



GLENCORE

**REVISED APPLICATION FOR
VERIFICATION OF
BIOPHYSICAL STRATEGIC
AGRICULTURAL LAND**

MOUNT OWEN CONTINUED OPERATIONS

September 2015

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1.0 Introduction

The Mount Owen Continued Operations Project is a proposed coal mining Project in the Hunter Valley of NSW. The location of the Project is shown in **Figure 1.1**.

The existing Mount Owen Mine is owned and operated by Mount Owen Pty Limited (Mount Owen), a subsidiary of Glencore. The application for continued operations in the Project Area will, if approved, extend the life of the existing mine to 2030 (an additional 12 years).

The Mount Owen Project Area totals 485 hectares. Most of the Project Area is located within existing mining lease areas however a further mining lease is required for the Project to be undertaken over the 97.1 hectare area covered by Assessment Lease 08 (AL08) (refer to **Figure 1.2**). The Project Area is within the landscape covered by the Upper Hunter Strategic Regional Land Use Plan (SRLUP) (DP&I, 2012). The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) requires detailed examination of land and soil characteristics of State Significant mining developments that requires a new mining lease. The intent of the Mining SEPP and the SRLUP is to ensure that high quality agricultural land and resources that may be impacted by mining proposals are identified early and subject to a rigorous and independent assessment before the development application can be determined.

In this report, the proposed disturbance area within AL08 of 97.1 hectares is referred to as the 'Verification Application Area (VAA)' (refer to **Figure 1.2**). The land within the VAA was not mapped as BSAL in the SRLUP. Previous land and soil capability mapping identifies the VAA as LSC classes 4 to 7, with low fertility and a moderate to high sheet erosion hazard when cleared (Umwelt 2015). The VAA, like other parts of the Project Area and the slopes on the northern side of the Hunter Valley, has been previously used for cattle grazing on native pasture. Where it is safe to do so, Glencore (through its grazing enterprise, Colinta) may conduct low intensity cattle grazing activities over parts of the VAA and other parts of the existing assessment lease. This report has been prepared to address the requirements of the NSW Interim Protocol for Verification of Biophysical Strategic Agricultural Land (the Interim Protocol) in relation to the VAA.

1.1 Project land and soil context

High quality agricultural land is generally in Land and Soil Capability Classes 1, 2 or 3, which is suitable for sustained cropping or improved pasture uses, without significant degradation. The Office of Environment and Heritage (OEH) has mapped this quality land, termed Biophysical Strategic Agricultural Land (BSAL) at the regional scale for the Upper Hunter SRLUP. BSAL identified in the OEH mapping in the vicinity of the Project is shown in **Figure 1.3**.

The existing evidence of land and soil characteristics in the VAA and elsewhere in the Project Area indicates that there is a very low likelihood that previously unrecognised BSAL will be identified in the VAA. There is a low risk to agriculture (in the sense of any potential impact on high value cropping land).

Notwithstanding the low risk of BSAL occurring, the Interim Protocol requires detailed soil sampling and testing to provide further evidence about soil quality and constraints affecting the soil materials in the VAA.

This report provides evidence of the soil types and an assessment of the presence of BSAL in the VAA, in accordance with the requirements of the Interim Protocol.

2.0 Interim Protocol requirements

2.1 Mining SEPP direction

The Mining SEPP and the Interim protocol state:

For applicants of State Significant mining and coal seam gas proposals that are located *'outside the mining area of an existing mining lease'* and are *'not located on BSAL'*, the applicant may:

- Apply for a site verification certificate to determine if any part of the Project Area meets the BSAL site criteria and would therefore be subject to the Gateway process; or
- Elect to proceed straight away to the Gateway process on the basis that their project area or part of the project area does contain BSAL.

Under Division 1 (2) these requirements *'do not apply to land that is outside the mining area of a proposed mining lease'*.

This information in this report is provided in relation to an application for a site verification certificate confirming there is no BSAL present in the VAA.

2.2 BSAL assessment area

Item 5 (Step 1) of the Interim Protocol requires that the assessment should be conducted for the entire area that is not covered by the existing mining lease, plus a 100 metre buffer area, to take into account minor changes in design. Where BSAL within the Project Area is part of a larger contiguous mass of BSAL, the boundary of the larger area must be identified.

2.2.1 Buffer area

As shown in **Figure 1.2**, the VAA is bounded on the western edge by existing Mining Lease 1561 (ML1561). AL08 only applies between the surface to a depth of 15.24 metres, with Coal Lease 382 (CL382) and ML1415 applying to subsurface areas below 15.24 metres.

The northern and southern boundaries of the VAA align with the boundary of the Project Area.

The eastern boundary of the VAA aligns with the Project's Proposed Disturbance Area. The Proposed Disturbance Area includes all areas which may be directly impacted by works associated with the Project, including mining, access roads and water management infrastructure. As no works are permitted outside the Proposed Disturbance Area, a buffer outside this boundary has not been included in the VAA in this application.

2.2.2 Contiguous BSAL

None of the land inside or outside the VAA has been mapped as BSAL at the regional scale. The terrain around the margins of the VAA is moderately to steeply undulating hillslope country within the catchment of a minor tributary of Main Creek, which is a tributary of Glennies Creek. The entire area lies within the Bayswater Soil Landscape.

2.3 Access to reliable water

Item 5 (Step 2) notes that the entire area covered by the Upper Hunter SRLUP is regarded as having access to a reliable water supply.

2.4 Mapping approach

Item 5 (Step 3) provides the following inclusions and exclusions from the VAA sampling and assessment area:

- The verification process, following Section 6 of the Interim Protocol (on site soil assessment), must be conducted across all parts of the VAA to which the proponent has access, subject to the exclusions noted below. Mount Owen has access to the entire 97.1 hectares included in the VAA.
- Areas to which the proponent has access but are not used for agriculture (such as heavily forested areas) may be excluded from the sampling area. The BSAL status of these areas is assessed using information from adjacent areas, and the similarity of underlying geology, terrain and previous regional mapping.

