FINAL

Soil Survey and Land Resource Assessment

Karuah East Quarry Project
# TABLE OF CONTENTS

1.0 **INTRODUCTION** ................................................................................................................. 1
   1.1 **BACKGROUND** ............................................................................................................... 1
   1.2 **PROJECT DESCRIPTION** ............................................................................................. 1
   1.3 **ASSESSMENT OBJECTIVES** ...................................................................................... 2
      1.3.1 **Standards** .............................................................................................................. 2

2.0 **EXISTING ENVIRONMENT** ................................................................................................. 3
   2.1 **SOIL LANDSCAPES** .................................................................................................... 3
   2.2 **GEOLOGY** ................................................................................................................ 3
   2.3 **TOPOGRAPHY** ......................................................................................................... 3
   2.4 **HYDROLOGY** ........................................................................................................... 4
   2.5 **VEGETATION** .......................................................................................................... 4
   2.6 **SURROUNDING LAND USE** .................................................................................... 4

3.0 **SURVEY ASSESSMENT** ..................................................................................................... 5
   3.1 **SOIL SURVEY METHODOLOGY** .............................................................................. 5
      3.1.1 **Reference Map** .................................................................................................. 5
      3.1.2 **Soil Profiling** ..................................................................................................... 5
      3.1.3 **Soil Field Assessment** ........................................................................................ 6
      3.1.4 **Soil Laboratory Testing** ..................................................................................... 6
   3.2 **SOIL SURVEY RESULTS** ............................................................................................ 7
      3.2.1 **Soil Type 1: Brown Chromosol** ....................................................................... 8
      3.2.2 **Soil Type 2: Red Dermosol** .............................................................................. 9
      3.2.3 **Soil Type 3: Leptic Tenosol** .......................................................................... 10

4.0 **LAND CAPABILITY AND SUITABILITY ASSESSMENT** .................................................. 11
   4.1 **LAND CAPABILITY** .................................................................................................. 11
      4.1.1 **Land Capability Methodology** ......................................................................... 11
      4.1.2 **Land Capability Results** .................................................................................... 12
   4.2 **AGRICULTURAL SUITABILITY** ............................................................................. 13
      4.2.1 **Agricultural Suitability Methodology** ............................................................... 13
      4.2.2 **Agricultural Suitability Results** ...................................................................... 13

5.0 **SOIL MANAGEMENT** ....................................................................................................... 15
   5.1 **SOIL STRIPPING ASSESSMENT** ........................................................................... 15
      5.1.1 **Soil Stripping Methodology** .............................................................................. 15
      5.1.2 **Soil Stripping Depths & Volume** .................................................................... 16
      5.1.3 **Soil Stripping Depths & Volume Assumptions** ............................................ 17
      5.1.4 **Topsoil Balance** .............................................................................................. 17
   5.2 **TOPDRESSING MANAGEMENT** .............................................................................. 17
      5.2.1 **Topsoil Re-spreading and Seedbed Preparation** ........................................ 18

6.0 **REFERENCES** ................................................................................................................ 19
TABLES

TABLE 1 – FIELD ASSESSMENT PARAMETERS ........................................................................................................ 6
TABLE 2 – LABORATORY ANALYSIS PARAMETERS .................................................................................................. 7
TABLE 3 – LABORATORY TEST METHODS .................................................................................................................. 7
TABLE 4 – SOIL TYPES .................................................................................................................................................. 7
TABLE 5 – BROWN CHROMOSOL PROFILE .................................................................................................................. 8
TABLE 6 – RED DERMOSOL PROFILE ........................................................................................................................ 9
TABLE 7 – LEPTIC TENOSOL SOIL PROFILE ................................................................................................................ 10
TABLE 8 – RURAL LAND CAPABILITY CLASSES ........................................................................................................ 11
TABLE 9 – COMPARISON OF PRE AND POST-MINING RURAL LAND CAPABILITY CLASSES ....................................... 12
TABLE 10 – AGRICULTURAL SUITABILITY CLASSES .................................................................................................. 13
TABLE 11 – COMPARISON OF PRE AND POST-MINING AGRICULTURAL LAND SUITABILITY CLASSES ......................... 13
TABLE 12 – TOPSOIL STRIPPING SUITABILITY CRITERIA .............................................................................................. 15
TABLE 13 – RECOMMENDED STRIPPING DEPTHS ....................................................................................................... 16
TABLE 14 - TOPSOIL BALANCE ........................................................................................................................................ 17

FIGURES

FIGURE 1 - LOCATION PLAN .............................................................................................................................................. 2
FIGURE 2 - SOIL TYPES AND TEST PIT LOCATIONS ....................................................................................................... 7
FIGURE 3 - LAND CAPABILITY CLASSES (PRE MINING) ................................................................................................. 12
FIGURE 4 - LAND CAPABILITY CLASSES (POST MINING) .............................................................................................. 12
FIGURE 5 – AGRICULTURAL SUITABILITY CLASSES ...................................................................................................... 14

PLATES

PLATE 1 – BROWN CHROMOSOL PROFILE .................................................................................................................. 9
PLATE 2 – BROWN CHROMOSOL LANDSCAPE ............................................................................................................... 9
PLATE 3 – RED DERMOSOL PROFILE .......................................................................................................................... 10
PLATE 4 – RED DERMOSOL LANDSCAPE ..................................................................................................................... 10
PLATE 5 – LEPTIC TENOSOL PROFILE ........................................................................................................................ 11
PLATE 6 – LEPTIC TENOSOL LANDSCAPE .................................................................................................................... 11

APPENDICES

APPENDIX 1 – FIELD ASSESSMENT PROCEDURE
APPENDIX 2 – SOIL INFORMATION
APPENDIX 3 – SOIL TEST RESULTS
APPENDIX 4 – GLOSSARY
1.0 INTRODUCTION

GSS Environmental (GSSE) was commissioned by Karuah East Pty Ltd (Karuah East) to undertake a land resources assessment with respect to soil and rural land capability classification for the proposed disturbance areas associated with the proposed Karuah East Quarry Project. The study area for the assessment is located in Lot 12 and 13 of DP 1024564, Pacific Highway, Karuah, New South Wales as detailed in Figure 1.

