global environmental solutions

# Biophysical Strategic Agricultural Land Assessment

## Integra Underground

## LW15 – LW20 Modification

Report Number 630.12151

November 2017

HV Coking Coal Pty Ltd

Version: Draft

# Biophysical Strategic Agricultural Land Assessment

# Integra Underground

# LW15 – LW20 Modification

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road New Lambton NSW 2305 Australia

(PO Box 447 New Lambton NSW 2305 Australia)
T: 61 2 4037 3200 F: 61 2 4037 3201
E: newcastleau@slrconsulting.com www.slrconsulting.com



**DOCUMENT CONTROL**

| Reference | Status | Date | Prepared | Checked | Authorised |
|---|---|---|---|---|---|
| 630.12151 | Draft | August 2017 | Murray Fraser | Clayton Richards | |
| 630.12151 | Final | November 2017 | Murray Fraser | Clayton Richards | Clayton Richards |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# Table of Contents



**TABLES**

# Table of Contents

# 1 INTRODUCTION

The Integra Underground Mine is located approximately 12 km to the north-west of Singleton, in the Singleton Local Government Area. HV Coking Coal Pty Ltd (HVCC) (a wholly owned subsidiary of Glencore Coal Australia Pty Limited (Glencore) currently holds approval under PA 08_0101 (as modified) to conduct longwall mining operations at a rate of up to 4.5 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal mine until the end of 2035.

PA 08_0101 provides approval for the mining of 17 longwall (LW) panels within the Middle Liddell Seam, along with various other mining areas within the Hebden and Barrett coal seams.

LWs 1 to 12 within the Middle Liddell Seam were previously mined by the former owners (Vale Australia Pty Limited) prior to the mine being placed in Care and Maintenance in May 2014. HVCC acquired all of the assets associated with the Integra Underground Mine in late 2015 and intends to mine LW13 and LW14 during 2017 and 2018.

HVCC proposes modifications to the approved Integra Underground mine plans to facilitate a greater recovery of coal from the Middle Liddell Seam within the mining tenements held by HVCC and neighbouring mines also owned by Glencore. The mine plan modifications would entail:

- Realignment of the main headings following on from LW14 to facilitate the proposed extension to longwall panel length;
- Extensions to the lengths of the approved LW15 to LW17; and
- Mining of an additional three LW panels (LW18 to LW20).

The proposed layout of LW16 to LW20 will extend beyond the Integra Underground Project Area as currently approved under PA 08_0101. The extended longwalls occur within the approved Mount Owen Coal open cut Project Area and Mount Owen Coal Disturbance Area (as recently approved under SSD-5850) and the approved Glendell Project Area and Glendell Disturbance Area (as approved under DA 80/952). Accordingly, the land overlying LW15 to LW20 has either previously been disturbed by surface mining activities or will be subject to approved surface mining activities.

Hansen Bailey engaged SLR Consulting Australia Pty Ltd (SLR) on behalf of HVCC to undertake a Biophysical Strategic Agricultural Land (BSAL) Assessment to support the Project.

## 1.1 Study Area

The Assessment Area for the BSAL Assessment was the LW15 – LW20 footprint of the LW15 – LW20 extraction area plus a 100 metre buffer, totalling 243 hectares (**Figure 1**). None of the Assessment Area is mapped as BSAL according to the NSW Government (DP&I, 2012).

The majority of the Assessment Area has been previously disturbed by mining activities (**Figure 2**). An area comprising 24 hectares inside the rail loop remains undisturbed and is the subject of this BSAL Assessment (the Study Area).

## 1.2 Legislation and Standards

### 1.2.1 Interim Protocol for Site Verification and Mapping of BSAL

In April 2013, the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Interim Protocol) ((Office of Environment & Heritage (OEH) and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (DPI-OASFS), 2013)) was released by the NSW Government. The Interim Protocol outlines the process for seeking verification of whether or not land mapped as BSAL meets the established BSAL criteria. The *State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013* (the 2013 Mining SEPP amendment) requires certain types of developments to verify whether the proposed site is on BSAL.

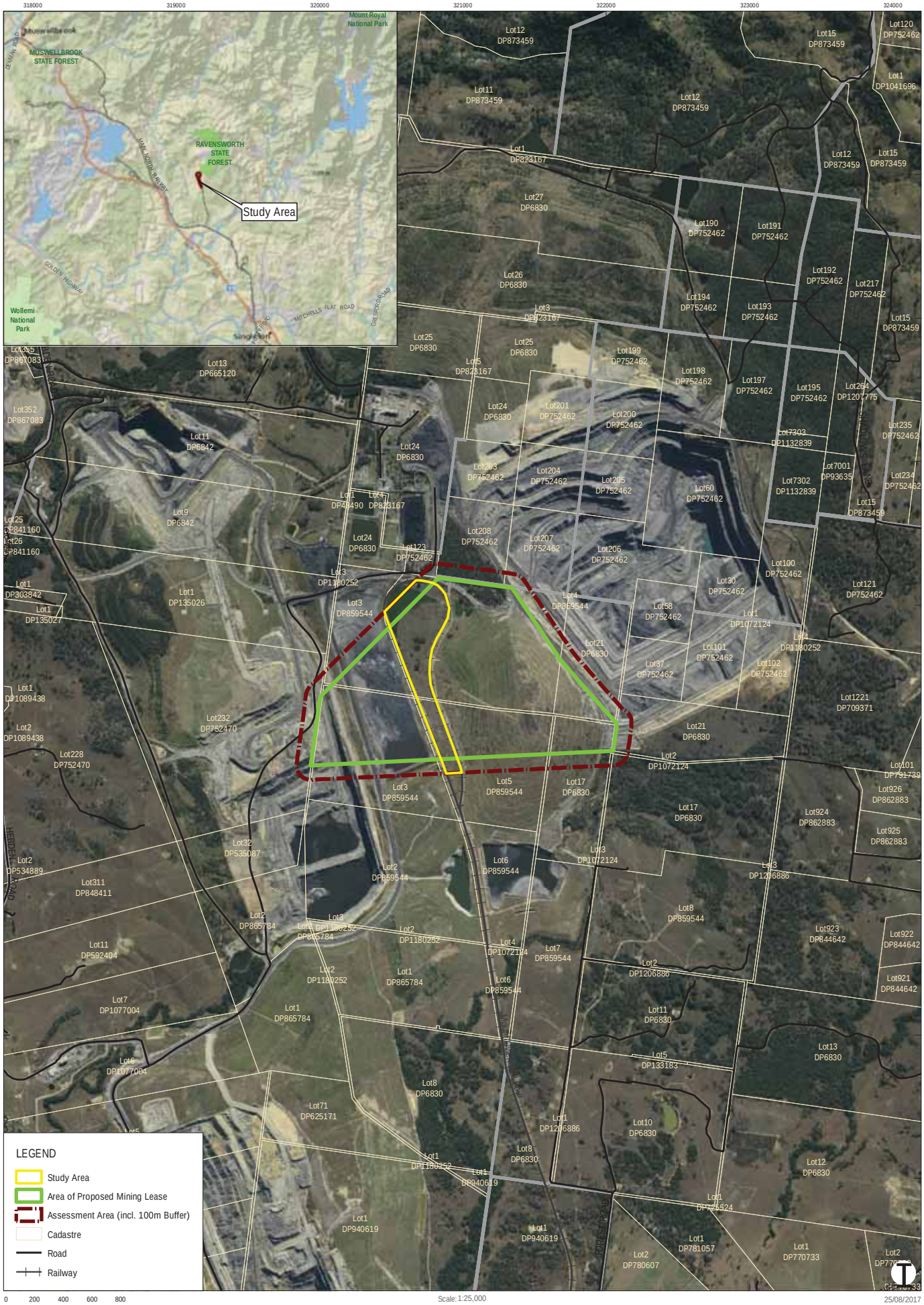
The purpose of the Interim Protocol is to assist proponents and landholders to understand what is required to identify the existence of BSAL. It outlines the technical requirements for the on-site identification and mapping of BSAL.

All figures within this assessment have been presented at 1:25,000 scale, as per the Interim Protocol. Zoomed figures at a scale of 1:10,000 are presented in **Appendix A**.

### 1.2.2 Assessment Standards

The key standards for this assessment include:

- Interim Protocol.
- Australian Soil Classification (ASC) system (Isbell, 2002).
- Guidelines for Surveying Soil and Land Resources (NCST, 2008).
- Australian Soil and Land Survey Field Handbook (NCST, 2009).



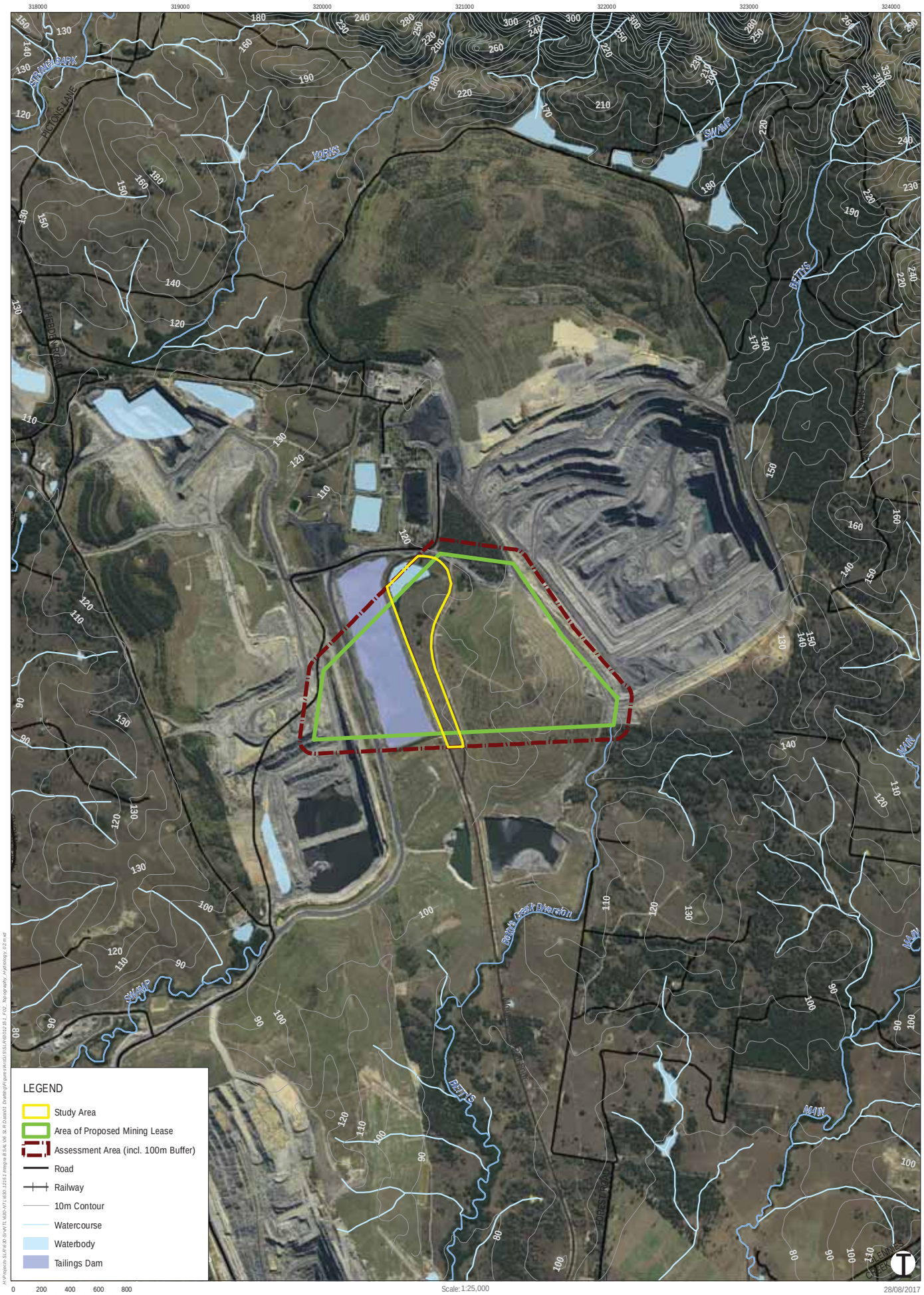

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Study Area

FIGURE 1




Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Topography and Hydrology

**FIGURE 2**

# 2 METHODOLOGY

The site verification methodology for the Study Area has been undertaken based on the Interim Protocol; including the following steps:

1. Identify the project area (termed Study Area in this report) which will be assessed for BSAL;
2. Confirm access to a reliable water supply;
3. Choose the appropriate approach to map the soils information;
4. Risk assessment; and
5. Field Soil Survey and BSAL Assessment.

