BOWDENS SILVER

ABN: 37 009 250 051

Documentation Supporting an Application for a Site Verification Certificate

for the

Bowdens Silver Project

Prepared by:

R.W. CORKERY & CO. PTY. LIMITED

and

Soil Management Designs

August 2017

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August 2017

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SOILmgt

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LIST OF ACRONYMS AND UNITS

AHD	Australian Height Datum
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
BSPL	Bowdens Silver Pty Limited
cm	centimetre
EL	Exploration Licence
eSPADE	Soil Profile Attribute Data Environment
ha	hectare
LSC	Land and Soil Capability
mm	millimetre
NATA	National Association of Testing Authorities
OEH	Office of Environment and Heritage
SEPP	State Environmental Planning Policy
SVC	Site Verification Certificate

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EXECUTIVE SUMMARY

Bowdens Silver Pty Limited (BSPL) proposes to construct and operate an open cut mine to recover mineralised rock (ore) containing silver and small percentages of zinc and lead, approximately 2.5km northeast of Lue village in the Mid-Western Region Local Government Area. The open cut and associated infrastructure would be located within an area referred to as the "Mine Site" covering approximately 1 230ha.

As the Project is classified as a State Significant Development, Clause 50 of the *Environmental Planning and Assessment Regulation 2000* requires that the development application must be accompanied by either a "Site Verification Certificate", which certifies that the land on which the proposed development is to be carried out is not biophysical strategic agricultural land (BSAL), or a "Gateway Certificate".

As such, BSPL is seeking a Site Verification Certificate for the Mine Site with this Site Verification Report being prepared in accordance with the NSW Government issued document, "*Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land 2013"*. The Interim Protocol outlines the preliminary process by which land with potential BSAL attributes is identified and the subsequent steps for further detailed investigation, laboratory analysis and identification of soil landscape units with BSAL characteristics or otherwise.

As the preliminary process identified that the region in which the Mine Site is located experiences reliable rainfall and, with certain sections of the Mine Site also meeting additional BSAL criteria such as slope and rock outcrop, BSPL commissioned a detailed site soil survey.

The site soil survey was conducted by accredited soil scientists, Dr David McKenzie and Mr Adrian Harte of Soil Management Designs. Dr McKenzie is a Certified Professional Soil Scientist (CPSS) who holds a PhD in Soil Science. A total of 39 soil test pit sites, located within the Mine Site and the 100m buffer zone around the Mine Site boundary (in accordance with Interim Protocol), were identified for investigation. At each soil test pit site, soil samples were collected for submission to a NATA accredited laboratory for analysis in accordance with the Interim Protocol. Seven Soil Landscape Units were identified as occurring within the Mine Site.

Whilst four of the 39 soil test pits investigated were identified as displaying BSAL characteristics, each of these soil test pit sites were not adjacent to one another and thus do not form a single contiguous area greater than 20ha. Therefore, none of the seven Soil Landscape Units identified during the assessment met the minimum threshold for declarable BSAL, whereby 70% of the soil test pits within a Soil Landscape Unit meet the BSAL criteria.

As a consequence of the above, a Site Verification Certificate is sought which acknowledges that no BSAL is present within the Mine Site.

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1. INTRODUCTION

Bowdens Silver Pty Limited (BSPL) proposes to construct and operate an open cut mine to recover mineralised rock (ore) containing silver and small percentages of zinc and lead to depths of at least 180m ("the Project"). The open cut and associated infrastructure would be located within the "Mine Site" covering an approximately 1 230ha area and located approximately 2.5km northeast of Lue village in the Mid-Western Region Local Government Area on landholdings predominantly owned by BSPL and within Exploration Licences (EL) 5920 and EL 6354, both of which are held by BSPL (refer **Figure 1**).

The Project is classified as a State Significant Development in accordance with Clause 5 (mining) of Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP) because the capital investment value would be more than $30 million.

As the Project is classified as State Significant Development, Clause 50A of the *Environmental Planning and Assessment Regulation 2000* requires that development applications for mining or petroleum development on certain identified land (including land shown on the *Strategic Agricultural Land Map*) must be accompanied by either a "Site Verification Certificate" that certifies that the land on which the proposed development is to be carried out is not biophysical strategic agricultural land (BSAL), or a "Gateway Certificate".

BSPL is seeking a Site Verification Certificate (SVC) for the Mine Site (refer **Figure 2**). This Site Verification Report has been prepared in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land 2013* ("the Interim Protocol").

Figure 3 provides a range of base information relied upon during the assessment of the Project.

2. MINE SITE DESCRIPTION

2.1 TOPOGRAPHY AND DRAINAGE

The Mine Site is situated on the western flanks of the Great Dividing Range with the regional topography of the area dominated by elevated rocky ridges and broad flat alluvial valleys. The topography generally ranges in elevation from approximately 800m AHD within the peaks and ridges associated with the Great Dividing Range in the east, to elevations below 500m AHD within the alluvial valleys to the west of the Mine Site.

Locally, the topography is dominated by a number of ridges and valleys. The local topography surrounding the Mine Site comprises three north-south orientated ridges with small intermediate valleys and a broad, flat alluvial valley extending from the southern sections of the Mine Site and containing Hawkins Creek. All three ridges extend into the Mine Site from the northeast (Eastern Ridge) and north (Central Ridge and Western Ridge) with slopes generally decreasing towards the southeast of the Mine Site (refer **Figure 4**). The Central Ridge, located in the north of the Mine Site, has a maximum elevation of approximately 780m AHD. The small valley to the east of this ridge, which contains Price Creek, an ephemeral watercourse, extends into the Mine Site from the north, falls to an elevation of approximately 570m AHD at the confluence of Price Creek and Hawkins Creek before rising again to the top of the Eastern Ridge, also at an elevation of 780m AHD.

