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Rixs Creek Continuation of Mining Project

Soils and Land Impact Assessment

Report Number 630.10803

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Rixs Creek Pty Limited

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Rixs Creek Continuation of Mining Project

Soils and Land Impact Assessment

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1 INTRODUCTION

Rix's Creek Pty Limited engaged SLR Consulting Australia Pty Ltd to undertake a Soils and Land Resource Assessment for the Rix's Creek Continuation of Mining Project (the Project). It has been prepared as part of the Environmental Impact Statement (EIS) required to accompany the application to the NSW Department of Planning and Infrastructure (DP&I) for development consent under Part 4 of the *Environmental Planning and Assessment Act 1979*.

1.1 Rix's Creek Continuation of Mining Project

This section provides an introduction to the Rix's Creek Mine, the proposed Rix's Creek Continuation of Mining Project (the Project), and the purpose and content of this report.

1.1.1 Overview

Rix's Creek Mine (the Mine) of Rix's Creek Pty Limited, is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Mine is an open cut coal mine approximately 5 km north-west of Singleton in the Hunter Valley Coalfields of NSW. The Mine currently produces approximately 1.5 million tonnes per annum (Mtpa) of product coal from its existing operations.

Bloomfield is seeking approval for the Rix's Creek Continuation of Mining Project (the Project), which relates to the continued operation of the existing open cut coal mine. The Project would allow the Mine to continue to operate as an open cut mine, accessed via its existing infrastructure facilities.

The Project seeks to extend the life of the existing open cut mining operation at Rix's Creek until approximately 2037. The continuation of mining operations will extend in a north-westerly direction and require a modification to Mine Lease 1432 for an out of pit dump. The continuation of operations will utilise the existing mine access, Coal Handling and Preparation Plant, coal stockpiling and rail facilities.

1.1.2 Proposed Development

The Project seeks to continue the existing mining operation at the Mine and to mine up to 4.5Mtpa ROM coal per year. Mining methods will be the same as those currently employed at the Mine, being multi-seam bench open cut techniques. Run of mine (ROM) coal will continue to be processed onsite at the existing CHPP which has capacity to accept the proposed increase in throughput. Product coal will then be transported by rail to the Port of Newcastle. It is estimated that the Mine could yield a total of 32 million saleable tonnes of coal at an overburden ratio of approximately 10.5:1 before coal seams are exhausted.

The components of the proposed development comprise:

- The ongoing use of, and future additions to, the existing mine fleet;
- Use of the existing mine infrastructure facilities including the CHPP;
- Continuation of operating hours - 24 hours a day 7 days a week;
- Use of existing and new rejects and tailings emplacements;
- Rail transport of product coal to the Port of Newcastle;
- Mine closure and rehabilitation; and
- Environmental management.

1.2 Purpose of the report

1.2.1 Director-General's Requirements

The Rix's Creek Continuation of Mining Project Environmental Impact Statement has been prepared in accordance with Division 4.1, Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) which ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision-making process.

In preparing this Soils and Land Impact Assessment, the Director–General's Requirements (DGRs) issued for the Rix's Creek Continuation of Mining Project (SSD 13_6300) on 3 March 2014 have been addressed as required by Clause 75F of the EP&A Act. The key matters raised by the Director-General for consideration in the Soils and Land Impact Assessment are outlined in **Table 1** along with a reference to where the requirements are addressed in the report.

Table 1 Director General Requirements Applicable to the Soils and Land Impact Assessment

Director General Requirement		Section Addressed
Soils and Land Impact Assessment	Land Resources - including an Agricultural Impact Statement and a detailed description of the potential impacts on: • soils and land capability (including salinity and contamination, as well as a summary of the information used to obtain a site verification certificate);	Section 3 Soil Survey plus separate BSAL Verification Report.
	• landforms and topography (including steep slopes); and	Section 4 Land and Soil Capability Assessment
	• other land uses within the vicinity of the mine, (including agricultural, forestry, conservation and recreational use).	Section 2 Existing Environment

1.2.2 Soils and Land Impact Assessment Objectives

The 339.5 ha study area is proposed to be utilised for an out of pit overburden emplacement area. This soil assessment has been undertaken to identify the soil types present on the site and to quantify the amount of material suitable for re-use in rehabilitation. A further assessment was made on the land and soil capability of the study area to provide an understanding as to the quality of agricultural land on site. Appended to this report is the BSAL verification report, which was undertaken in accordance with the interim protocol for site verification of BSAL (OEH 2013).

1.3 Report Structure

This report is structured as follows:

Section 1 Introduction – outlines the Project and presents the purpose of this report.

Section 2 Existing Environment

Section 3 Soil Survey – describes the methodology of the soil field survey, its results and describes potential impact resulting from the proposed project.

Section 4 Land Capability Impact Assessment – describes the methodology of the land capability impact assessment, its results and describes potential impact resulting from the proposed project.

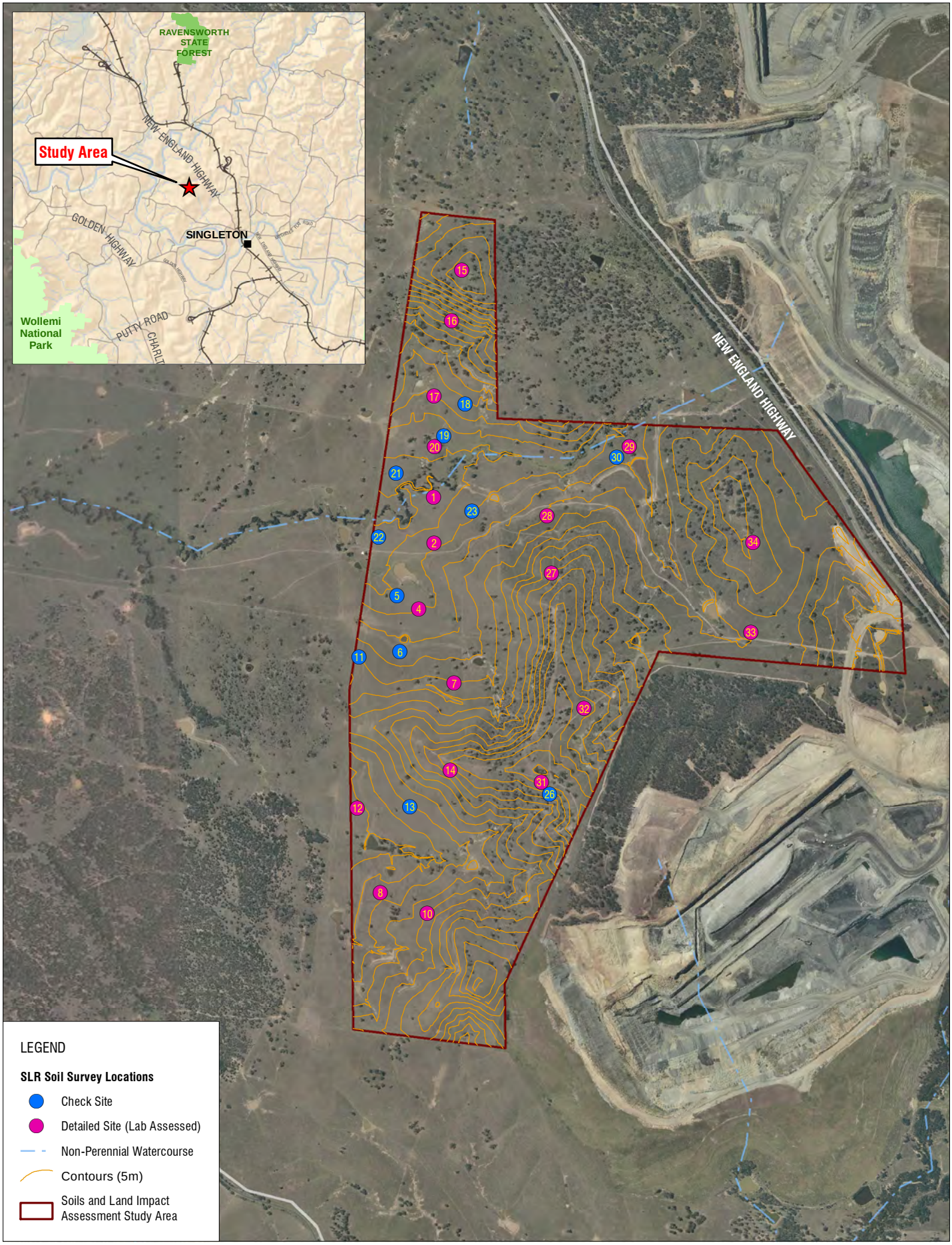
Section 5 Disturbance Management – provides a summary of the environmental mitigation and management recommendations

Section 6 Conclusion

Section 7 References

Appendix A Certificate of Analyses – Results of soil analyses from NATA accredited laboratory used to complete this Soils and Land Impact Assessment

Appendix B BSAL Verification Report



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Rix's Creek Soils and Land Impact Assessment

Regional Locality

FIGURE 1

2 EXISTING ENVIROMENT

2.1 Climate

The Study Area is located in the Hunter Valley region of NSW, typically having a cool temperate climate with moderately dry winters and wetter summers. The annual average rainfall is 665.1 mm with the majority of this rainfall falling in the summer months of December to February (Singleton STP) Bureau of Meteorology (BOM) station No. 061397, 2015).

Temperatures within the region range from an average monthly maximum of 31.7 ^{0}C in January to an average monthly minimum of 4.2^{0}C in August (Singleton STP) Bureau of Meteorology (BOM) station No. 061397, 2015). The average annual evaporation within the Project Boundary ranges between 1400 - 1800 mm (Average pan Evaporation (Annual) Map 2008 BOM Product Code: IDCJCM0006) (BOM, 2008; 2012).

2.2 Topography and Hydrology

The Study Area is located within the Hunter River catchment, specifically the Hunter Residual sub-catchment. The topography within the Study Area is typical of the Central Lowlands topographic zone, with rounded, undulating low hills underlain by Permian mudstones, sandstone, shale, siltstone, conglomerate and coal. Elevation through the region ranges from 20 to 330 m.

2.3 Soil Landscapes

Rix's Creek Mine is located in the Central Lowlands topographic zone within the Sydney Basin geological province. The soil landscapes units within the Study Area have been mapped by the former NSW Department of Land and Water Conservation, incorporating the NSW Soil Conservation Service (now part of the DPI), at the scale of 1:250,000 (Kovac & Lawrie, 1991). The soil landscape units, as described by this publication are 'areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements'. The soil landscape units that occur within the Study Area are:

- Roxburgh Soil Landscape, covering approximately 97% of the Study Area. The Roxburgh soil landscape describes soils that have formed from Permian Singleton Coal Measures on elevations 80 to 370m and slopes 0 to 10% with 60-120 m local relief. These measures also comprise sandstone, shale, mudstone, conglomerate and coal which has in situ weathered parent rock material derived from colluvium. The Roxburgh unit covers undulating low hills and undulating hills with minor to moderate sheet erosion. Soils are primarily Yellow Podzolic soils (Chromosols) on upper to midslopes with Red Solodic soils (Sodosols) and Brown Podzolic soils on upper concave slopes, and Lithosols (Rudosols/Tenosols) on steeper slopes. This soil landscape occurs within approximately 229 ha (97%) of the Study Area.
- Sedgefield Soil Landscape, covering approximately 3 % of the Study Area; The Sedgefield soils landscape consists of undulating low hills with elevations from 60-170 m. Slope gradients are approximately 6%, with local relief of 40-60 m. The landscape is mostly tall open-forest. The soils are dominated by Yellow Soloths (Kurosols/Sodosols) on upper to midslopes and Yellow Solodic Soils on lower slopes and drainage lines (Sodosols). Black Soloths also occur in seepage areas on slopes. Limitations to this unit include severe gully and sheet erosion and highly dispersible subsoils. This soil landscape occurs throughout 10 ha (3%) of the Study Area.

