Specialist Consultant Studies

East Boggabri Joint Venture

Proposed East Boggabri Coal Mine

Soils and Land Capability Study of the Proposed Transport Route

Prepared by

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Specialist Consultant Studies Compendium
Part 3b

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Soils and Land Capability Study

of the Northern Section of the Proposed Transport Route

Proposed East Boggabri Coal Mine

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EXECUTIVE SUMMARY

A soils and land capability study has been conducted along the proposed transport route linking the proposed East Boggabri Coal Mine Project Site with the facilities at the current Whitehaven Coal Mine, referred to as the northern section of the proposed transport route.

The proposed route runs through sections of private property as well as along and across existing Shire roads. The transport route Study Area comprised the sections of the route located on private property.

The length of the proposed route is 8.76km and the total area affected is 21.9ha.

Soils in the transport route Study Area have been described and two Soil Mapping Units have been identified.

The physical and chemical attributes of the soils of the transport route Study Area have been quantified through a combination of field assessment and laboratory testing and indicate:

- the soils are currently relatively stable but have a generally low to moderate erodibility rating as determined using the laboratory data obtained from samples from the transport route Study Area in the Soiloss computer model;
- the soils have a generally high structure grade and so can be stripped and respread using scrapers;
- for SMU 3 and SMU 4, the topsoil material (to 15cm depth) can be reused as topsoil;
- the subsoil from SMU 3 can be used as material for such appropriate on-farm works as may be agreed between the Proponent and landholders;
- stripping of subsoil from SMU 4 should be limited to the minimum depth possible because of the salinity and dispersibility (and possible sodicity) exhibited by this material;
- the subsoil from SMU 4 should be transported to Whitehaven or East Boggabri and buried under the subsoil material being used in rehabilitation of the final landscape; and
- all soils will be subject to structural degradation if worked when too moist.

Depth of stripping recommendations have been provided.

The land capability and agricultural land suitability of the transport route Study Area in the pre-disturbance state has been determined.

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1 INTRODUCTION AND DESCRIPTION OF PROJECT

1.1 Introduction

A number of proposed coal transport routes from the proposed East Boggabri Coal Mine to the Whitehaven Coal Handling and Preparation Plant (CHPP) have been examined in the recent past.

The favoured and now proposed route (see **Figure 1**) is one that links the East Boggabri Coal Mine site with the current Whitehaven Coal Mine operation in a relatively direct line. Once within the Whitehaven Coal Mine, the route will join the current transport route that links Whitehaven Coal Mine with the Whitehaven CHPP and rail loading facility via Hoads Lane and the Blue Vale Road.

The transport route Study Area lies wholly within Narrabri Shire.

This soils study and the land capability and agricultural land suitability assessments are limited to the area that would be disturbed by the proposed road construction.

Field sampling of the area was carried out on 8th and 9th February, 2005.

The brief for the study required the preparation of a report on:

(i) the soils of the proposed transport route between the East Boggabri Coal Mine and the Whitehaven Coal Mine (transport route “Study Area”) that are likely to be disturbed by construction of a haul road; and

(ii) the land capability and agricultural land suitability of the proposed transport route.

The report was required to include sufficient level of detail to satisfy the Department of Mineral Resources in relation to Mining Operations Plan guidelines and to satisfy the requirements of the Department of Infrastructure, Planning and Natural Resources' specifications for soil surveys associated with activities related to proposed mining operations.

This report describes the soils based upon eleven representative soil profiles as well as laboratory analyses of a selection of representative profiles and land capability of the transport route Study Area.

In particular, this report provides:

- the results of the field survey and laboratory testing of samples;
- a discussion of the results of field survey and laboratory physical and chemical analysis in technical as well as “Plain English” terms;
- a discussion of the stripping suitability of the soil materials found along the proposed transport route;
- details of soil handling strategies and recommendations about soil stripping and stockpiling; and
- details of the land capability and agricultural suitability at the Project Site.