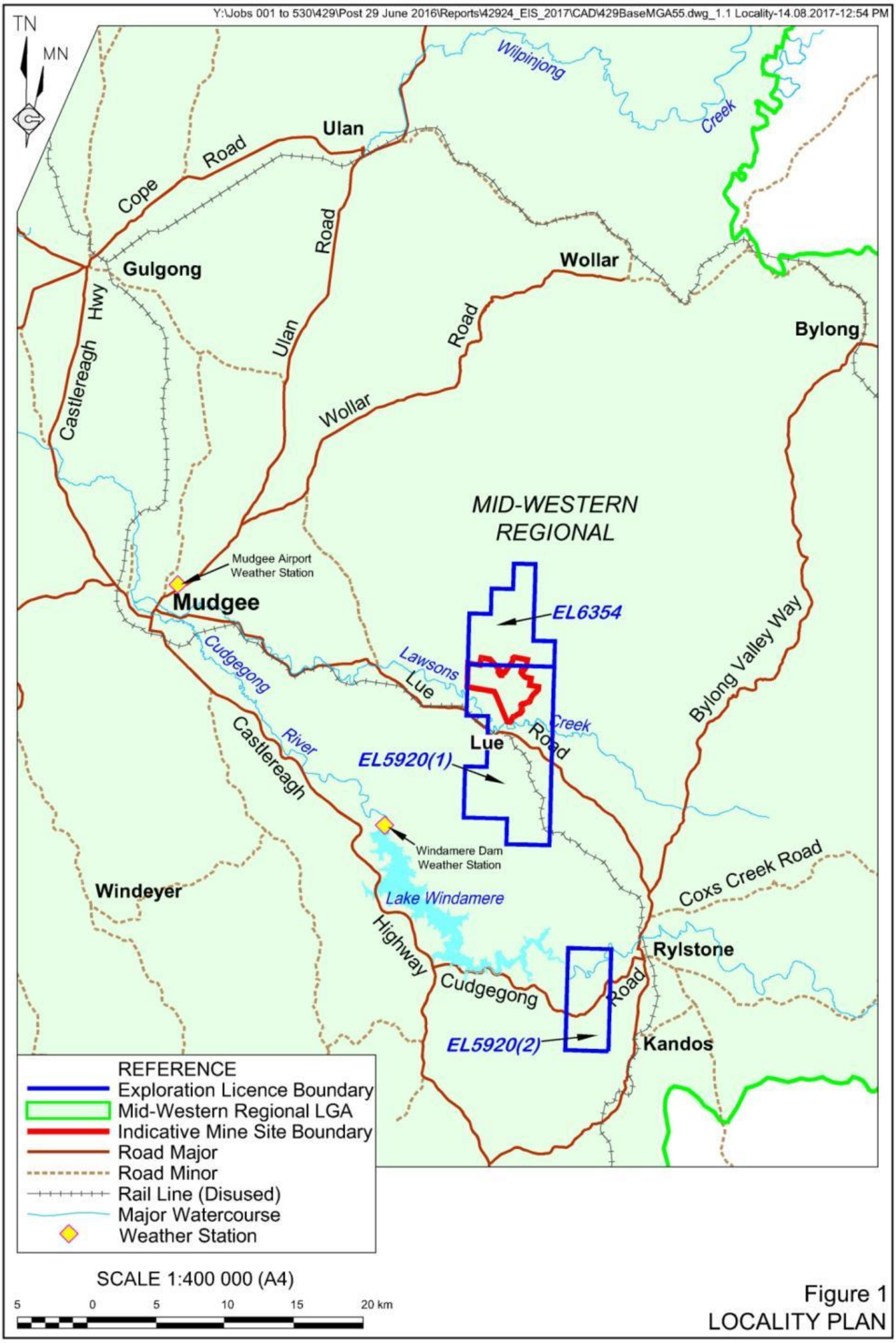

Figure 1
LOCALITY PLAN

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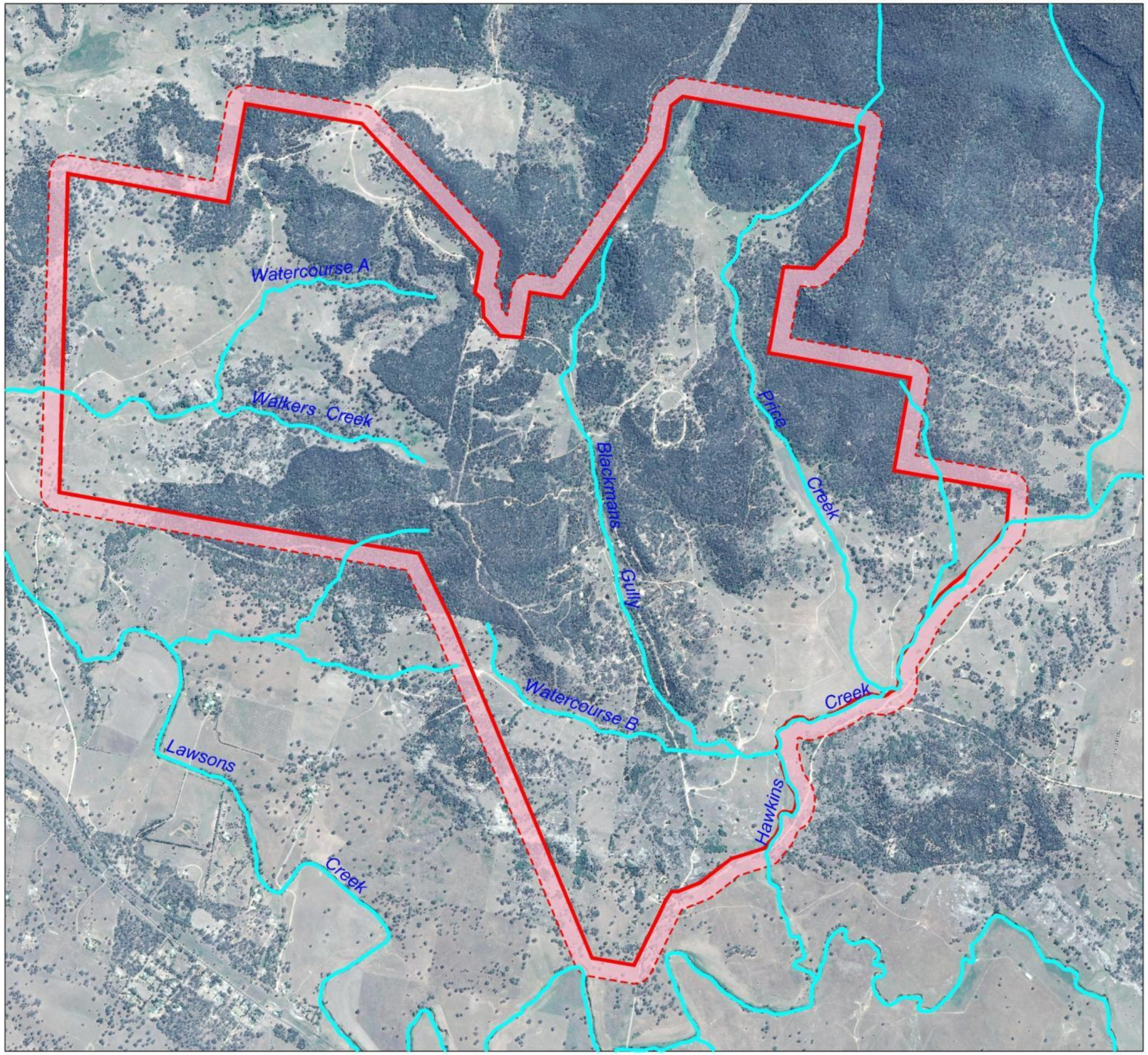
TN
MN



REFERENCE
- Indicative Mine Site Boundary (1230ha)
- 100m Buffer Zone (200ha)
- Watercourse / Drainage Line

SCALE 1:25 000 (A3)

250 0 250 500 750 1000 1250 m

Base Photo Source: Google Earth - 6 December 2015

Figure 2
MINE SITE

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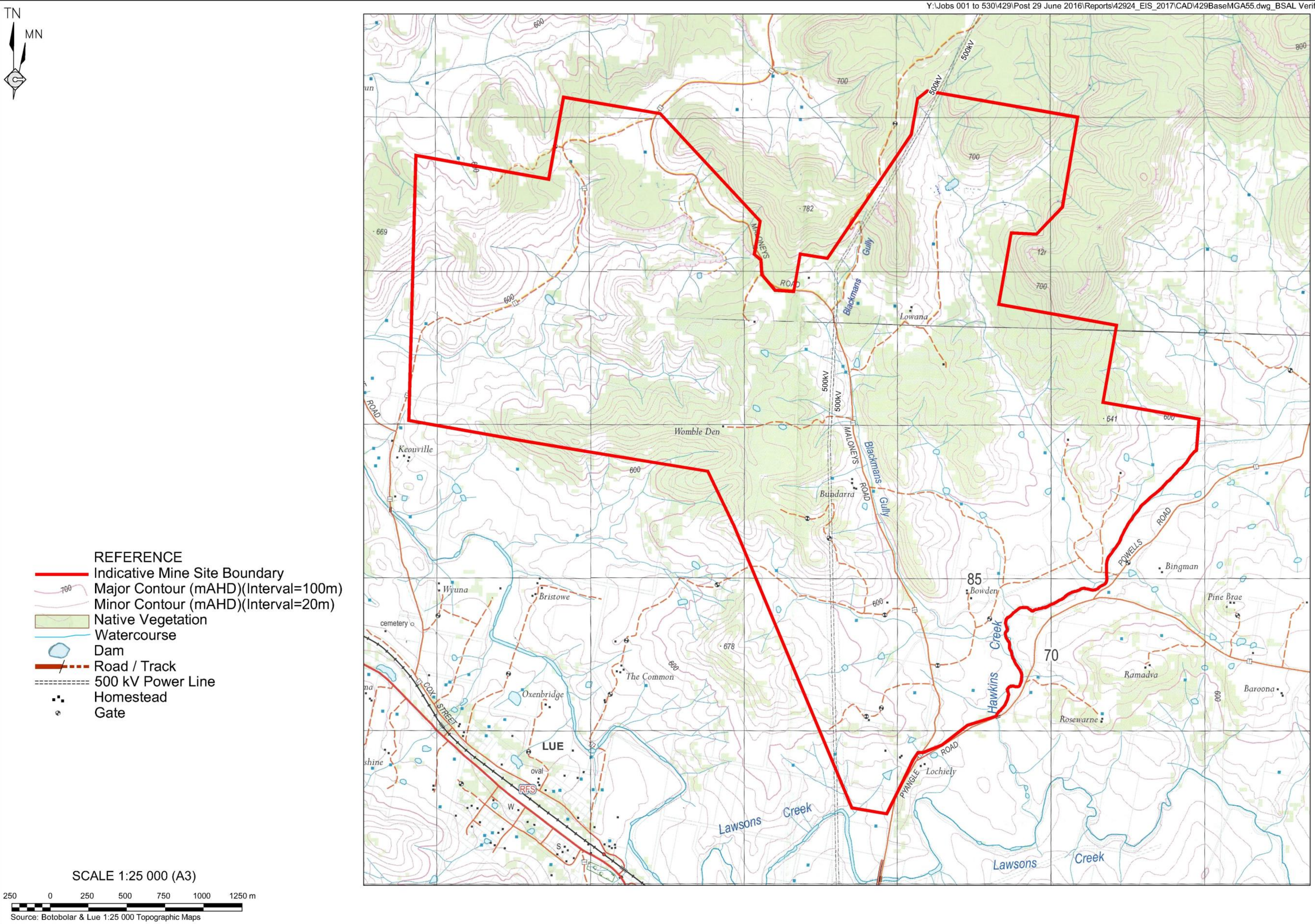