2.4 Land Use

Current land use is predominately low intensity cattle grazing, with some fenced areas excluding stock undergoing natural regrowth. The grazing land comprises predominately improved pasture grasses.

3 SOIL SURVEY

3.1 Soil Survey Methodology

The following resources and techniques were used as an initial examination of the Study Area:

- Satellite imagery and topographic maps;

  Satellite imagery and topographic map interpretation was used as a remote sensing technique allowing analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the Study Area.

- Reference information;

  Source materials, including cadastral data, prior and current physiographic, geological, vegetation, and water resources studies were used to obtain correlations between pattern elements and soil properties that may be observable in the field. Land resource mapping and soil surveys of the area were utilised to assist in defining boundaries of units and classes at a more intensive scale included:

  Soil Landscape of the Singleton1:250 000 Sheet (Kovac & Lawrie, 1990).

  Land and Soil Capability Mapping of NSW OEH 2014.

3.1.1 Survey Scale

SLR undertook a field survey to map the soil types within the Study Area. The field survey undertaken was an integrated free survey. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (NSCT, 2008). Survey points are irregularly located according to the survey teams' judgement to enable the delineation of soil. Soil boundaries can be abrupt or gradual, and catena and toposequences are used to aid the description of gradual variation.

The soil survey was conducted at a 1:25,000 scale in accordance with McKenzie et al (2008). This scale requires that an observation is taken every 5 to 25 ha. Based on this, the Study Area (339.5 ha) required a minimum of 14 observations. The survey made 34 observations which equates to one every 10ha which satisfies a 1:25,000 scale.

3.1.2 Survey Observations

To satisfy the survey requirements the field survey was comprised of 34 sites and included the following:

- 22 Detailed Sites: includes a subset of 20 representative sites that were laboratory analysed; and

- 12 Check Sites: includes profile excavations that are not fully described, soil profile exposures from overturned trees, rock outcrops and vegetation associations.

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 soil corer to the required depth of 1.2 m, or to bedrock. After assessment, soil cores have been backfilled with the remaining soil. Detailed soil profile morphological descriptions recorded information that covered the parameters specified in **Table 2.**

Table 2 Detailed Soil Profile Description Parameters

Descriptor	Application
Horizon depth	Weathering characteristics, soil development
Field colour	Permeability, susceptibility to dispersion/erosion
Field texture grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary distinctness and shape	Erosional/dispositional status, textural grade
Consistence force	Structural stability, dispersion, ped formation
Structure pedality grade	Soil structure, root penetration, permeability, aeration
Structure ped and size	Soil structure, root penetration, permeability, aeration
Stones – amount and size	Water holding capacity, weathering status, erosional/depositional character
Roots – amount and size	Effective rooting depth, vegetative sustainability
Ants, termites, worms etc.	Biological mixing depth

Soil Laboratory Assessment

Soil samples were sent to the laboratory for analysis to assist in the classification of soil taxonomic classes and assist in the assessment of BSAL classification.

Soil samples were collected from each major soil horizon and at appropriate depths. Typically depths were 0-10 cm, 20-30 cm, 50-60 cm and 80-90 cm. In total 71 samples were sent to the Scone Research Centre (NSW, Australia) for analysis for the suite of parameters as listed in Table 3. This laboratory is National Association of Testing Authority (NATA) accredited (**Appendix 1**).

Table 3 Detailed Soil Profile Description Parameters

Laboratory Analysis
• Electrical conductivity (EC) • pH (1:5) • Exchangeable cations • Cation exchange capacity (CEC) • Particle size Analysis* • Colour^ • Emerson Aggregate Test

*Soil texture in Section 3 has been the gravel content adjusted for to determine soil texture in accordance with the soil texture triangle

^laboratory colour is used except when mottling is greater than 20% as field colour more accurately assess primary colour and dominant mottle colour.

Check Sites

Check sites were assessed and comprise of soil pits, exposed soil (such as cut slopes), topsoil exposure of up to 0.3 m using a spade and exposed soil profiles from roots.

Soil Classification Nomenclature

The applicable technical standard for naming the units of soil identified is the ASC system (Isbell, 1996).

3.2 Soil Survey Results

3.2.1 Soil Type 1: Subnatric Brown Sodosols

The Subnatric Brown Sodosols dominated the study area and were located on the creeklines, flats, lower slopes, midslopes and on the ridgeline in the north. These soils varied in topsoil depth from 0.1m to 0.3m, with an abrupt to clear boundary to the clay subsoil. Sodicity within the upper section of the subsoil ranged from 7.5 ESP to 16.7 ESP, reaching 25.8 ESP in the lower profile of one site. Stripping recommendations are made providing the options for ameliorating the moderately sodic material. **Table 4** and **Table 5** provide a summary and analysis of this soil type.

Table 4 Subnatric Brown Sodosol (Summary)

Site Description	
 **Plate 1 –** Profile (Site 17)	 **Plate 5 –** Landscape (Site 17)
ASC Name	Subnatric Brown Sodosol
Representative Sites	1,2,4,5,6,7,8,12,13,15,16,17(Pictured),18,19,20,21,23,24, 25,26,29,31,32,33.
Dominant Slope Association	Mid to Lower slopes and flats (1 to 10% slope)
Land Use	Grazing
Soil Fertility	Moderately Low

Table 5 Subnatric Brown Sodosol (Analysis)

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

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

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

3.2.2 Soil Type 2: Eutrophic Brown Chromosols

The Eutrophic Brown Chromosols consist of two varieties down to the Sub Group ASC level: Haplic Eutrophic Brown Chromosol and Sodic Eutrophic Brown Chromosol. These soils are brown texture contrast soils with high cation exchange capacity. The soil type is located on the upper slopes and ridges within the study area. The stripping of this material is recommended without treatment being required however if stripping down to the sodic layers within the Sodic Eutrophic Brown Chromosol, amelioration is recommended.

Table 6 and **Table 7** provide a summary and analysis of this soil type.

Table 6 Eutrophic Brown Chromosol (Summary)

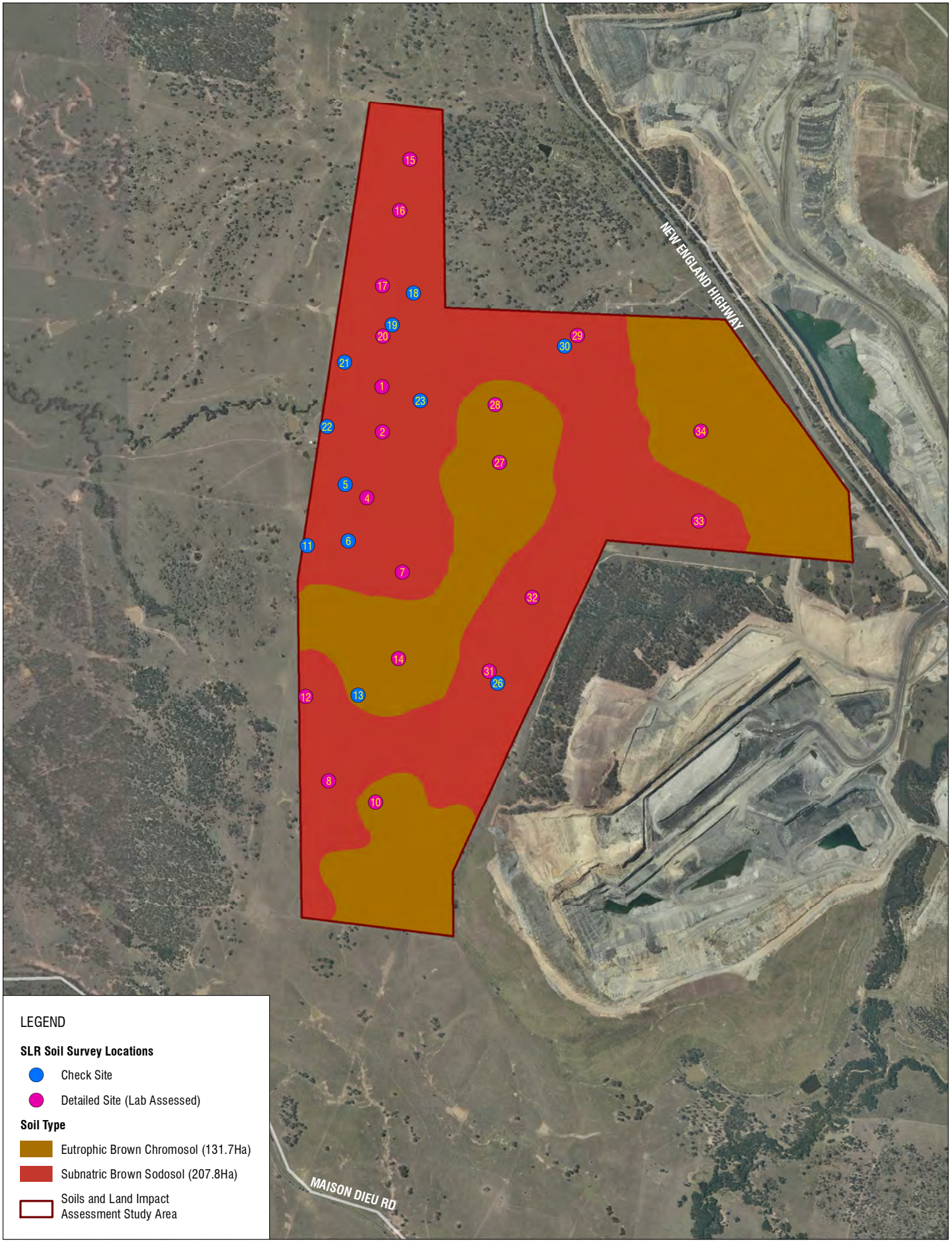
Site Description	
 **Plate 1 –** Profile (Site 14)	 **Plate 5 –** Landscape (Site 14)
ASC Name	Eutrophic Brown Chromosol
Representative Sites	10 and 14 (Pictured) 27,28.
Dominant Slope Association	Moderately steep (5% to 15% slopes)
Land Use	Grazing
Soil Fertility	Moderately High

Table 7 Eutrophic Brown Chromosol (Analysis)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very dark greyish brown (10YR 3/2) loam with weak pedality and weak consistence. Slightly acidic (pH 6.3) and non sodic (ESP 0.9). Non saline with moderate cation exchange capacity. Nil Coarse fragments. Many roots and well drained. Clear boundary to B21.
B21	0.20 – 0.60	Dark yellowish brown (10YR 4/4) heavy clay with strong pedality and moderate consistence. Mildly alkaline (pH 7.6) and non sodic (ESP 4.8). Non saline with moderate cation exchange capacity. Nil Coarse fragments. Many fine roots and moderately drained. Clear boundary to B22.
B22	0.60 – 1.00	Yellowish Brown (10YR 5/6) heavy clay with strong structure and strong consistence. Moderately alkaline (pH 8.4) and sodic (ESP 10.3). Non saline with high cation exchange capacity. Nil Coarse fragments. Many fine roots and imperfectly drained.