For the remainder of this report the proposed project area in which the land resource assessment was conducted will be referred to as the “study area”. As part of the proposed Karuah East Quarry, the project application will be subject to ground disturbances resulting from quarrying related activities including construction of industrial area infrastructure (administration building, maintenance workshops etc), haul roads and the open pit.

1.1 Background

Hunter Quarries currently extract hard black andesite material which is suited to a wide range of uses including production of aggregate and road base material from its existing operation and adjoining lands. Approval was granted to a designated development on the adjoining land (Lot 21 DP 1024341, Lot 11 DP 1024564 & Lot 12 DP 1024564) by the Minister as State Significant Development on 3rd June 2005 (DA265/10/2004).

The Karuah Quarry currently operates under development approval DA 265/2004 and is approved to produce up to 500 000 tonnes per annum (tpa) of ‘andesite’ basalt material suitable for use as road base, construction aggregate and concrete batching, among various other applications.

Following exploratory works adjacent the existing approved quarry, additional resource has been identified to the east on land owned by the Proponent. It is proposed that this additional resource would be extracted through the development of the ‘Karuah East Project’, a stand-alone operation to the existing quarry.

The Karuah East Project would comprise the development of a stand-alone hard rock quarry and associated processing and facilities area to allow the extraction of up to 1.5 million tonnes per annum (Mtpa) from a total resource of approximately 29 million tonnes.

The Karuah East Project is to be assessed as a Major Project under Part 3A of the Environmental Planning and Assessment Act 1979 (EP & A Act). As such, an Environmental Assessment is required to support the application for project approval. GSS Environmental (GSSE) has subsequently been engaged by Karuah East Pty Ltd to prepare a Soil and Land Capability Assessment which will form part of the Environmental Assessment.

1.2 Project Description

Karuah East proposes to extract hard black basalt material “andesite” from the study site, which will generally involve:

- removal and stockpiling of vegetation;
- blasting the quarry face;
- ripping and removal of the material by dozer to the stockpile area;
- crushing and sorting of raw material ready for transport; and
- progressive rehabilitation of worked quarry areas.

Up to 1.5 million tonnes of material is proposed to be extracted from the site with an estimated total resource of approximately 29 million tonnes.
Excavation of the open cut pit and construction of out-of-pit overburden stockpiles, haul roads and other service roads will result in ground disturbance and therefore will impact on the land resource within the study area. To ensure sufficient topsoil resources are available for post-quarrying rehabilitation, it is important that all suitable soil reserves are identified and recovered ahead of the proposed disturbance. The following report presents the results of the survey undertaken by GSSE and the assessment of soil resources, land capability and agricultural suitability classification within the project area.

1.3 Assessment Objectives

The major objectives of the assessment undertaken by GSSE include:

Objective 1 Classify and determine the soil profile types within the Project Boundary at a sufficient detail to satisfy the requirements of the Department of Industry and Investment (DII);

Objective 2 Provide a description of, and figures showing, the pre and post land capability within the Project Boundary in accordance with Department of Environment, Climate Change and Water (DECCW) guidelines;

Objective 3 Provide a description of, and figures showing, the pre and post agricultural land suitability within the Project Boundary in accordance with DII guidelines; and

Objective 4 Provide selective topsoil and subsoil management recommendations for mining rehabilitation and assess post-mining land uses for the quarry operation.

This report outlines the methodology and results of the soil and land capability assessment conducted to satisfy the assessment objectives. This includes background research, field assessment and laboratory analysis of soil samples sourced from within the study area as well as proposed management measures.

1.3.1 Standards

To satisfy Objective 1 of the soil and land capability assessment, the soil taxonomic classification system used was the Australian Soil Classification (ASC) system. This system is routinely used as the soil classification system in Australia.

To satisfy Objective 2 of the soil and land capability assessment, the relevant guideline applied was Systems Used to Classify Rural Lands in New South Wales (Cunningham et al., 1988). This is the guideline approved by Department of Environment, Climate Change & Water (DECCW) (formerly approved by the NSW Soil Conservation Service).

To satisfy Objective 3 of the soil and land capability assessment, the relevant guideline applied was the Agricultural Suitability Maps – uses and limitations (NSW Agricultural & Fisheries, 1988). This is the guideline approved by Industry and Investment NSW (I&I NSW) (formerly the NSW Agricultural & Fisheries).

To satisfy Objective 4 of the soil and land capability assessment, the Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas (Elliot and Veness, 1981) was utilised to determine which soils throughout the site are suitable for conserving and utilising in the mine site rehabilitation program. The approach described in this guideline remains the benchmark for land resource assessment in the Australian mining industry.
FIGURE 1
Karuah East Quarry Soil Assessment
Location Plan

V:\HQP05-002\Figures\Drafts\Fg1_HQP05-002_LocPlan_110420.dwg
To be printed A4
2.0 EXISTING ENVIRONMENT

2.1 SOIL LANDSCAPES

The soil landscapes within the project site have been mapped by the Land & Water Conservation incorporating the Soil Conservation Service of NSW at the scale of 1:100,000 by Matthei (1995). The soil landscape units described by these publications 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 project site are as follows:

- North Arm Cove unit is the most common and is present extensively throughout the eastern and central areas of the Project Site;
- Gan Gan unit occurs in the north western area of the Project Site;
- Gan Gan variant A occurs small pocket in the project site north-west, and;
- Nungra unit small pockets in the Project Sites southern area.

The North Arm Cove soil landscape occurs as undulating to rolling rises on Nerong Volcanics in the Karuah Mountains and Medowie Lowlands, east of the Karuah River. Local relief up to 50m and slope gradient of <15%. Common soil occurrences of this landscape include a weakly structured light sandy clay loam, bleached hardsetting sandy clay loam and mottled blocky clay. Limitations include high erosion hazard and seasonal waterlogging on lower slopes.