Mount Owen have access to the entire VAA area and, while the area is not presently grazed, it has been in the past. **Figure 2.1** shows the areas managed by Mount Owen and Colinta (a Glencore subsidiary) which could potentially be used for low intensity grazing.

Specific parts of the VAA also carry moderately dense spotted gum/ironbark woodland (mapped as endangered ecological community (EEC)). Where the EEC provides a dense vegetation cover, these woodland areas have been excluded from the BSAL sampling area. The exclusion areas are also shown in **Figure 2.2**.

Previous environmental investigations in the VAA have identified four Aboriginal sites, including three isolated finds and an extensive, low density artefact scatter along a tributary drainage line. These sites are registered in the OEH AHIMS. The artefact scatter almost certainly extends outside the VAA along the banks of the drainage line which is a tributary of Main Creek. The Aboriginal sites are shown in **Figure 2.2**. It is an offence to disturb a known Aboriginal site without an appropriate permit from OEH. The Aboriginal sites have therefore been excluded from the assessment area for the VAA.

2.5 Risk assessment

The Interim Protocol refers to a risk assessment process to provide guidance on the appropriate sampling density. Appendix 3 of the Interim Protocol notes that sampling densities should be linked to risk:

- Sampling density 1 site per 25 to 400ha for low risk to agriculture.
- Sampling density 1 site per 5 to 25 hectares for high risk to agriculture.

The risk criteria in the appendix are drawn from the Guideline for Agricultural Impact Statements (NSW Government, 2015), and were not originally intended for risks to BSAL. It refers to 'agricultural resources or industries' not to the best quality agricultural resources which are included in BSAL.

However, if the criteria identified in Tables 7, 8 and 9 of Appendix 3 of the Interim Protocol are applied as written, the consequence of the proposed mining activities in the VAA would fit the 'major consequence' description and the likelihood is 'almost certain'. This would lead to an assessment of High Risk.

In relation to the examples of high risk provided in Appendix 3 of the Interim Protocol (activities located on or near fertile alluvial soils), the current VAA is not a high risk area.

If the risk assessment guide was designed to assess risks to BSAL, the VAA would have a consequence ranking of minor, for instance described as:

Minor or indirect damage to BSAL (indirect impacts such as dust or changes to the hydrology of minor creeks or noise), on extensive grazing enterprises. No cropping land (or class 1, 2 or 3 land) is directly affected.

The probability ranking would be likely or almost certain, depending on the distance to the nearest BSAL. In this case, the risk ranking would be medium.

Based on this risk analysis, the appropriate soil sampling density should be around 1 site per 25 hectares. If the high risk assessment is applied, the sampling density would increase to 1 site per 5 hectares.

Given the uncertainty around the risk descriptors, a sampling density of approximately 1 site per 10 hectares has been applied to the survey design.

2.6 Soil and landscape verification criteria

The soil and landscape verification criteria are designed to identify soils which have no permanent limitations to plant growth and are suitable for cropping. A minimum of 20 hectares of contiguous land area and soil meeting the BSAL criteria is required (including contiguous areas inside and outside the Project Area), reflecting the area necessary for feasibly conducting a viable cropping enterprise.

Table 2.1 lists the site based BSAL assessment criteria, and notes any criterion which would immediately exclude part of the VAA from the assessment, based on existing (pre field confirmation) data. Details of field based soil description and sampling are in **Section 3.0**, and results of the assessment of the Project Area are in **Section 4.0**.

Table 2.1 Site based verification criteria – preliminary assessment

Criterion	Comment
1. Is slope less than or equal to 10%	The northern corner of the VAA and a small area in the south eastern corner exceed the slope threshold. Slope analysis is based on LiDAR data and continuous triangulation. Slope data is provided in Figure 2.3 .
2. Is there less than 30% rock outcrop (on slopes of more than 10%)?	Rock outcrop in the VAA does not exceed 30% at any point.
3. Does less than or equal to 20% of the area have unattached rock fragments that are more than 60mm in diameter?	Surface float of coarse fragments across the VAA does not exceed 20% at any point
4. Does less than or equal to 50% of the area have gilgais greater than 500mm deep?	No gilgai is present in the VAA.

Criterion	Comment
5. Is the slope less than 5%	Areas of less than 5% slope (primarily ridge and spur crests) are shown in Figure 2.4
6. Are there nil rock outcrops (with slope > 5%)	There are few if any rock outcrops on slopes of less than 5%
<p>7. (a) Does the soil have moderate fertility? (b) Does the soil have moderately high or high fertility (with slope less than 5%)</p> <p>Note soil fertility takes into account inherent fertility, permeability, structure, tilth and typical soil depth. Kurosols, Sodosols and Rudosols all have low or moderately low fertility ranking.</p> <p>Soils with moderately low fertility can only support plants suited to grazing; large inputs of fertiliser are required to make the soils suitable for arable purposes (see Table 1 in the Interim Protocol, from Murphy 2007)</p>	<p>The fertility of soils is low or moderately low (see Table 6 in Appendix 2 of the Interim Protocol).</p> <p>Regional scale mapping (soil landscape and fertility) indicates the soils are within the Bayswater Soil Landscape. Profile depth in this soil landscape is 40-300 cm, pH 5.5 to 7.0. Soils are poorly drained to well drained, with low to high water holding capacity.</p> <p>Field based soil testing (see Section 4.1.1) provides Project scale data for verification.</p> <p>Soil depth in some areas is less than 750mm to bedrock.</p>
<p>8. Is effective rooting depth to a physical barrier greater than or equal to 750 millimetres?</p> <p>Physical barriers include bedrock, weathered bedrock, hard pans and continuous gravel layers and the type of barrier must be described. Effective rooting depth must be reported to the nearest 50 millimetres increment.</p>	Some profiles on upper slopes have a soil depth to bedrock (weathered conglomerate and/or mudstones) of less than 750mm. Foot slope soils have profile depths of more than 750mm.
<p>9. Is soil drainage better than poor?</p> <p>Look for grey and gley colours in dominant and subdominant mottles (not bioturbation mottling). Mottles must be distinct or prominent, with specific value/chroma ratings.</p>	The B horizon of most profiles is mottled, but mottles are not distinct (moist condition)
10. Is salinity (ECe) less than or equal to 4dS/M or are chlorides <800mg/kg when gypsum is present, within the uppermost 600mm of the soil profile?	<p>The main soils are Yellow Solodic and Yellow and Brown Podzolic soils occurring on slopes, and Alluvial Soils in drainage lines (Kovac and Lawrie, 1991).</p> <p>Yellow Solodic and Alluvial soils are associated with high soil salinity, while Red and Yellow Podzolic soils are associated with Low soil salinity. This indicates soils associated with the Bayswater Soil Landscape may be saline (with ECe greater than 4dS/m).</p>