Horizon	ECe		Laboratory pH	
	dS/m	Rating	Value	Rating
A1	0.5	Non Saline	6.3	Slightly Acidic
B21	0.6	Non Saline	7.6	Mildly Alkaline
B22	1.6	Non Saline	8.4	Moderately Alkaline

Horizon	CEC		ESP	
	cmol/kg	Rating	%	Rating
A11	15	Moderate	0.9	Non Sodic
B21	23	Moderate	5.2	Non Sodic
B22	29	High	10.3	Sodic



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Rix's Creek Soils and Land Impact Assessment

Soil Types

FIGURE 2

4 LAND CAPABILITY IMPACT ASSESSMENT

4.1 Land and Soil Capability Assessment

The LSC classification applied to the Study Area was in accordance with the OEH guideline *The Land and Soil Capability Assessment Scheme; Second approximation* (OEH 2012a) (referred to as the LSC Guideline). This scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. The scheme consists of eight classes, which classify the land based on the severity of long-term limitations. The LSC classes are described in **Table 8** and their definition has been based on two considerations:

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

Table 8 Land and Soil Capability Classes

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation

4.1.1 Methodology

Calculating LSC Classes

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform and more specifically: slope, landform position, acidity, salinity, drainage, rockiness; and climate.

The eight hazards associated with these biophysical features that are assessed by the scheme are:

1. Water erosion
2. Wind erosion
3. Soil structure decline
4. Soil acidification
5. Salinity
6. Water logging
7. Shallow soils and rockiness
8. Mass movement

Each hazard is assessed against set criteria tables, as described in the LSC Guideline; each hazard for the land is ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

Hazard 1: Water Erosion

The Study Area lies within the Eastern and Central NSW Division, and the appropriate criteria for this division were used in the assessment. Assessment of water erosion hazard is almost solely dependent on the slope percentage of the land , based on each soil landscape unit. The only exception is land which falls within the slope range of 10-20%, which may be designated LSC Class 4 or 5 depending on the presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess wind erosion hazard for each soil type. Three criteria were assessed to be consistent for each soil type:

- Wind erosive power for the Study Area has been mapped as ‘Moderate’ (NSW Department of Trade and Investment);
- Exposure of the land to wind was also determined to be “Moderate” throughout the Study Area; and
- The average rainfall for the region is 622.3 mm (BOM 2013), and therefore the Study Area lies within the “greater than 500 mm rainfall” category.

The determining factor with regard to wind erosion hazard was therefore the erodibility of each soil type as determined by soil texture according the LSC Guideline.

Hazard 3: Soil Structure Decline

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

Hazard 4: Soil Acidification

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

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The recharge potential for the site was determined based on an average annual rainfall of 622.3 mm, with annual evaporation of 1400-1600 mm (BOM 2013). This would suggest a low recharge potential and a low discharge potential.

The Study Area according to the Salt Store Map of NSW, is located in area of low salt store. However, due the current available scale of this mapping, laboratory tested EC values were used to determine salt store.

Hazard 6: Water Logging

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

Hazard 7: Shallow Soils and Rockiness

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

Hazard 8: Mass Movement

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

4.1.2 Results

As listed in **Table 9**, the Study Area has been assessed and classified into the LSC Classes of 4 and 5, with one site Class 6.

Table 9 Land and Soil Capability Assessment

			Hazard Criteria								
			1	2	3	4	5	6	7	8	Overall
			Water erosion	Wind erosion	Structure	Acidity	Salinity	Water-logging	Soil depth	Movement	Class
Eutrophic Subnatric Brown Sodosol	1	Detailed (+lab)	1	1	4	3	1	4	2	1	**4**
	2	Detailed (+lab)	3	1	4	3	1	4	2	1	**4**
	4*	Detailed (+lab)	2	1	4	3	1	4	2	1	**4**
	5	Check	2	na	na	na	na	4	2	1	**4**
	6	Check	3	na	na	na	na	3	2	1	**3**
	7	Detailed (+lab)	3	2	4	3	1	3	2	1	**4**
	8	Detailed (+lab)	3	2	4	3	1	3	2	1	**4**
	12	Detailed (+lab)	1	1	3	3	1	4	2	1	**4**
	13	Check	3	na	na	na	na	2	2	1	**3**
	15	Detailed (+lab)	2	3	3	3	1	1	4	1	**4**
	16	Detailed (+lab)	5	2	4	3	1	1	2	1	**5**
	17	Detailed (+lab)	3	1	4	3	1	3	2	1	**4**
	18	Check	3	na	na	na	na	2	2	1	**3**
	19	Check	2	na	na	na	na	3	2	1	**3**
	20	Detailed (+lab)	2	1	4	3	1	4	2	1	**4**
	21	Check	1	na	na	na	na	4	2	1	**4**
	23	Check	2	na	na	na	na	4	2	1	**4**
	24	Exclusion	2	2	4	3	1	2	2	1	**4**
	25	Detailed (+lab)	1	1	5	3	1	4	2	1	**5**
	26	Check	5	na	na	na	na	1	2	1	**5**
	29	Detailed (+lab)	2	1	3	3	1	2	4	1	**4**
	31	Detailed (+lab)	5	3	4	3	1	1	2	1	**5**
	32	Detailed (+lab)	3	3	4	3	1	1	2	1	**4**
	33	Detailed (+lab)	2	1	4	3	1	3	2	1	**4**
Haplic Eutrophic Brown Chromosol	10	Detailed (+lab)	4	2	3	3	1	1	4	1	**4**
	27	Detailed (+lab)	3	3	4	3	1	1	4	1	**4**
	28	Check	3	na	na	na	na	1	4	1	**4**
Sodic Eutrophic Brown Chromosol	14	Detailed (+lab)	5	3	4	3	1	1	2	1	**5**
	34	Detailed (+lab)	2	3	4	3	1	1	2	1	**4**
Gilgai Vertosol	11	Check	na	na	na	na	na	na	na	na	**na**
	22	Check	na	na	na	na	na	na	na	na	**na**

The limitations associated with each land Class are discussed below and the land area of each Pre mining Class is shown in **Figure 3.**

Class 4 Land

Class 4 land includes sites from the two Eutrophic Brown Chromosols and the Subnatric Brown Sodosol. This classification indicates that the land is moderately capable for a range of land uses, and specialised practices are necessary to overcome very severe limitations. The primary constraint to this land class is soil structure, waterlogging and soil depth.

Class 5 Land

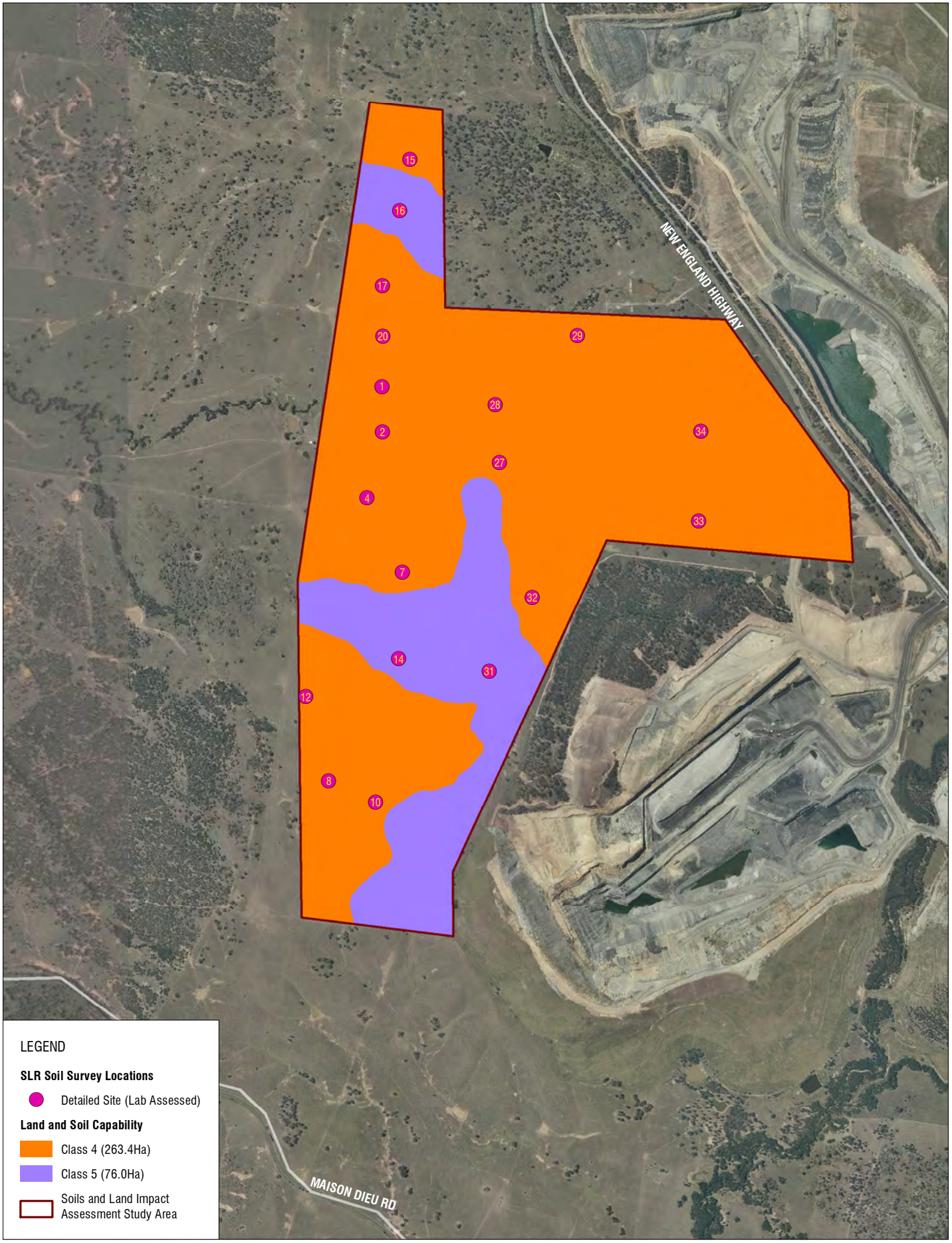
Class 5 land includes sites from the Sodic Eutrophic Brown Chromosol and the Subnatric Brown Sodosol. This classification indicates a moderate to low land capability, with severe limitations to high impact land management uses such as cropping. This land is generally more suitable for grazing with some limitations, or very occasional cultivation for pasture establishment. The primary constraint to this land class is water erosion hazard due to steep slopes.

4.2 Impact Assessment

The post-disturbance LSC classes determined for the Study Area were calculated based on proposed post mining landform slope and rehabilitated soil depths. There is an overall reduction in Class 4 land from 263.5ha to 117.9ha, with an increase in Class 5, Class 6 and Class 8 LSC as detailed in Table 10 below.