The Gan Gan soil landscape occurs on the steep hills of the Nerong Volcanics on the Karuah Mountains. Slope gradients >25%, local relief 100-200m, elevation 60 – 260m. Common soil occurrences of this landscape include a stony brownish black weakly pedal sandy loam, bleached stony hardsetting light sandy clay loam, and whole coloured light clay. Gan Gan variant A is found on lower footslopes and includes imperfectly drained soils that have sharp boundaries between soil materials and a depth of >200cm. Limitations include mass movement associated with steep slopes, shallow soils with rock outcrops and an extreme water erosion hazard.

The Nungra soil landscape occurs on widespread gently inclined footslopes and drainage plains of the Medowie Lowlands and Karuah Mountains physiographic regions. Slope gradient <3%, local relief <10m and elevation to 40m. Common soil occurrences include a greyish yellow brown weakly pedal silty clay loam, bleached hardsetting silty clay loam, greyish yellow brown mottled silty clay. Limitations include localised salinity, water erosion hazard, high run on, seasonal water logging and flood hazards.

2.2 GEOLOGY

In regional geology terms, the rock being quarried belongs to the Myall Block in the Tamworth Belt of the New England Orogen. The site forms part of what is known as the Nerong Volcanics, which are carboniferous siliceous volcanic flows of the rhyolitic and dacitic ignimbrites with occasional flows of tuffaceous sandstone and conglomerate.

2.3 TOPOGRAPHY

The Project Site is situated in the Karuah River Basin, on the south east facing slopes of a small mountain up to 150 m AHD and associated ridgeline falling to the south. Regional topography is irregular being defined by isolated mountains and ridges up to 170 m AHD falling steeply to tidal mudflats adjacent the Karuah River and rolling hills and ridges further from the Port Stephens estuary. Elevations within the
Project Site range from 50 – 150 m AHD with slopes in the Project area ranging between 4% in the lower areas up to 40% in the upper slopes of the Project Site.

2.4 HYDROLOGY

The Project Site is situated along a ridgetop in the upper catchments of both Yalimbah and Bulga Creeks. The catchment divide lies along the ridgetop where the proposed facilities and processing areas would lie. All runoff from the site ultimately reports to the Port Stephens estuary via either Yalimbah or Bulga Creeks. The land surface within the proposed extraction area (Lot 12) is characterised by mostly steep, heavily forested country. The majority of the this area lies within the Yalimbah Creek catchment, while a small portion of the area drains to the east and into the Bulga Creek catchment. The land where the facilities and processing area are proposed for construction (Lot 13) comprises mostly open pasture with scattered stands of eucalyptus.

2.5 VEGETATION

The vegetation communities surrounding the project site is best described as an Open Eucalypt Forest. The vegetation is fairly contiguous across the site. It is dominated by Grey Gum, White Mahogany, Small fruited Grey Gum, Tallowwood, Pink Bloodwood, Spotted Gum and Brush Box.

2.6 SURROUNDING LAND USE

The Project Site is located within a rural area. The Project Site is closely surrounded by a predominantly forested area surrounding the isolated mountain top on which the Project Site is situated. To the north beyond the edges of this forested area lie agricultural and grazing lands. The Pacific Highway is situated immediately to the south of the Project Site beyond which lies an extensive forested area surrounding an adjacent mountain. There are also significant SEPP 14 listed coastal wetlands and tidal mudflats surrounding Yalimbah and Bulga Creeks adjacent to this mountain. The existing Karuah Hard Rock Quarry and processing area is located immediately to the west of the Project Site, within the forested area surrounding the Project Site.
3.0 SURVEY ASSESSMENT

A soil survey was undertaken in November 2010 by GSSE to:

1. Classify and determine the soil profile types within the Project Disturbance Boundary;
2. Assess the suitability of the current topsoil material for future rehabilitation; and
3. Identify any potentially unfavourable soil material for rehabilitation within the Project Disturbance Boundary

This section outlines the methods used to conduct the soil survey component of the assessment and reports the results.

3.1 SOIL SURVEY METHODOLOGY

A field survey and a desktop study were undertaken for the Project area.

3.1.1 Reference Map

An initial soil map (reference map) was developed using the following resources and techniques:

- **Aerial photographs and topographic maps;**
  
  Aerial photo and topographic map interpretation was used as a remote sensing technique allowing detailed analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the Project Boundary;

- **Reference information;**
  
  Source materials were used to obtain correlations between pattern elements and soil properties that may be observable in the field. These materials included:
  
  - Cadastral data, prior and current physiographic, geological, vegetation, and water resources studies;

- **Previous reports; and**

  The following previous reports were reviewed as part of the desktop assessment:
  
  - Port Stephens 1:100,000 Sheet

- **Stratified observations.**

  Following production of a broad soil map, surface soil exposures, topography and vegetation throughout the potential disturbance areas were visually assessed to verify potential soil types, delineate soil type boundaries and determine preferred locations for targeted subsurface investigations (hereafter referred to as soil pits

3.1.2 Soil Profiling

Six soil profiles were assessed at selected sites to enable soil profile descriptions to be made. Subsurface exposure was generally undertaken by backhoe excavation of test pits to 1.2 m deep. The test pit locations were chosen to provide representative profiles of the soil types encountered during the survey. The soil layers were generally distinguished on the basis of changes in texture, structure and colour. Soil colours were assessed according to the Munsell Soil Colour Charts (Macbeth, 1994). Photographs of soil profile exposures were also taken. Soil profiles were also observed through the use of surface exposures located in existing erosion gullies, creek banks, roadway cuttings, dams and disused quarries. Soil test pit locations and soil types are shown in Figure 2.
3.1.3 Soil Field Assessment

Soil profiles within the Project Boundary were assessed in accordance with the Australian Soil and Land Survey Field Handbook - Third Edition (NCST, 2009) soil classification procedures. Detailed soil profile descriptions recorded information that covered the parameters as specified in Table 1. Soil profile logging was undertaken in the field using soil data sheets.