Criterion	Comment
<p>11. Is effective rooting depth to a chemical barrier greater than or equal to 750 millimetres? Effective rooting depth must be reported to the nearest 50 millimetres increment.</p> <p>A chemical barrier is defined as poor fertility, or elevated salinity. Profiles have been sampled for fertility indicators at multiple depth in the profile, from A0 horizon, through A1, A2, B1 and B2. To meet the fertility and chemical barrier requirements, samples must indicate</p>	<p>For preliminary assessment, note above that Kurosols, Sodosols and Rudosols are generally assumed to have low to moderate fertility.</p> <p>Soils in the Bayswater Soil Landscape may be saline (with ECe greater than 4dS/m).</p>

3.0 Field assessment method

This section describes the field based soil sampling process and laboratory testing conducted on soil samples from the VAA.

3.1 Soil sampling sites

Key factors in the soil sampling rationale include:

- The VAA has an area of 97.1 hectares.
- As discussed in **Section 2.5**, a sampling density of approximately 1 site per 10 hectares has been selected to provide representative coverage of the assessment area and to recognise the low risk of impacts on BSAL.
- Previous soil survey work (Umwelt 2015) has identified that the entire VAA is within the Bayswater Soil Landscape, with Sodosols and Kurosols identified as the predominant soil types, with Rudosols or Chromosols potentially present along low order drainage lines. The Interim Protocol requires three detailed soil sampling sites for each soil type. Six detailed soil sampling pits were excavated, consistent with two main soil types.
- The remaining soil sampling sites are check sites. Three check sites have previously been recorded in the VAA. An additional three check sites are included in this round of sampling.
- The total number of sites sampled/recorded within the VAA is 12. This is equivalent to a sampling density within the VAA of 1 site per 7 hectares.
- No detailed sites or check sites were undertaken within the exclusion areas (refer to **Figure 2.2**), with areas of exclusion being excluded from the sampling area due to:
 - Areas of slopes greater than 10 per cent (approximately 3.86 hectares).
 - Aboriginal artefact scatter locations (approximately 5.24 hectares)
 - The presence of dense vegetation, including the presence of endangered ecological communities (approximately 47.79 hectares) (refer to **Sections 2.4** and **3.2.1**).

3.2 Soil sampling method

This section describes the soil description and sampling process for exclusion areas, detailed sites and check sites and in the Project Area.

3.2.1 Exclusion areas

As discussed in **Section 2.4**, soil surveys (profile descriptions and soil sampling) are not required in areas of dense vegetation or sensitive ecological or heritage areas. Soil surveys were therefore excluded from areas of dense vegetation or Aboriginal sites. Additionally, soil surveys are not required in areas which were identified as not being BSAL due to landscape features (e.g. slopes exceeding 10 per cent). These areas are identified as exclusion areas for the purposes of the soil survey effort and are shown in **Figure 2.2** and shown in **Plates 3.1** and **3.2**.

For the purposes of Section 9.4.1 of the Interim Protocol, the field records include GPS coordinates and photographs of the areas exceeding the 10 per cent slope threshold (refer to **Plate 3.1**). GPS located photographs of the areas of dense vegetation (including spotted gum forest (EEC)) were also recorded in the field (refer to **Plate 3.2**).

3.2.2 Detailed sites

Six detailed soil description pits were excavated using a backhoe. Using the earlier soil survey work (Umwelt 2015), three detailed survey points were located in each of the previously identified predominant soil types (Sodosols and Kurosols). The presence of the Aboriginal site adjacent to the drainage line in the VAA effectively precluded any detailed sites from being located within the areas potentially containing Rudosols.

Soil pits were excavated to at least 750 millimetres, or less where bedrock was encountered at shallow depth.

Profile descriptions recorded soil materials from the surface to 750 millimetres, with information recorded on SALIS soil data sheets. The following information was recorded for the A and B horizon.

- Site ID and GPS coordinates
- Photos of the surface soil at the site and the landscape context (ground cover, vegetation community) of the site
- Soil profile data was recorded using the SALIS soil data cards:
 - General site condition, including run-on, run-off, surface condition, ground cover, evidence of erosion etc
 - Layer status, depth and boundary conditions
 - Colour and mottles (Munsell)
 - Bedrock type where evident
 - Texture
 - pH (Raupach)
 - Structure and fabric
 - Consistence
 - Presence of coarse fragments
 - Presence of roots
 - Evidence of drainage condition.

3.2.2.1 Soil sample collection

The Interim protocol requires soil samples to be collected and analysed from the detailed soil description and sampling sites.

Required sampling depths are noted below.

- 0-50 millimetres
- 50-150 millimetres
- 250-300 millimetres
- 300-600 millimetres
- 600-1000 millimetres

Samples must be entirely from within a single soil horizon and be identified by soil profile layer as well as by depth. The recommended soil sampling depths are noted below. For the soils in this survey area, horizon boundaries cross some of these sampling depths at multiple sites. Sampling depths have therefore been modified to ensure that samples are entirely from within a single soil horizon. Actual sampling depths are noted in the results tables in **Section 4.1.3**.