Table 10 Land and Soil Capability Areas

Land and Soil Capability	Pre mining LSC in Study Area		Post mining LSC in Study Area		Change in LSC in Study Area	
Class	**ha**	**%**	**ha**	**%**	**ha**	**%**
4	263.5	77.6	117.9	34.7	-145.6	-42.9
5	76.0	22.4	118.9	35.0	42.9	12.6
6	0.0	0.0	57.6	17.0	57.6	17.0
8	0.0	0.0	45.1	13.3	45.1	13.3
Total	**339.5**	**100.0**	**339.5**	**100.0**	**0.0**	**0.0**



LEGEND

SLR Soil Survey Locations

Detailed Site (Lab Assessed)

Land and Soil Capability

Class 4 (263.4Ha)

Class 5 (76.0Ha)

Soils and Land Impact Assessment Study Area

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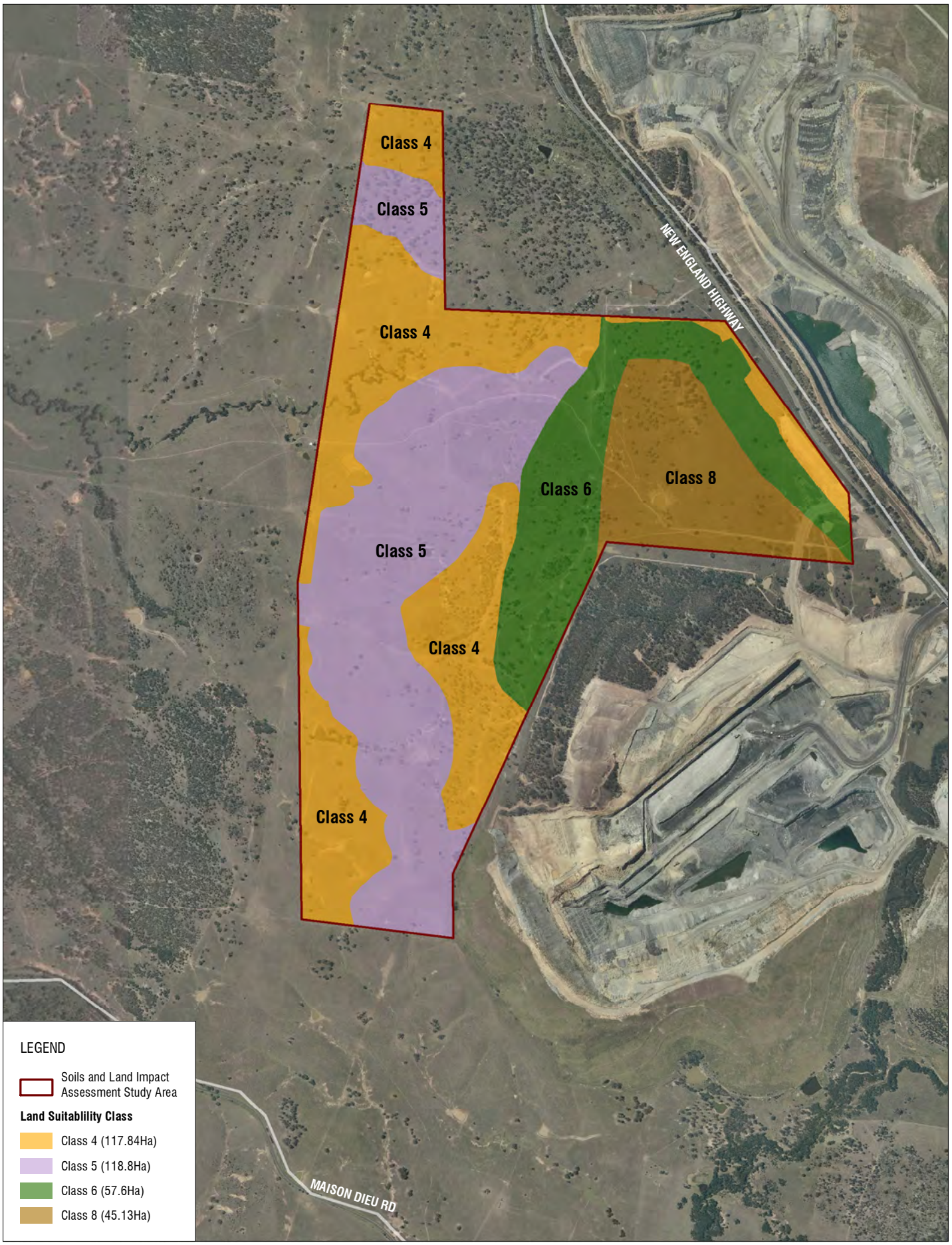
Pre Mining Land and Soil Capability

FIGURE 3



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Rix's Creek Soils and Land Impact Assessment

Post Mining Land and Soil Capability

FIGURE 4

5 DISTURBANCE MANAGEMENT

All soils within the Study Area have been assessed to determine suitability for stripping and re-use upon rehabilitation. This assessment is an integral process for successful rehabilitation of disturbance areas. This report provides information on the following key areas related to the management of the soil resources associated with the Project:

- Soil stripping assessment, which provides a soil stripping depth map indicating recommended stripping depths for soil salvage and re-use as topdressing in rehabilitation; and
- Soil management for soil that is stripped, stored and used as a topdressing material for rehabilitation.

The laboratory test results were used in conjunction with the field assessment results to determine the depth of soil material that is suitable for stripping and re-use for the rehabilitation of disturbed areas.

5.1 Soil Stripping Assessment Methodology

Determination of suitable soil to conserve for later use in rehabilitation works was conducted using a combination of the following:

1. In situ assessment of current soil profiles;
2. Elliot and Reynolds (2007) Procedure for the selection of material for use in topdressing of disturbed areas, In: Soils: Properties and Management (Charman & Murphy, 2000);
3. Queensland Growth Media Guidelines (DME, 1995), and
4. The professional opinion of the consulting Soil Scientist Mr Clayton Richards (CPSS 2) from 15 years experience in mine rehabilitation and minesoils management.

These procedures involve assessing soils for the suitability as primary or secondary growth media based on a range of physical and chemical parameters. **Table 11** and **Table 12** summarises the criteria used as a general guide for assessing suitability. Note these criteria are a guide and the in situ assessment of material determined the most suitable resources for use in rehabilitation.

Table 11 Soil Stripping Suitability Criteria (Elliot and Reynolds 2007)

Parameter	Desirable criteria
Structure Grade	>30% peds
Coherence	Coherent (wet and dry)
Mottling	Absent
Macrostructure	>10cm
Force to Disrupt Peds	≤ 3 (moderately weak force and above)
Texture	Finer than a Fine Sandy Loam
Gravel & Sand Content	<60%
pH	4.5 to 8.4
Salt Content	<1.5 dS/m

Table 12 QLD Growth Media Guidelines (DME 1995)

Soil Properties	Suitability Criteria	
	Primary Media (topsoil)	**Secondary Media (subsoil)**
Physical		
Coarseness		
Large boulders (dia. >2m)	Not present	Not common
Boulders (dia. 60 cm to 2 m)	<2% surface exposure	<20% surface exposure
Stones, cobbles and gravels (diameter 0.2 to 20 cm)	<30% surface exposure	<50% surface exposure
Sands	<90% particle size analysis	<90% particle size analysis
Clay Type		
Cracking	Not preferred	Suited
Non-cracking	Only if low ESP and salinity	Dependent on chemistry
Friable	Suited	Suited
Structure		
Massive Soils	Unsuited if single grained or hard block-like appearance	Acceptable if mixed with other soil
Columnar	Unsuited	Acceptable if amended with gypsum
Water repellency	Unsuited	Acceptable with some clay content
Chemical		
Sodicity		
ESP %	Loams <6% Clays <15%	Loams <10% Clays <30%
Salinity Electrical Conductivity	<1 mS/cm; <1,000 µS/cm	<2 mS/cm; <2,000 µS/cm
pH		
Acid soils	5.5 – 7.0	<5.5; amelioration required
Alkaline soils	7.0 – 8.0	<9.0; amelioration required

Gravel and sand content, pH and salinity were determined for all samples using the laboratory test results. Texture was determined in the field and cross referenced with laboratory results, specifically particle size analysis.

Structural grade is significant in terms of the soil's capability to facilitate water relations and aeration. Good permeability and adequate aeration are essential for the germination and establishment of plants. The ability of water to enter soil generally varies with structure grade and depends on the proportion of coarse peds in the soil surface. Well-structured soils have higher infiltration rates and better aeration characteristics. Structureless soils, without pores, are considered unsuitable as topdressing materials.

The shearing test is used as a measure of the soil's ability to maintain structure grade. Brittle soils are not considered suitable for revegetation where structure grade is weak or moderate because peds are likely to be destroyed and structure is likely to become massive following mechanical work associated with the excavation, transportation and spreading of topdressing material. Consequently, surface sealing and reduced infiltration of water may occur which will restrict the establishment of plants.

The force to disrupt peds, when assessed on soil in a moderately moist state, is an indicator of solidity and the method of ped formation. Deflocculated soils are hard when dry and slake when wet, whereas flocculated soils produce crumbly peds in both the wet and dry state. The deflocculated soils are not suitable for revegetation and may be identified by a strong force required to break aggregates.

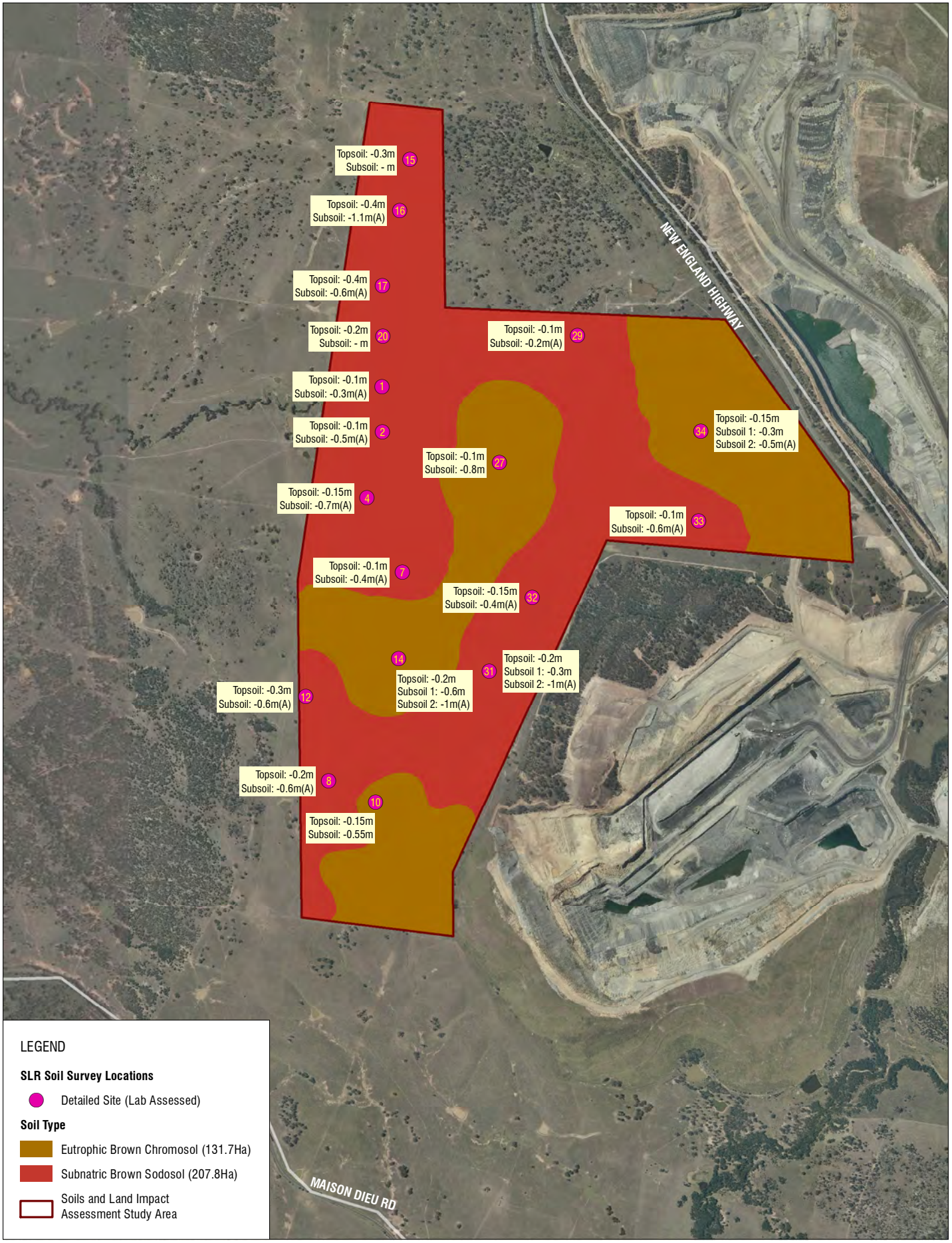
The presence of mottling within the soil may indicate reducing conditions and poor soil aeration. These factors are common in soil with low permeability, however some soils are mottled due to other reasons, including proximity to high water-tables or inheritance of mottles from previous conditions. Reducing soils and poorly aerated soils are unsuitable for revegetation purposes.