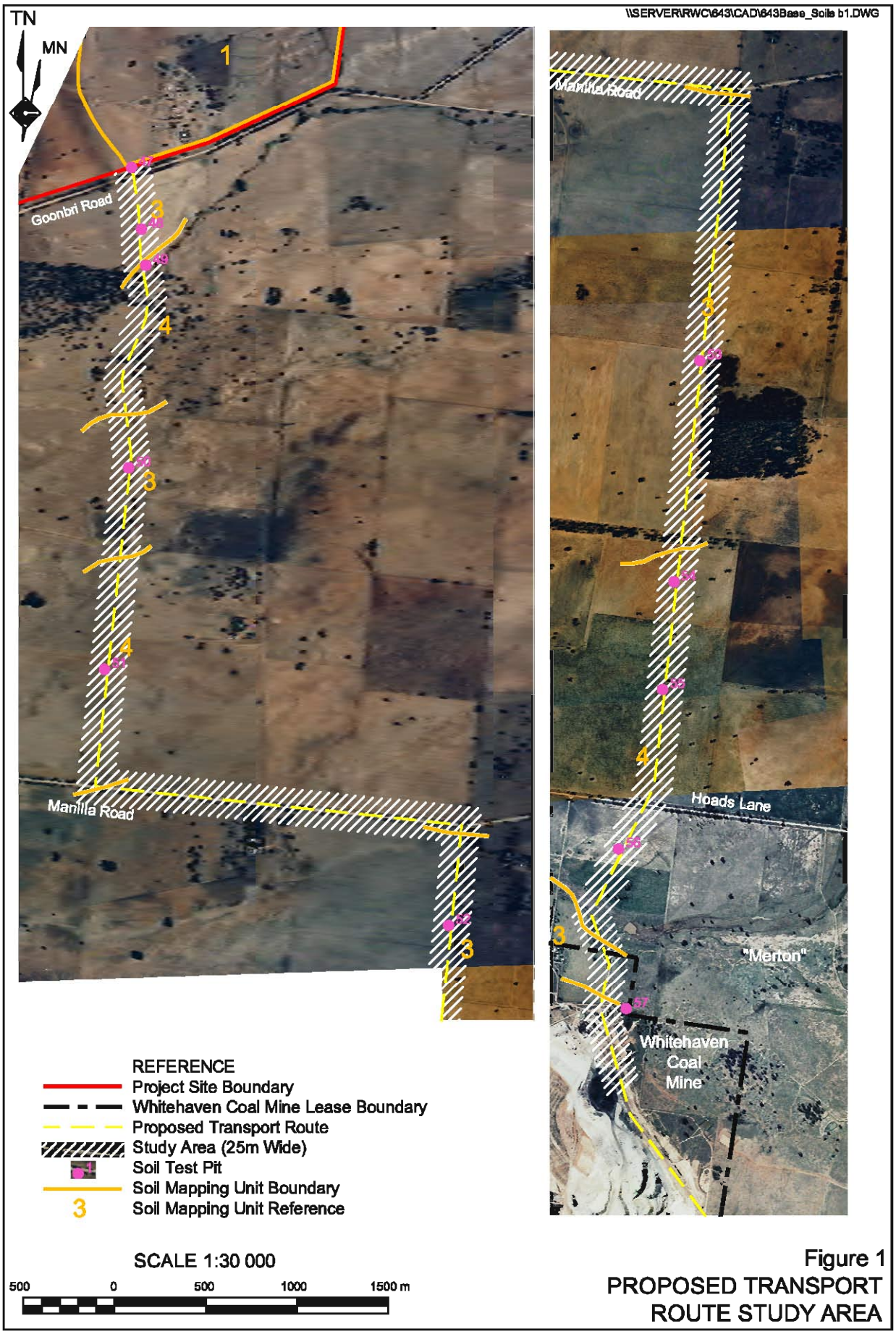

Figure 1
PROPOSED TRANSPORT ROUTE STUDY AREA

1.2 Description of the Proposed Transport Route

The Proponent proposes to establish a transport route between the Project Site and the Whitehaven CHPP and rail loading facility. This transport route would incorporate the following.

(i) Construction of roads on private land between the East Boggabri Coal Mine and the Whitehaven Mine.

(ii) Sections of existing public roads between the East Boggabri Coal Mine and the Whitehaven Mine.

(iii) An established transport route between the Whitehaven Coal Mine and the Whitehaven CHPP.

This report focuses on (i) above.

2 DESCRIPTION OF THE STUDY AREA

The transport route Study Area for the northern section of the proposed transport route from the East Boggabri Coal Mine site is 25m wide. Its total length between the 'Thuin' property boundary on the Goonbri Road and the beginning of the current haul road from Whitehaven Coal Mine is 10.78km. However, only 8.76km of the route comprises the transport route Study Area as the remainder traverses a section of the existing Manilla Road.

The total area of the transport route Study Area is 21.9ha.

The northern section of the proposed transport route leaves the 'Thuin' property where the proposed mine is located and crosses the Goonbri Road to the west of the 'Thuin' homestead. It then proceeds in a generally south-southeast direction for approximately 600m to a crossing of Bollol Creek and then into the property 'Tarrawonga' where the direction changes slightly to south-southwest for a distance of 2.8km to the Manilla Road.