Global Positioning System (GPS) recordings were taken for all sites where detailed soil descriptions were made. Vegetation type and land use were also recorded. Soil exposures from excavated pits were photographed during field operations as colour photography of profile sites is a useful adjunct to description of land attributes.

Table 1 – Field Assessment Parameters

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizon Depth</td>
<td>Weathering characteristics, soil development</td>
</tr>
<tr>
<td>Field Colour</td>
<td>Permeability, susceptibility to dispersion / erosion</td>
</tr>
<tr>
<td>Field Texture Grade</td>
<td>Erodibility, hydraulic conductivity, moisture retention, root penetration</td>
</tr>
<tr>
<td>Boundary Distinctness and Shape</td>
<td>Erosional / dispositional status, textural grade</td>
</tr>
<tr>
<td>Consistence Force</td>
<td>Structural stability, dispersion, ped formation</td>
</tr>
<tr>
<td>Structure Pedality Grade</td>
<td>Soil structure, root penetration, permeability, aeration</td>
</tr>
<tr>
<td>Structure Ped &amp; Size</td>
<td>Soil structure, root penetration, permeability, aeration</td>
</tr>
<tr>
<td>Stones – Amount &amp; Size</td>
<td>Water holding capacity, weathering status, erosional / depositional character</td>
</tr>
<tr>
<td>Roots – Amount &amp; Size</td>
<td>Effective rooting depth, vegetative sustainability</td>
</tr>
<tr>
<td>Ants, Termites, Worms etc</td>
<td>Biological mixing depth</td>
</tr>
</tbody>
</table>

Soil layers from each test pit were also assessed according to a procedure devised by Elliot and Veness (1981) for the recognition of suitable topdressing material. This procedure assesses soils based on grading, texture, structure, consistency, mottling and root presence. A more detailed explanation of the Elliot and Veness procedure is presented in Appendix 1 of this report.

3.1.4 Soil Laboratory Testing

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.

Soil samples of about 1 – 2 kg were collected from each soil layer. In total, 12 soil samples were sent to the Department of Lands Scone Research Centre (Scone Research Centre) for analysis. Certificate of analysis for these results are contained in Appendix 3. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in Table 2.
Soil Survey & Land Resource Assessment
Hard Rock Quarry – Karuah East

Table 2 – Laboratory Analysis Parameters

<table>
<thead>
<tr>
<th>Property</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical:</strong></td>
<td></td>
</tr>
<tr>
<td>Coarse fragments (&gt;2mm)</td>
<td>Soil workability; root development; droughtiness</td>
</tr>
<tr>
<td>Particle-size distribution (&lt;2mm)</td>
<td>Nutrient retention; exchange properties; erodibility; droughtiness; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities</td>
</tr>
<tr>
<td>Aggregate stability (Emerson Aggregate Test)</td>
<td>Susceptibility to surface sealing under rainfall or irrigation; effect of raindrop impact and slaking; permeability; infiltration; aeration; seedling emergence; correlation with other properties</td>
</tr>
<tr>
<td><strong>Chemical:</strong></td>
<td></td>
</tr>
<tr>
<td>Soil reaction (pH) (1:5, soil: water suspension)</td>
<td>Nutrient availability; nutrient fixation; toxicities (especially Al, Mn); liming; sodicity; correlation with other physical, chemical and biological properties</td>
</tr>
<tr>
<td>Electrical conductivity (EC) (1:5, soil: water suspension)</td>
<td>Appraisal of salinity hazard in soil substrates or groundwater, total soluble salts</td>
</tr>
<tr>
<td>Cation exchange capacity (CEC) and exchangeable cations</td>
<td>Nutrient status; calculation of exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration</td>
</tr>
</tbody>
</table>

The laboratory methods used by the Scone Research Centre for each physical and chemical parameter are provided in Table 3.

Table 3 – Laboratory Test Methods

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size Analysis (PSA)</td>
<td>Sieve &amp; hydrometer</td>
</tr>
<tr>
<td>pH</td>
<td>1:5 soil/water extract</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>1:5 soil/water extract</td>
</tr>
<tr>
<td>Emerson Rating</td>
<td>Emerson Aggregate Test</td>
</tr>
<tr>
<td>CEC &amp; exchangeable cations</td>
<td>(AgTU)+ extraction</td>
</tr>
</tbody>
</table>

3.2 SOIL SURVEY RESULTS

Table 4 provides an overview of each soil type and their quantitative distribution within Project Disturbance Boundary. Figure 2 illustrates their spatial distribution. All soil test results are provided in Appendix 2.

Table 4 – Soil Types

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>ASC Name</th>
<th>Area (%)</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brown Chromosols</td>
<td>29</td>
<td>8.6</td>
</tr>
<tr>
<td>2</td>
<td>Red Dermosols</td>
<td>15</td>
<td>4.5</td>
</tr>
<tr>
<td>3</td>
<td>Leptic Tenosol</td>
<td>56</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>100</strong></td>
<td><strong>29.5</strong></td>
</tr>
</tbody>
</table>
3.2.1 Soil Type 1: Brown Chromosol

**Description:** The Brown Chromosol soil unit generally consists of a texture contrast profile of greyish yellow brown sandy loams overlying a clay subsoil. These weak to moderately structured soils range from slightly acid to moderately acid at depth. The soils are non-saline. The topsoil and subsoil are non-sodic.

**Location:** These soils cover 29% or 8.6 ha of the project area and are present on the lower slopes near the southern boundary of the project area. Profile sites 1 and 2 occur within this unit.

**Landuse:** The land overlying these soils is dominated by cleared pasture. Farm tracks and sparse low lying shrubs are present throughout the area.

**Management:** The top 0.30m of this soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. The subsoil is generally not suitable for stripping and re-use as a topdressing in rehabilitation operations due to very high clay content and a massive structure. However, consideration is given to selectively stripping and conserving this material for use as an intermediate layer between parent material and the final topdressing layer.