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

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

The Interim Protocol requires that:

> *"The assessment area should include the entire project area and include at least a 100 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 Study Area for this BSAL Assessment is shown in **Figure 1**. The Study Area includes a 100 metre buffer surrounding the footprint of LW15 – LW20, and totals 243 hectares.

## 2.2 Step 2: Confirm access to a reliable water supply

The Interim Protocol requires that:

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

Representative rainfall data for the Study Area has been obtained from the nearest Bureau of Meteorology (BOM) weather station located at Singleton (Singleton STP 061397). The Singleton BOM Station has recorded an average annual rainfall of 677 millimetres (based on records from 2002 – present); therefore the Study Area meets the minimum average annual rainfall of 350 millimetres to have access to a reliable water supply.

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

The Interim Protocol states that:

> *"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."*

The Proponent has access to the majority of the Study Area.

## 2.4 Step 4: Risk assessment

The Interim Protocol states that:

> *"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."*

The Project consists of underground mining of six longwall panels. SLR has assessed the following potential impacts of the project activities within the Study Area on agriculture:

- Consequence: Level 5 – Very minor damage and minor impact to agricultural resources or industries.

- Probability: B – Likely. Known to occur or it has happened.

The risk matrix result was B5 which is considered a low risk. The Study Area therefore required an inspection density of 1:100,000.

## 2.5 Step 5: Field Soil Survey and BSAL Assessment

The field survey for the BSAL Assessment was undertaken on July 20th 2017 by SLR's Associate Agronomist, Murray Fraser, while Clayton Richards (CPSS 2) was responsible for technical review of the BSAL assessment.

## 2.6 Field Soil Survey Methodology

For soil to be classified as BSAL it must meet the criteria outlined in the flow chart shown in **Diagram 1**. If any criteria is not met (except for those outlined in step 5 or step 6), the site is not BSAL and there is no need to continue the assessment.

The design of the soil survey program was developed by following a process of applying the BSAL methodology as a desktop exercise in the first instance to identify any areas that would obviously not meet the criteria (termed exclusion zones). The field survey program was then developed to ensure that areas of relatively higher likelihood of meeting BSAL criteria were targeted for field analysis.

### 2.6.1 Exclusion Zones

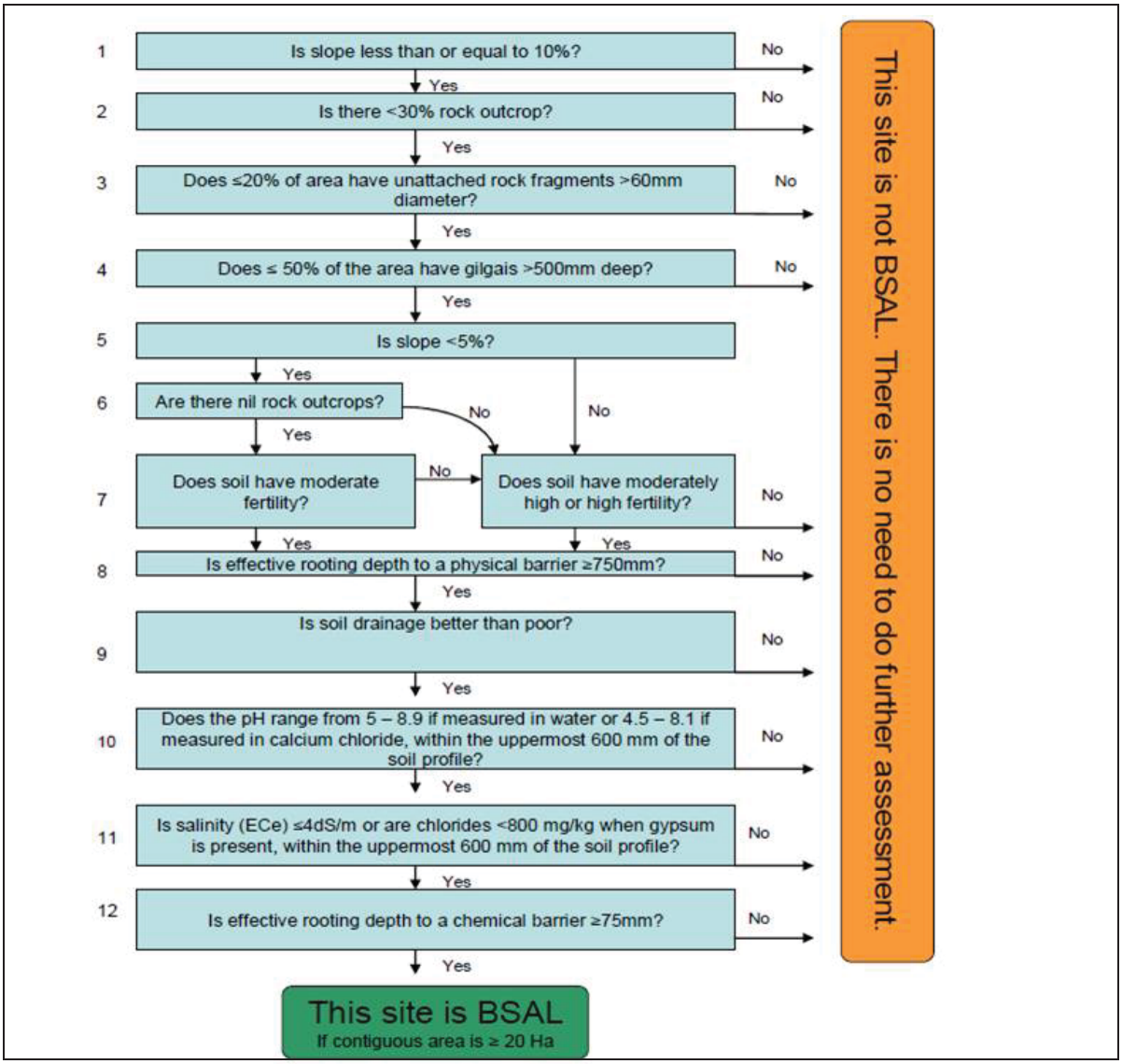
Using aerial imagery and groundtruthing during the field survey, 205 hectares within the Assessment Area was excluded from the soil survey due to being previously disturbed by open-cut mining activities (**Figure 4**). A further 2 hectares in the south-east of the Assessment Area was excluded due to it already being approved for disturbance under Mount Owen Complex's Development Consent SSD-5850 (**Figure 4**).

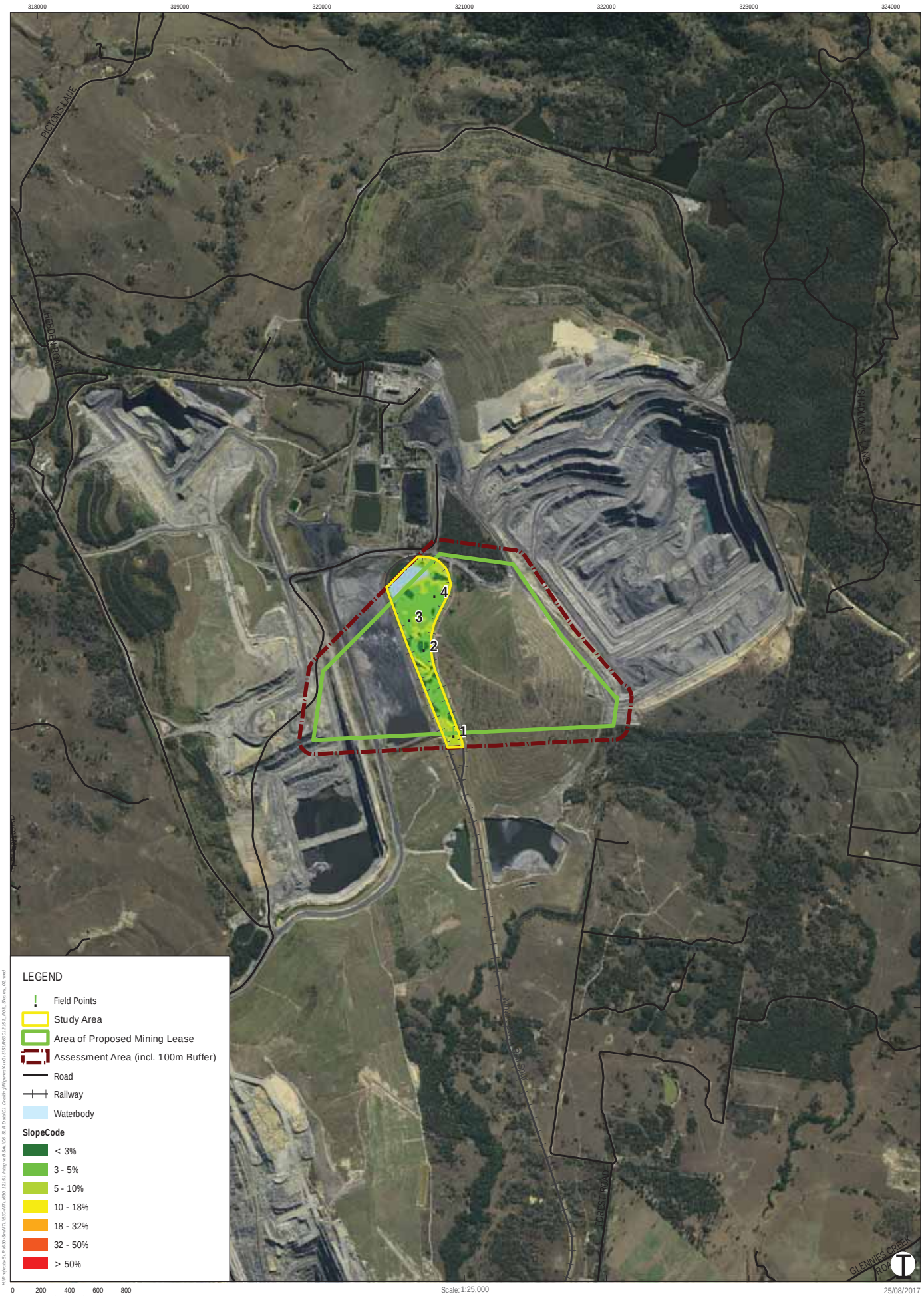
Subsequently, any land that did not meet the minimum contiguous 20 hectares to be classified as BSAL was also excluded. In total, 8 hectares was determined not to meet the Interim Protocol BSAL methodology criteria within the Study Area (**Figure 4**). Land contiguous to the Study Area was taken into consideration when classifying areas of land to be less than 20 contiguous hectares.