5.2 Soil Stripping Depths

The recommended stripping depths summary for each detailed soil site within the Study Area is shown in **Table 13. The recommended stripping depths for each detailed soil survey point is shown in Figure 4. Figure 5** shows the recommended stripping depth of material to be used as topdressing. **Figure 6** shows the recommended stripping depth of material to be used as subsoil or an intermediate layer between overburden/rejects and topsoil, which does not require any treatment or amelioration for sodicity. **Figure 7** shows the stripping depth of material to be used as subsoil if treatment or amelioration for sodicity was incorporated into the soil handling process.

Table 13 Recommended Stripping Depths

		Stripping depth for Topdressing	Comments	Stripping depth for Subsoil	Comments
Eutrophic Subnatric Brown Sodosol	1	0.10	No treatment	0.30	Sodic Subsoil requires treatment and ESC.
	2	0.10	No treatment	0.50	Sodic Subsoil requires treatment and ESC.
	4*	0.15	No treatment	0.70	Sodic Subsoil requires treatment and ESC.
	7	0.10	No treatment	0.40	Sodic Subsoil requires treatment and ESC.
	8	0.20	No treatment	0.60	Sodic Subsoil requires treatment and ESC.
	12	0.3	No treatment	0.6	Sodic Subsoil requires treatment and ESC.
	15	0.30	No treatment		
	16	0.40	No treatment	1.10	Sodic Subsoil requires treatment and ESC.
	17	0.40	No treatment	0.60	Sodic Subsoil requires treatment and ESC.
	20	0.20	No treatment		
	24	0.10	Treatment Required	0.30	Sodic Subsoil requires treatment and ESC.
	25	0.10	Treatment Required		
	29	0.10	No treatment	0.20	Sodic Subsoil requires treatment and ESC.
	31	0.20	No treatment	0.30	No Treatment Required
				1.00	Sodic Subsoil requires treatment and ESC.
	32	0.15	No treatment	0.40	Sodic Subsoil requires treatment and ESC.
	33	0.10	No treatment	0.60	Sodic Subsoil requires treatment and ESC.
Haplic Eutrophic Brown Chromosol	10	0.15	No treatment	0.55	No Treatment Required
	27	0.10	No treatment	0.80	No Treatment Required
Sodic Eutrophic Brown Chromosol	14	0.20	No treatment	0.60	No Treatment Required
			No treatment	1.00	Sodic Subsoil requires treatment and ESC.
	34	0.15	No treatment	0.30	No Treatment Required
			No treatment	0.50	Sodic Subsoil requires treatment and ESC.



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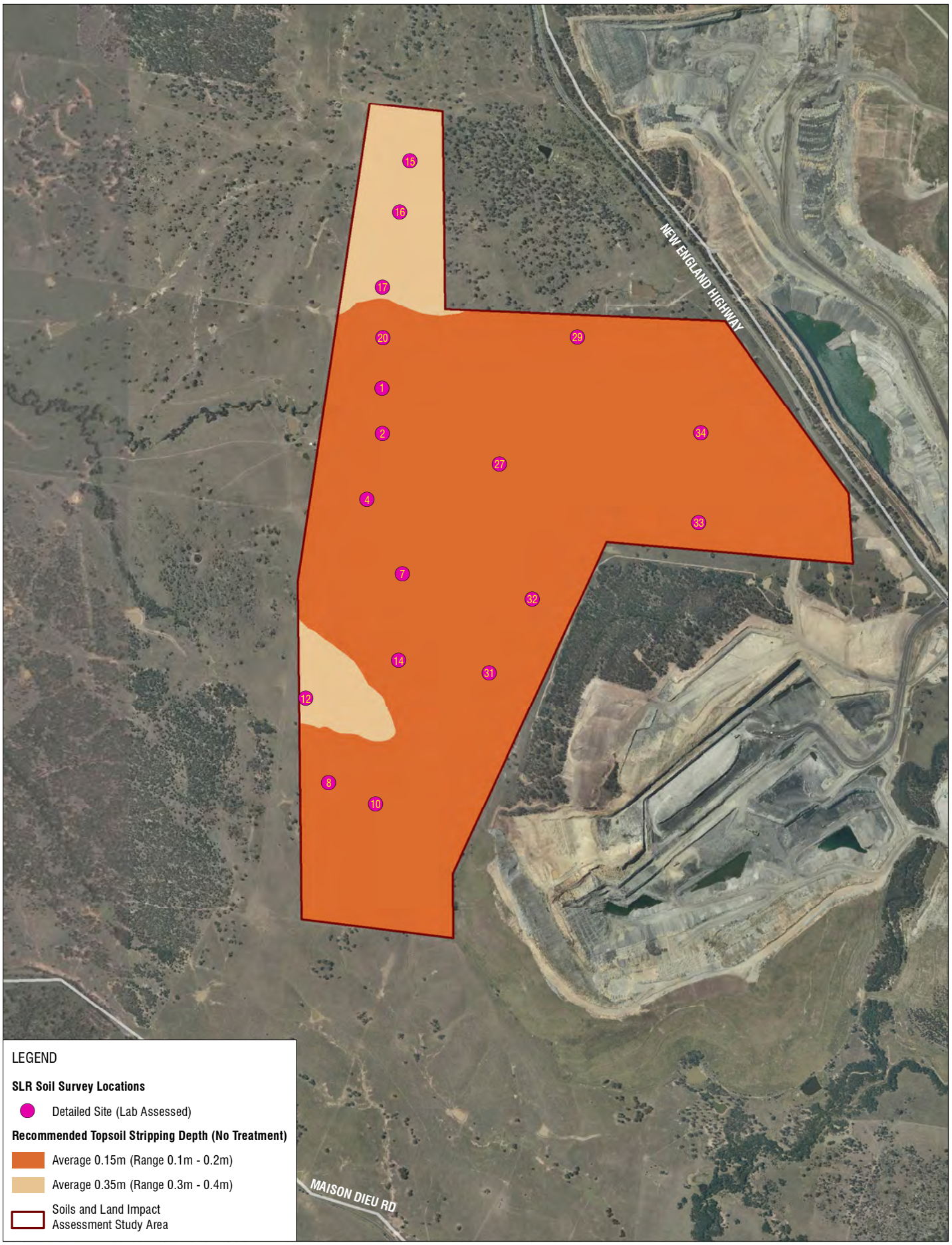
Survey Sites Stripping Depths

FIGURE 5



LEGEND

SLR Soil Survey Locations

Detailed Site (Lab Assessed)

Recommended Topsoil Stripping Depth (No Treatment)

Average 0.15m (Range 0.1m - 0.2m)

Average 0.35m (Range 0.3m - 0.4m)

Soils and Land Impact Assessment Study Area

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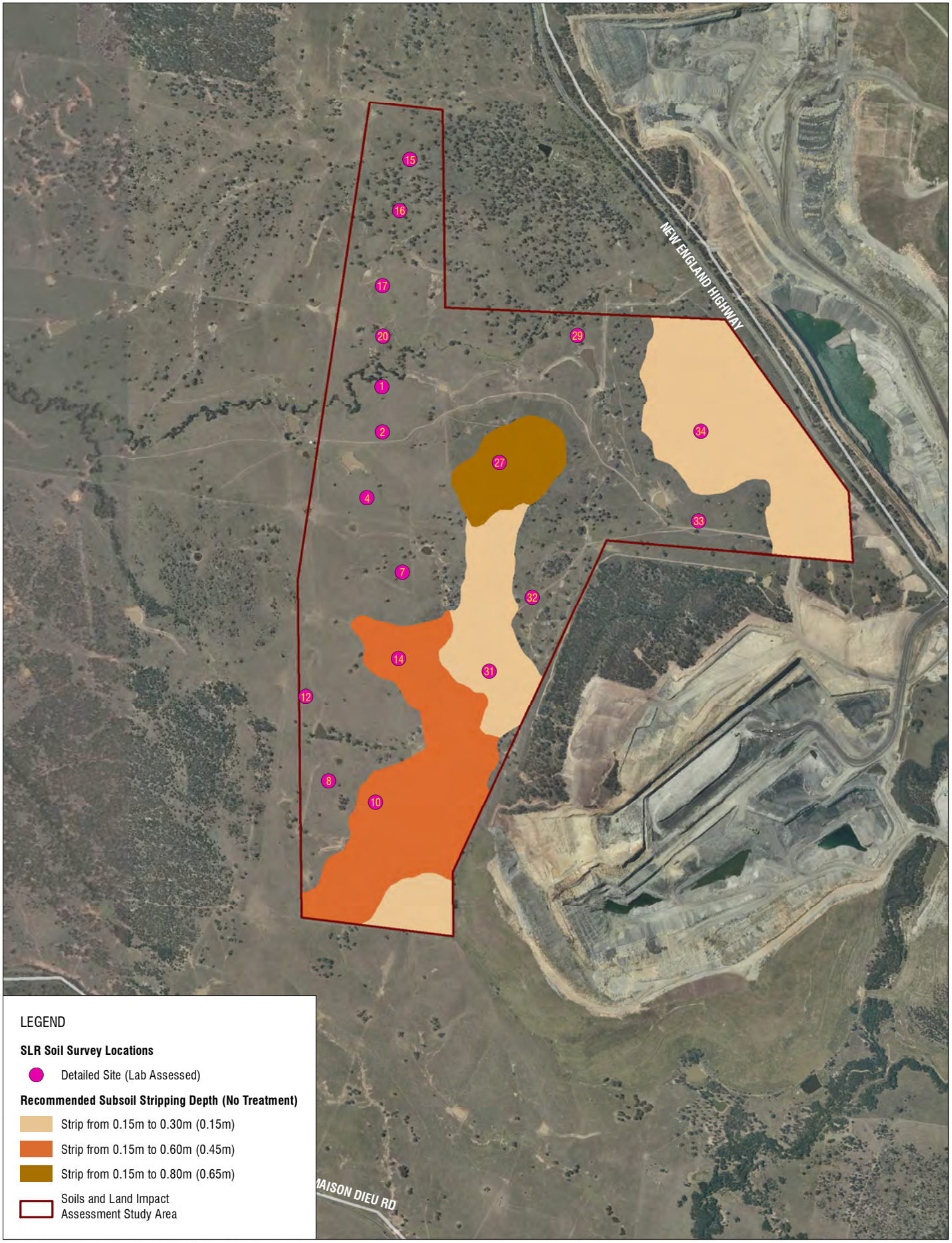
Topsoil Stripping Depths