**Table 5 – Brown Chromosol Profile**

<table>
<thead>
<tr>
<th>LAYER</th>
<th>DEPTH (m)</th>
<th>DESCRIPTION (Site 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 to 0.20</td>
<td>Very Dark Grey (5YR 5/1), weak to moderate consistence sandy clay loam. Moderate pedality (blocky 5-20mm) soil with moderate acidity (pH 6.0), very low dispersion (EAT 8 &amp; 3(1)), non-saline (0.02dS/m) and moderate drainage characteristics. Roots are fine to medium, common to many. Stones &lt;10%. Approximate sample depth 0.10m. Sharp even boundary to layer 2.</td>
</tr>
<tr>
<td>2</td>
<td>0.20 to 0.30</td>
<td>Brown (7.5YR 5/2), moderate consistence sandy clay loam. Moderate pedality (blocky 5-20mm) soil with moderate acidity (pH 5.9), very low dispersion (EAT 3(1)), non-saline (0.02dS/m) and moderate drainage characteristics. Roots common to few. Approximate sample depth 0.25m. Sharp and even boundary to layer 3.</td>
</tr>
<tr>
<td>3</td>
<td>0.30 – 0.90 +</td>
<td>Yellowish Brown (10YR 6/3) heavy clay. An apedal massive soil that is strongly acidic (pH 5.3), very low dispersion (EAT 3(1)), non-saline 0.09dS/m) and poor to moderate drainage characteristics. There are no roots or stones. 10% presence of grey mottling. Approximate sample depth 0.80m.</td>
</tr>
</tbody>
</table>

Plate 1 –Brown Chromosol Profile  
Plate 2 –Brown Chromosol Landscape
3.2.2 Soil Type 2: Red Dermosol

**Description:** The Red Dermosol soil unit generally consists of dark yellowish brown to yellowish red clay profiles with a structured B2 horizon, which lacks a texture contrast between the A and B horizons. These uniform soils are slightly acidic with low fertility. The topsoil and subsoil are sodic to moderately sodic, and are non-saline. These Dermosols exist throughout the site in both red and brown form.

**Location:** These soils cover 15% or 4.55 ha of the project area and are found on the flatter lowlands and drainage plains. There are also present in areas of uncleared woodland, dominated by native species.

**Landuse:** The land overlying these soils is dominated by formerly cleared woodland with the presence of native and foreign grass species and juvenile eucalyptus species.

**Management:** This soil is generally suitable for stripping and re-use during rehabilitation operations due to very high clay content. However, consideration is given to selectively stripping and conserving this material for use as an intermediate layer between reshaped overburden and the final topdressing layer. Due to the drainage characteristics of clay, this soil type would be best suited as an intermediate layer which would retain moisture drained from the well-drained topsoil.

<table>
<thead>
<tr>
<th>LAYER</th>
<th>DEPTH (m)</th>
<th>DESCRIPTION (Site 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00 to 0.10</td>
<td>Dark brown (7.5YR 3/4), weak to moderate consistence clay. Weak to moderate pedality (blocky 5-20mm) soil with slight acidity (pH 5.6), very low dispersion (EAT 8 &amp; 3(1)), non-saline (0.01dS/m) and poor to moderate drainage characteristics. Roots are fine to medium, common to many. Approximate sample depth 0.5m. Clear, even boundary to layer 2.</td>
</tr>
<tr>
<td>2</td>
<td>0.10 to 1.00+</td>
<td>Yellowish red (5YR 4/6), strong consistence clay. Apedal soil with slight acidity (pH 5.1), very low dispersion (EAT 3(1)), non-saline (0.02dS/m) and poor to moderate drainage characteristics. Roots are few and fine. Approximate sample depth 0.5m. Presence of grey mottling at 5%.</td>
</tr>
</tbody>
</table>

Plate 3 – Red Dermosol Profile  
Plate 4 – Red Dermosol Landscape
3.2.3 Soil Type 3: Leptic Tenosol

**Description:** The Leptic Tenosol soil unit consists of shallow, moderately drained sandy clay loams which have developed on crests and slopes around the Project Site. These soils have weak pedologic organisation below the a1 horizon and consistently have partially weathered or decomposing rock at a shallow depth. These soils are moderately to slightly acidic, are non-saline and fertility is low to very low.

**Location:** The soils cover 56% or 16.4 ha of the project area and are found on the upper slopes and ridges in the project area. The shallow soils are located predominately in the proposed extraction area for the quarry.

**Landuse:** The land overlying these soils is dominated by uncleared open forest with shrub understory. Common tree species include smooth barked apple and scribbly gum. Road tracks occur throughout the area.

**Management:** The existing topsoil horizon exhibits limited material and structural weakness and is therefore unsuitable for stripping, stockpiling and re-spreadining as a topdressing material for reshaped areas. The subsoil has poor fertility and dispersion characteristics and is poorly suited for re-use. The Leptic Tenosol is not recommended to be used for rehabilitation activities.

<table>
<thead>
<tr>
<th>LAYER</th>
<th>DEPTH (m)</th>
<th>DESCRIPTION (Murphy 1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 – 0.10</td>
<td>Dark brown (7.5YR 3/2) sandy clay loam. The soil exhibits weak pedality, with 5 – 20 mm sub angular blocky peds, containing few sub rounded to sub angular gravels to stone size substrate rock fragments. The soil contains many fine to medium roots.</td>
</tr>
<tr>
<td>2</td>
<td>0.10 – 0.50</td>
<td>Dull yellowish brown (10YR 5/4) light medium clay that is moderately strong with 10 – 50 mm angular blocky peds. Abundance of large weathered sub angular rock fragments. Significant limitations in sodicity and dispersibility characteristics.</td>
</tr>
<tr>
<td>3</td>
<td>50+</td>
<td>Partially weathered / decomposing rock</td>
</tr>
</tbody>
</table>

Plate 5 – Leptic Tenosol Soil Exposure  
Plate 6 – Leptic Tenosol Soil Landscape
4.0 LAND CAPABILITY AND SUITABILITY ASSESSMENT

The Project Boundary has been assessed for both rural land capability and agricultural suitability. The methods and results for both assessments are presented in this section fulfilling report objectives 2-1 and 2-2.