In the VAA, the upper part of the topsoil on slopes has often been removed by previous sheet erosion and a hard set A2 horizon forms the ground surface, except for intermittent remnants of the A1 horizon. The A2 horizon rarely extends to a depth of more than 300 millimetres. Where these conditions apply, soil samples were labelled accordingly. In situations where the A1 horizon is largely absent, the upper sample for laboratory analysis includes the full depth of the A2 horizon.

3.2.2.2 Laboratory testing

Laboratory testing was conducted to provide data for the following parameters, related to fertility and chemical barriers in the profile:

- Salinity (EC and ECe)
- pH
- Exchangeable sodium percentage (ESP)
- Cation Exchange capacity (CEC)
- Ca:Mg ratio

Results from the laboratory testing are discussed in **Section 4.1.3**.

3.2.3 Check sites

In accordance with Section 10.0 of the Interim Protocol, check sites were recorded from shallow shovel pits and hand augering, into the upper B-horizon or 500 millimetres (whichever came first); some check sites were sampled at a reduced depth where bedrock was encountered. The check sites are located on a selection of terrain units and slopes, to provide representative descriptions of soil types across the landscape.

For each check site, the following information was recorded for the A and B horizon.

- Site ID and GPS coordinates
- Photos of the surface soil at the site and the landscape context of the site
- Soil profile data was recorded using the SALIS soil data cards:
 - General site condition, including run-on, run-off, surface condition, ground cover, evidence of erosion etc.
 - Layer status, depth and boundary conditions
 - Colour and mottles (Munsell)
 - Texture
 - pH
 - structure and fabric
 - consistence
 - presence of coarse fragments
 - presence of roots

No samples were collected from check sites for laboratory testing. Given the consistent soil types across the VAA area, the texture contrast, colour and pH are sufficient to identify the soil type at these sites.

4.0 Soil sampling results and assessment

Descriptions of soil materials present in each layer of each of the six detailed soil profiles have been entered in SALIS. Selected profiles, to represent the soil type(s) present in the VAA are described below.

4.1 Soil materials, profile descriptions and classification

4.1.1 Typical soil profiles – detailed sites

Tables 4.1 to 4.6 provide details of profile characteristics for the six detailed profiles recorded in the VAA.

Table 4.1 Profile MOCO Site 28

MOCO Site 28		E3236799448 N64111317828 Recorded 22 July 2015
<p>Spur crest; slope 4.7%.</p> <p>Underlying geology is lithic sandstone, no rock outcrop.</p> <p>Currently native grassland.</p>		
Profile characteristics		
A0 0-150mm	10YR 4/3 (moderately moist) sandy loam (fine and fraction). No stones, no segregations, no mottles. pH 5.5. Weak pedality, polyhedral peds, 10-20mm. Clear boundary	
A1 150-280mm	10YR 5/3 (moderately moist) sandy loam (fine sand fraction). pH 5.5. Apedal massive, earthy fabric. No stones, no segregations, no mottles. Hardsetting when dry, puggy when wet. Abrupt boundary.	
A2 280-370mm	10YR 6/3 (moderately moist) clay loam (fine sand fraction). No mottles, no no segregations. Distinct accumulation of stones (20-50% at base of unit. Moderate pedality, polyhedral, 10-20mm. Occasional charcoal. Hard set when dry, puggy when wet. Sharp boundary.	
B1 370-670mm	10YR6/2 (moderately moist) heavy clay (no sand), mottled 10YR 5/6. Moderate pedality, subangular blocky, rough faced, 20-50mm. No segregations. pH 5.5. Pit base is in weathered lithic sandstone	

Plates 4.1 and 4.2 illustrate the landscape context of the MOCO Site 28 and the soil materials that are present in the profile.

Table 4.2 Profile characteristics, MOCO Site 29

MOCO Site 29		E 323501.9422 N 6411017.9586 Recorded 22 July 2015
<p>Lower slope, 20 metres from a tributary drainage line. Slope 2.8%.</p> <p>Underlying geology is lithic sandstone and mudstone.</p> <p>Vegetation – cleared spotted gum/ironbark and bulloak tall woodland, now native grassland.</p> <p>Groundcover varies from 100% to 10% at and around the site.</p>		
Profile characteristics		
A1 0-120mm	10YR 3/2 (slightly moist) sandy loam (fine sand fraction). pH 5.5. Bioturbation across abrupt A1/A2 boundary. No mottles, no stones, no segregations. Weak pedality, polyhedral, 10-20mm.	
A2 120-380mm	10YR 5/3 (slightly moist) sandy loam (fine sand fraction). No mottles, no stones, no segregations. Apedal massive with earthy fabric. Hard setting when dry, puggy when wet. Roots lines and infilled worm burrows clearly visible. pH 6.0. Abrupt boundary.	
B1 380-470mm	10YR 6/2 (slightly moist) clay loam sandy (fine sand fraction). Faint dull orange mottle, 10-20%. pH 7.0. Moderate pedality, subangular blocky, 20-50mm. Abrupt boundary.	
B2 470-800mm	10YR 4/3 (moderately moist) sandy clay (fine and coarse sand fraction, medium clay). No stones, no segregations. 20-50% orange mottle. Moderate pedality, subangular blocky, 20-50mm. Clear boundary	
B3 800-990mm	10YR 4/2 (moderately moist) clay loam with very little sand. Orange mottles 20-50%. Moderately pedal, subangular blocky, 20-50mm. pH 6.0. Profile continues.	

Plates 4.3, 4.4 and 4.5 illustrate the landscape context of the MOCO Site 29 and the soil materials that are present in the profile.