Figure 3
BASE MAP

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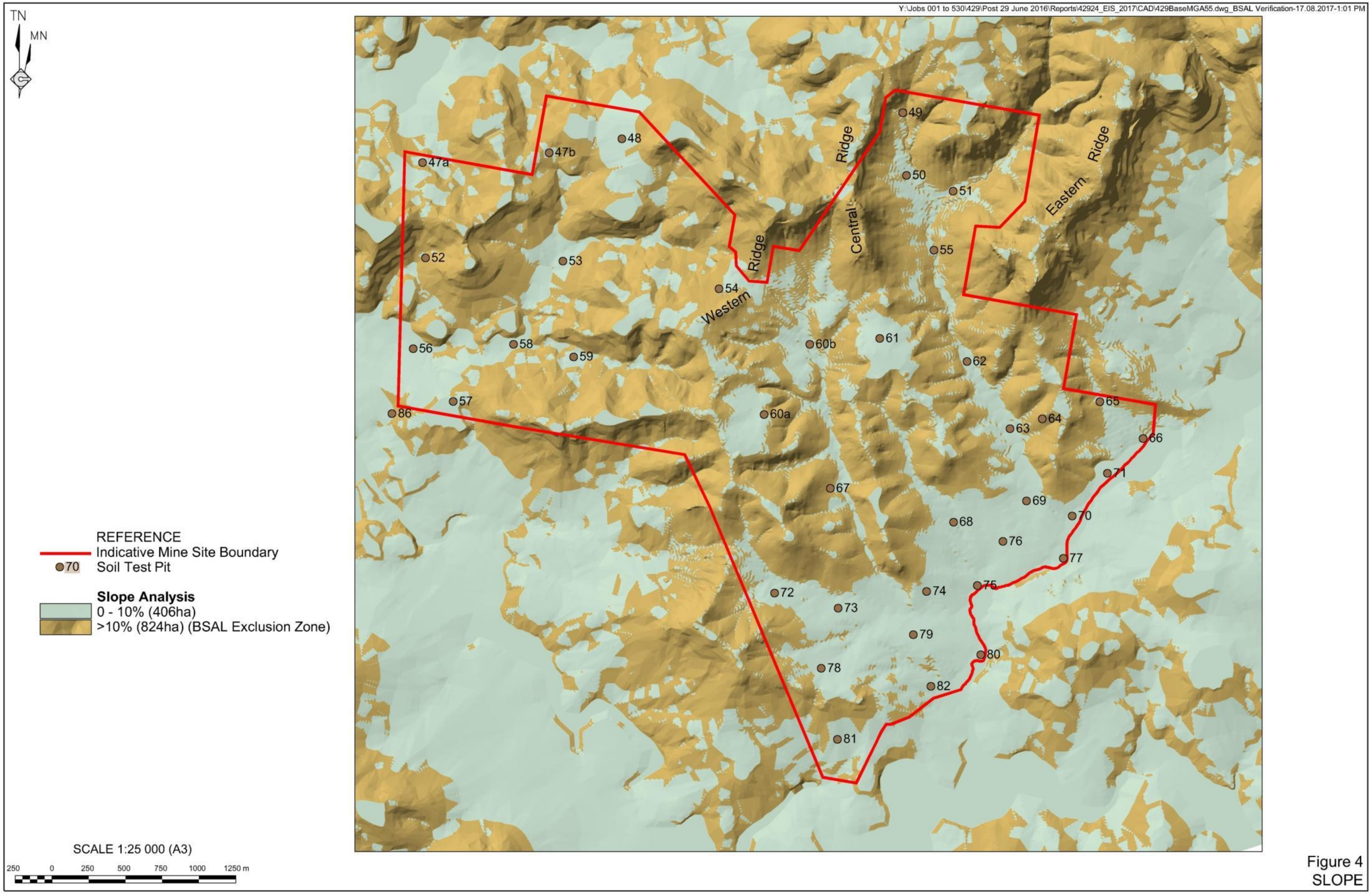

Figure 4
SLOPE

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Blackmans Gully, another ephemeral watercourse within the Mine Site, has a catchment defined by the Central and Western Ridges and flows to the south-southwest, also merging with Hawkins Creek to the south of the Mine Site. Elevations on the ridgelines in this catchment vary between 640m AHD and 650m AHD, with the lowest elevation approximately 570m AHD at the confluence of Blackmans Gully and Hawkins Creek.

Two spurs of the Western Ridge also extend northwest and west to define the northern and southern extents of the catchment of Walkers Creek which is an ephemeral watercourse that flows west from the Mine Site, merging with Lawsons Creek, the regional watercourse downstream of the Mine Site. The maximum elevation on the ridgeline within this catchment is approximately 780m AHD (north of the Mine Site), with the lowest elevation between approximately 520m AHD and 530m AHD at the confluence of Walkers Creek and Lawsons Creek.

Within the Mine Site, the slopes are typically >10% along the ridgelines and upper valleys with slope transitioning to <10% in the lower valleys (refer **Figure 4**). Whilst some of the elevated areas ‘plateau’ in certain sections along the topographic highs, these sections are isolated and do not connect to form a contiguous area.

2.2 LAND USE

The principal land use within the Mine Site is the grazing of cattle and sheep, with minor cropping. BSPL either owns or has options to purchase approximately 1 600ha of land that is presently divided into a number of paddocks. Sections of the BSPL landholding have previously been subjected to clearing for the purposes of cropping and grazing activities. A majority of this cleared land is not arable, but is suitable for grazing purposes only. The remaining land is considered unsuitable for agricultural uses due to rock outcrop and tree density. Cropping activity has historically involved the periodic planting of cereal crops, legumes or pasture improvements as well as a small area being used for vegetable production. Sections of the landholding are currently being run as a sheep and cattle grazing operation by BSPL.

3. REVIEW OF EXISTING INFORMATION

3.1 SUMMARY OF INFORMATION SOURCES

The following existing soil resource information relevant to the Mine Site was reviewed for this report.

- Geology data provided by BSPL.
- Soil Profile Attribute Data Environment (eSPADE) soil profiles (OEH, 2014).
- Regional soil type and landscape mapping (Murphy and Lawrie, 1998).
- Existing BSAL mapping (DPE, 2013).

A summary of relevant information from these sources is provided in the following subsections.

3.2 GEOLOGY / PARENT MATERIALS FOR SOIL FORMATION

The Mine Site is situated near the northeastern margin of the Lachlan Fold Belt, one of the main components of the Tasman Fold Belt System, and the western edge of the Sydney Basin. The main geological group from which soils on the Mine Site are derived are those of the Sydney Basin (see **Figure 5**) and include:

- Sedimentary units of the Narrabeen Group;
- Illawarra Coal Measures;
- Rylstone Volcanics (breccia and conglomerate); and
- Sedimentary units of the Shoalhaven Group.

3.3 ESPADE SOIL PROFILE DATABASE

A search of the OEH 'eSPADE' website was conducted to identify any existing soil profile information within or immediately surrounding the Mine Site. No eSPADE soil profiles were identified.

3.4 SOIL TYPES AND LANDSCAPES

Three Soil Landscape Units have previously been mapped and described by Murphy and Lawrie (1998) within and adjacent to the Mine Site namely:

- Rylstone Siliceous Sands: situated in the southern section of the Mine Site as valley fill within Walkers Creek and the floodplains of Hawkins Creek and Lawsons Creek;
- Barrigan Creek Yellow Podzolic Soils: situated in the central section of the Mine Site on the Eastern, Central and Western Ridges and as valley fill in Blackmans Gully and Price Creek; and
- Lees Pinch Shallow Soils: situated on the western spur of the Western Ridge and topographic highs of the Walkers Creek catchment and as valley fill in the headwaters of Walkers Creek.

These soil landscapes have not been relied upon for this assessment. Rather, a detailed site soils survey and definition of Soil Landscape Units was undertaken (refer Section 4.5.3).

3.5 EXISTING BSAL MAPPING

The existing BSAL mapping, as prepared for the Upper Hunter Strategic Regional Land Use Plan, does not identify any BSAL within the Mine Site. The closest mapped BSAL is located approximately 500m to the northwest of the closest point of the Mine Site boundary (refer **Figure 5**).