FIGURE 6



LEGEND

SLR Soil Survey Locations

Detailed Site (Lab Assessed)

Recommended Subsoil Stripping Depth (No Treatment)

Strip from 0.15m to 0.30m (0.15m)

Strip from 0.15m to 0.60m (0.45m)

Strip from 0.15m to 0.80m (0.65m)

Soils and Land Impact Assessment Study Area

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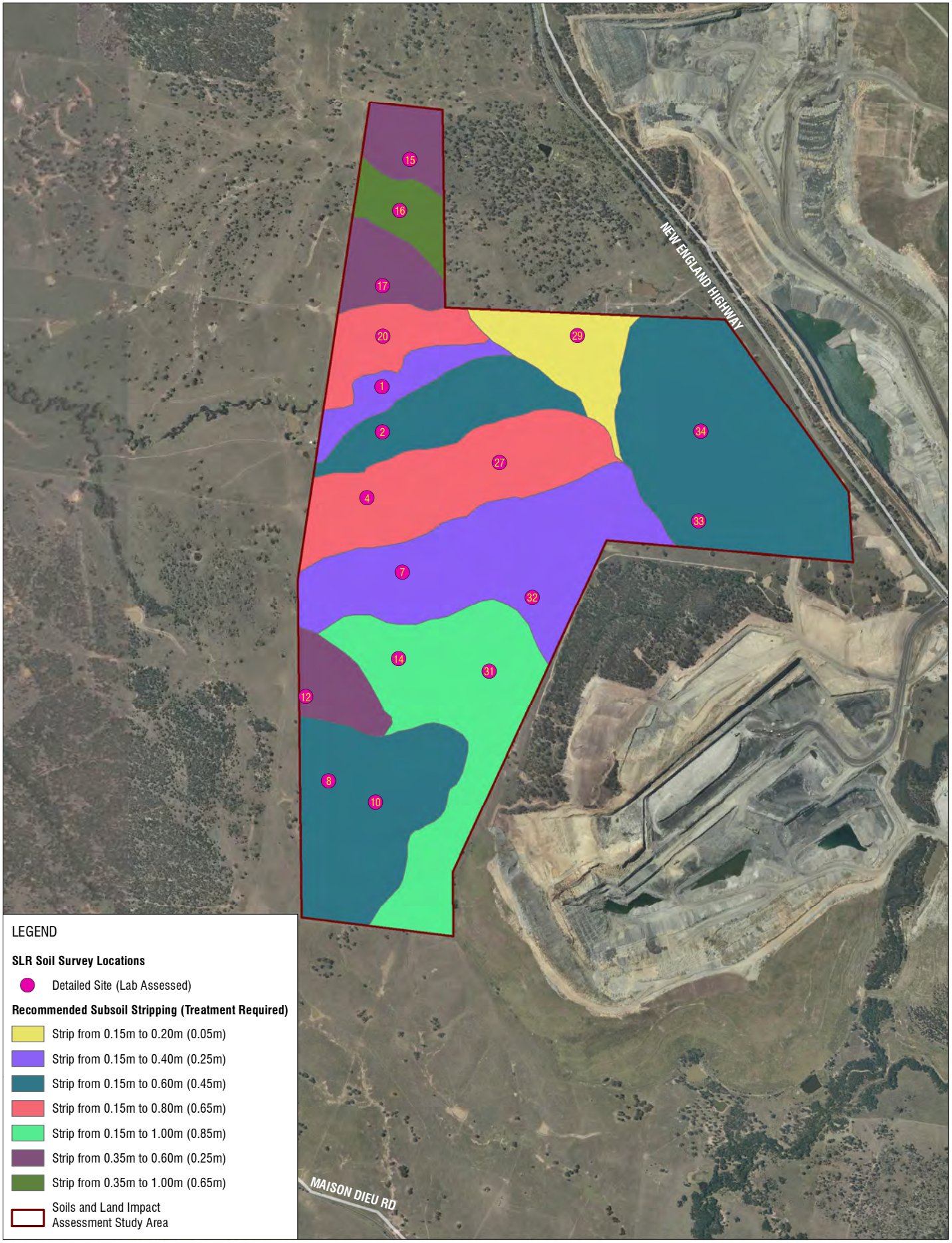
Rix's Creek Soils and Land Impact Assessment

Subsoil Stripping Depths (No Treatment)

FIGURE 7



LEGEND

SLR Soil Survey Locations

- Detailed Site (Lab Assessed)

Recommended Subsoil Stripping (Treatment Required)

- Strip from 0.15m to 0.20m (0.05m)
- Strip from 0.15m to 0.40m (0.25m)
- Strip from 0.15m to 0.60m (0.45m)
- Strip from 0.15m to 0.80m (0.65m)
- Strip from 0.15m to 1.00m (0.85m)
- Strip from 0.35m to 0.60m (0.25m)
- Strip from 0.35m to 1.00m (0.65m)
- Soils and Land Impact Assessment Study Area

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Rix's Creek Soils and Land Impact Assessment

Subsoil Stripping Depths (Treatment Required)

FIGURE 8

5.3 Soil Stripping Volumes

The following table outlines the estimated volumes of topsoil and subsoil available from the proposed disturbance/stripping area within the overall study area.

Table 14 Soil Stripping Volumes

	Soil Profile Depth (m)	Average Stripping Depth (m)	Area (ha)	Volume (m^3)
Topsoil	0 - 0.15	0.15	236.26	354,390
	0 - 0.35	0.35	7.83	27,405
		Total	244.1	381,795
Subsoil Option#1 (No Treatment Required)	0.15 - 0.30	0.15	64.9	97,350
	0.15 - 0.60	0.45	36.5	164,250
	0.45 - 0.80	0.65	12.84	83,460
	No Stripping	0	129.83	0
		Total	244.1	345,060
Subsoil Option #2 (Treatment Required)	0.15 - 0.20	0.05	8.26	4,130
	0.15 - 0.40	0.25	53.38	133,450
	0.15 - 0.60	0.45	93.1	418,950
	0.15 - 0.80	0.65	33.95	220,675
	0.15 - 1.00	0.85	48.3	410,550
	0.35 - 0.60	0.25	7.1	17,750
		Total	244.1	1,205,505

Table 15 Minimum Soil Volumes Required for Rehabilitation

Post mining LSC Class	Area (ha)	Minimum Depth of Soil (m)	Volume required (m3)
4	32.90	0.50	164500
5	96.40	0.50	482000
6	57.60	0.25	144000
8	45.13	0	0
Total	**232.03**	**Total**	**790,500**

The total volume of soil material required to meet the minimum depths of targeted post mining LSC classes is 790,500m3. The total material available within the disturbance area, which does not require amelioration and can be used without treatment is 381,795m3 of topsoil and 345,060m3 of Subsoil, therefore the 63,645m3 shortfall will have to be made up with the subsoil on site, which does require amelioration. Note there is ample subsoil material available within the disturbance area to strip and re-use in mine rehabilitation in order to create a deeper soil profile than the minimum requirement for each LSC class. This excess subsoil material does require amelioration treatment to reduce the impact of sodicity on the final soil profile.

5.4 Soil Stripping Management

The following management and mitigation strategies are recommended to reduce the potential for degradation of soils within the Study Area and adjoining lands. These recommendations are based on the assessment of the existing site conditions and apply to both topsoil and subsoil stripping;

- Strip material to the depths stated in **Table 13**, subject to any further field investigations during stripping activities.

- Soil should preferably be stripped in a slightly moist condition. Material should not be stripped in either an excessively dry or wet conditions. Whilst mining and construction schedules dictate stripping times, consideration should be given to near term weather forecasts.

- The three main treatment options available for the amelioration of sodic soil is the application of gypsum, lime or organic matter, or a combination of these materials.

- Place stripped material directly onto area to be rehabilitated and spread immediately (if mining sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling. The majority of the soil to be stripped in the Study area will be stockpiled, so locating this material nearby future rehabilitation areas will limit haulage. Stockpiles should not be placed near major drainage lines.

- Grade or push soil into windrows with graders or dozers for later collection by open bowl scrapers or for loading into rear dump trucks by front-end loaders. These techniques are examples of preferential less aggressive soil handling systems. This minimises compression effects of the heavy equipment that is often necessary for economical transport of soil material.

- Soil transported by dump trucks may be placed directly into storage. Soil transported by scrapers is best pushed to form stockpiles by other equipment (e.g. dozer) to avoid tracking over previously laid soil.

- The surface of soil stockpiles should be left in as coarsely structured a condition as possible in order to promote infiltration and minimise erosion until vegetation is established, and to prevent anaerobic zones forming.

- As a general rule, maintain a maximum stockpile height of 3 m. Clayey soils should be stored in lower stockpiles for shorter periods of time compared to coarser textured sandy soils.

- If long-term stockpiling is planned (i.e. greater than 12 months), seed and fertilise stockpiles as soon as possible. An annual cover crop species that produce sterile florets or seeds should be sown. A rapid growing and healthy annual pasture sward provides sufficient competition to minimise the emergence of undesirable weed species. The annual pasture species will not persist in the rehabilitation areas but will provide sufficient competition for emerging weed species and enhance the desirable micro-organism activity in the soil.

- Prior to re-spreading stockpiled topsoil onto reshaped overburden, an assessment of weed infestation on stockpiles should be undertaken to determine if individual stockpiles require herbicide application and / or “scalping” of weed species prior to topsoil spreading.

- An inventory of available soil should be maintained to ensure adequate topsoil materials are available for planned rehabilitation activities.

- Topsoil should be spread, treated with fertiliser and seeded in one consecutive operation, to reduce the potential for topsoil loss to wind and water erosion.

- Thorough seedbed preparation should be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas should be lightly contour ripped (after topsoil spreading) to create a “key” between the soil and the subsoil or spoil. Ripping should be undertaken on the contour and the tynes lifted for approximately 2 m every 200 m to reduce the potential for channelised erosion. Best results will be obtained by ripping when soil is moderately moist to dry and when undertaken immediately prior to sowing. The respread topsoil surface should be scarified prior to, or during seeding, to reduce run-off and increase infiltration. This can be undertaken by contour tilling with a fine-tyned plough or disc harrow.

5.5 Options for Felled Timber

There will be a small number of felled trees during the clearing process within the Study Area. There are two main uses for this felled timber; Firstly there is the option to stockpile the felled timber in heaps or rows for later use on rehabilitation to assist in minimizing surface water erosion when placed along the contour by slowing down runoff and increasing infiltration. Secondly the felled timber can be mulched on site and incorporated into the stripped soil as surface mulch. Given the anticipated long duration of storage of this soil, the mulched timber should be composted by the time respreading on rehabilitated landforms occurs. Mulch not fully composted may inhibit germination of rehabilitation. The mulching option is more costly to undertake however the benefits of increased organic matter in some of these marginal soils will enhance rehabilitation outcomes in the long term.