Table 4.3 Profile characteristics, MOCO Site 30

MOCO Site 30		E 323809.4142 N 6410883.8822 Recorded 22 July 2015
<p>Lower slope, with extensive run-on. Slope 4.8%.</p> <p>Underlying bedrock is lithic sandstone and mudstone.</p> <p>Vegetation is cleared spotted gum and ironbark woodland, with bull oak in mid-story.</p> <p>Currently native grassland.</p>		
Profile characteristics		
A1 0-80mm	10YR3/2 sandy loam (fine sand fraction). Sits on top of profile as a discrete layer of organic material over gravelly, sandy A2. No mottles, no stones, no segregations. Weak pedality, subangular blocky 10-20mm. Sharp boundary.	
A2 80-460mm	10YR 5/3 (slightly moist, no mottles) sandy loam (fine sand fraction); includes roots, burnt roots, gravel, bioturbation evidence, occasional colour variations. Gravel content increases with depth (to 10-20%, with size range 2-6mm through to 20-60mm). Hard setting when dry, puggy when wet. Massive, earthy fabric. Clear boundary.	
B1 460-860mm	10YR 5/2 (moderately moist) heavy clay. Mottled 20-50%, orange. Some gravel (2-10%, less than 20mm diameter); moderate pedality, subangular blocky, 20-50mm. Some roots in upper part of this horizon, decreasing at depth. pH 5.5. layer continues below base of pit.	

Plates 4.6 and 4.7 illustrate the landscape context of the MOCO Site 30 and the soil materials that are present in the profile.

Table 4.4 Profile characteristics, MOCO Site 31

MOCO Site 31		E 323723 N 6410769 Recorded 22 July 2015
<p>Lower slope – adjacent to tributary drainage line. Slope 4%.</p> <p>Underlying bedrock – local alluvium, over lithic sandstone.</p> <p>Vegetation cleared spotted gum/ironbark open forest, with bull oak midstory. Primarily native grassland.</p>		
Profile characteristics		
A1 – 0-100mm	10YR 3/2 (moist) loam fine sandy. No mottles. Forms a discrete layer, with an abrupt but wavy lower boundary. No mottles, no segregations. pH 5.0. Weak pedality, polyhedral, rough faced. Abrupt boundary.	
A2 -100-210mm	10YR 5/2 (moist, with seepage evident at base), strongly bioturbated sandy loam (with fine and coarse sand fraction). No mottles, no stones, no segregations. pH 6.0. Very weak pedality, subangular blocky, rough faced. Dispersible. Abrupt boundary.	
B1 – 210-900mm	10YR 5/2 (moist) (slightly lighter colour at depth to 10YR 6/3), medium heavy clay. Dull orange mottle, 2-10%, increasing to 10-20% at depth. Includes some fine sand and occasional weathered stones (and ironstone); 2-10% and 2-6mm. No segregations. Moderate pedality, subangular blocky. Base of pit, profile continues.	

Plates 4.8, 4.9 and 4.10 illustrate the landscape context of the MOCO Site 31 and the soil materials that are present in the profile.

Table 4.5 Profile characteristics, MOCO Site 32

MOCO Site 32		E323143.5111 N6410479.3857 Recorded 22 July 2015
<p>Mid slope profile. Slope 1.2%.</p> <p>Underlying geology – lithic sandstone.</p> <p>Vegetation – extensively cleared spotted gum and ironbark open forest, with bull oak regrowth dominating mid story. Currently native grassland.</p>		
A0 – 0-90mm	Wash on deposits over eroded A2 surface. Material lifts off the hard set A2. 10YR5/2 (dry) loam fine sandy (fine sand fraction); weak pedality, rough faced peds; pH 5.5. No coarse fragments, no segregations. Abundant organic debris. Abrupt boundary.	
A1 - Absent	Absent	
A2 – 90-220mm	10YR7/2 (dry) bleached loam fine sandy. No mottles. Very hard set, large subangular blocky peds, at least 100mm diameter. Puggy when wet. No stones, no segregation. pH 5.5. Abrupt boundary.	
B1 – 220-730mm	10YR4/2 (moderately moist) medium heavy clay. Rare stones, no segregations; faint (2-10%) dull orange mottle. Moderate pedality, rough faced peds, subangular blocky. Roots present. pH 6.0. Clear boundary.	
B2 – 730-950mm	7.5YR4/6 sandy loam (fine sand fraction); 10-20% faint dull orange mottle. Occasional charcoal, fine roots present. Fine gravel/ pebbles (2-10%). Moderate pedality, subangular blocky, rough faced peds. pH 5.5. Layer continues.	

Plates 4.11 and **4.12** illustrate the landscape context of the MOCO Site 32 and the soil materials that are present in the profile.

Table 4.6 Profile characteristics, MOCO Site 34

MOCO 34		E 323648.4932 N 6410426.0724 Recorded 22 July 2015
<p>Hillcrest profile. Slope 0.6%.</p> <p>Underlying geology is lithic sandstone and conglomerate.</p> <p>Vegetation – Bull oak regrowth with scattered spotted gum and ironbark (regrowth), grassy understory</p>		
Profile characteristics		
A1, 0-130mm	10YR4/2 (slightly moist), whole coloured sandy loam. Sand fraction is coarse. pH 5.5. Weak pedality with rough faced subangular blocky peds, 20-50mm. No segregations. Abrupt boundary.	
A2, 130-370mm	Bleached, 10YR6/2 (slightly moist), whole coloured sandy loam. Sand fraction is coarse and the material is 90% gravel. Gravel material is weathered pebbles from conglomerate, ranging in size from 2-6mm to 20-60mm. pH 5.5. Massive structure with earthy fabric. No segregations. Abrupt boundary.	
C, 370-500mm	<p>Weathered bedrock (mottled weathered sandstone); texture sandy clay loam; sand fraction is coarse, light medium clay. Distinct orange mottle, 20-50% of soil material. pH 5.5.</p> <p>Base of pit.</p>	

Plates 4.13 and 4.14 illustrate the landscape context of MOCO Site 34 and the soil materials that are present in the profile.

4.1.2 Results from check sites – profile form

A total of six check sites have been recorded in the VAA.