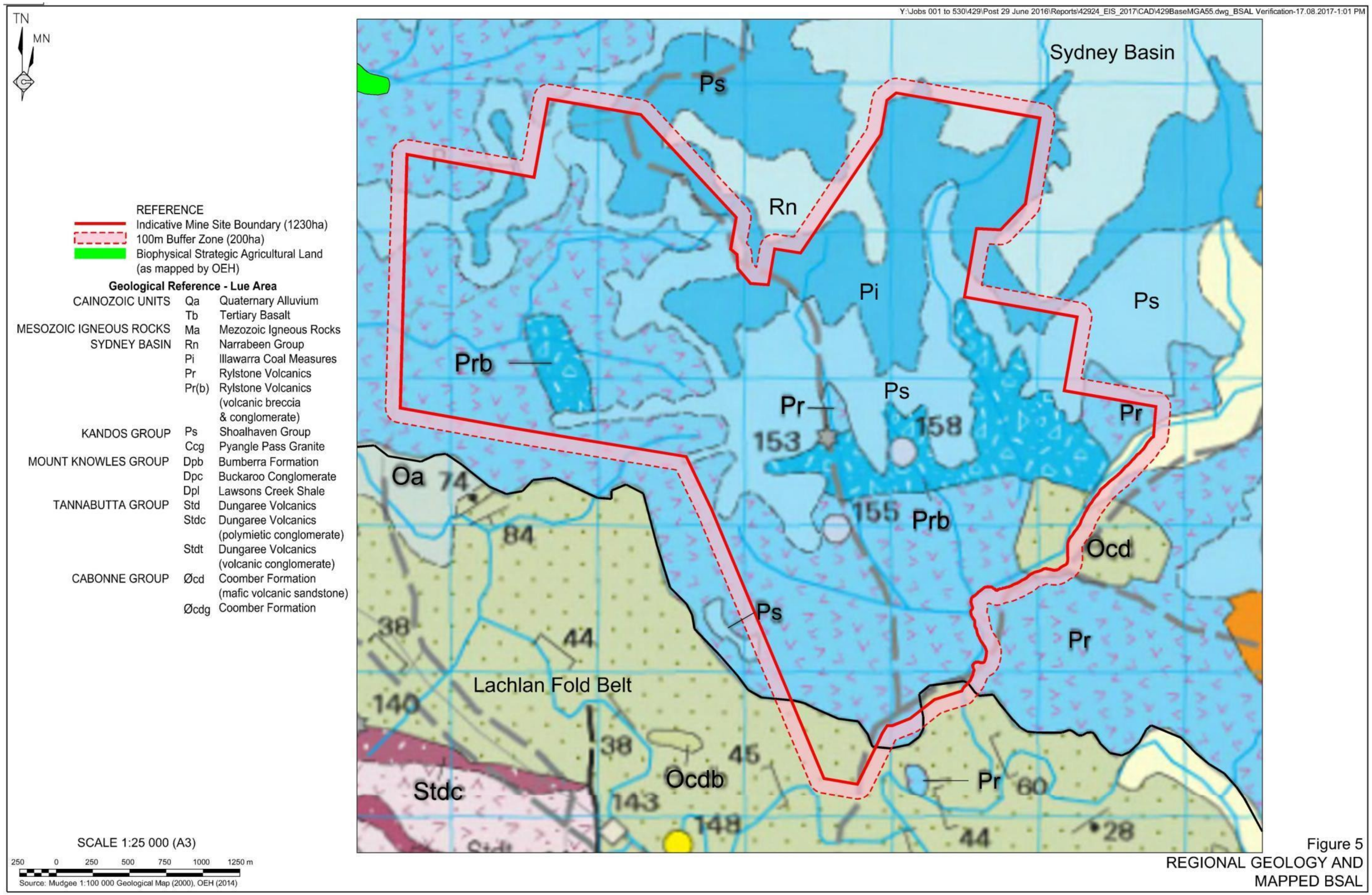

Figure 5
REGIONAL GEOLOGY AND MAPPED BSAL

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4. SITE BSAL VERIFICATION

4.1 INTRODUCTION

The Interim Protocol identifies BSAL as being land with a rare combination of natural resources which renders it as being highly suitable for agriculture as it is naturally capable of sustaining high levels of productivity whilst requiring minimal management practices to maintain this high quality. Regional mapping of BSAL identifies BSAL as meeting the following criteria.

- Access to a reliable water supply.
- Inherent General Fertility.
- Land and Soil Capability (LSC) Classes I or II as mapped by OEH.

The following subsections present a site specific assessment, as required the Interim Protocol for the identification / verification of BSAL.

4.2 IDENTIFICATION OF ASSESSMENT AREA

Figure 2 presents the Mine Site which encompasses an area of 1 230ha. In accordance with the Interim Protocol, **Figure 2** also presents an additional 100m buffer zone around the Mine Site to account for minor changes in design, surrounding disturbance and minor expansion. With the inclusion of this buffer zone, the total assessment area for the purposes of soils and landscape verification is approximately 1 430ha.

4.3 WATER SUPPLY RELIABILITY

A review of reliable rainfall mapping sourced from the NSW Department of Primary Industry – Water (DPI-Water, 2013) indicates that the Mine Site is situated in an area which receives in excess of 350mm per year in 9 out of 10 years.

This was further verified following a review of annual rainfall data verifying the coarse resolution mapping available from DPI-Water. This review identified that relatively continuous data was available from the Mudgee Airport automatic weather station operated by the Bureau of Meteorology (BoM) (BoM ID 62101), located approximately 25km from the Mine Site. Information from this station was available for the period 2007-2013 and 2015/2016. As annual rainfall data for 2014 was not available from Mudgee Airport AWS, this information was sourced from BoM's Windamere Dam station (BoM ID 62093) which is located approximately 12km from the Mine Site. The locations of both weather stations are displayed on **Figure 1**. It is recognised that Windamere Dam station is situated closer to the Mine Site however, the available information is less continuous over the period shown below than the Mudgee Airport AWS.

- 2007 – 723.8mm
- 2008 – 826.8mm
- 2009 – 471.8mm
- 2010 – 1152.4mm
- 2011 – 577.4mm
- 2012 – 738.2mm
- 2013 – 480.0mm
- 2014 – 719.8mm
- 2015 – 641.0mm
- 2016 – 883.4mm

The review of the BOM rainfall data for the most recent 10 year period identified that rainfall exceeded 350mm in each of the last 10 years.

Figure 6 provides a flow chart of the assessment of Site Water Reliability provided in the Interim Protocol with the outcome of the assessment highlighted in green.