Land greater than 10% slope (**Figure 3**) within the Study Area was identified using topographical data derived from LIDAR. Areas with slope greater than 10% slope were excluded from the soil survey program. In total, 1 hectare was determined not to meet the BSAL methodology Criteria 1 (**Figure 4**). The Slope Analysis methodology is provided in **Appendix B**. Within the Study Area a large dam covering 3 hectares was identified, this was also excluded from the soil survey program.

In summary, 219 hectares was determined not to meet the BSAL methodology criteria within the Assessment Area. This reduced the land to be assessed by the field soil survey program to 24 hectares (**Table 1** and **Figure 4**), described as the Study Area.

**Diagram 1 BSAL Soil Laboratory Analysis Parameters**





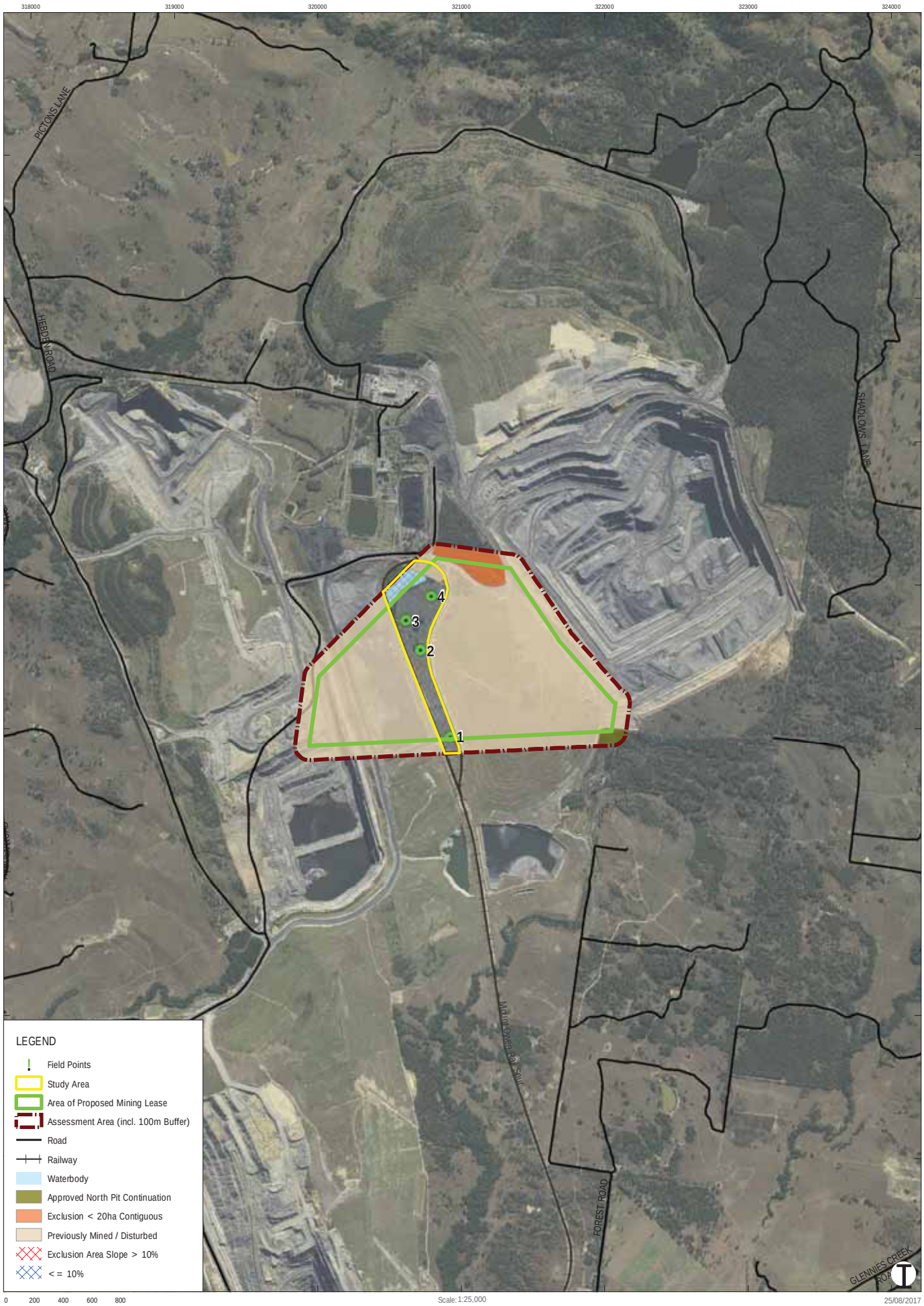

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Slope Analysis

**FIGURE 3**




Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Exclusion Areas

**FIGURE 4**

### 2.6.2 Soil Survey Density

To satisfy the Interim Protocol requirements, the field soil survey program was comprised of four detailed sites, as shown on **Figure 4**. A breakdown of the soil survey density, as per Interim Protocol requirements, is provided in **Table 1**.

**Table 1 Soil Survey Density**

| Survey Area | Hectares | Survey Scale | Required Sites | Sites Completed |
|---|---|---|---|---|
| < 10% slope & > 20 ha | 24 | 1:100,000 | 1* | 4 |
| Exclusion > 10% Slope | 1 | Nil | Nil | Nil |
| Exclusion < 20 ha | 8 | Nil | Nil | Nil |
| Exclusion waterbody | 3 | Nil | Nil | Nil |
| Previously mine disturbed | 205 | Nil | Nil | Nil |
| Approval for disturbance | 2 | Nil | Nil | Nil |
| **Total** | **243** | **1:100,000** | **1*** | **4** |
| ***** A minimum of 3 observation sites per Soil Unit are required according to the Interim Protocol | | | | |

### 2.6.3 Soil Survey Observation Types

*Detailed Sites*

Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST, 2009). Each soil-profile exposure was excavated by a hydraulic soil corer to either a depth of 1.0 metre, to equipment refusal, or to bedrock. After assessment, soil core holes were backfilled with the remaining soil. Detailed soil profile morphological descriptions were prepared to record the information specified in the Interim Protocol.

Samples were sent to the Scone Research Centre (NSW, Australia) for analysis of the suite of parameters listed in **Table 2**. This laboratory is National Association of Testing Authority (NATA) accredited. Laboratory Soil Test Results Certificates of Analysis are contained in **Appendix C**.

**Table 2 BSAL Soil Laboratory Analysis Parameters**

| Laboratory Analysis | |
|---|---|
| • Electrical Conductivity (EC)<br>• pH (1:5 Water & $CaCl_2$)<br>• Total Cation Exchange & Exchangeable Cations | • Cation Exchange Capacity (CEC)<br>• Particle Size Analysis<br>• Munsell Colour |
| | |

Soil salinity data was determined through measurement of the electrical conductivity (EC) of soil:water (1:5) suspensions. These values are converted to the EC of a saturated extract (ECe) based on soil texture in accordance with the Interim Protocol.

*Check Sites*

Check sites are mapping observations examined in sufficient detail to allocate the site to a specific soil type and map unit. Due to the high number of detailed sites completed and laboratory assessed, no check sites were completed in this assessment.

# 3 SOILS ASSESSMENT

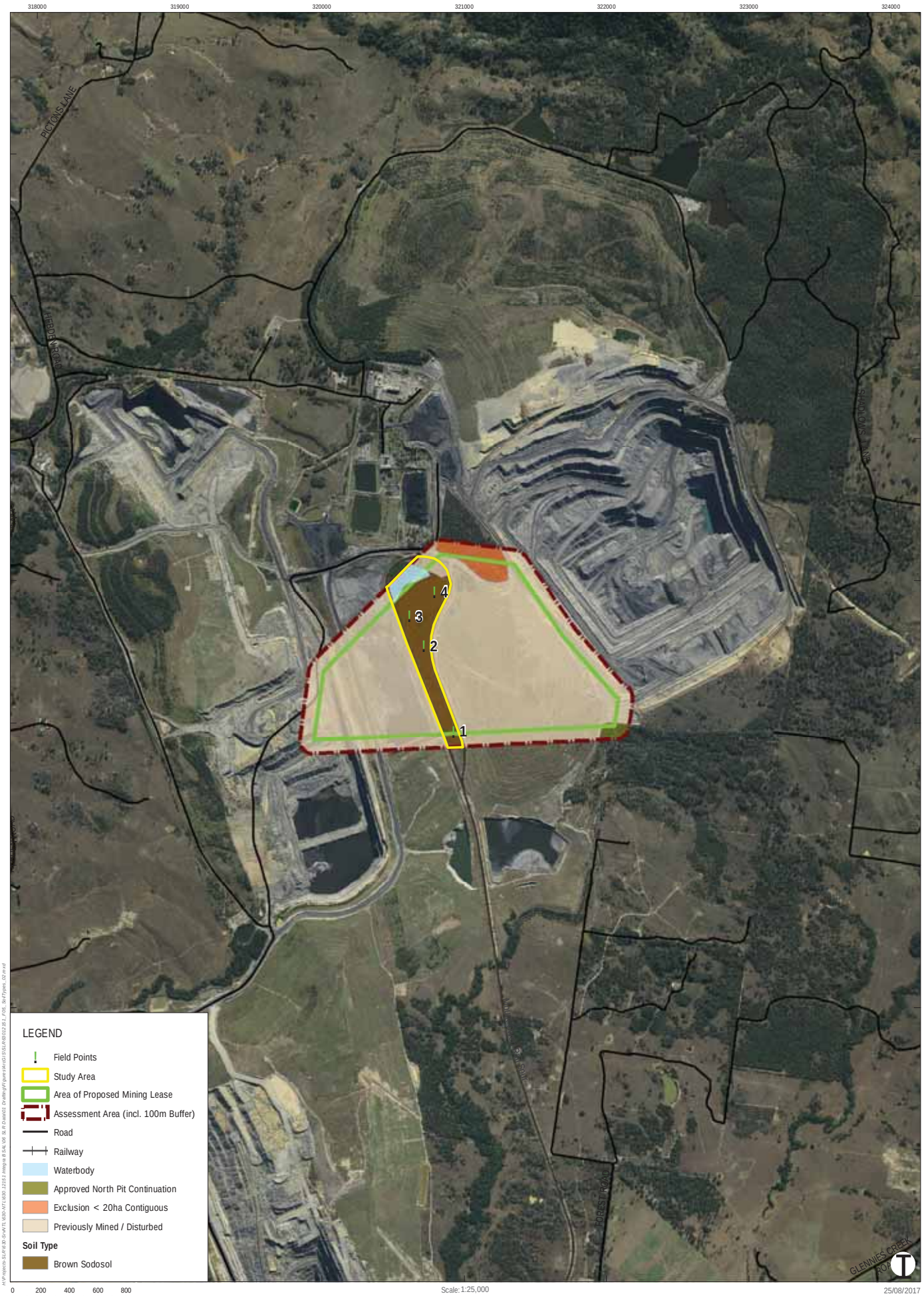
In accordance with the Interim Protocol, a soil mapping unit (Soil Unit) may contain some soil variation, but will typically only contain a single dominant soil type. The dominant soil type will comprise greater than 70% of the Soil Unit. Therefore, a Soil Unit may contain a dominant soil type as well as subdominant and/or soil variants. When a Soil Unit does not have a clear dominant soil type, soil variation must be accepted.