Three check sites (MOCO Site 4, MOCO Site 7 and MOCO Site 25(B)) are from soil sampling undertaken in 2014.

Check sites MOCO Site 26, MOCO Site 27 and MOCO Site 33 were collected during the July 2015 survey.

Summary profile information for these check sites are detailed in **Table 4.7**.

Table 4.7 Summary of check site characteristics

Site Details	Profile character
MOCO Site 26 E 323313 N 6411763 Upper slope	<p>Groundcover 90%, native grass and forbs.</p> <p>A1, 0-120mm. 10YR 4/2 (slightly moist); Sticky sandy loam, (fine sand), pH 5.5. Clear boundary.</p> <p>A2, 120-240mm. 10YR 4/4 (moist); sandy loam, gritty sand with conglomerate pebbles. pH 5.5. Clear boundary.</p> <p>B, 240-400mm+. 10YR 5/4 (moist); clay sand, gritty with coarse sand and conglomerate pebbles. pH 5.5. Auger hole ends in weathered sandstone.</p>
MOCO Site 27 E 323633 N 6411387 Undulating mid to lower slope	<p>Ground cover 90%, native grasses and forbs.</p> <p>A1, 0-120mm. 10YR 4/2 (moist); Loam fine sandy, sharp boundary.</p> <p>A2, 120-170mm. 10YR 6/3 (moist) (bleached), sticky, light sandy clay with abundant stones to 20mm. pH 6.0. Sharp boundary.</p> <p>B, 170-450mm. 10YR 5/4 (moist) with diffuse orange mottles (10YR5/6). Medium heavy clay (sticky) strongly pedal. pH 6.0</p> <p>Soil continues, however further sampling could not be obtained due to equipment refusal</p>
MOCO Site 33 E 323143 N 6410479 Crest	<p>Iron bark and bull oak woodland; tussock grass.</p> <p>A1, 0-80mm 10YR3/2 (moist); clay loam fine sandy. Fine roots throughout. Bioturbation across sharp boundary.</p> <p>A2, 80-210mm. 10YR 5/3 (moist). Sandy loam, puggy, with rare weathered stones. Would set hard if dry. Apedal massive. pH 6.0. sharp boundary.</p> <p>B, 210-250mm. 10YR 4/3 (moist), not mottled. Light medium clay, fine sandy. Occasional charcoal fragments and burnt roots. Rare weathered stones. pH 7.0. Soil continues, however further sampling could not be obtained due to equipment refusal.</p>
MOCO Site 25(B) E 323944 N 6410884 Midslope	<p>A1, 0-170mm; 10YR3/3 (moist); loam. Fine roots throughout. Abrupt boundary.</p> <p>A2, 170-220mm; 10YR3/4 (moist); fine sandy loam. Gradual boundary.</p> <p>Gravel Layer, 220-550mm; 10YR 5/3 (moist); clay – medium. Gravel layer, very little soil. Gradual boundary, no roots, slightly acid pH (5.5).</p> <p>B2/B3, 550->750mm; 10YR 6/3 (moist); clay – heavy. Heavy clay with mottles. No roots, distinct orange mottles, slightly acid pH (5.5).</p>

Site Details	Profile character
MOCO Site 4 E 323443 N 6411289 Midslope	A1 , 0-60mm; 10YR3/2 (moist); fine sandy loam. Sharp boundary, common fine roots. A2 , 60-120mm; 10YR4/2 (moist); fine sandy clay loam. Sharp boundary, common fine roots. B1 , 120-350mm; 10YR4/4 (moist); medium clay. Gradual boundary, few fine roots. B2 , 350-750mm; 10YR5/4 (moist); medium clay. No roots.
MOCO Site 7 E 323912 N 6410593 Open depression	A1 , 0-120mm; 10YR3/3 (moist); fine sandy loam. Diffuse boundary, few fine roots present. A2 , 120-220mm; 10YR5/3 (moist); fine sandy loam. Gradual boundary, few medium roots. B1 , 220-550mm; 10YR5/4 (moist); fine sandy loam. No roots B2 , 550-650mm; 10YR6/4 (moist); medium-heavy clay. No roots.

Plates 4.15 to 4.17 illustrate the landscape context of Check Sites 26, 27 and 33 profiles.

4.1.3 Laboratory test results

Laboratory test results from the samples taken from the detailed soil test pits are included in **Appendix 1**¹.

4.1.3.1 Assessment against BSAL criteria

As discussed in **Section 2.0**, the land within the VAA in general meets the first six landscape and soil BSAL criteria, related to slope and stoniness. As noted earlier, there are two areas which exceed the 10% slope criteria. The critical parameter for the remaining areas within the VAA is soil fertility. The entire VAA is mapped as having low or moderately low fertility at the regional scale and the purpose of the soil laboratory testing was to confirm the OEH fertility mapping.

Table 4.8 presents data relevant to the fertility of the soils, based on multiple samples from A and B horizons. Included in this table are:

- Soil pH (1:5 soil: water suspension in accordance with the method 4A1 in Rayment and Lyons 2011).
- Salinity (ECe).
- Soil chemistry (ESP and Ca:Mg ratio).

Criteria for these indicators of low fertility listed in **Table 4.8** are taken from Table 4 of the Interim Protocol. Shaded cells in **Table 4.8** indicate sampling results that do not meet BSAL soil fertility criteria.

¹ It is noted that laboratory sampling result detail the site numbers as D3, D4, D5, D6, D7 and D9. However, eDIRT only allows sample numbers without letters and sites with these numbers already exist for the Project on SALIS. As such, these numbers have been changed to 28, 29, 30, 31, 32 and 34 respectively. These changes have been noted in **Appendix 1**.