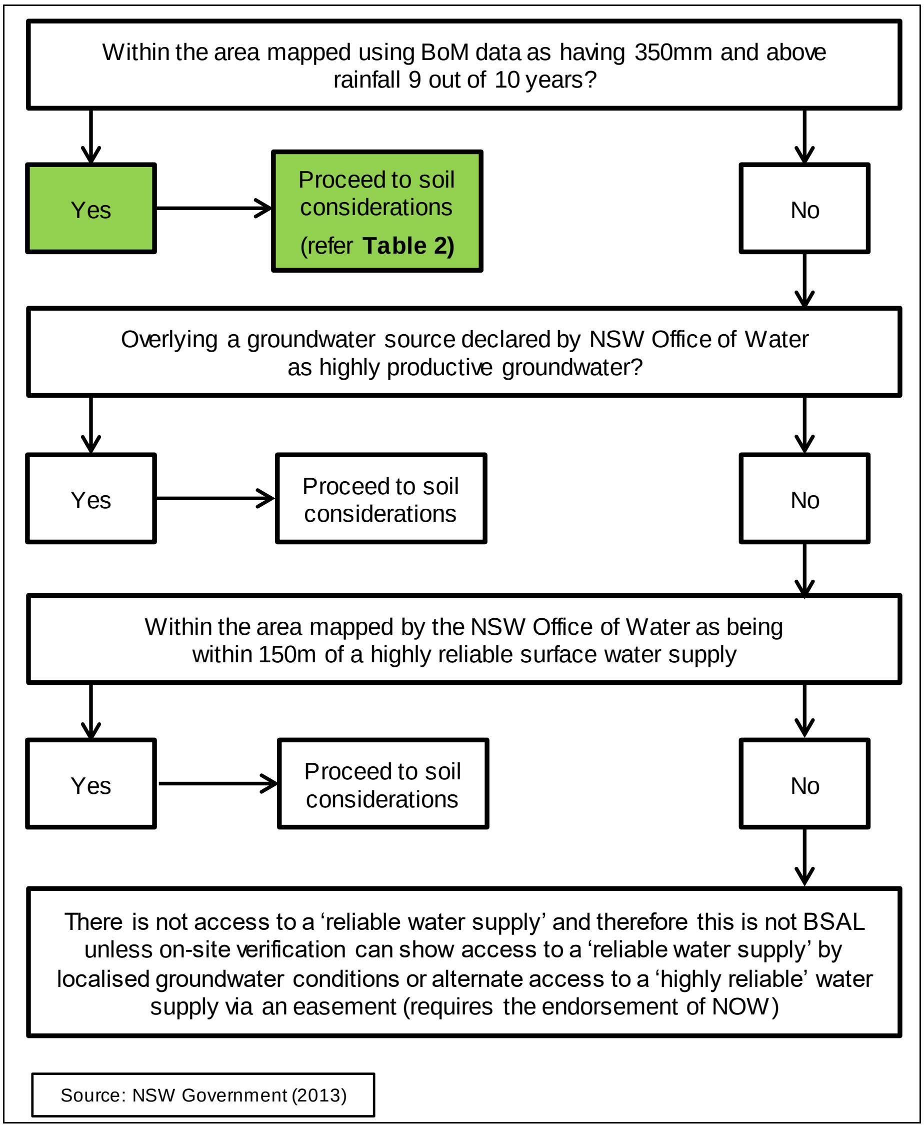


Figure 6
Assessment of Water Reliability

4.4 RISK ASSESSMENT / SOIL SAMPLING INTENSITY

A total of 39 backhoe pits (approximately 1.4m deep; shallower where hard rock was encountered) were assessed for this report. The locations of the pits are shown on **Figure 8**. The soil pits were located in a way that covered as many of the major variations in elevation and landforms as possible. The pits in the areas with slope <10% were on a flexible grid spacing of approximately 400m (approximately 1 pit per 16ha). This provided an intensity of sampling that satisfies the Interim Protocol nominated sampling density of 1 site per 5-25ha for intensive mining developments (see Gallant *et al.* 2008).

More importantly, the pit spacing allowed an assessment of the size of an area of BSAL to determine whether it met the minimum area requirement of 20ha, as described in the Interim Protocol, namely:

- one pit on its own that satisfied Steps 1 to 12 of the BSAL criteria (Section 5) – represents approximately 16ha, i.e. not above the BSAL threshold of 20ha; and
- two pits together that satisfied Steps 1 to 12 of the BSAL criteria (Section 5) – represents approximately 30ha, i.e. almost certainly above the BSAL threshold of 20ha.

This meant that all of the <10% slope field sites with a soil depth >75cm required laboratory analysis to determine whether or not each site actually had BSAL characteristics. Key soil factors such as salinity, sodicity and cation exchange capacity (CEC) cannot be measured or predicted accurately in the field.

In the steeper areas (>10%) where BSAL status can only be negative, a broader pit spacing of approximately 800m was used. This provided enough soil pits in each of the steep land Soil Landscape Units to satisfy the minimum requirement of three detailed soil pits per Soil Landscape Unit.

4.5 SITE SOILS AND LANDSCAPE

4.5.1 Slope Analysis

A LiDAR survey was commissioned by BSPL with the information collected in January 2016. LiDAR was selected as the most suitable method of information capture due to the varying degree of vegetative cover across the Mine Site. The LiDAR point information was processed to generate a digital elevation model which was interrogated to classify the terrain based on slope (>10% or <10%) and exclude areas from the BSAL assessment on this basis. **Figure 4** presents the results of the slope analysis to identify BSAL exclusion areas as a consequence of slope and presents the locations of the test pits selected for the site soil survey and test pit program.

4.5.2 Approach to Soil Description and Analysis

As the Mine Site is located within an area identified as having reliable rainfall, BSPL commissioned Soil Management Designs to conduct a site soils survey at the Mine Site in mid-February 2017 using soil test pits and to collect data for the assessment of BSAL.

The site soils survey was conducted by accredited soil scientists, Dr David McKenzie and Mr Adrian Harte, in conjunction with Mr Tom Purcell and Ms Sally Mayberry from BSPL. Dr McKenzie is a Certified Professional Soil Scientist (CPSS) and holds a PhD in Soil Science and has ‘Chartered Scientist’ accreditation with British Society of Soil Science.

A total of 39 soil test pit sites were located within the principal areas of proposed mining disturbance and the 100m buffer zone (refer **Figure 4**).

At each soil test pit site, a profile approximately 1.4m deep (shallower where hard rock was encountered) was excavated with a backhoe and trimmed with a geological pick for the capture of high resolution (4MB) SLR photography, physical inspection of the in situ soil structure and observation of plant root growth. In accordance with the Interim Protocol, soil samples were collected for submission to Incitec Pivot Werribee Laboratory, a NATA accredited laboratory for analysis. Results of the laboratory analyses are summarised in **Table 2** and presented in **Appendix 3**.

Details of field observations are presented in **Appendix 1**, soil compaction test results are presented in **Appendix 2** and the compilation of laboratory results are presented in **Appendix 3**. This information, along with photographs showing soil profiles and landscape views has also been submitted to NSW Office of Environment and Heritage via their eDIRT data entry software.

The following characteristics were assessed for the layers identified in each of the soil profiles:

- thickness of each layer (horizon);
- soil moisture status at the time of sampling;
- pH (using Raupach test kit);
- colour of moistened soil (using Munsell reference colours);
- pedality of the soil aggregates;
- amount and type of coarse fragments (gravel, rock, manganese oxide nodules);
- texture (proportions of sand, silt and clay), estimated by hand;
- presence/absence of free lime and gypsum;
- root frequency; and
- dispersibility and the degree of slaking in deionised water (after 10 minutes).

Site factors noted included current land use, landform, slope (measured with a SUUNTO clinometer), aspect, and surface rock.

The soil structure information (refer **Appendix 2**) has been summarised to give SOILpak ‘compaction severity’ scores (McKenzie, 2001). The score is on a scale of 0.0 to 2.0, with a score of 0.0 indicating very poor structure for crop root growth and water entry/storage. Ideally, the SOILpak score of the root zone should be in the range 1.5 to 2.0.

Hand texturing (National Committee on Soil and Terrain, 2009) provides an approximation of the clay content of a soil. In conjunction with the estimation of coarse fragment (gravel) content, it provides a low-cost alternative to particle size analysis.

Total available water (TAW) for the upper 1m of soil (refer **Appendix 1**) has been estimated using texture, structural form and coarse fragment content data (McKenzie *et al*. 2008).

All of the pits on land <10% slope and >75cm soil depth were sampled for laboratory analysis. The sampling intervals for laboratory analysis were as per the Interim Protocol, i.e. 0 to 5cm; 5 to 15cm, 15 to 30cm; 30 to 60cm and 60 to 100cm. Where important horizon boundaries did not coincide with these depth intervals, extra samples were taken to ensure that distinctive horizons (e.g. A2 horizons) were kept separate for analysis.

The soil samples were analysed for exchangeable cations, pH, EC, chlorides, nutrient status (nitrate-nitrogen, phosphorus, sulfur, zinc, copper, boron) and organic matter content (refer **Appendix 3**). An ammonium acetate method was used for the extraction of exchangeable cations. The CEC values are the sum of exchangeable sodium, potassium, calcium, magnesium and aluminium; exchangeable sodium data are presented as exchangeable sodium percentage (ESP). Phosphorus was determined using the Colwell method, sulphur by the CPC method, boron by a calcium chloride ($CaCl_2$ extraction) and zinc/copper by a DTPA extraction (see Rayment and Lyons (2011) for further details). These methods are compatible with the key components of the Interim Protocol.

Soil dispersibility, as measured by the Aggregate Stability in Water (ASWAT) test (Field *et al.* 1997), was assessed by Soil Management Designs in Orange, NSW. The results are presented in **Appendix 3**. The ASWAT test has been related to the well-known Emerson aggregate stability test by Hazelton and Murphy (2007) as shown in **Table 1** below.

Table 1
Comparison of Emerson Aggregate Class and ASWAT Test Score

Dispersibility	Emerson Aggregate Classes	Probable score for the ASWAT test (Field *et al.* 1997)
Very high	1 and 2(3)	12-16
High	2(2)	10-12
High to moderate	2(1)	9-10
Moderate	3(4) and 3(3)	5-8
Slight	3(2), 3(1) and 5	0-4
Negligible/aggregated	4, 6, 7, 8	0

An advantage of the ASWAT test is that the results can be linked with management issues such as the need for gypsum application and avoidance of wet working (McKenzie, 2013).

The conversion factors of Slavich and Petterson (1993) allowed the electrical conductivity of saturated paste extracts (EC_e) to be calculated from the EC of 1:5 soil:water suspensions ($EC_{1:5}$) and texture.

Figure 7 presents the flow chart and criteria considered for each of the soil test pits for the classification of BSAL.