Within the Study Area, one Soil Unit has been identified based on the dominant soil type, a Brown Sodosol (**Table 3** and **Figure 5**). The Soil Unit contains a minimum of three detailed sites in compliance with the Interim Protocol.

**Table 3 Soils Assessment Summary**

| Soil Unit | Dominant Soil Type | Area | Survey Type | Site Number |
|---|---|---|---|---|
| 1 | Brown Sodosol | 24 Hectares | Detailed | 1, 2, 3, 4 |
| | | | Check | Nil |
| | | | | |

All four assessed soil profiles from Soil Unit 1 are described in **Section 3.1**.




Scale: 1:25,000
GDA 1994 MGA Zone 56

25/08/2017
630.12151

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Soil Types

FIGURE 5

## 3.1 Soil Unit 1: Brown Sodosol

Soil Unit 1 is a Subnatric Brown Sodosol. Sodosols are soils with a strong texture contrast between the A horizon and a sodic B horizon which is not strongly acidic. Within the Study Area Soil Type 1 showed little variance in physical and chemical parameters. Profiles were generally silty loam in the A horizons with a clear boundary to a light-medium or heavy clay in the B horizons. Four representative sites for Soil Unit 1 are described below.

**Table 4 Summary: Mesonatric Brown Sodosol (Site 1)**

| **Overview** | |
|---|---|
|  | |
| **Landscape Site 1** | |
| **ASC Name** | Mesonatric Brown Sodosol |
| **Representative Site** | Site 1 |
| **Survey Type** | Detail |
| **Dominant Topography** | Mid Slope Bench |
| **Dominant Land Use** | Native Grass Pasture |
| **Vegetation** | Casuarina, Barbed Wiregrass, Rhodes Grass |
| **Inherent Soil Fertility** | Moderately Low |
| **Slope** | 9% |
| **Verified** | Non-BSAL |

**Table 5 Profile: Mesonatric Brown Sodosol (Site 1)**

| Profile | Horizon / Depth (m) | Description |
|---|---|---|
|  | A1<br>0.0 – 0.10 | Dark brown (7.5YR 3/3) silty loam, weakly structured 5-20 mm blocky peds with weak consistence and a rough fabric.<br>Nil mottling, <5% gravel 5-10 mm, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10 |
| | A2<br>0.10 – 0.20 | Brown (10YR 4/3) silty loam, weakly structured 10-30 mm blocky peds with a moderate consistence and a rough fabric. Nil mottling, 5% gravel 5-10 mm, abundant fine roots. Well drained with an clear and even boundary. Sampled 0.10 – 0.20 |
| | B21<br>0.20 – 0.50 | Yellowish brown (10YR 5/6) heavy clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric.<br>30% distinct orange mottles; nil stone content; coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50 |
| | B22<br>+ 0.50 | Yellowish brown (10YR 5/6) heavy clay, strongly structured >40 mm subangular blocky peds with strong consistence and a rough fabric.<br>30% distinct grey mottles, nil stone content, few coarse roots. Poorly drained with layer continuing beyond sampling depth. Sampled 0.65 – 0.75 |

**Table 6 Chemical Parameters: Mesonatric Brown Sodosol (Site 1)**

| Layer | pH ($CaCl_2$) | | ESP | | ECe (1:5) | | Ca:Mg | |
|---|---|---|---|---|---|---|---|---|
| | Unit | rating | % | rating | dS/m | rating | ratio | rating |
| A1 | 6.2 | Slightly Acidic | 3.9 | Non-Sodic | 0.2 | Non-Saline | 0.98 | Low |
| A2 | 6.4 | Slightly Acidic | 5.9 | Non-Sodic | 0.7 | Non-Saline | 0.72 | Low |
| B21 | 7.5 | Mildly Alkaline | 17.0 | Strongly Sodic | 2.0 | Slightly Saline | 0.30 | Low |
| B22 | 7.9 | Moderately Alkaline | 22.6 | Strongly Sodic | 3.9 | Slightly Saline | 0.29 | Low |

**Table 7 Summary: Subnatric Brown Sodosol (Site 2)**

| Overview | |
|---|---|
|  | |
| **Landscape Site 2** | |
| **ASC Name** | Subnatric Brown Sodosol |
| **Representative Site** | Site 2 |
| **Survey Type** | Detail |
| **Dominant Topography** | Lower Slope Bench |
| **Current Land Use** | Native Grass Pasture |
| **Vegetation** | Casuarina, Barbed Wiregrass |
| **Inherent Soil Fertility** | Moderately Low |
| **Slope** | 3% |
| **Verified** | Non-BSAL |

**Table 8 Profile: Subnatric Brown Sodosol (Site 2)**

| Profile | Horizon / Depth (m) | Description |
|---|---|---|
|  | A1<br>0.0 – 0.10 | Dark brown (7.5YR 3/3) silty loam, weakly structured 10-20 mm blocky peds with weak consistence and a rough fabric.<br>Nil mottling, <5% gravel 5-10 mm, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10 |
| | B21<br>0.10 – 0.25 | Strong brown (7.5YR 4/6) light-medium clay, moderately structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct orange mottles;, nil stone content, coarse roots common. Moderately drained with a gradual and even boundary. 0.25 – 0.35 |
| | B22<br>0.25 – 0.60 | Yellowish brown (10YR 5/4) silty clay, strongly structured >40 mm subangular blocky peds with moderate consistence and a rough fabric.<br>30% distinct grey mottles; nil stone content; coarse roots common. Poorly drained with an abrupt and even boundary. Sampled 0.50 – 0.60 |
| | BC<br>+0.60 | Weathered parent material. Not sampled |

**Table 9 Chemical Parameters: Subnatric Brown Sodosol (Site 2)**

| Layer | pH ($CaCl_2$) | | ESP | | ECe (1:5) | | Ca:Mg | |
|---|---|---|---|---|---|---|---|---|
| | Unit | rating | % | rating | dS/m | rating | ratio | rating |
| A1 | 6.5 | Slightly Acidic | 3.3 | Non-Sodic | 0.2 | Non-Saline | 0.90 | Low |
| B21 | 6.9 | Neutral | 9.4 | Marginally Sodic | 0.6 | Non-Saline | 0.39 | Low |
| B22 | 7.0 | Neutral | 22.6 | Strongly Sodic | 3.6 | Slightly Saline | 0.29 | Low |
| | | | | | | | | |

**Table 10 Summary: Subnatric Brown Sodosol (Site 3)**

| Overview | |
|---|---|
|  | |
| **Landscape Site 3** | |
| **ASC Name** | Subnatric Brown Sodosol |
| **Representative Site** | Site 3 |
| **Survey Type** | Detail |
| **Dominant Topography** | Lower Slope Bench |
| **Dominant Land Use** | Native Grass Pasture |
| **Vegetation** | Casuarina, Wiregrass, Barbed Wiregrass |
| **Inherent Soil Fertility** | Moderately Low |
| **Slope** | 5% |
| **Verified** | Non-BSAL |

**Table 11 Profile: Subnatric Brown Sodosol (Site 3)**

| Profile | Horizon / Depth (m) | Description |
|---|---|---|
|  | A1<br>0.0 – 0.15 | Dark brown (7.5YR 3/3) silty loam, moderately structured 5-10 mm blocky peds with weak consistence and a rough fabric.<br>Nil mottling, <5% gravel 5-10 mm, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10 |
| | B21<br>0.15 – 0.30 | Strong brown (7.5YR 4/6) heavy clay, strongly structured 20-40 mm blocky peds with strong consistence and a rough fabric. 10% distinct orange mottles, nil stone content, coarse roots common. Moderately drained with a gradual and even boundary. Sampled 0.15 – 0.25 |
| | B22<br>0.30 – 0.65 | Yellowish brown (10YR 5/4) silty clay, moderately structured 20-40 mm blocky peds with strong consistence and a rough fabric.<br>30% distinct yellow mottles; <5% gravel 10-15 mm; coarse roots common. Poorly drained with an abrupt and even boundary. Sampled 0.50 – 0.60 |
| | BC<br>+0.65 | Weathered parent material. Not sampled |

**Table 12 Chemical Parameters: Subnatric Brown Sodosol (Site 3)**

| Layer | pH ($CaCl_2$) | | ESP | | ECe (1:5) | | Ca:Mg | |
|---|---|---|---|---|---|---|---|---|
| | Unit | rating | % | rating | dS/m | rating | ratio | rating |
| A1 | 6.4 | Slightly Acidic | 2.7 | Non-Sodic | 0.2 | Non-Saline | 0.85 | Low |
| B21 | 6.1 | Slightly Acidic | 6.7 | Marginally Sodic | 0.3 | Non-Saline | 0.37 | Low |
| B22 | 8.6 | Strongly Alkaline | 14.0 | Sodic | 3.2 | Slightly Saline | 0.42 | Low |

**Table 13 Summary: Subnatric Brown Sodosol (Site 4)**

| Overview | |
|---|---|
|  | |
| **Landscape Site 4** | |
| **ASC Name** | Subnatric Brown Sodosol |
| **Representative Site** | Site 4 |
| **Survey Type** | Detail |
| **Dominant Topography** | Mid Slope Bench |
| **Dominant Land Use** | Native Grass Pasture |
| **Vegetation** | Casuarina, Wiregrass |
| **Inherent Soil Fertility** | Moderately Low |
| **Slope** | 4% |
| **Verified** | Non-BSAL |

**Table 14 Profile: Subnatric Brown Sodosol (Site 4)**

| Profile | Horizon / Depth (m) | Description |
|---|---|---|
|  | A1<br>0.0 – 0.05 | Dark brown (7.5YR 3/2) loam, moderately structured 5-20 mm blocky peds with moderate consistence and a rough fabric.<br>Nil mottling, 10% gravel 5-15 mm; abundant fine roots. Well drained with an abrupt and even boundary. Sampled 0.0 – 0.05 |
| | B21<br>0.05 – 0.20 | Dark yellowish brown (10YR 4/4) light medium clay, moderately structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. Nil mottling, nil stone content, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.10 – 0.20 |
| | B22<br>0.20 – 0.50 | Dark yellowish brown (10YR 4/4) medium clay, strongly structured >40 mm blocky peds with strong consistence and a rough fabric.<br>20% distinct orange mottles; nil stone content; coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50 |
| | B23<br>+0.50 | Brown (7.5YR 5/4) clay loam, strongly structured >40 mm blocky peds with strong consistence and a rough fabric.<br>30% distinct orange mottles, nil stone content, few coarse roots. Poorly drained with layer continuing beyond sampling depth. Sampled 0.65 – 0.75 |

**Table 15 Chemical Parameters: Subnatric Brown Sodosol (Site 4)**

| Layer | pH ($CaCl_2$) | | ESP | | ECe (1:5) | | Ca:Mg | |
|---|---|---|---|---|---|---|---|---|
| | Unit | rating | % | rating | dS/m | rating | ratio | rating |
| A1 | 6.2 | Slightly Acidic | 2.4 | Non-Sodic | 0.2 | Non-Saline | 1.02 | Low |
| B21 | 7.3 | Neutral | 8.3 | Marginally Sodic | 0.7 | Non-Saline | 0.28 | Low |
| B22 | 7.7 | Mildly Alkaline | 22.7 | Strongly Sodic | 4.3 | Moderately Saline | 0.18 | Low |
| B23 | 6.7 | Neutral | 28.1 | Strongly Sodic | 7.5 | Moderately Saline | 0.14 | Low |

# 4 BIOPHYSICAL STRAGTEGIC AGRICULTURAL LAND ASSESSMENT

This BSAL assessment has been conducted in accordance with Interim Protocol. The BSAL status was determined on the dominant soil type within each Soil Unit. The BSAL assessment and limitations for each soil unit and sample site is shown in **Table 17**.