Table 4.8 Soil fertility results against criteria¹

Site and horizon ID	pH	ECe*	ESP (%) [#]	Ca:Mg ratio [#]	Does this meet the BSAL requirements?
	Threshold values In water 5.0-8.9	<4dS/m	<15	>0.1	
Site 28: Hillcrest					
Site 28 (A1) 0-100mm	5.4	0.01	14	0.42	Yes
Site 28 (A2) 150-300mm	5.7	<0.01	17	0.08	No
Site 28 (A3) 300-350mm	6.0	<0.01	21	0.13	No
Site 28 (B) 350-450mm	5.7	0.04	20	0.07	No
Site 28 Discussion: While the first 100 mm of Site 28 meets the soil chemistry criteria for BSAL, the Interim Protocol requires consistent complying characteristics for fertility for the upper 600mm, and chemical barrier information for the full 750mm of the profile. Below the upper 100mm of Site 28, samples fail the ESP and/or the Ca:Mg ratio requirements. Profile discontinued on bedrock at 670mm. This soil is not BSAL					
Site 29: Lower slope					
Site 29 (A0) 0-100mm	5.3	0.01	11	1.07	Yes
Site 29 (A1) 100-150mm	6.0	<0.01	23	0.58	No
Site 29 (A2) 150-300mm	6.7	0.03	27	0.21	No
Site 29 (A3) 300-450mm	6.7	0.13	29	0.11	No
Site 29 (B1) 450-600mm	6.4	0.27	30	0.07	No

Site and horizon ID	pH	ECe*	ESP (%) [#]	Ca:Mg ratio [#]	Does this meet the BSAL requirements?
	Threshold values In water 5.0-8.9	<4dS/m	<15	>0.1	
Site 29 (B2) 600-750mm	6.0	0.35	32	0.07	No
Site 29 Discussion: While the first 100 mm of Site 29 meets the criteria for BSAL, the Interim Protocol requires consistent complying characteristics for fertility for the upper 600mm, and chemical barrier information for the full 750mm of the profile. In consideration of this requirement, Site 29 does not meet the criteria for BSAL, in regard to ESP and the Ca:Mg ratio, across all samples. This soil is not BSAL					
Site 30: Low gradient lower slope					
Site 30 (A1) 0-100mm	5.7	0.01	13	1.29	Yes
Site 30 (A2(1)) 100-150mm	6.0	<0.01	17	0.60	No
Site 30 (A2(2)) 300-450mm	6.3	0.01	23	0.24	No
Site 30 (B(1)) 450-600mm	5.3	0.16	28	0.03	No
Site 30 (B2) 600-750mm	5.5	0.11	24	0.04	No
Site 30 Discussion: While the top 100 mm of Site 30 meets the criteria for BSAL, the Interim Protocol requires consistent complying characteristics for fertility for the upper 600mm, and chemical barrier information for the full 750mm of the profile. In consideration of this requirement, Site 30 does not meet the criteria for BSAL, in regard to ESP and the Ca:Mg ratio, across all samples. This soil is not BSAL					

Site and horizon ID	pH	ECe*	ESP (%) [#]	Ca:Mg ratio [#]	Does this meet the BSAL requirements?
	Threshold values In water 5.0-8.9	<4dS/m	<15	>0.1	
Site 31: lower slope/flat					
Site 31 (A1) 0-100mm	6.1	0.03	9	0.29	Yes
Site 31 (A2) 100-300mm	6.6	0.01	18	0.16	No
Site 31 (B1) 300-450mm	5.8	0.61	22	0.15	No
Site 31 (B2) 450-609mm	5.1	0.03	36	0.13	No
Site 31 Discussion: While the upper 100 mm of Site 31 meets the criteria for BSAL, the Interim Protocol requires consistent complying characteristics for fertility for the upper 600mm, and chemical barrier information for the full 750mm of the profile. In consideration of this requirement, Site 31 does not meet the criteria for BSAL, in regard to ESP, across all samples. <i>This sol is not BSAL</i>					
Site 32: mid slope, A1 horizon lost to sheet erosion					
Site 32 (A0) 0-100mm	5.9	0.05	17	0.60	No
Site 32 (A2) 100-150mm	7.2	0.36	28	0.17	No
Site 32 (B(1)) 150-300mm	7.1	0.49	26	0.08	No
Site 32 (B(2)) 300-450mm	7.1	0.50	30	0.06	No
Site 32 (B(3)) 450-600mm	6.3	0.32	31	0.04	No
Site 32 (B(4)) 600-750mm	6.2	0.30	32	0.04	No

Site and horizon ID	pH	ECe*	ESP (%) [#]	Ca:Mg ratio [#]	Does this meet the BSAL requirements?
	Threshold values In water 5.0-8.9	<4dS/m	<15	>0.1	
Site 32 Discussion: BSAL soils must comply with the fertility criteria to a depth of 600mm and chemical barrier criteria to 750mm. In consideration of this requirement, Site 32 does not meet the criteria for BSAL, in regard to ESP and the Ca:Mg ratio, at any depth in the profile. <i>This soil is not BSAL</i>					
Site 34: ridge crest					
Site 34 (A1) 0-100mm	4.9	0.01	18	0.33	No
Site 34 (A2) 100-250mm	5.4	<0.01	21	0.17	No
Site 34 (C) 300+mm	5.4	0.05	16	0.11	No
Site 34 Discussion: BSAL soils must comply with soil fertility requirements to a depth of 600mm and require an effective rooting depth to a chemical barrier greater than or equal to 750 mm. In consideration of this requirement, Site 34 does not meet the criteria for BSAL, in regard to ESP at any depth in the profile. Bedrock was encountered in the base of the pit, at 500mm. <i>This soil is not BSAL.</i>					

¹ Highlighted cells indicate failure to meet BSAL criteria.

* Soil Conservation Laboratory results (refer to **Appendix 2**) adjusted using the conversion factors noted in table 3 on Page 25 of the Interim Protocol.

³ Soil Conservation laboratory analysis and results (refer to **Appendix 2**) followed the method set out in Table 5 on page 26 of the Interim Protocol, for soils with pH in the range 5.1 to 7.9.

4.2 Soil classification

Soils at detailed sites must be classified using the Australian Soil Classification (ASC) to family level (Isbell, 1996).