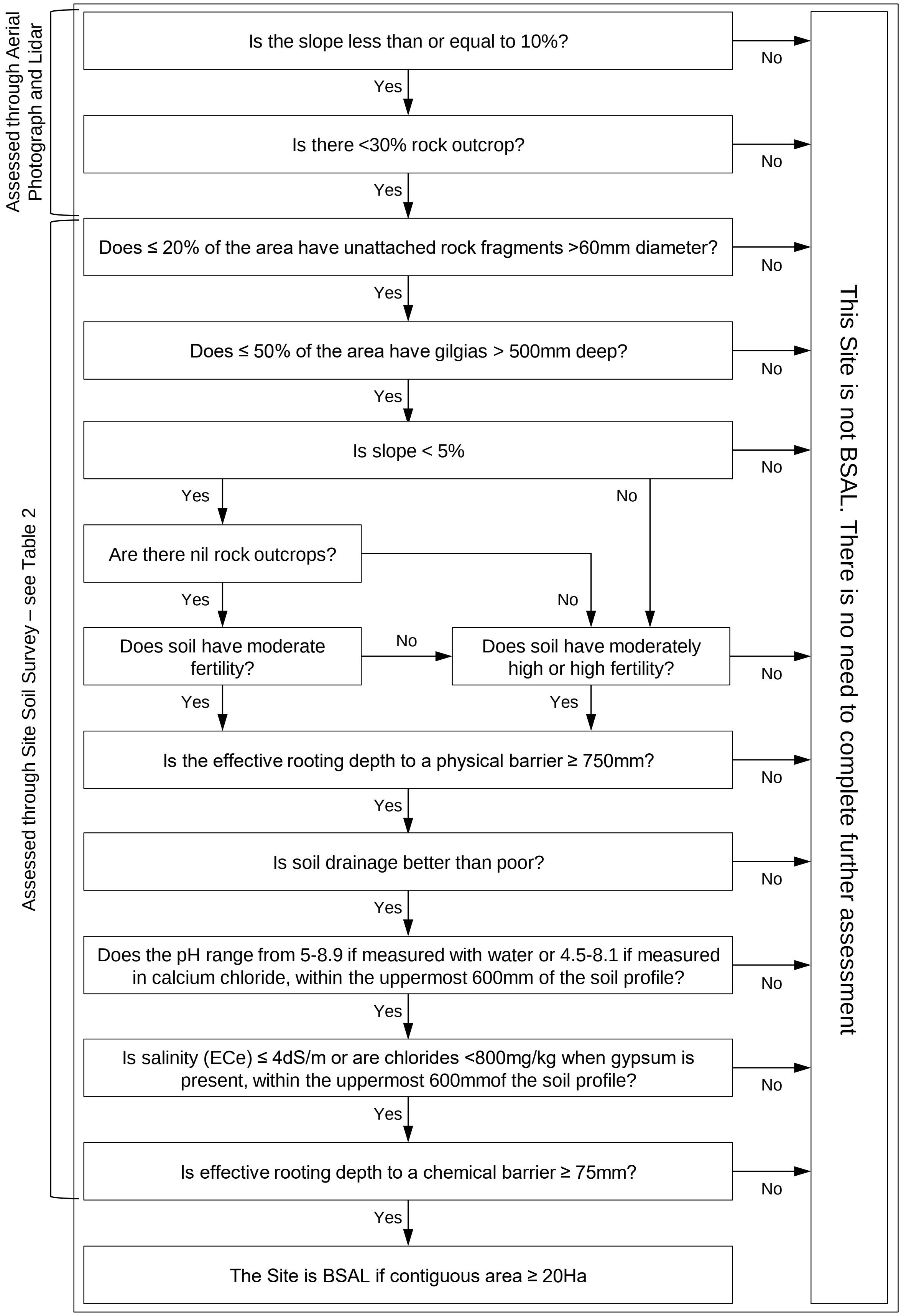
4.5.3 Soil Landscapes and Site Soil Types

4.5.3.1 Introduction

Seven Soil Landscape Units were identified during the site soils survey (refer **Figure 8**) with the dominant or co-dominant soil types subsequently being classified using the Australian Soils Classification. **Table 2** presents details on the occurrence (in brackets) of the dominant and subdominant soil types (Australian Soil Classification) for each of the Soil Landscape Units.

The Soil Landscape Unit is defined as an association of soils described and delineated by means of landforms (Dent and Young, 1981).

A soil landscape unit is considered here to be BSAL dominant if >70% of the soil landscape unit is comprised of soil type/s which meet the BSAL criteria.



Source: NSW Government (2013)

Figure 7
Flow Chart for Site Assessment of BSAL

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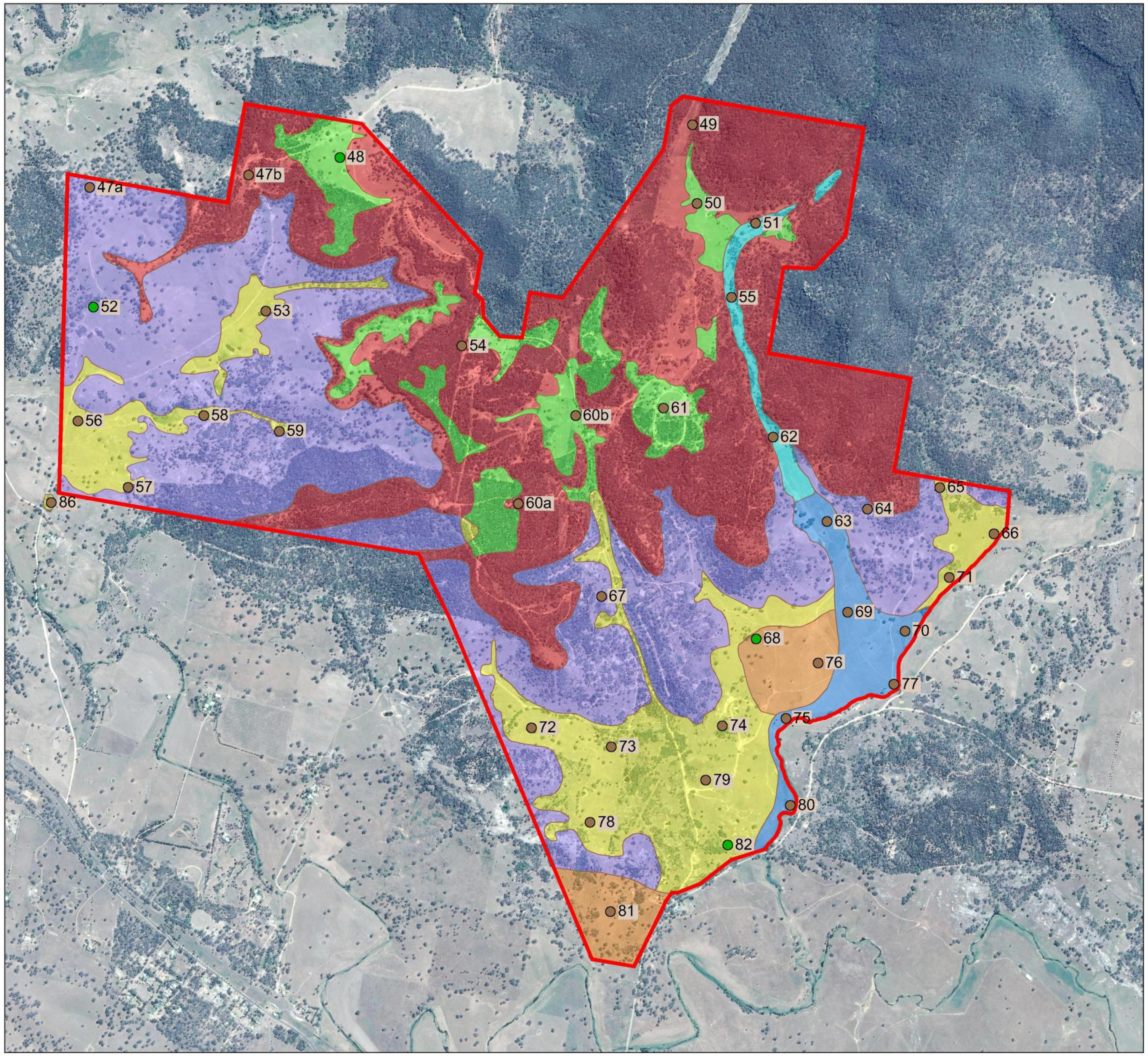

REFERENCE
Indicative Mine Site Boundary

Soil Test Pit Result
52 BSAL
70 Non BSAL

Soil Landscape Units
Sedimentary - steep land (>10%)
Sedimentary - gentle slope (<10%)
Acid volcanic - steep land (>10%)
Acid volcanic - gentle slope (<10%)
Ordovician shale
Alluvium - high quality
Alluvium - medium quality