6 CONCLUSION

Topsoil is suitable for stripping across the assessment site, from a minimum depth of 0.10 m to a maximum depth of 0.40 m. With the exception of sites 24 and 25, all topsoils can be used without treatment. Subsoils can also be widely stripped, down to a maximum depth of 1.10 m for soils at Site 16. However, the majority of subsoils are sodic and will need treatment (gypsum, lime, or the addition of organic material would be of benefit). In addition, sodic subsoils where exposed will need to managed with appropriate erosion and sediment control structures in place (contour banks, drop structures, sediment retention ponds, rock armoring etc)

These materials would be of benefit in capping and topsoiling any overburden dumps created by mining operations. The proposed post-mining landform was used to calculate a soil balance for the area, as detailed in Section 5.3 above. The LSC classes of the post mining landform within the study area will include areas of Class 4, 5, 6 and 8. This implies that the rehabilitated landform will be suitable to various intensities of grazing over the majority of the land.

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Department of Primary Industries
Soil Conservation Service

SOIL TEST REPORT

Scone Research Centre

REPORT NO:	SCO14/075R2
REPORT TO:	Adam Koppers SLR Consulting 10 Kings Road New Lambton NSW 2305
REPORT ON:	Seventy one soil samples
PRELIMINARY RESULTS ISSUED:	21 May 2014
REPORT STATUS:	Final
DATE REPORTED:	24 May 2014
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

SR Young
(Laboratory Manager)

Scone Research Centre, PO Box 283 Scone 2337, 709 Gundy Road Scone 2337
Ph: 02 6545 1666, Fax: 02 6545 2520

SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO14/075R2
Client Reference: Adam Koppers
SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
1	Site 1 0-10 cm	21	36	37	6	0	8	0.03	6.6	5.3	10YR 4/2	10YR 2/2
2	Site 1 20-30 cm	49	23	25	3	<1	2(2)	0.17	7.9	6.8	10YR 4/2	10 YR 2/2
3	Site 1 50-60 cm	58	22	18	2	0	2(3)	0.64	8.6	7.6	2.5Y 5/3	2.5Y 4/3
4	Site 1 70-80 cm	52	22	24	2	0	2(3)	1.00	8.5	7.7	2.5Y 5/3	2.5Y 4/3
5	Site 1 100-110 cm	48	28	21	3	<1	2(3)	1.17	9.2	8.4	2.5Y 6/3	2.5Y 5/3
6	Site 2 0-10 cm	34	31	30	5	<1	8	0.08	6.2	5.2	10YR 5/3	10YR 4/3
7	Site 2 30-40 cm	66	19	12	3	<1	2(1)	0.31	7.3	6.2	2.5Y 5/3	2.5Y 4/4
8	Site 2 50-60 cm	68	16	12	4	<1	2(2)	0.65	7.8	7.0	2.5Y 5/4	2.5Y 5/4
9	Site 2 70-80 cm	70	18	9	3	<1	2(3)	1.06	7.3	6.6	2.5Y 5/4	2.5Y 5/4
10	Site 2 100-110 cm	66	19	11	4	<1	2(3)	1.12	6.1	5.6	10YR 6/6	10YR 5/8
11	Site 3 0-10 cm	21	33	36	10	<1	3(1)	0.03	6.9	5.9	10YR 5/3	10YR 4/2
12	Site 3 20-30 cm	50	21	24	5	<1	2(1)	0.18	6.1	5.1	10YR 6/3	10YR 5/3
13	Site 3 50-60 cm	60	21	16	3	<1	2(2)	0.59	6.0	5.2	2.5Y 6/3	2.5Y 5/3
14	Site3 80-90 cm	67	15	16	2	<1	2(2)	1.22	8.7	8.0	10YR 5/4	10YR 4/4

Report No: SCO14/075R2
Client Reference: Adam Koppers
SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
15	Site 7 0-10 cm	24	30	40	6	<1	3(1)	0.04	6.1	5.1	10YR 5/2	10YR 3/2
16	Site 7 30-40 cm	55	17	23	4	1	2(1)	0.14	7.6	6.3	10YR 5/2	10YR 4/2
17	Site 7 50-60 cm	56	17	24	3	<1	2(1)	0.28	8.3	7.3	2.5Y 5/3	2.5Y 4/3
18	Site 7 80-90 cm	63	15	16	5	1	2(2)	0.94	8.9	8.1	2.5Y 5/4	2.5Y 5/4
19	Site 8 0-10 cm	20	20	57	3	0	8	0.06	6.1	4.9	7.5YR 5/3	7.5YR 4/2
20	Site 8 30-40 cm	24	34	40	2	0	2(1)	0.15	7.2	5.9	7.5YR 5/6	7.5YR 4/6
21	Site 10 0-10 cm	37	29	26	6	2	8	0.08	6.8	5.9	10YR 4/3	10YR 3/2
22	Site 10 30-40 cm	58	23	15	4	0	5	0.05	7.2	6.1	10YR 4/3	10YR 3/3
23	Site 12 0-10 cm	28	25	35	11	1	3(3)	0.04	6.3	4.9	10YR 5/3	10YR 3/2
24	Site 12 40-50 cm	57	16	19	7	1	2(2)	0.23	7.7	6.6	10YR 5/3	10YR 4/3
25	Site 12 70-80 cm	64	15	14	6	1	2(1)	1.20	8.9	8.2	7.5YR 5/4	7.5YR 4/4
26	Site 12 100-110 cm	62	14	15	8	1	2(1)	1.19	9.0	8.2	7.5YR 5/6	5YR 4/6

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Report No: SCO14/075R2
Client Reference: Adam Koppers
SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
27	Site 14 0-10 cm	20	24	48	8	<1	3(1)	0.05	6.3	5.4	10YR 5/3	10YR 3/2
28	Site 14 40-50 cm	53	22	23	2	0	2(1)	0.11	7.6	7.0	10YR 6/4	10YR 4/4
29	Site 14 70-80 cm	61	19	19	1	0	2(1)	0.27	8.4	7.4	2.5Y 6/4	10YR 5/6
30	Site 15 0-10 cm	12	14	30	44	<1	3(1)	0.04	5.9	4.8	10YR 5/3	10YR 3/3
31	Site 15 15-25 cm	13	11	32	44	<1	3(1)	0.01	5.9	4.5	10YR 7/2	10YR 4/3
32	Site 15 35-45 cm	34	11	24	31	<1	2(2)	0.06	6.2	4.6	10YR 7/3	10YR 5/6
33	Site 16 0-10 cm	16	19	47	18	<1	3(1)	0.03	6.1	5.1	10YR 5/3	10YR 3/2
34	Site 16 25-35 cm	18	15	42	23	2	2(1)	0.01	6.2	4.7	10YR 6/3	10YR 5/3
35	Site 16 45-55 cm	49	14	29	8	<1	2(2)	0.16	6.4	5.2	10YR 6/4	10YR 4/6
36	Site 16 70-80 cm	56	19	22	3	<1	2(2)	0.29	7.4	6.3	2.5Y 5/4	2.5Y 5/4

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SOIL CONSERVATION SERVICE
Scone Research Centre

Report No: SCO14/075R2
Client Reference: Adam Koppers
SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
37	Site 17 0-10 cm	23	21	42	14	<1	8	0.04	6.0	4.9	10YR 4/3	10YR 3/2
38	Site 17 25-35 cm	47	16	27	10	0	2(1)	0.12	7.4	6.1	10YR 4/3	10YR 3/3
39	Site 17 45-55 cm	52	16	23	9	<1	2(2)	0.32	8.3	7.1	10YR 5/4	10YR 4/3
40	Site 17 70-80 cm	40	16	31	13	0	2(1)	0.79	9.0	8.2	7.5YR 5/6	7.5YR 5/6
41	Site 17 100-110cm	34	18	36	12	0	2(1)	0.82	9.0	8.2	7.5YR 6/6	7.5YR 5/6
42	Site 20 0-10 cm	25	32	35	8	0	3(1)	0.05	6.0	4.9	10YR 5/2	10YR 3/2
43	Site 20 30-40 cm	38	20	33	9	<1	2(2)	0.18	6.3	5.0	10YR 6/3	10YR 4/3
44	Site 20 60-70 cm	42	16	32	10	<1	2(3)	0.71	6.8	6.0	10YR 6/4	10YR 5/4
45	Site 20 90-100 cm	41	12	35	12	0	2(2)	0.77	7.5	6.5	10YR 5/8	10TR 4/6
46	Site 24 0-10 cm	20	14	32	31	3	8	0.04	5.9	4.6	10YR 5/2	10YR 4/2
47	Site 24 10-20 cm	14	12	36	36	2	7	0.08	5.7	4.6	10YR 6/2	10YR 4/2
48	Site 24 70-80 cm	38	9	25	28	<1	2(1)	0.60	5.6	4.9	10YR 6/3	10YR 5/3

SOIL CONSERVATION SERVICE
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SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
49	Site 25 0-10 cm	21	30	43	6	<1	3(2)	0.05	6.3	4.9	2.5Y 5/2	2.5Y 3/2
50	Site 25 20-30 cm	36	18	40	6	0	2(2)	0.41	7.9	6.8	2.5Y 6/3	2.5Y 5/4
51	Site 25 60-70 cm	25	26	39	10	0	2(2)	0.61	7.9	6.8	10YR 6/6	10YR 5/6
52	Site 27 0-10 cm	29	20	42	9	0	8	0.05	6.0	5.0	10YR 5/3	10YR 4/3
53	Site 27 10-20 cm	46	21	30	3	0	3(1)	0.03	6.9	5.7	10YR 5/6	10YR 4/4
54	Site 27 30-40 cm	46	21	30	3	<1	3(1)	0.04	8.0	6.9	10YR 5/4	10YR 4/3
55	Site 29 0-10 cm	11	14	30	45	<1	3(1)	0.02	5.5	4.5	10YR 6/2	10YR 4/2
56	Site 29 10-20 cm	9	15	29	45	2	3(1)	0.01	6.2	4.5	10YR 7/2	10YR 5/3
57	Site 29 30-40 cm	33	10	21	33	3	2(2)	0.08	6.4	4.8	10YR 7/3	10YR 6/4
58	Site 31 0-10 cm	23	25	43	8	1	3(1)	0.05	6.6	5.4	10YR 5/3	10YR 3/2
59	Site 31 20-30 cm	57	20	21	2	<1	8	0.03	7.5	6.1	7.5YR 5/6	7.5YR 4/6
60	Site 31 35-45 cm	56	19	23	2	0	2(1)	0.08	8.1	6.7	10YR 5/4	10YR 4/4
61	Site 31 60-70 cm	59	25	14	2	0	2(1)	0.37	8.6	7.3	2.5Y 6/4	2.5Y 5/4
62	Site 31 80-90 cm	63	19	16	2	0	4	0.47	9.1	8.1	2.5Y 6/4	2.5Y 6/4

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Scone Research Centre

Report No: SCO14/075R2
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SLR Consulting
10 Kings Road
New Lambton NSW 2305