According to the Interim Protocol, the findings of this BSAL Assessment, as shown in **Table 16**, are:

- An exclusion area of 1 hectare for land greater than 10% slope was identified and excluded from the soil survey.
- An exclusion area of 8 hectares for land less the 20 hectares contiguous area was identified and excluded from the soil survey.
- An exclusion area of 3 hectares for land which comprises a waterbody (dam) was identified and excluded from the soil survey.
- An exclusion area of 205 hectares for land which has previously been disturbed by open-cut mining was identified and excluded from the soil survey.
- An exclusion area of 2 hectares for land which has previously been approved for mine disturbance (SSD-5850).
- One Soil Unit comprising 24 hectares, a Brown Sodosol, was identified during the soil survey and was considered non-BSAL.
- All Brown Sodosol sites failed BSAL Criteria **7** (low fertility) and **9** (poor drainage).
- Additionally, Site 1 failed Criteria 12 (sodicity), Site 2 failed Criteria 8 (soil depth) and Criteria 12 (sodicity), Site 3 failed Criteria 8 (soil depth) and Site 4 failed Criteria 11 (salinity) and Criteria 12 (sodicity).

**Table 16 BSAL Assessment Summary**

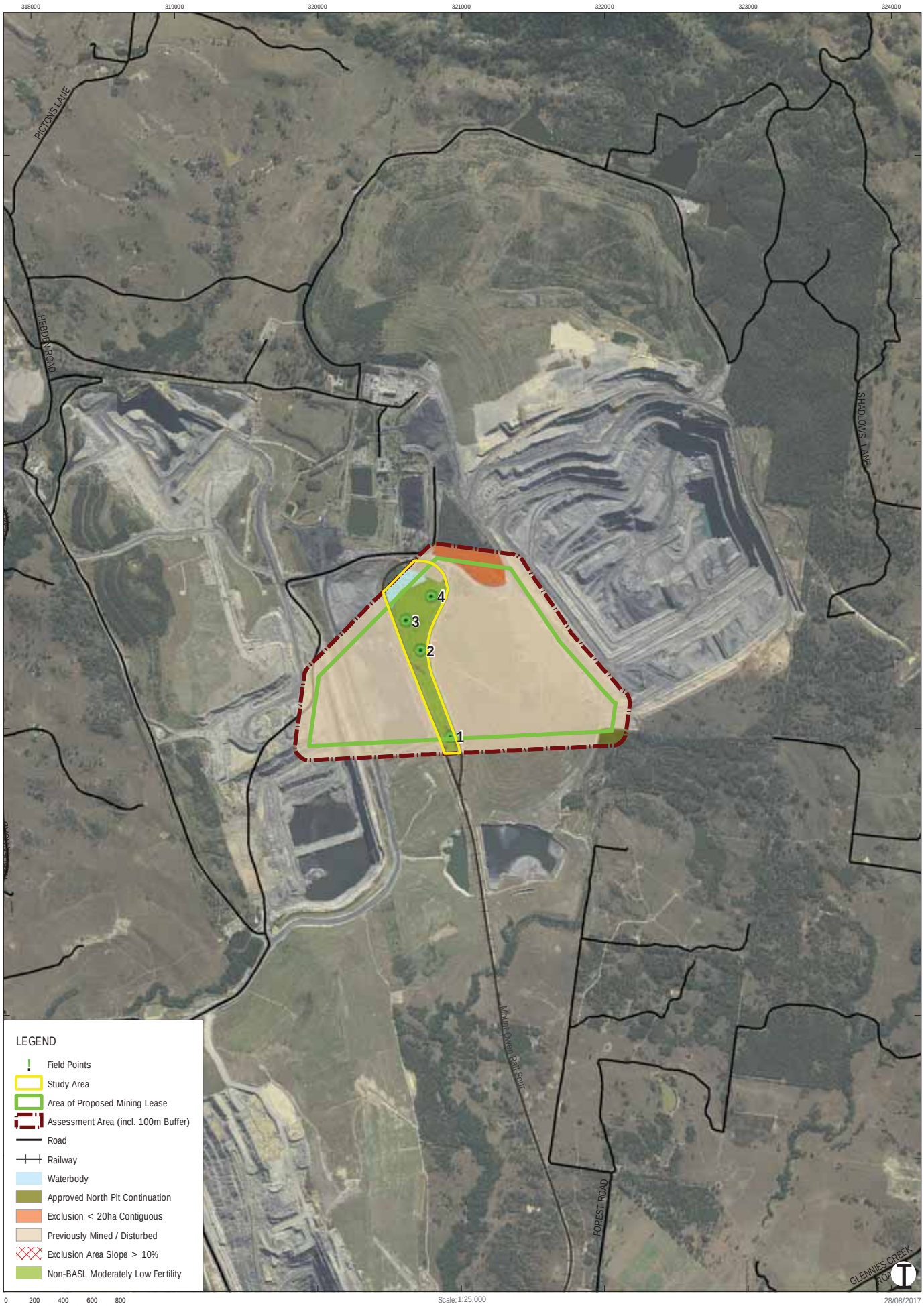
| Soil Survey BSAL Assessment | Hectares |
|---|---|
| Verified BSAL | Nil |
| Verified Non-BSAL | 24 |
| **BSAL Sub Total** | **24** |
| Exclusion > 10% Slope | 1 |
| Exclusion < 20 ha | 8 |
| Exclusion waterbody | 3 |
| Previously mine disturbed | 205 |
| Approval for disturbance | 2 |
| **Exclusion Sub Total** | **219** |
| **BSAL Assessment Area Total** | **243** |

There were no soil types within the Study Area which met the criteria in the Interim Protocol to be classified as BSAL, and as such the entire Study Area has been mapped as non-BSAL, shown in **Figure 6**.

**Table 17 BSAL Assessment**

| Site Number | Inspection Type | ASC Soil Type (to Great Group for detailed sites) | 1. Is slope < 10%? | 2. Is there < 30% Rock Outcrop? | 3. < 20% unattached Rock Fragments > 60mm? | 4. Does < 50% have Gilgais >500mm deep? | 5. Is Slope <5%? | 6. Are there 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 (water) and 4.5 and 8.1 ($CaCl_2$)? | 11. Is salinity (ECe) < 4 dS/m | 12. Is ERD to a chemical barrier >750mm? | Is the Soil Unit BSAL? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soil Unit 1 Brown Sodosol** | | | | | | | | | | | | | | | | |
| 1 | Detailed | Mesonatric Brown Sodosol | ✓ | ✓ | ✓ | ✓ | ✖ | ✓ | ✖ | ✖ | ✓ | ✖ | ✓ | ✓ | ✖ | No |
| 2 | Detailed | Subnatric Brown Sodosol | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✖ | ✖ | ✖ | ✖ | ✓ | ✓ | ✖ | |
| 3 | Detailed | Subnatric Brown Sodosol | ✓ | ✓ | ✓ | ✓ | ✖ | ✓ | ✖ | ✖ | ✖ | ✖ | ✓ | ✓ | ✓ | |
| 4 | Detailed | Subnatric Brown Sodosol | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✖ | ✖ | ✓ | ✖ | ✓ | ✖ | ✖ | |
| | | | | | | | | | | | | | | | | |

✓ = passes the BSAL criteria ✖ = fails the criteria but not excluded as BSAL ✖ = fails the BSAL criteria




Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

**BSAL Map**

**FIGURE 6**

# 5 CONCLUSION

This BSAL Assessment for the Integra Underground LW15 – LW20 Modification was undertaken by SLR Consulting. The Assessment Area for this BSAL Assessment is the LW15 – LW20 footprint, plus a 100 metre buffer, totalling 243 hectares. None of the Assessment Area is mapped as BSAL according to the NSW Government (DP&I, 2012).

The one Soil Unit, a Brown Sodosol comprising 24 hectares, was identified and mapped within the Study Area and verified as non-BSAL due failure of Interim Protocol Criteria 7 (fertility) and Criteria 9 (poor soil drainage). Multiple sites also failed Criteria 8 (soil depth), Criteria 11 (salinity) and Criteria 12 (sodicity). As such, there was 24 hectares of land verified as non-BSAL within the Study Area based on the soil survey results.

Additionally, there was 1 hectare excluded as BSAL due to greater than 10% slope, 8 hectares excluded due to it being less than 20 hectares contiguous area, 3 hectares comprising a waterbody, 205 hectares excluded due to being previously disturbed by open-cut mining and 2 hectares excluded due to previous approval for mining disturbance(SSD-5850). Therefore the total Assessment Area has been mapped as non-BSAL.

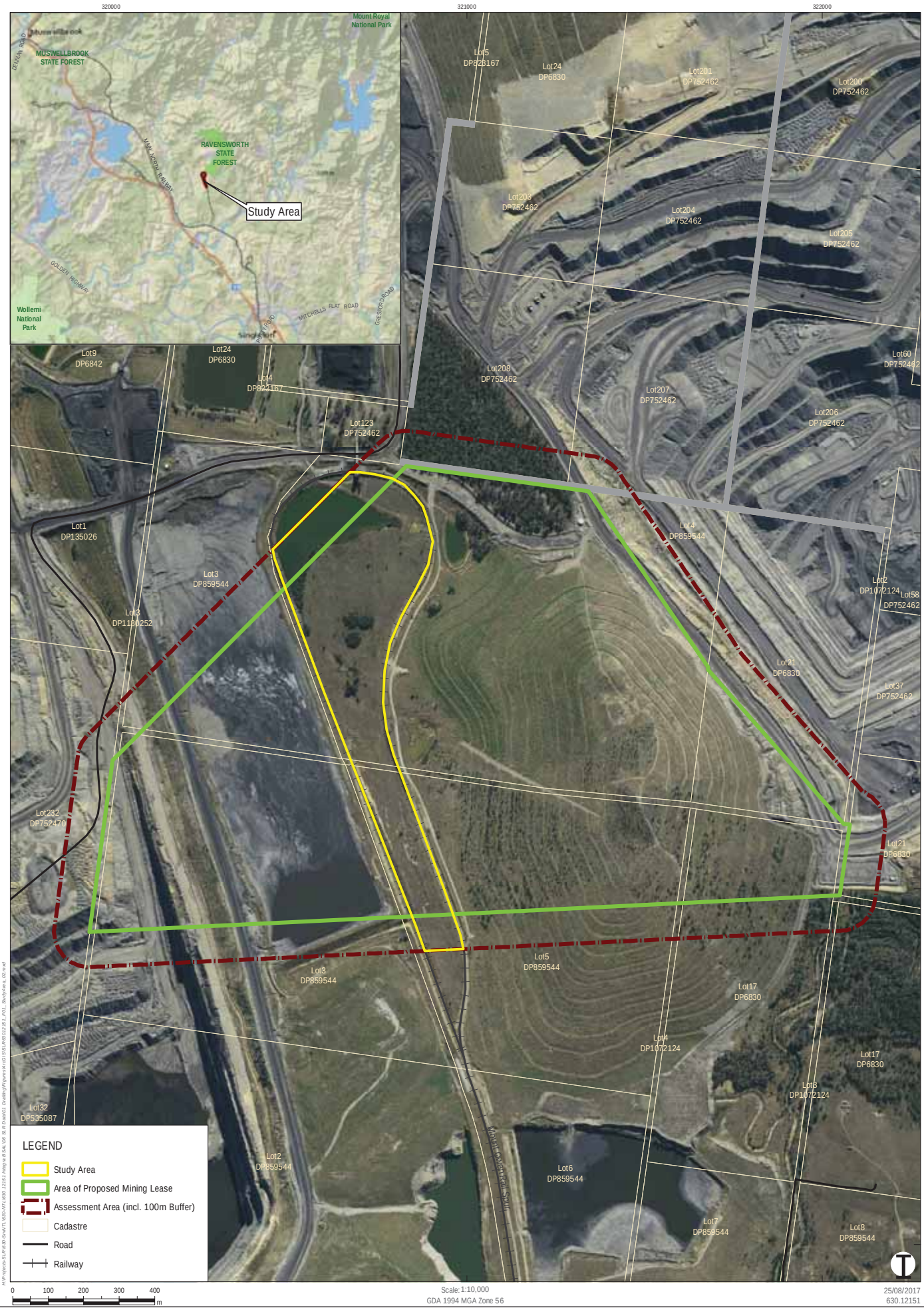
It can be concluded that there is no qualifying BSAL within the Assessment Area.

