEC with 10% coarse fragments 10-15 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| B2 | 0.30 – 0.70 | Brown loamy sand with very weak pedality and consistence. Slightly acidic and non-saline. Very low CEC with 25% coarse fragments 10-20 mm. Rapidly drained with coarse roots common. Clear and even boundary |
| C | 0.70+ | Weathered sandstone (not laboratory tested) |

| Horizon | ECe | | Laboratory pH | |
|---|---|---|---|---|
| | dS/m | Rating | Value | Rating |
| A1 | 0.5 | Non-Saline | 5.9 | Moderately Acidic |
| A2 | 0.1 | Non-Saline | 6.1 | Slightly Acidic |
| B2 | 0.1 | Non-Saline | 6.1 | Slightly Acidic |
| C | N/A | N/A | N/A | N/A |

| Horizon | CEC | | ESP | |
|---|---|---|---|---|
| | cmol/kg | Rating | % | Rating |
| A1 | 5.2 | Very Low | 1.0 | Non-Sodic |
| B1 | 2.3 | Very Low | 4.3 | Non-Sodic |
| B2 | 1.5 | Very Low | 3.3 | Non-Sodic |
| C | N/A | N/A | N/A | N/A |

# 3 CONCLUSION

The Ulan West Mine Expansion BSAL Verification Assessment was undertaken in October 2014 by SLR's Murray Fraser and supervised by Clayton Richards (CPSS 2). The assessment area was defined as the proposed Project Area totalling approximately 275 ha, as well as the required 100 m buffer (75 ha). The Project Area was assessed in accordance with the Interim Protocol and it was found that no BSAL existed within the 350 ha comprising the BSAL Verification Assessment Area.

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