Lab No	Method	P7B/2 Particle Size Analysis (%)					P9B/2	C1A/5	C2A/4	C2B/4		
	Sample Id	clay	silt	f sand	c sand	gravel	EAT	EC (dS/m)	pH	pH ($CaCl_2$)	Colour (dry)	Colour (moist)
63	Site 33 0-10 cm	26	21	37	11	5	8	0.04	6.2	5.0	10YR 5/3	10YR 3/3
64	Site 33 30-40 cm	60	14	20	6	0	2(3)	0.58	7.2	6.3	10YR 6/6	10YR 5/6
65	Site 33 70-80 cm	61	15	18	6	0	2(3)	1.18	6.8	6.1	7.5YR 6/6	7.5YR 5/6
66	Site 33 100-110 cm	56	15	22	7	<1	2(3)	0.75	7.4	6.4	10YR 6/4	10YR 4/6
67	Site 34 0-10 cm	26	27	39	7	1	8	0.06	5.9	5.0	10YR 5/3	10YR 4/3
68	Site 34 20-30 cm	53	21	23	3	0	2(1)	0.04	7.2	5.9	7.5YR 5/6	5YR 5/6
69	Site 34 40-50 cm	53	21	23	3	<1	2(1)	0.14	8.3	7.0	7.5 YR 6/3	7.5YR 5/6
70	Site 32 0-10 cm	19	17	48	12	4	3(1)	0.04	5.9	4.9	10YR 6/3	10YR 3/3
71	Site 32 30-40 cm	42	14	27	17	0	2(2)	0.09	7.2	6.0	7.5YR 6/4	7.5YR 4/6

END OF TEST REPORT

Department of Primary Industries

Diagnostic and Analytical Services
Environmental Laboratory
1243 Bruxner Highway WOLLONGBAR NSW 2477
Phone 02 6626 1103 Email wollongbar.csu@dpi.nsw.gov.au

Report No **WN14/0313**

Owner SOIL CONSERVATION SERVICE
PO BOX 283
SCONE NSW 2337

Submitted 15.5.14

Received 19.5.14

Samples received 71 x soil

SCO 14/075

Soil Analysis Report

Analytical Method	Method Number	Date Analysed
Extraction of Gillman and Sumpter Exchangeable Cations (including pre-wash as required)	In-house Method 014	21/05/14
Determination of Gillman and Sumpter Exchangeable Cations by ICP-AES	In-house Method 670	21/05/14

Results attached

Craig Hunt.
CRAIG HUNT
TECHNICAL OFFICER
22 MAY, 2014 RG

FINAL REPORT S YOUNG - EMAIL EXCEL FILE

- *These 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 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. The laboratory will return residual samples at client expense when requested.*
- *Test results and findings may be provided to authorised staff and used for statistical, surveillance, extension, certification and regulatory purposes in accordance with Departmental policies. The information assists disease and residue control programs and underpins market access for agricultural products. The source of the information will remain confidential unless otherwise required by Law or regulatory policies.*

NATA

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Accreditation No: 14173

Sample ID	Lab No.	Aluminium	Calcium	Potassium	Magnesium	Sodium	Cation Exchange Capacity	Calcium/ Magnesium ratio	Aluminium Saturation	Exchange-able Calcium	Exchange-able Potassium	Exchange-able Magnesium	Exchangeable Sodium (ESP)
	Unit	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg		%	%	%	%	%
	LOR	0.1	0.03	0.01	0.007	0.03							
1	4031	<0.1	8.4	0.24	4.9	0.86	14	1.7	<0.7	58	1.6	34	5.9
2*	4032	<0.1	13	0.24	13	3.7	30	0.96	<0.3	43	0.80	44	12
3*	4033	<0.1	6.5	0.13	10	4.7	22	0.63	<0.5	30	0.60	48	22
4*	4034	<0.1	3.9	0.092	6.1	3.0	13	0.64	<0.8	30	0.70	47	23
5*	4035	<0.1	7.3	0.19	10	4.0	21	0.73	<0.5	34	0.88	46	18
6	4036	<0.1	7.5	0.91	9.8	1.1	19	0.76	<0.5	39	4.7	50	5.7
7*	4037	<0.1	10	0.40	19	3.0	33	0.53	<0.3	31	1.2	58	9.4
8*	4038	<0.1	9.6	0.16	20	5.1	35	0.47	<0.3	27	0.47	58	14
9*	4039	<0.1	8.3	0.21	18	5.1	32	0.46	<0.3	26	0.64	57	16
10*	4040	<0.1	4.8	0.12	11	3.3	19	0.43	<0.5	25	0.62	57	17
11	4041	<0.1	11	0.35	4.2	0.37	16	2.5	<0.6	68	2.2	27	2.4
12	4042	0.13	7.4	0.25	13	2.9	23	0.58	0.55	31	1.1	55	12
13*	4043	<0.1	5.9	0.16	11	2.6	20	0.54	<0.5	30	0.81	56	13
14*	4044	<0.1	12	0.28	17	4.2	33	0.69	<0.3	35	0.87	51	13
15	4045	0.14	9.2	0.79	4.5	0.47	15	2.0	0.90	61	5.2	30	3.1
16	4046	<0.1	12	0.50	14	2.7	29	0.92	<0.3	43	1.7	46	9.3
17	4047	<0.1	13	0.39	15	4.8	33	0.85	<0.3	39	1.2	46	14
18*	4048	<0.1	13	0.29	15	4.0	32	0.85	<0.3	40	0.92	47	12
19	4049	<0.1	8.2	0.71	5.1	0.44	14	1.6	<0.7	56	4.9	35	3.0
20	4050	<0.1	8.3	0.25	12	2.2	22	0.70	<0.5	36	1.1	52	9.8
21	4051	<0.1	13	1.3	8.6	0.69	24	1.5	<0.4	56	5.3	36	2.9
22	4052	<0.1	14	1.0	12	0.80	28	1.2	<0.4	50	3.7	43	2.9
23	4053	<0.1	6.9	0.87	7.4	0.77	16	0.93	<0.6	43	5.4	46	4.8
24	4054	<0.1	8.4	0.75	18	4.3	31	0.48	<0.3	27	2.4	57	14
25*	4055	<0.1	11	0.24	19	5.3	35	0.56	<0.3	30	0.68	54	15
26*	4056	<0.1	11	0.28	17	4.6	33	0.63	<0.3	33	0.86	52	14
27	4057	<0.1	11	1.1	3.5	0.13	15	3.0	<0.7	69	7.1	23	0.83
28	4058	<0.1	11	0.45	10	1.2	23	1.1	<0.4	48	1.9	44	5.2
29	4059	<0.1	13	0.30	12	3.0	29	1.0	<0.3	45	1.0	43	11
30	4060	<0.1	3.3	0.56	1.4	0.19	5.6	2.3	<1.8	59	10	25	3.4
31	4061	0.32	1.4	0.18	0.96	0.15	3.1	1.5	10	47	6.0	31	4.8
32	4062	0.50	1.9	0.13	7.3	2.0	12	0.27	4.2	16	1.1	61	17
33	4063	<0.1	5.3	0.47	2.1	0.15	8.0	2.6	<1.2	66	5.8	26	1.8
34	4064	0.18	2.6	0.14	2.0	0.26	5.1	1.3	3.5	51	2.8	38	5.1
35	4065	<0.1	8.0	0.22	9.9	2.7	21	0.81	<0.5	38	1.1	47	13
36*	4066	<0.1	9.3	0.16	11	2.9	23	0.87	<0.4	40	0.70	46	12
37	4067	<0.1	7.4	0.96	3.9	0.26	13	1.9	<0.8	59	7.6	31	2.0
38	4068	<0.1	9.0	0.42	12	1.8	24	0.73	<0.4	38	1.8	52	7.7
39*	4069	<0.1	8.2	0.21	12	1.8	23	0.66	<0.4	36	0.92	54	8.2

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Accredited for compliance with ISO/IEC 17025.

Accreditation No: 14173

Sample ID	Lab No.	Aluminium	Calcium	Potassium	Magnesium	Sodium	Cation Exchange Capacity	Calcium/ Magnesium ratio	Aluminium Saturation	Exchange-able Calcium	Exchange-able Potassium	Exchange-able Magnesium	Exchangeable Sodium (ESP)
	Unit	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg		%	%	%	%	%
	LOR	0.1	0.03	0.01	0.007	0.03							
40*	4070	<0.1	8.9	0.15	9.9	1.4	20	0.90	<0.5	44	0.72	48	6.8
41*	4071	<0.1	6.9	0.16	8.9	1.7	18	0.77	<0.6	39	0.92	50	9.6
42	4072	<0.1	6.9	0.54	5.2	0.58	13	1.3	<0.8	52	4.1	39	4.4
43	4073	<0.1	4.2	0.20	9.8	2.8	17	0.42	<0.6	24	1.2	57	16
51*	4074	<0.1	1.2	0.051	3.3	1.6	6.2	0.37	<1.6	20	0.82	53	25
51*	4075	<0.1	1.4	0.074	3.9	1.8	7.3	0.36	<1.4	19	1.0	54	25
46	4076	0.17	2.8	0.34	3.7	0.48	7.4	0.75	2.3	37	4.6	49	6.4
47	4077	0.18	1.9	0.19	2.2	0.63	5.1	0.88	3.6	38	3.7	42	12
51*	4078	<0.1	0.57	0.052	3.5	0.89	5.1	0.16	<2	11	1.0	69	18
49	4079	<0.1	4.3	0.35	5.8	0.91	11	0.75	<0.9	38	3.1	50	7.9
50*	4080	<0.1	1.9	0.071	7.7	2.1	12	0.24	<0.8	16	0.60	65	18
51*	4081	<0.1	0.60	0.072	5.1	1.5	7.3	0.12	<1.4	8.3	0.99	70	20
52	4082	<0.1	8.5	1.2	5.8	0.34	16	1.4	<0.6	53	7.8	36	2.1
53	4083	<0.1	11	1.2	8.9	0.32	21	1.2	<0.5	50	5.7	42	1.5
54	4084	<0.1	13	0.60	10	0.68	24	1.2	<0.4	52	2.4	42	2.8
55	4085	0.44	2.2	0.38	0.95	0.11	4.1	2.3	11	54	9.3	23	2.8
56	4086	0.25	1.0	0.11	0.97	0.25	2.6	1.1	9.6	40	4.3	37	9.4
57	4087	0.11	1.0	0.11	9.4	2.2	13	0.11	0.87	8.1	0.84	73	17
58	4088	<0.1	13	1.0	4.6	0.17	19	2.8	<0.5	69	5.6	24	0.92
59	4089	<0.1	11	0.62	11	0.85	24	0.98	<0.4	46	2.6	47	3.5
60	4090	<0.1	11	0.38	11	1.7	24	0.98	<0.4	45	1.6	46	7.0
61*	4091	<0.1	11	0.23	14	2.8	28	0.80	<0.4	39	0.82	49	10
62*	4092	<0.1	14	0.15	14	1.9	30	0.94	<0.3	45	0.51	48	6.3
63	4093	<0.1	3.9	0.60	7.1	0.49	12	0.55	<0.8	32	4.9	58	4.0
64*	4094	<0.1	2.6	0.13	16	2.4	21	0.16	<0.5	12	0.59	76	11
65*	4095	<0.1	1.4	0.10	13	2.7	17	0.11	<0.6	8.0	0.59	75	16
66*	4096	<0.1	1.6	0.080	11	2.4	15	0.14	<0.7	11	0.52	73	16
67	4097	<0.1	7.2	0.95	5.7	0.18	14	1.3	<0.7	51	6.8	40	1.3
68	4098	<0.1	7.4	0.69	12	0.84	21	0.63	<0.5	36	3.4	57	4.0
69	4099	<0.1	6.9	0.46	13	1.8	22	0.54	<0.5	31	2.1	58	8.2
70	4100	<0.1	6.7	0.68	2.7	0.12	10	2.5	<1	65	6.6	26	1.2
71	4101	<0.1	7.9	0.22	7.0	1.3	16	1.1	<0.6	48	1.3	43	8.0

*Prewash undertaken for EC >0.3

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