*This page has been left blank intentionally*

# Appendix A

## Zoomed Figures

## Scale 1:10,000



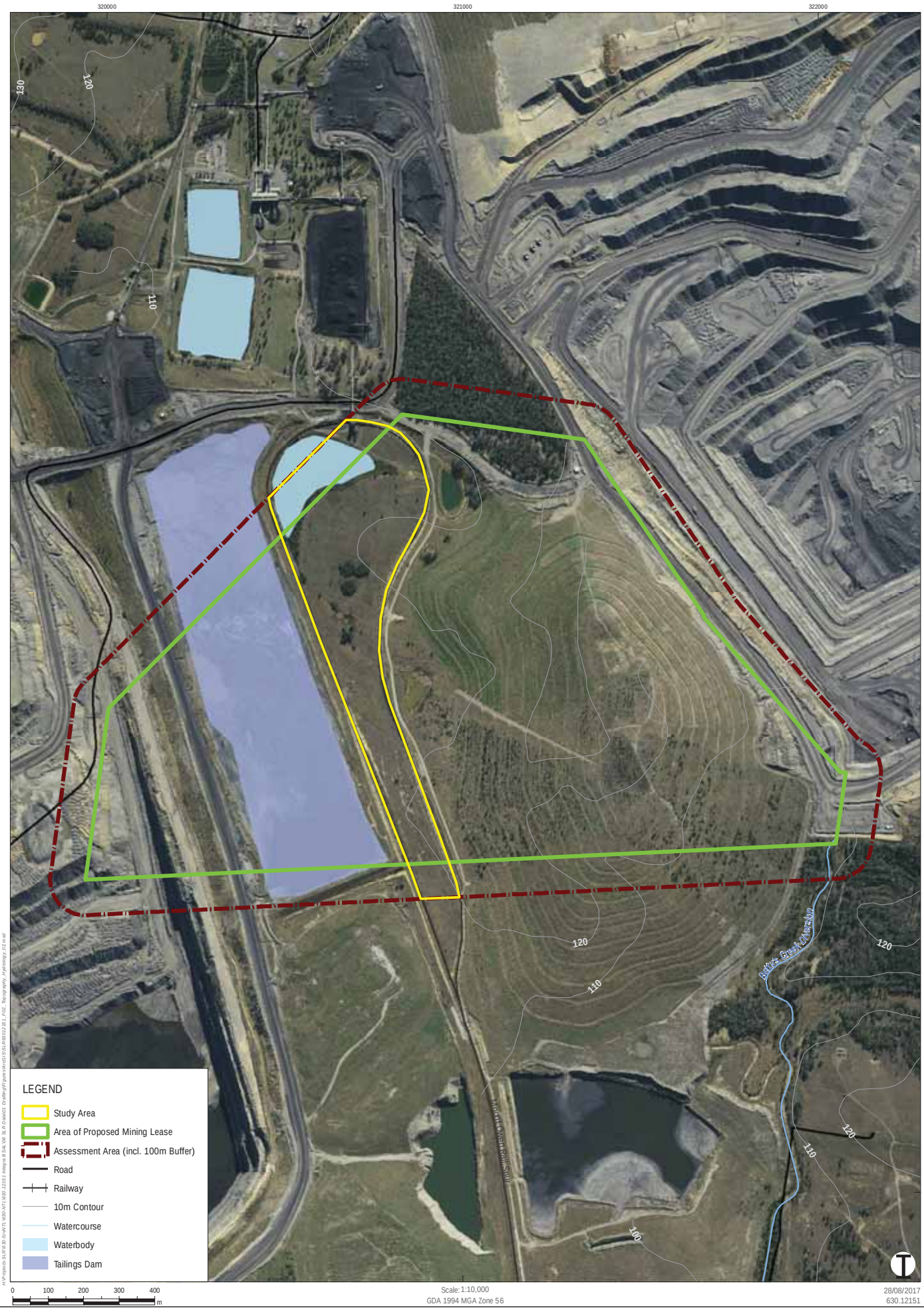

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

**Study Area**

**FIGURE 1**



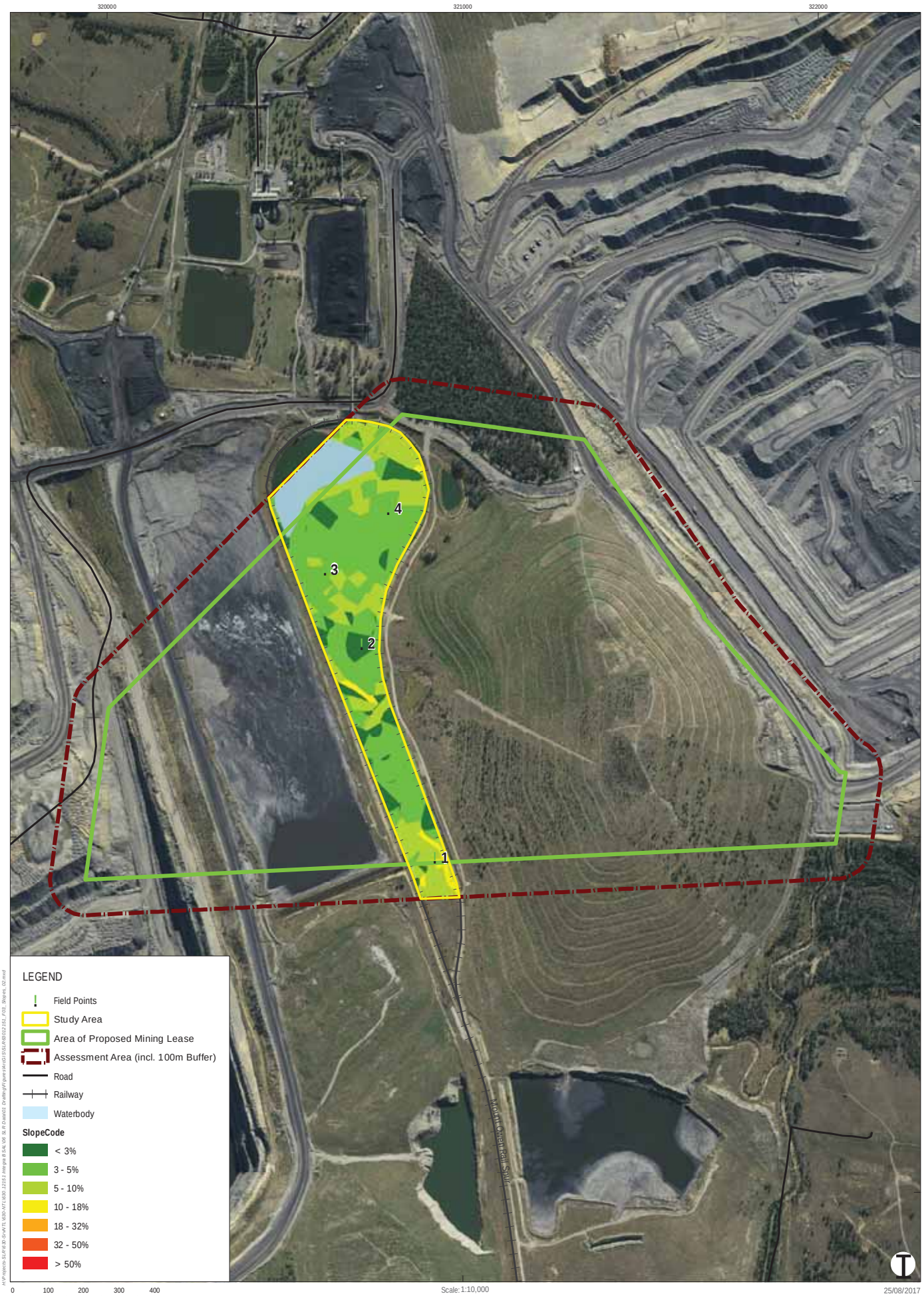

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Topography and Hydrology

**FIGURE 2**




Scale: 1:10,000
GDA 1994 MGA Zone 56

25/08/2017
630.12151

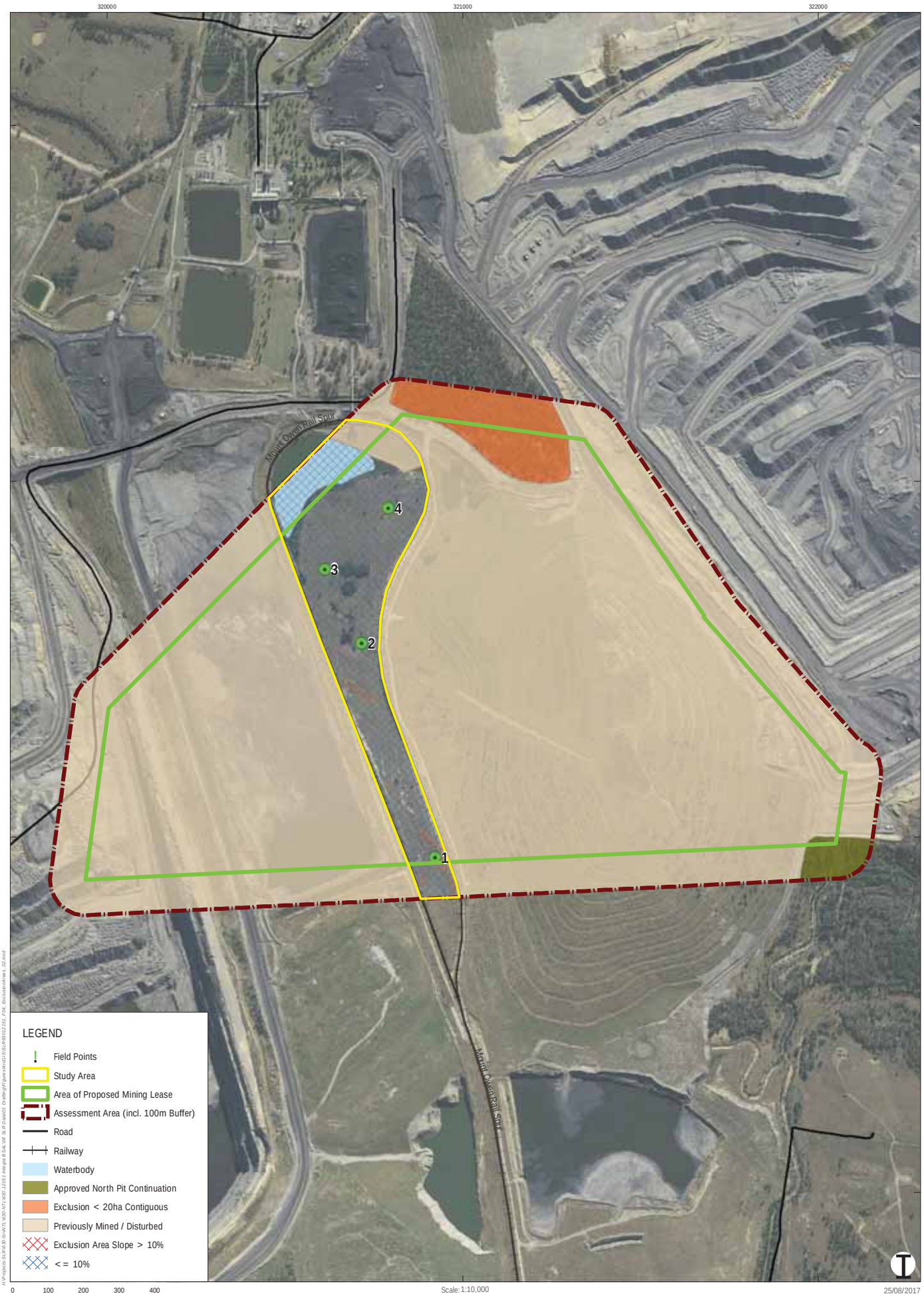
Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Slope Analysis

**FIGURE 3**




Scale: 1:10,000
GDA 1994 MGA Zone 56

25/08/2017
630.12151

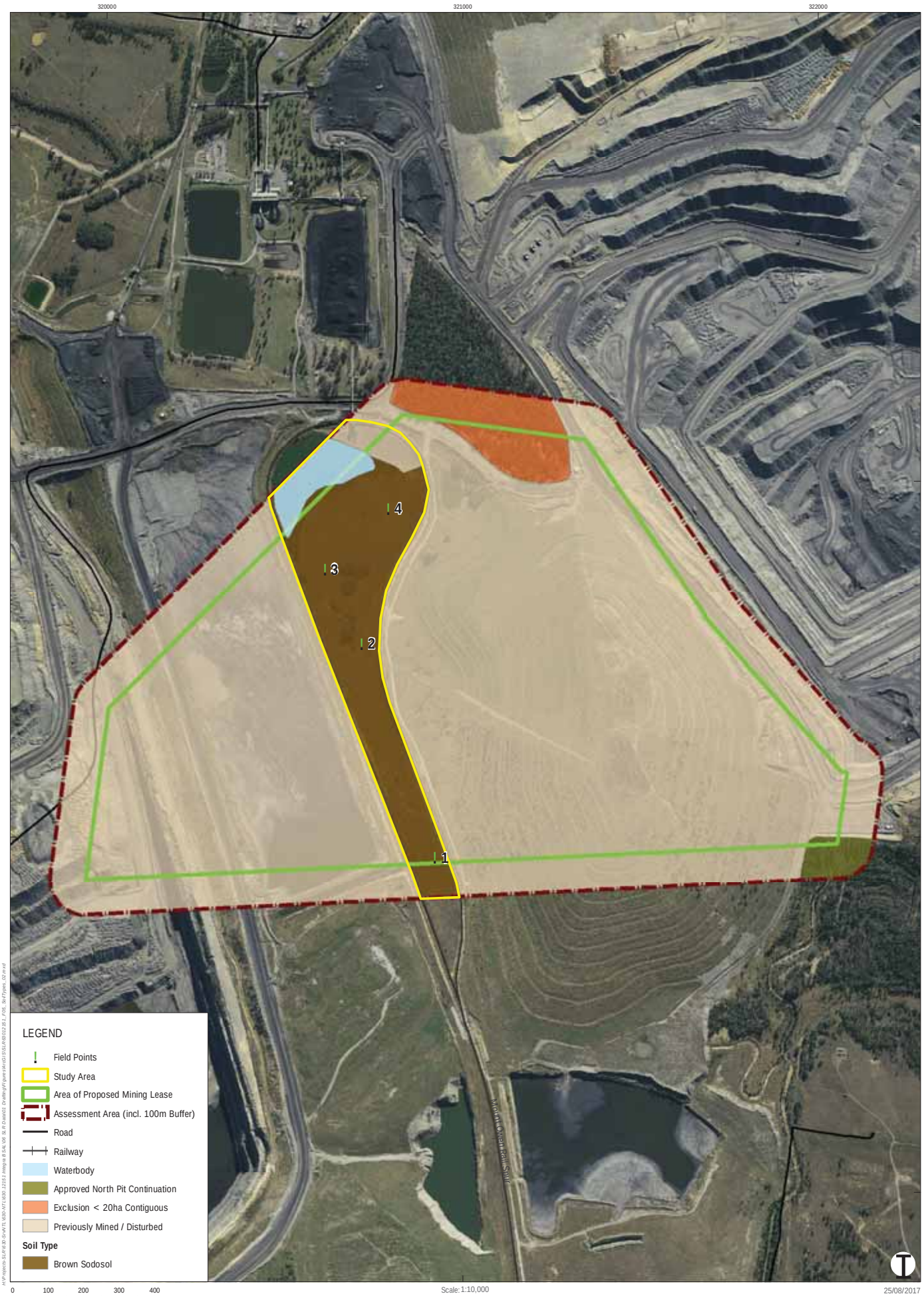
Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Exclusion Areas

FIGURE 4



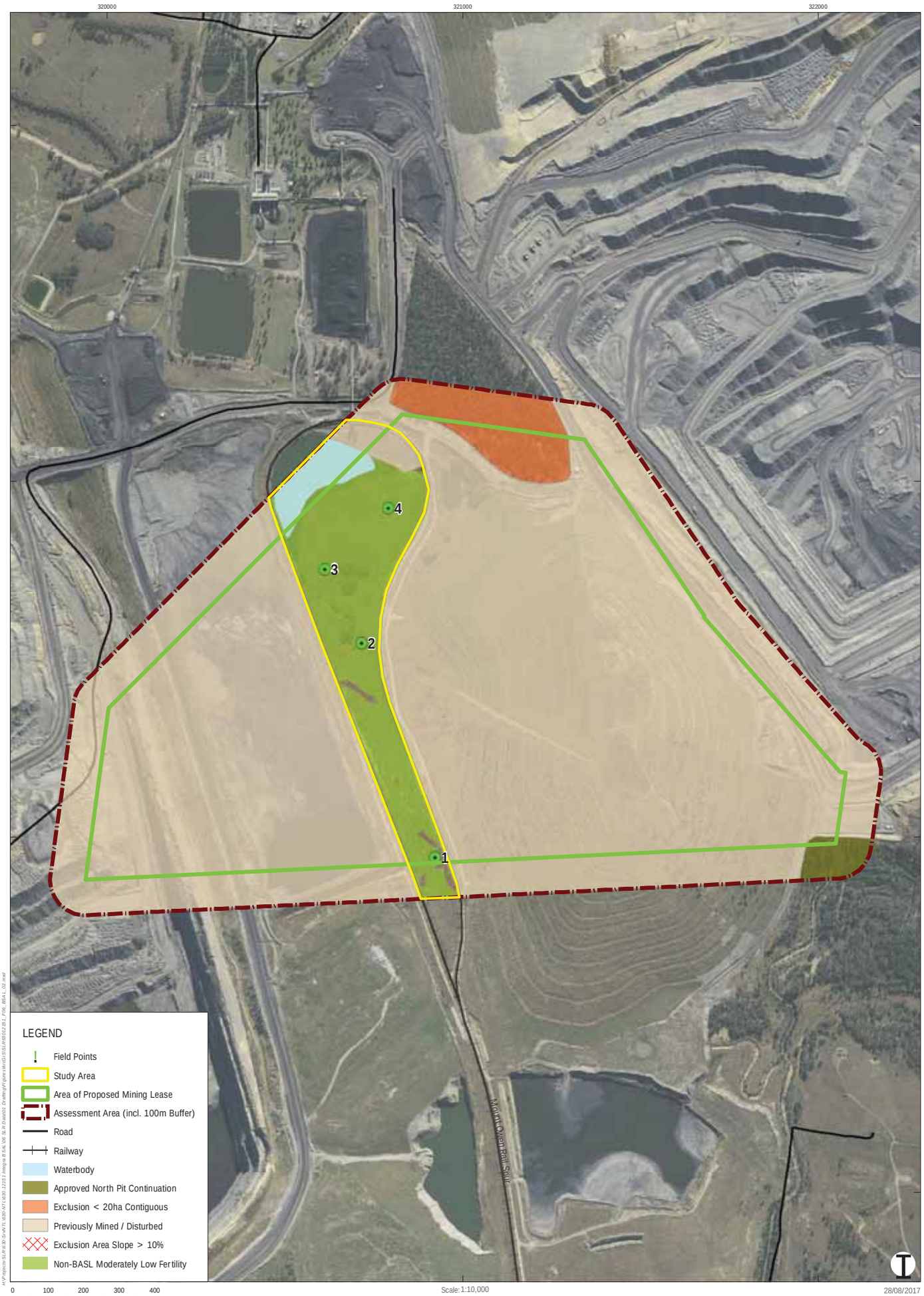

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## Soil Types