SCALE 1:25 000 (A3)

250 0 250 500 750 1000 1250 m

Soils Source: Soil Management Designs
Base Photo Source: Google Earth - 6 December 2015

Figure 8
SOIL LANDSCAPE UNITS AND
SOIL TEST PITS RESULTS

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Table 2
Soil Types Associated with the Soil Landscape Units

Soil Landscape Unit	Number of sites described	Dominant soil type(s)	Sub-Dominant soil type(s)
Sedimentary – steep land	3	Kurosol (2)	Tenosol (1)
Sedimentary – gentle slope	5	Tenosol (2) Chromosol (2)	Kurosol (1)
Acid volcanic – steep land	4	Chromosol (2)	Dermosol (1), Rudosol (1)
Acid volcanic – gentle slope	15	Kurosol (4)	Sodosol (3), Dermosol (4), Tenosol (2), Chromosol (1) Rudosol (1)
Ordovician shale	3	Dermosol (3)	
Alluvium – high quality	3	Stratic Rudosol (3)	
Alluvium – moderate quality	6	Chromosol (2) Sodosol (2)	Dermosol (1), Hydrosol (1)

A brief summary and photograph of a representative soil test pit for each dominant or co-dominant soil type for the respective Soil Landscape Units is presented as follows.

4.5.3.2 Sedimentary – steep land

Site Description - Kurosol

Soil Test Pit 47B	Landscape view, soil test pit 47B
Australian Soil Classification	Kurosol
Representative Soil Test Pits	47B, 49, 54
Dominant Slope Association	>10%
Land Use	Grazing
Soil Fertility	Low to moderately low
BSAL	No

4.5.3.3 Sedimentary – gentle slope (co-dominant)

Site Description - Tenosol	
	
Soil Test Pit 61	**Landscape view, soil test pit 61**
Australian Soil Classification	Tenosol
Representative Soil Test Pits	60A, 61
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Low
BSAL	No

Site Description - Chromosol

Soil Test Pit 48	Landscape view, soil test pit 48
Australian Soil Classification	Chromosol
Representative Soil Test Pits	48, 50
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately high (Chromosol)
BSAL	No

4.5.3.4 Acid volcanic – steep land

Site Description - Chromosol

Soil Test Pit 47A	**Landscape view, soil test pit 47A**
Australian Soil Classification	Chromosol
Representative Soil Test Pits	47A, 59, 64, 67
Dominant Slope Association	>10%
Land Use	Grazing
Soil Fertility	Moderately high - low
BSAL	No

4.5.3.5 Acid volcanic – gentle slope

Site Description - Kurosol	
	
Soil Test Pit 58	**Landscape view, soil test pit 58**
Australian Soil Classification	Kurosol
Representative Soil Test Pits	52, 53, 56, 57, 58, 65, 66, 71, 72, 73, 74, 78, 79, 82, 86
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately high - low
BSAL	No

4.5.3.6 Ordovician shale

Site Description - Dermosol	
	
Soil Test Pit 68	**Landscape view, soil test pit 68**
Australian Soil Classification	Dermosol
Representative Soil Test Pits	68, 76 and 81
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately high
BSAL	No

4.5.3.7 Alluvium – high quality

Site Description – Stratic Rudosol

Soil Test Pit 62	Landscape view, soil test pit 62
Australian Soil Classification	Stratic Rudosol
Representative Soil Test Pits	51, 55 and 62
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately low
BSAL	No

4.5.3.8 Alluvium – moderate quality

Site Description - Chromosol	
	
Soil Test Pit 69	**Landscape view, soil test pit 69**
Australian Soil Classification	Chromosol
Representative Soil Test Pits	69, 80
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately high
BSAL	No

Site Description - Sodosol	
	
Soil Test Pit 70	**Landscape view, soil test pit 70**
Australian Soil Classification	Sodosol
Representative Soil Test Pits	70, 77
Dominant Slope Association	<10%
Land Use	Grazing
Soil Fertility	Moderately low
BSAL	No

4.6 BSAL ASSESSMENT

The assessment has identified that no Soil Landscape Unit identified within the Mine Site has soil and landscape features which satisfy all criteria required for classification as BSAL (refer **Table 3**). The findings of the on-site BSAL assessment are summarised as follows.

- Whilst four of the 39 soil test pits investigated were identified as having soils which displayed BSAL characteristics (48, 52, 68 and 82, refer **Figure 8**), these test pit sites were not adjacent to one another and therefore do not form a single contiguous area greater than 20ha.
- Of the Soil Landscape Units identified during the assessment, none met the threshold for declarable BSAL whereby at least 70% of the soil test pits must meet the BSAL criteria.
- Of the isolated soil test pit sites which did exhibit BSAL characteristics, the following information was obtained.
  - Site 48 was the only soil test pit from the 'Sedimentary-gentle slope' Soil Landscape Unit that met BSAL criteria.

- Site 68, was the only soil test pit from the 'Ordovician shale' Soil Landscape Unit which met the BSAL criteria, however, this Soil Landscape Unit is not classified as BSAL as two of the three soil test pits were non-BSAL due to the presence of rock at depths less than 75cm.
- Sites 52 and 82 were the only soil test pits from 'Acid volcanic-gentle slope' Soil Landscape Unit that could be classified as BSAL however the remaining 10 soil test pits of this Soil Landscape Unit did not meet BSAL criteria.
- Soil test pits 51, 55 and 62 of the 'Alluvium-high quality' Soil Landscape Unit were classified as non-BSAL as this unit was identified as being a "Stratic Rudosol" under the Australian Soil Classification. The Interim Protocol considers "Stratic Rudosols" as being non-BSAL however, should this soil type ever be considered "moderate or higher" fertility" under the Interim Protocol (**Appendix 2**) interpretation of the Australian Soil Classification, this Soil Landscape Unit would remain classified as non-BSAL as it covers an area which fails to meet the minimum 20ha BSAL threshold.

As a consequence of the above, a Site Verification Certificate is sought to acknowledge that no BSAL is present within the Mine Site.