4.1 LAND CAPABILITY

4.1.1 Land Capability Methodology

The land capability system applied to the Project is in accordance with the Department of Environment, Climate Change & Water (DECCW) (formerly the NSW Soil Conservation Service). The relevant guideline is called Systems Used to Classify Rural Lands in New South Wales (Cunningham et al., 1988).

This system classifies the land on its potential for sustainable agricultural use if developed, rather than its current land use, and includes three types of land uses:

- land suitable for cultivation;
- land suitable for grazing; and
- land not suitable for rural production.

The system consists of eight classes, which classify the land based on the severity of long-term limitations. Limitations are the result of the interaction between physical resources and a specific land use. A range of factors are used to assess this interaction. These factors include climate, soils, geology, geomorphology, soil erosion, topography and the effects of past land uses.

The principal limitation recognised by these capability classifications is the stability of the soil mantle and classes are ranked on their increasing soil erosion hazard and decreasing versatility of use. A description of the eight land capability classes is provided in Table 8.

Table 8 – Rural Land Capability Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Land Use</th>
<th>Management Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Regular Cultivation</td>
<td>No erosion control requirements</td>
</tr>
<tr>
<td>II</td>
<td>Regular Cultivation</td>
<td>Simple requirements such as crop rotation and minor strategic works</td>
</tr>
<tr>
<td>III</td>
<td>Regular Cultivation</td>
<td>Intensive soil conservation measures required such contour banks and waterways</td>
</tr>
<tr>
<td>IV</td>
<td>Grazing, occasional cultivation</td>
<td>Simple practices such as stock control and fertiliser application</td>
</tr>
<tr>
<td>V</td>
<td>Grazing, occasional cultivation</td>
<td>Intensive soil conservation measures required such contour ripping and banks</td>
</tr>
<tr>
<td>VI</td>
<td>Grazing only</td>
<td>Managed to ensure ground cover is maintained</td>
</tr>
<tr>
<td>VII</td>
<td>Unsuitable for rural production</td>
<td>Green timber maintained to control erosion</td>
</tr>
<tr>
<td>VIII</td>
<td>Unsuitable for rural production</td>
<td>Should not be cleared, logged or grazed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special Zonings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>Urban areas</td>
</tr>
<tr>
<td>SF</td>
<td>State Forests</td>
</tr>
<tr>
<td>M</td>
<td>Mining &amp; quarrying areas</td>
</tr>
</tbody>
</table>

Source: Cunningham et al., 1988
4.1.2 Land Capability Results

The pre-mining and post-mining rural land capability classification of the area within the Project Boundary, in accordance with DECCW mapping, is shown in Figures 3 and 4. A comparison of the pre and post-mining rural land capability classification is provided in Table 9.

Table 9 – Comparison of Pre and Post-Mining Rural Land Capability Classes

<table>
<thead>
<tr>
<th>Land Class</th>
<th>Pre-mining</th>
<th>Post-mining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>%</td>
</tr>
<tr>
<td>Class IV</td>
<td>13.2</td>
<td>44</td>
</tr>
<tr>
<td>Class VII</td>
<td>16.4</td>
<td>56</td>
</tr>
<tr>
<td>Class VIII</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Total</td>
<td>29.6</td>
<td>100</td>
</tr>
</tbody>
</table>

4.1.2.1 Pre-Mining

Class IV Land

Class IV land consists of Soil Type 1 and 2 (Brown Chromosol and Red Dermosol), and covers an area of 13.2 ha. This classification indicates that the land is suitable for grazing with only occasional cultivation and is the best class of grazing land. The majority of Class IV land occurs within the proposed infrastructure area.

Class VII Land

Class VII land consists of Soil Type 3 (Leptic Tenosol) and covers an area of 16.4 ha. This land is considered unsuitable for rural production and is best protected by green timber to control erosion. The majority of Class VII land occurs within the proposed quarry extraction area. Constraints associated with soil types include its slope, heavy subsoil clay content, shallow topsoil depth and susceptibility to erosion.

4.1.2.2 Post-mining

The main parameters for determining post mining land capability is steepness of slope and quality of material used as topdressing in rehabilitation. The majority of the disturbed post mining landform consists of slopes of 10 degrees and will be covered in low to moderate quality topdressing. Following rehabilitation of the infrastructure area the land capability of the Soil Type 1 and 2 lands will be returned to Class IV.

The areas of Class VII land prior to mining will be divided between Class VII and Class VIII land post mining. The main open cut footprint and associated areas of the haul road and a segment to the north west of the infrastructure area, classified as Soil Type 3, will remain as land capability Class VII. The benches will be protected with green timber and unsuitable for agricultural use. The lowest section of the open cut footprint, that being below 75 RL (reduced level), will be classed as VIII due to the potential for ponding.
FIGURE 3
Karuah East Quarry Soil Assessment
Pre Land Capability

LEGEND:
- Project Site Boundary
- Proposed Quarry Area
- Vegetation Offset Area
- Proposed Karuah East Quarry
- Vegetation Offset Area
- Proposed infrastructure area
- Haul Road
- Land Capability Class

Class IV
Class VII

Base Aerial Source: Google Earth
To be printed A3
FIGURE 4

Karuah East Quarry Soil Assessment
Post Land Capability

LEGEND:
- Project Site Boundary
- Proposed Quarry Area
- Vegetation Offset Area
- Proposed Karuah East Quarry
- Void
- Proposed infrastructure area
- Haul Road

Land Capability Class:
- Class IV
- Class VII
- Class VIII
- Void

Base Aerial Source: Google Earth
4.2 AGRICULTURAL SUITABILITY

4.2.1 Agricultural Suitability Methodology

The agricultural suitability system applied to the Modification is in accordance with I&I NSW (formerly the NSW Agricultural & Fisheries). The relevant guideline is the *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries, 1988).