**FIGURE 5**




H:\Projects-SLR\630-SrvNTs\630-NT1\630.12151 Integra BSAL\06 SLR Data\02 Drafting\GIS\arcmxd\GIS\SLR\630121S1_F06_BSAL_02.mxd

Sheet Size : A3

SLR

www.slrconsultingaustralia.com.au PH: 61 2 4037 3200

## BSAL Map

**FIGURE 6**

# Appendix B

## Slope Analysis Methodology

# Appendix B

## Slope Analysis Methodology

### *Methodology*

1. Acquire appropriate elevation information. In this case, LIDAR data provided by Centennial Mandalong Pty Ltd.

2. Load Contours into ArcMap 10.3

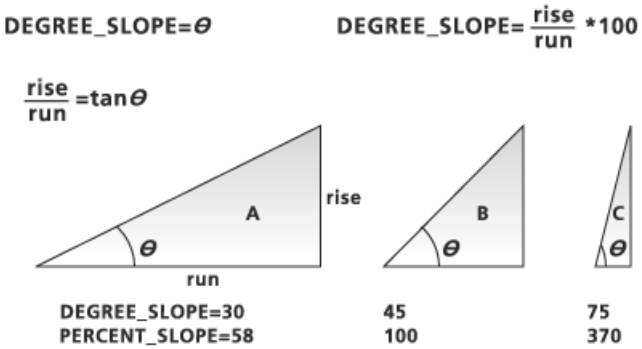
3. Using 3D Analyst Extension - Create a TIN Surface based on the contours (http://resources.arcgis.com/en/help/main/10.1/index.html#/Create_TIN/00q90000001v000000/)

4. Using 3D Analyst Extension – Run the Surface Slope Tool (http://resources.arcgis.com/en/help/main/10.1/index.html#//00q900000076000000) using a custom Break File (attached).