The transport route then makes a left hand right angle bend and proceeds east-southeast along Manilla Road for a distance of 2.0km to the eastern boundary of the property 'Kyalla' where it makes a right angle bend to the right and again heads in a south-southwest direction for 3.9km (2.4km through 'Kyalla' and 1.5km through 'Bungalow' property) before it crosses Hoads Lane.

After crossing Hoads Lane to the northeast of the Whitehaven Coal Mine site the proposed transport route heads south-south west and then south-southeast to join the existing transport route within the Whitehaven Coal Mine area. The length of this section of the proposed transport route is 1.46km.

The proposed transport route Study Area is shown in **Figure 1**.

The northern section of the transport route Study Area comprises level plain country for most of its length. At the proposed Project Site the transport route Study Area commences on the lower slopes of a ridge that is located close to the centre of the East Boggabri site. A similar low ridge area is located at the Whitehaven end of the transport route Study Area.

The total length of the transport route Study Area is used for agriculture with grazing of native / naturalized and improved pastures and cropping operations being carried out.

3 LITERATURE REVIEW

3.1 Current Information on the Soils of the Transport Route Study Area

The area in which the proposed transport route is located lies within the boundaries of the Boggabri 1:100 000 scale topographic map sheet area.

A soil survey by DIPNR is currently in progress for the area, the report has yet to be finalised and published.

3.1.1 Narrabri Soil Conservation Service Technical Manual

The Narrabri Soil Conservation Service Technical Manual (Anon, 1978) provides the only soil published descriptions for the transport route Study Area.

This manual identifies the following two broad soil types that occur within the transport route Study Area.

- Brown Solodic / Brown Clay Complex (Type A).
- Black Earths.

3.1.1.1 Brown Solodic / Brown Clay Complex (Type A)

These are a mixture of hardsetting dull brown to grey-brown soils with a texture contrast and usually a well developed A_2 horizon and hardsetting brown-grey clays.

3.1.1.2 Black Earths

The Black Earths are uniformly medium to heavy clay in texture, brownish black in colour and strongly structured. The surface is seasonally cracking and self-mulching.

4 METHODOLOGY

4.1 Preparations

Prior to field investigations, the transport route Study Area was subjected to stereoscopic airphoto interpretation to ascertain the nature of the landforms present at the site and to develop a broad appreciation of the landform units that would require sampling.

The 1: 25 000 scale colour airphotos used were those produced by the Department of Land and Property Information.

The prints used in the stereoscopic interpretation were Boggabri Run 5, Print Nos. 109, 110 and Run 6, Print Nos. 141, 142, flown on 6th September, 2001.

4.2 Field Procedures

For the soils study, sampling involved the complete description of ten profiles to a depth of 2.5m or the depth of backhoe refusal. The locations of the soil sampling sites within the transport route Study Area are shown in **Figure 1**.

An additional pit description from a previous soil survey of the ridge at the Whitehaven end of the proposed transport route was included in this assessment to provide an indication of the soil type at the southern end of the transport route Study Area.

The soil profiles at each pit location were fully described in the field after a detailed examination of the different layers.

For each test profile (site) described, details of the following soil properties were noted.

- Texture
- Fabric
- Structure
- Consistence
- Boundary sharpness
- Colour (moist and dry)
- Gravel/stone occurrence
- Presence of roots
- Presence of lime
- Presence of manganese
- pH

Soil pH was measured using the Raupach method (Raupach indicator and barium sulfate). Soil colour (moist and dry) was determined using Munsell soil colour charts (Macbeth, 1992). The classification of the soils that were described was based on Isbell (1996).

In determining the soil classifications the CD-ROM titled “The Australian Soil Classification – An Interactive Key” (Jacqier et al, 2001) was used.

The information obtained was recorded in a form that is compatible with that required for entry on soil data cards used in the DIPNR’s SPADE Soil Database.

Samples from all layers in two of these profiles (Nos 53 and 56) were forwarded to the Department of Lands’ NATA – registered soil testing laboratory at Scone for more detailed analysis to determine the following properties.

- Range of particle size (particle size analysis).
- Dispersion percentage.
- Coherence (Emerson aggregate test).
- Electrical conductivity.

Soil Stripping Suitability

The stripping suitability of the soils at the sites sampled using the backhoe pits was determined on the basis of the procedure outlined by Elliott and Veness (1981).

From the data gained in this process, recommendations on the depths of topsoil and subsoil stripping were developed.

5. RESULTS

From the information gained from both the detailed soil profile descriptions, and the additional check pits, two Soil Mapping Units (SMUs) were identified.