The system consists of five classes, providing a ranking of rural lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for crop growth within certain limits. Class 1 ranks the land as most suitable for agricultural activities and Class 5 the least suitable. Classes 1 to 3 are generally considered suitable for a wide variety of agricultural production, whereas, Classes 4 and 5 are unsuitable for cropping however are suitable for some grazing activities.

The overall suitability classification for each specific soil type is determined by the most severe limitation, or a combination of the varying limitations. A description of each Agricultural Suitability Class is provided in Table 10.

<table>
<thead>
<tr>
<th>Class</th>
<th>Land Use</th>
<th>Management Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Highly productive land suited to both row and field crops.</td>
<td>Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.</td>
</tr>
<tr>
<td>2</td>
<td>Highly productive land suited to both row and field crops.</td>
<td>Arable land suitable for regular cultivation for crops but not suited to continuous cultivation.</td>
</tr>
<tr>
<td>3</td>
<td>Moderately productive lands suited to improved pasture and to cropping within a pasture rotation.</td>
<td>Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture.</td>
</tr>
<tr>
<td>4</td>
<td>Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.</td>
<td>Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage.</td>
</tr>
<tr>
<td>5</td>
<td>Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.</td>
<td>Land unsuitable for agriculture or at best suited only to light grazing.</td>
</tr>
</tbody>
</table>

Source: NSW Agriculture & Fisheries (1990)

4.2.2 Agricultural Suitability Results

The main soil properties and other landform characteristics considered significant for the agricultural land suitability assessment are topsoil texture, topsoil pH, solum depth, external and internal drainage, topsoil stoniness and slope as well as bio-physical factors such as elevation, rainfall and temperature. A comparison of the pre and post-mining agricultural land suitability classification is provided in Table 11. No Class 1 Agricultural Suitability land occurs within the Project Boundary.

<table>
<thead>
<tr>
<th>Land Class</th>
<th>Pre-mining</th>
<th>Post-mining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>%</td>
</tr>
<tr>
<td>Class 3</td>
<td>13.2</td>
<td>44</td>
</tr>
<tr>
<td>Class 5</td>
<td>16.4</td>
<td>56</td>
</tr>
<tr>
<td>Total</td>
<td>29.6</td>
<td>100</td>
</tr>
</tbody>
</table>
4.2.2.1 Pre-Mining

Class 3 lands cover 13.2 ha of the study area. Class 3 lands are moderately productive lands suited to improved pasture and to cropping within a pasture rotation. These lands are generally located throughout the proposed infrastructure area and are associated with Soil types 1 and 2 on low slopes and flats.

Class 5 lands cover 16.4 ha of the study area. Class 5 lands are marginal lands not suitable for cultivation and with a low to very low productivity for grazing. These lands are generally associated with steep hillsides and hilltops located within the proposed extraction area. Due to limited pedologic development associated with Soil Type 3, the cultivation of these soils for agriculture would involve the removal of the protective vegetative cover and will facilitate rapid erosion processes and lead to severe land degradation. The sodic characteristic of Soil Type 3 indicates a limitation in fertility and a tendency for the soil particles to disperse in wet conditions.

4.2.2.2 Post-mining

The main parameters for determining post mining agricultural suitability, as with land capability, is steepness of slope and quality of material used as topdressing in rehabilitation. The disturbed land of the infrastructure area will have a post mining landform consisting of gentle slopes and foothill areas and will be covered in low to moderate quality topdressing with an intermediate layer of clay. These factors will result in an agricultural suitability Class 3.

The proposed quarry area will be constrained by the high presence of rocky material and minimal soil development, therefore material cannot be stripped and topdressing cannot be applied post mining. Additionally the final landform and void assemblage are heavily constrained by steepness. Due to these characteristics, this land will continue to be unsuitable for agricultural use post mining, and are Class 5.
FIGURE 5

Karuah East Quarry Soil Assessment

Agricultural Suitability

LEGEND:

Project Site Boundary
Proposed Quarry Area
Vegetation Offset Area
Proposed Karuah East Quarry
Void
Proposed infrastructure area
Haul Road
Agricultural Suitability Class:
Class 3
Class 1

To be printed A3

V:\HQP05-002\Figures\Drawings\Fg5_HQP05-002_AgSuit_110705.dwg

Karuah East Quarry Soil Assessment
Agricultural Suitability

FIGURE 5
5.0  SOIL MANAGEMENT

Soil that is proposed to be disturbed during the Project has been assessed to determine its suitability for stripping and re-use on rehabilitation sites. This assessment is an integral process for successful rehabilitation of the Project. This report provides information on the following key areas related to the management of the topsoil resources for the area within the Project Boundary.

- Topsoil stripping assessment which provides a topsoil stripping depth map indicating recommended stripping depths for topsoil salvage and re-use as topdressing in rehabilitation; and
- Topsoil volume calculated from recommended stripping depths of each soil type;
- Topsoil balance calculated with consideration for rehabilitation of infrastructure area & roads; and
- Topsoil management for soil that is stripped, stored and used as a topdressing material for rehabilitation.

5.1  SOIL STRIPPING ASSESSMENT

5.1.1 Soil Stripping Methodology

Determination of suitable soil to conserve for later use in mine rehabilitation has been conducted in accordance with Elliott and Veness (1981). The approach remains the benchmark for land resource assessment in the Australian mining industry. This procedure involves assessing soils based on a range of physical and chemical parameters. Table 12 lists the key parameters and corresponding desirable selection criteria used for the selection of soil material for use as topdressing.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Desirable criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure Grade</td>
<td>&gt;30% peds</td>
</tr>
<tr>
<td>Coherence</td>
<td>Coherent (wet and dry)</td>
</tr>
<tr>
<td>Motting</td>
<td>Absent</td>
</tr>
<tr>
<td>Macrostructure</td>
<td>&gt;10cm</td>
</tr>
<tr>
<td>Force to Disrupt Peds</td>
<td>≤ 3 force</td>
</tr>
<tr>
<td>Texture</td>
<td>Finer than a Fine Sandy Loam</td>
</tr>
<tr>
<td>Gravel &amp; Sand Content</td>
<td>&lt;60%</td>
</tr>
<tr>
<td>pH</td>
<td>4.5 to 8.4</td>
</tr>
<tr>
<td>Salt Content</td>
<td>&lt;1.5 dS/m</td>
</tr>
</tbody>
</table>

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. All other physical parameters outlined in Table 11 were determined during the field assessment.