Soils from check sites must be classified using the ASC to suborder level. In both cases, a Great Soil Group Class may also be allocated. Northcote soil profile factual classifications are also provided.

Table 4.9 provides a summary of the soil materials, Northcote profile forms, ASC classes and Great Soil Group for the six detailed soil profiles.

Table 4.9 Soil classification – Detailed Sites

Site ID	Soil materials	Northcote PPF	ASC suborder	ASC family
MOCO Site 28 Detailed site	Strong texture contrast. A2 horizon bleached and hard setting. pH acid throughout. B horizon mottled. ESP20; pH5.7; Ca:Mg 0.07	Db2.41	Brown Sodosol	Mottled mesonatric
MOCO Site 29 Detailed site	Strong texture contrast. A2 horizon hard setting, not bleached. Ph acid throughout. B horizon dull orange mottle. ESP30; pH 6.4; Ca:Mg 0.07	Db2.21	Brown sodosol	Mottled hypernatric
MOCO Site 30 Detailed site	Strong texture contrast. A1 separates from rest of profile. A2 gravelly, not bleached, hard setting. B horizon mottled orange. ESP24; pH =5.5; Ca:Mg<0.1	Db2.21	Brown sodosol	Mottled mesonatric
MOCO Site 31 Detailed site	Strong texture contrast. A2 sets hard, not bleached. Seepage at base. B horizon has dull orange mottle. ESP22-36 (B); pH 5.8; Ca:Mg 0.13	Db2.21	Brown Sodosol	Mottled mesonatric
MOCO Site 32 Detailed site	Strong texture contrast. A0 lifts off. A1 eroded. A2 bleached and hard setting. B horizon has faint dull orange mottle. ESP30; Ca:Mg<0.1; pH >5.5	Dy3.41	Yellow sodosol	Hypernatric
MOCO Site 34 Detailed site	Strong texture contrast. Shallow profile over sandstone bedrock. Bleached hardsetting A2 over clay from weathering sandstone, with distinct mottle. ESP16; pH <5.5; Ca:Mg>0.1	Db2.41	Brown kurosol	Natric

Table 4.10 provides a summary of the soil materials, Northcote profile forms, ASC classes and Great Soil Group for the six check sites.

Table 4.10 Soil classification – Check Sites

Site ID	Soil materials	Northcote PPF	ASC suborder	ASC family
Site MOCO 26 E 323485 N 6412667	Strong texture contrast, A2 not bleached. B horizon whole coloured. pH acid throughout (A1 and A2 5.5, B 6.0).	Db1.21	Likely to be as for 30 Brown Sodosol	Expect Mesonatric
Site MOCO 27 E 323633 N 6411387	Strong texture contrast, A2 bleached. B horizon mottled. pH 5.0 in A1 and 5.5 in A2 and B1. Shallow soil material over sandstone	Db2.41	Likely to be as for 28 Brown Sodosol	Expect Mottled mesonatric
Site MOCO 33 E 321034 N 6409056	Strong texture contrast. A2 slightly bleached, hard setting, dispersible; B horizon not mottled. pH acid throughout (A1 5.5, A2 6.0, B 6.5).	Dy2.21	Likely to be as for 32 Brown sodosol	Expect hypernatric
MOCO Site 4 E 323443 N 6411289	These soils have well drained sandy loam to loam topsoils with a strong texture contrast at 0.2 to 0.35 metres to a poorly drained, strongly structured sodic clay B horizon which is not strongly acidic. ESP7, pH 6.0, Ca:Mg >0.1	Dy2.21	Brown Sodosol	Expect at least mesonatric
MOCO Site 7 E 323912 N 6410593	The soil profile is characterised by moderately drained, weakly structured fine sandy loam topsoil over heavy clay B horizon. ESP6, pH 5.7, Ca:Mg >0.1 (A horizon data only). (5.5 in B)	Db1.21	Brown Chromosoll	n/a
MOCO Site 25B E 323944 N 6410884	The soil profile is characterised by well drained, moderately structured sandy loam topsoil overlying a gravel layer which is overlying a massive clay. ESP4, pH 5.9, Ca:Mg >0.1. (A horizon data only). (5.5 in B)	Dy3.21	Brown Chromosol	n/a

4.2.1 Mapping of soil types

Figure 4.1 provides information in regard to the soils in the VAA including:

- Soil profile types
- Soil map units, within the soil landscape, including variants from crest to lower slope.

4.3 Mapping of BSAL

While Item 9.6.3 of the Interim Protocol requires the preparation of a map showing BSAL in relation to the VAA. Based on existing regional scale soil mapping and preliminary site inspection, no BSAL was predicted to occur within the VAA.

The detailed soil profile descriptions and soil analysis confirm that no BSAL is present within the VAA, with all soils failing to meet the BSAL fertility criteria.

As no BSAL has been identified within the VAA nor been recorded at the regional scale within a radius of 2.5 kilometres; no map of BSAL has been developed for this application.

5.0 Conclusion

BSAL verification using both the Upper Hunter SRLUP assessment methodology and the OEH Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land identified there was no BSAL within the VAA, with all soils failing to meet the criteria of adequate soil fertility.

6.0 References

Department of Planning and Infrastructure (DP&I). (2012). *Strategic Regional Landuse Plan for the Upper Hunter*.

Isbell, R.F. (1996). *Australian Soil Classification*. CSIRO Publishing, Australia.

Kovac, M. and Lawrie, J.M. (1991). *Soil Landscapes of the Singleton 1:250,000 Sheet*. Soil Conservation Service of NSW.

NSW Government. (2015). *Strategic Regional Land Use Policy – Guideline for Agricultural Impact Statements at the Exploration Stage*.

Office of Environment and Heritage (OEH) and Office of Agricultural Sustainability and Food Security (OASFS). (2013). *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land*.

Umwelt (Australia) Pty Limited (Umwelt). (2015). *Mount Owen Continued Operations Project: Soil Assessment*.

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