Table 3
Bowdens Silver Project BSAL Soil Data

Soil Landscape Unit (SLU)	Map ID	Slope (%)	Rockiness & Gilgai				Phys Barrier	Waterlogging (cm)			Chemical Barrier												Australian Soil Classification				BSAL Status	SLU with >70% of pits as BSAL?	LSC Class
											Acidity pH CaCl2				ESP				Salinity ECe, dS/m										
			Rock Outcrop	Rock Frag. %	size (mm)	Gilgai	Depth to >90% rock (cm)	Depth to >10% mottles	Depth to >20% Mn	Depth to waterlogged layer	0-5cm	5-15cm	15-30cm	30-60cm	0-5cm	5-15cm	15-30cm	30-60cm	0-5cm	5-15cm	15-30cm	30-60cm	Great Group	Suborder	Order	Fertility Status			
Sedimentary - steep	47B	12	0	2	20	no	140	60	-	60	4.3	4.3	4.3	4.1	0.8	0.5	0.6	1.1	0.41	0.28	0.10	0.10	Magnesic	Red	Kurosol	Moderately Low	No	No	5
Sedimentary - steep	49	18	0	0	0	no	140	60	-	60	4.7	4.9	4.9	4.5	1.1	0.4	0.6	3.7	0.55	0.55	0.41	0.41	Magnesic	Brown	Kurosol	Moderately Low	No		4
Sedimentary - steep	54	23	0	0	0	no	100	-	-	-	4.0	4.0	4.1		2.0	3.0	2.1		0.41	1.93	0.43		Lithic	Leptic	Tenosol	Low	No		6
Sedimentary - gentle slope	48	8	0	0	-	no	140+	120	-	120	5.1	5.2	5.7	6.2	0.7	0.1	0.1	0.5	0.97	0.55	0.17	0.17	Eutrophic	Red	Chromosol	Moderately High	Yes	No	3
Sedimentary - gentle slope	50	4	0	0	-	no	140+	45	-	45	5.8	6.4	5.9	6.2	2.0	1.9	1.3	1.6	0.76	0.67	0.38	0.18	Eutrophic	Grey	Chromosol	Moderately High	No		6
Sedimentary - gentle slope	60A	5	0	1	60	no	30	-	-	-	4.0	4.0	4.0		2.4	2.7	3.3		0.19	0.29	0.29		Lithic	Leptic	Tenosol	Low	No		6
Sedimentary - gentle slope	60B	4	0	0	0	no	70	40	-	40	5.4	4.8	4.7	4.5	1.4	1.8	2.4	4.4	0.67	0.76	0.26	0.52	Mesotrophic	Red	Kurosol	Moderate	No		6
Sedimentary - gentle slope	61	3	0	5	20	no	50	-	-	-	4.2	4.1	4.0	4.1	0.3	0.3	1.0	0.3	0.41	0.28	0.19	0.19	Lithic	Bleached - Leptic	Tenosol	Low	No		5
Acid volcanic - steep	47A	14	0	15	30	no	100	50	-	50	5.3	5.7	6.0	5.7	0.1	0.1	0.1	0.4	0.69	0.69	0.26	0.26	Eutrophic	Red	Chromosol	Moderately High	No	No	4
Acid volcanic - steep	59	14	0	0	-	no	30	-	-	-	5.3	4.5	4.2		0.1	0.2	0.6		1.14	0.45	0.14		-	Leptic	Rudosol	Low	No		6
Acid volcanic - steep	64	26	0	20	25	no	100	-	-	-	4.7	4.6	4.4	4.7	0.3	0.1	0.5	0.6	0.55	0.55	0.28	0.14	Mesotrophic	Yellow	Dermosol	Moderately High	No		6
Acid volcanic - steep	67	17	0	0	-	no	130	-	40	40	5.4	5.1	5.2	5.4	1.2	0.2	0.2	1.1	0.55	0.41	0.26	0.26	Mesotrophic	Red	Chromosol	Moderately High	No		6
Acid volcanic - gentle slope	52	9	0	5	20	no	140+	-	-	-	5.1	5.6	5.9	5.9	0.1	0.1	0.3	0.1	0.57	0.57	0.29	0.18	Eutrophic	Red	Dermosol	Moderately High	Yes	No	3
Acid volcanic - gentle slope	53	8	0	0	-	no	140+	30	-	30	4.5	4.6	5.5	6.7	1.3	1.1	1.3	3.7	2.76	0.69	0.41	0.47	Eutrophic	Brown	Chromosol	Moderately High	No		6
Acid volcanic - gentle slope	56	3	0	0	0	no	60	40	-	40	4.2	4.3	4.4	5.7	1.6	2.2	2.0	6.0	0.41	0.28	0.28	0.17	Mottled-Subnatric	Brown	Sodosol	Moderately Low	No		6
Acid volcanic - gentle slope	57	4	0	20	10-40	no	90	70	-	70	4.6	5.0	4.6	4.3	0.2	0.2	1.7	5.0	0.97	0.55	0.30	1.50	Eutrophic	Red	Kurosol	Moderate	No		5
Acid volcanic - gentle slope	58	8	0	0	-	no	140	-	-	-	4.9	5.3	5.3	4.2	1.8	1.8	1.7	4.0	0.55	0.41	0.28	0.23	Mesotrophic	Grey	Kurosol	Moderate	No		4
Acid volcanic - gentle slope	65	3	0	0	0	no	80	-	-	-	4.5	4.3	4.6	4.7	3.1	2.1	2.2	2.4	0.10	0.38	0.17	0.09	Mesotrophic	Grey	Dermosol	Moderately High	No		4
Acid volcanic - gentle slope	66	8	0	0	-	no	110	-	-	-	4.7	4.7	4.4	4.8	0.3	0.5	3.4	13.8	0.41	0.28	0.19	0.43	Mesonatric	Red	Sodosol	Moderately Low	No		4
Acid volcanic - gentle slope	71	1	0	0	-	no	140+	100	-	110	5.0	5.3	5.8	6.6	4.8	16.1	25.5	31.7	1.05	2.66	4.82	4.04	Mottled-Hypernatric	Grey	Sodosol	Moderately Low	No		4
Acid volcanic - gentle slope	72	7	0	1	20	no	80	45	-	45	4.4	4.0	4.2	4.1	0.9	0.3	1.2	2.5	0.97	0.55	0.41	0.26	Mesotrophic	Grey	Kurosol	Moderate	No		6
Acid volcanic - gentle slope	73	6	0	1	30	no	65	40	-	40	4.7	4.5	4.6	4.3	0.2	0.2	0.2	0.3	0.83	0.55	0.28	0.17	Mesotrophic	Grey	Kurosol	Moderate	No		6
Acid volcanic - gentle slope	74	8	0	1	40	no	45	-	-	-	4.4	4.4	4.3	4.2	0.2	0.2	0.2	0.2	0.69	0.55	0.41	0.14	Lithic	Leptic	Tenosol	Low	No		6
Acid volcanic - gentle slope	78	6	0	2	40	no	30	-	-	-	5.0	4.6	4.5	4.3	1.9	0.1	0.2	0.3	1.52	0.97	0.69	0.10	-	Leptic	Rudosol	Low	No		6
Acid volcanic - gentle slope	79	4	0	1	30	no	35	-	-	-	4.2	4.3	4.2		0.2	0.1	0.1		0.55	0.55	0.26		Lithic	Leptic	Tenosol	Low	No		6
Acid volcanic - gentle slope	82	5	0	0	-	no	100	-	-	-	5.1	4.7	4.9	4.9	0.7	0.2	0.3	0.3	0.38	0.38	0.28	0.10	Mesotrophic	Red	Dermosol	Moderately High	Yes		3
Acid volcanic - gentle slope	86	7	0	2	50	no	60	-	-	-	4.5	4.4	4.7	5.4	0.4	1.3	1.0	1.6	0.55	0.41	0.28	0.10	Dystrophic	Brown	Dermosol	Moderate	No		4
Ordovician shale	68	8	0	0	0	no	90	-	-	-	4.7	5.4	5.4	5.8	0.2	0.2	0.2	0.2	0.43	0.34	0.17	0.17	Mesotrophic	Red	Dermosol	Moderately High	Yes	No	3
Ordovician shale	76	6	0	1	40	no	70	35	-	35	4.7	4.8	5.1	6.9	0.8	1.2	2.1	3.3	1.52	1.05	0.67	0.86	Mesotrophic	Red	Dermosol	Moderately High	No		6
Ordovician shale	81	7	0	1	30	no	30	-	-	-	5.7	4.9	5.1	5.1	2.6	1.6	7.4	16.5	0.60	0.45	0.26	0.52	Mesotrophic	Brown	Dermosol	Moderately High	No		6
Alluvium - high quality	51	3	0	0	-	no	140+	-	-	-	5.0	5.2	5.0	5.1	0.2	0.2	0.3	0.2	0.69	0.41	0.28	0.45	-	Stratic	Rudosol	Moderately Low	No	No	4
Alluvium - high quality	55	2	0	1	30	no	140+	-	-	-	4.7	5.0	5.2	5.5	0.1	0.4	0.1	0.3	0.97	0.41	0.28	0.19	-	Stratic	Rudosol	Moderately Low	No		4
Alluvium - high quality	62	2	0	1	40	no	140+	-	-	-	4.8	4.7	5.1	5.5	1.4	0.3	0.1	0.2	1.14	0.45	0.28	0.28	-	Stratic	Rudosol	Moderately Low	No		5
Alluvium - moderate quality	63	3	0	0	-	no	100+	80	-	80	5.9	4.5	4.7	5.5	4.9	3.7	3.4	3.5	2.47	1.52	1.05	0.80	Chromosolic	Oxyaquic	Hydrosol	Moderately Low	No	No	3
Alluvium - moderate quality	69	2	0	0	-	no	140+	50	-	50	4.7	4.4	4.4	4.6	0.7	2.4	1.1	1.3	1.24	0.55	0.28	0.17	Mesotrophic	Grey	Chromosol	Moderately High	No		4
Alluvium - moderate quality	70	1	0	0	-	no	140+	110	-	110	4.5	4.7	5.0	6.4	3.8	3.3	5.0	15.0	2.00	0.76	0.34	0.53	Mesonatric	Grey	Sodosol	Moderately Low	No		5
Alluvium - moderate quality	75	1	0	0	-	no	130+	35	-	35	4.9	4.6	4.9	5.3	1.0	1.0	0.7	2.4	2.49	0.86	0.34	0.23	Mesotrophic	Black	Dermosol	Moderately High	No		6
Alluvium - moderate quality	77	2	0	0	0	no	130+	60	-	60	4.7	4.8	4.9	6.3	4.4	6.9	8.4	16.4	1.14	0.95	0.67	2.39	Mottled-Mesonatric	Black	Sodosol	Moderately Low	No		4
Alluvium - moderate quality	80	1	0	0	-	no	140+	70	-	70	4.8	4.7	5.0	5.4	1.2	2.0	2.2	4.6	0.86	0.43	0.26	0.20	Mesotrophic	Black	Chromosol	Moderately High	No		4

BSAL status for soil factor is not achieved

"Moderate fertility" soil type that is non BSAL if situated on slope between 5% to 10%

BSAL status for soil factor is achieved

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