5. Using a Spatial Join, correlate the Surface Slope at the Soil Survey coordinates.

### *The Surface Slope Tool*

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




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

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

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

Table example:

```
break, code

  10.0, 11

  25.0, 22

  40.0, 33

  70.0, 44
```

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

# Appendix C

## Laboratory Soil Test Results

Department of Industry
Soil Conservation Service

# SOIL TEST REPORT



**Scone Research Centre**

---

| | |
|---|---|
| REPORT NO: | SCO17/127R2 |
| REPORT TO: | Murray Fraser<br>SLR Consulting<br>10 Kings Rd<br>New Lambton NSW 2305 |
| REPORT ON: | Fourteen soil samples<br>Your ref: Integra Soil Assessment 630.12151 |
| PRELIMINARY RESULTS ISSUED: | 4 August 2017 |
| REPORT STATUS: | Final |
| DATE REPORTED: | 7 August 2017 |
| METHODS: | Information on test procedures can be obtained from Scone Research Centre |

TESTING CARRIED OUT ON SAMPLE AS RECEIVED


---

L Dunn
Scone Laboratory

**SOIL CONSERVATION SERVICE**
**Scone Research Centre**



Report No: SCO17/127R2
Client Reference: Murray Fraser
SLR Consulting
10 Kings Rd
New Lambton NSW 2305

| Lab No | Method | C1A/5 | C2A/4 | C2B/4 | Colour | | P7B/2 Particle Size Analysis (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Id | EC (dS/m) | pH | pH ($CaCl_2$) | Dry | Moist | clay | silt | f sand | c sand | gravel |
| 1 | 1 0-10cm | 0.02 | 6.2 | 4.9 | 10YR 5/3 | 7.5YR 3/3 | 15 | 31 | 41 | 11 | 2 |
| 2 | 1 10-20cm | 0.07 | 6.4 | 5.0 | 10YR 6/3 | 10YR 4/3 | 17 | 30 | 37 | 11 | 5 |
| 3 | 1 40-50cm | 0.35 | 7.5 | 6.3 | 10YR 6/4 | 10YR 5/6 | 51 | 23 | 20 | 6 | 0 |
| 4 | 1 65-75cm | 0.67 | 7.9 | 6.8 | 10YR 6/4 | 10YR 5/6 | 56 | 22 | 17 | 5 | 0 |
| 5 | 2 0-10cm | 0.02 | 6.5 | 5.4 | 10YR 5/3 | 7.5YR 3/3 | 13 | 31 | 44 | 8 | 4 |
| 6 | 2 15-25cm | 0.07 | 6.9 | 5.7 | 10YR 5/6 | 7.5YR 4/6 | 44 | 23 | 29 | 4 | 0 |
| 7 | 2 50-60cm | 0.42 | 7.0 | 6.2 | 10YR 6/4 | 10YR 5/4 | 48 | 28 | 21 | 3 | 0 |
| 8 | 3 0-10cm | 0.02 | 6.4 | 5.4 | 10YR 5/3 | 7.5YR 3/3 | 16 | 33 | 41 | 6 | 4 |
| 9 | 3 15-25cm | 0.05 | 6.1 | 4.9 | 7.5YR 6/6 | 7.5YR 4/6 | 55 | 24 | 19 | 2 | 0 |
| 10 | 3 50-60cm | 0.37 | 8.6 | 7.4 | 10YR 5/3 | 10YR 5/4 | 51 | 27 | 17 | 3 | 2 |
| 11 | 4 0-5cm | 0.02 | 6.2 | 5.5 | 10YR 4/2 | 7.5YR 3/2 | 16 | 20 | 38 | 15 | 11 |
| 12 | 4 10-20cm | 008 | 7.3 | 6.2 | 10YR 5/4 | 10YR 4/4 | 45 | 19 | 22 | 14 | 0 |
| 13 | 4 40-50cm | 0.57 | 7.7 | 6.8 | 10YR 5/4 | 10YR 4/4 | 50 | 22 | 17 | 11 | <1 |
| 14 | 4 65-75cm | 0.87 | 6.7 | 6.2 | 10YR 6/6 | 7.5YR 5/4 | 38 | 24 | 28 | 10 | 0 |

nt=not tested

END OF TEST REPORT

Department of Primary Industries

**Biosecurity Laboratory Operations**
**Environmental Laboratory**
**1243 Bruxner Highway, WOLLONGBAR NSW 2477**
Phone: 02 6626 1103 Email: wollongbar.csu@dpi.nsw.gov.au

Report No. **WN180106**

Lynn Dunn
Soil Conservation Service
PO Box 283
SCONE NSW 2337

# Soil Analysis Report

14 Sample(s) received on 7/08/17 . Tested as per the following methods.

| Method | Method Description |
|---|---|
| S273 | Gillman & Sumpter Exchangeable Cations |

**Notes:**

**Results relate only to the items tested.**

*- When required, samples air dried at 40ºC as per Soil Chemical Methods - Australasia (Rayment and Lyons 2011).*
*- Results are expressed on an air-dry weight basis unless otherwise stated.*
*- This report should not be reproduced except in full.*
*- Samples will be retained for one calendar month from the date of the final report. Samples will then be discarded.*
*- Clients wishing to recover their samples must contact the laboratory within this period. This laboratory will return residual samples at client expense.*

Date of issue 10/08/17

NATA ACCREDITED FOR TECHNICAL COMPETENCE
Accredited for compliance with ISO/IEC 17025 – Testing
Accreditation No. 14173

ASPAC

Approved for Release by: Craig Hunt
Craig Hunt
Technical Officer

| Laboratory No.<br>Client's ID | Units | Limit of Reporting | 1<br>SCO17/127<br>/1 | 2<br>SCO17/127<br>/2 | 3<br>SCO17/127<br>/3 | 4<br>SCO17/127<br>/4 | 5<br>SCO17/127<br>/5 |
|---|---|---|---|---|---|---|---|
| **Exchangeable Cations** | | | | | | | |
| Aluminium | cmol(+)/kg | 0.1 | 0.18 | 0.20 | <0.1 | <0.1 | <0.1 |
| Calcium | cmol(+)/kg | 0.03 | 3.9 | 2.6 | 4.2 | 4.6 | 3.7 |
| Potassium | cmol(+)/kg | 0.01 | 0.34 | 0.16 | 0.15 | 0.24 | 0.52 |
| Magnesium | cmol(+)/kg | 0.007 | 4.0 | 3.6 | 14 | 16 | 4.1 |
| Sodium | cmol(+)/kg | 0.03 | 0.34 | 0.41 | 3.9 | 6.1 | 0.28 |
| CEC (effective) | cmol(+)/kg | 0.20 | 8.8 | 7.0 | 23 | 27 | 8.6 |
| Calcium/ Magnesium | | | 0.99 | 0.71 | 0.29 | 0.28 | 0.92 |
| Percent Aluminium Saturation | % of ECEC | | 2 | 3 | N/A | N/A | N/A |
| Exchangeable Calcium | % of ECEC | | 45 | 37 | 19 | 17 | 43 |
| Exchangeable Potassium | % of ECEC | | 3.8 | 2.4 | 0.65 | 0.89 | 6.0 |
| Exchangeable Magnesium | % of ECEC | | 45 | 52 | 63 | 60 | 47 |
| Exchangeable Sodium Percentage | % of ECEC | | 3.8 | 5.9 | 17 | 22 | 3.2 |

| Laboratory No.<br>Client's ID | Units | Limit of Reporting | 6<br>SCO17/127<br>/6 | 7<br>SCO17/127<br>/7 | 8<br>SCO17/127<br>/8 | 9<br>SCO17/127<br>/9 | 10<br>SCO17/127<br>/10 |
|---|---|---|---|---|---|---|---|
| **Exchangeable Cations** | | | | | | | |
| Aluminium | cmol(+)/kg | 0.1 | <0.1 | <0.1 | <0.1 | 0.44 | <0.1 |
| Calcium | cmol(+)/kg | 0.03 | 3.9 | 4.0 | 4.1 | 4.4 | 6.3 |
| Potassium | cmol(+)/kg | 0.01 | 0.28 | 0.15 | 0.53 | 0.36 | 0.14 |
| Magnesium | cmol(+)/kg | 0.007 | 10 | 14 | 4.8 | 12 | 15 |
| Sodium | cmol(+)/kg | 0.03 | 1.5 | 5.2 | 0.26 | 1.2 | 3.5 |
| CEC (effective) | cmol(+)/kg | 0.20 | 16 | 23 | 9.7 | 18 | 25 |
| Calcium/ Magnesium | | | 0.37 | 0.29 | 0.86 | 0.36 | 0.41 |
| Percent Aluminium Saturation | % of ECEC | | N/A | N/A | N/A | 2 | N/A |
| Exchangeable Calcium | % of ECEC | | 24 | 17 | 43 | 24 | 25 |
| Exchangeable Potassium | % of ECEC | | 1.7 | 0.65 | 5.5 | 1.9 | 0.54 |
| Exchangeable Magnesium | % of ECEC | | 65 | 60 | 49 | 65 | 60 |
| Exchangeable Sodium Percentage | % of ECEC | | 9.1 | 22 | 2.7 | 6.7 | 14 |

| **Laboratory No.**<br>**Client's ID** | **Units** | **Limit of Reporting** | **11**<br>**SCO17/127**<br>**/11** | **12**<br>**SCO17/127**<br>**/12** | **13**<br>**SCO17/127**<br>**/13** | **14**<br>**SCO17/127**<br>**/14** |
|---|---|---|---|---|---|---|
| **Exchangeable Cations** | | | | | | |
| Aluminium | cmol(+)/kg | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Calcium | cmol(+)/kg | 0.03 | 4.3 | 3.6 | 2.5 | 1.8 |
| Potassium | cmol(+)/kg | 0.01 | 0.54 | 0.38 | 0.13 | 0.14 |
| Magnesium | cmol(+)/kg | 0.007 | 4.2 | 13 | 14 | 13 |
| Sodium | cmol(+)/kg | 0.03 | 0.22 | 1.5 | 5.0 | 5.9 |
| CEC (effective) | cmol(+)/kg | 0.20 | 9.2 | 18 | 22 | 21 |
| Calcium/ Magnesium | | | 1.0 | 0.28 | 0.18 | 0.14 |
| Percent Aluminium Saturation | % of ECEC | | N/A | N/A | N/A | N/A |
| Exchangeable Calcium | % of ECEC | | 46 | 19 | 12 | 8.8 |
| Exchangeable Potassium | % of ECEC | | 5.8 | 2.1 | 0.59 | 0.66 |
| Exchangeable Magnesium | % of ECEC | | 45 | 70 | 65 | 62 |
| Exchangeable Sodium Percentage | % of ECEC | | 2.4 | 8.1 | 23 | 28 |