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. Better 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.

5.1.2 Soil Stripping Depths & Volume

Laboratory soil analytical results (refer Appendix 3) were used in conjunction with the field assessment (refer Appendix 1) to determine the depth of soil material suitable for recovery and re-use as a topdressing material in rehabilitation. Structural and textural properties of soils, along with stones, dispersion potential, sodicity and acidity/alkalinity are the most common and significant limiting factors in determining depth of soil suitability for re-use. Soil Types 1 and 2 have been identified as having appealing characteristics for rehabilitation purposes. This includes the topsoil and sub soil of each Soil Type. Soil Type 3 is inappropriate for stripping and rehabilitation purposes.

The recommended stripping depth for each soil type, together with area of land and calculated volume are provided in Table 13.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Project Soil Name</th>
<th>Soil Layer</th>
<th>Recommended Stripping Depth (m)</th>
<th>Area (ha)</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brown Chromosols</td>
<td>Topsoil</td>
<td>0.30</td>
<td>8.63</td>
<td>25,890</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsoil</td>
<td>0.90</td>
<td>8.63</td>
<td>77,670</td>
</tr>
<tr>
<td>2</td>
<td>Red Dermosols</td>
<td>Topsoil</td>
<td>0.10</td>
<td>4.55</td>
<td>4,550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsoil</td>
<td>1.10</td>
<td>4.55</td>
<td>50,050</td>
</tr>
<tr>
<td>3</td>
<td>Leptic Tenosols</td>
<td>Topsoil</td>
<td>0.0</td>
<td>16.4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsoil</td>
<td>0.0</td>
<td>16.4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Total Volume</strong></td>
<td><strong>Total Volume</strong></td>
<td>(10% handling loss allowance)</td>
<td>158,160</td>
<td>142,344</td>
</tr>
</tbody>
</table>

Allowing for a 10% handling loss, approximately 142,344 m³ of suitable topdressing is available within the mining project boundary. The majority of topsoil disturbance will result from the excavation of the open cut pit, which is generally located in the Leard State Forest upon the Soil Type 1. This soil is not recommended to be stripped. Areas to be disturbed within the infrastructure boundary will be stripped and stockpiled for re-use in rehabilitation for the area from where it was stripped. This will include a topsoil layer as well as an intermediate layer. The intermediate layer will be established with the clay soils stripped, and due to their non sodic nature (ESP <5) these soils will be beneficial to reset into the soil profile to increase the rehabilitated soil profiles water holding capacity.
5.1.3 Soil Stripping Depths & Volume Assumptions

The topsoil balance was undertaken with the following assumptions:

- Only the sandy clay loam topsoil of Soil Type 1 will be used as the final surface topdressing in rehabilitation. The clay topsoil of Soil Type 2 and all subsoils are only suitable as an intermediate layer between the overburden and the final surface topdressing material, due to high clay content;
- A 10% handling loss has been applied;
- Rehabilitation involving topsoil respreading will occur on the entire infrastructure area. The open cut footprint will be rehabilitated through direct tree planting and more specific rehabilitation measures due to lack of appropriate material;
- Topsoil will be respread on final landforms at a minimum of 15cm, and an intermediate layer will be established at a minimum of 30cm.

5.1.4 Topsoil Balance

A topsoil and subsoil mass balance has been conducted. It incorporates all disturbed areas within the project area and is based on an assessment of the total topsoil and subsoil volumes to be stripped as outlined in Section 5.1.2.

Table 14 below provides a summary of the preliminary topsoil mass balance. Current estimates suggest there will be sufficient topsoil resources available to address the rehabilitation requirements of the site, and an abundant amount of subsoil to be applied as an intermediate layer.

<table>
<thead>
<tr>
<th>Table 14 - Topsoil Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topsoil</td>
</tr>
<tr>
<td>Amount of topsoil available to be stripped</td>
</tr>
<tr>
<td>Amount of topsoil required for rehabilitation at closure</td>
</tr>
</tbody>
</table>

Subsoil

| Amount of subsoil available to be stripped | 131,400 |
| Amount of subsoil required for rehabilitation works at closure | 39,300 |

5.2 TOPDRESSING MANAGEMENT

Where topsoil stripping and transportation is required, the following topsoil handling techniques are recommended to prevent excessive soil deterioration, note this also applies to subsoil stripping:

- Strip material to the depths stated in Table 13, subject to further investigation as required.
- Topsoil should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- Place stripped material directly onto reshaped overburden and spread immediately (if mining sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling.
- Clay material is to be applied first to create an intermediate layer. This is done to reinstate the soil profile as best as possible. The loam topsoil can then be spread to overlie this layer.
- Grading or pushing soil into windrows with graders or dozers for later collection for loading into rear dump trucks by front-end loaders 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 overburden trucks may be placed directly into storage.
- 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 will provide 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 (particularly onto designated tree seeding areas), 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.

### 5.2.1 Topsoil Re-spreading and Seedbed Preparation

Where practical, suitable topsoil should be re-spread directly onto reshaped areas. Where topsoil resources allow, topsoil should be spread to a nominal depth of 100 mm on all re-graded spoil. 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 spoil. Ripping should be undertaken on the contour. Best results will be obtained by ripping when soil is moist 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.
6.0 REFERENCES


Department of Natural Resources (2005). Land Capability Spatial Data. Resource Information Unit, Hunter Region