These SMUs were as follows.

- **Soil Mapping Unit 3**[1] – Duplex Soils – these occur on slightly more elevated areas of the floodplain country between the proposed East Boggabri Coal Mine and Whitehaven Coal Mine. These soils have a relatively sandy surface layer of varying depth overlying more clayey material. They extend to the lower slopes at both ends of the transport route.

- **Soil Mapping Unit 4**[1] – Clay Soils – the lower floodplain areas have more clayey soils that are described within this unit. These soils are clayey throughout the topsoil and upper subsoil horizons although sandy material is encountered at depth in some profiles.

The soil mapping unit boundaries are shown in **Figure 1**.

It is important to note that not all soil layers described for each of the Soil Mapping Units are present in every profile. Soils are inherently variable in nature and while they may have similar overall characteristics they may vary in layer detail and properties.

Appendix 1 contains detailed information on the layers present in the twelve pits that were described in detail.

5.1 Soil Mapping Unit Descriptions

5.1.1 Introduction

Descriptions of the layers found in the profiles of the two SMUs identified within the transport route Study Area are set out below.

In each case, the soil within each unit is described in two ways – a “Plain English” version followed by a technical description.

Definitions of the technical terms used in the descriptions can be found in **Appendix 4** or by consulting McDonald et al (1990) or Houghton and Charman (1986).

5.1.2 Soil Mapping Unit 3 – Duplex Soils

5.1.2.1 General Description

Soil Mapping Unit 3 is comprised of duplex soils that have a shallow (up to 60cm) coarse textured layer overlying a clay subsoil. These soils occur on the slightly more elevated sections of the floodplain country between the Project Site and the Whitehaven Coal Mine.

Some of these soils have bleached A_2 horizons.

[1] Soil Mapping Units 1 and 2 have been attributed to soils on the Project Site of the proposed East Boggabri Coal Mine (see GCNRC, 2005a).

5.1.2.2 "Plain English: Description:

Low rises on floodplains or fringing lower slope locations.

Soil 122 to 250cm deep; surface condition loose, soft, firm to hardsetting; surface stone usually absent.

Topsoil – sandy clay loam, silty clay loam; silty clay in texture in one or two layers; roots common to many; no lime present; no manganese present; pH 4.5 to 6.0; gravel absent or some gravel rounded, angular or flat <5mm to 3cm; not mottled; bleached A2 horizon sometimes present..

Subsoil – up to four subsoil horizons identified in sample pits; B horizon subsoils generally comprised of clay; occasionally with coarser textured layers; gravel usually common through the profile

5.1.2.3 Technical Description (based on test pits):

(a) Australian Soil Classification Name: Grey Chromosol

(b) Field Description:

Level Plain, low rise or midslope location; Surface condition loose, soft, firm to hardsetting; surface stone usually absent.

Layer 1 – (always present) A1.1 horizon (16cm to 32cm thick) – sandy clay loam, silty clay loam; silty clay in texture; roots common to many; no lime present; no manganese present; pH 4.5 to 6.0; gravel absent or some gravel rounded, angular or flat <5mm to 3cm; not mottled; not bleached; brown (7.5YR 4/3, 7.5YR5/3, 10YR5/3), light brownish grey (10YR6/2) dry; brown (7.5YR4/3), dark brown (7.5YR3/3), dark reddish grey (5YR 4/2),very dark greyish brown (10YR3/2) moist; peds rough-faced or rough / smooth-faced, highly pedal (100%), <5mm to 15mm in size; firm to very strong consistency, occasionally weak, dry; usually hydrophobic or slightly so*; abrupt, clear, gradual or sharp to:-*

Layer 2 – (sometimes present) A1.2 horizon (20cm to 28cm thick) – sandy clay loam; few to many roots present; no lime present; no manganese present; pH 6.0 to 7.5; gravel absent or some gravel present, rounded, <5mm to 2cm; not mottled; not bleached; brown (7.5YR5/3, 7.5YR 5/4), light brown (7.5YR6/3) dry; brown (7.5YR4/4), dark brown (7.5YR3/2), reddish brown (5YR 4/4) moist; peds rough-faced or rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; very firm to strong consistency dry; not hydrophobic; *sharp to abrupt to:-*

Layer 3 – (rarely present) A2 horizon (recorded 27cm thick) – sandy clay loam; many roots present; no lime present; no manganese present; pH 6.5; gravel rounded and angular to 2cm common; not mottled; bleached very pale brown (10YR7/3) dry, brown (7.5YR4/3) moist; peds rough-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; firm consistency dry; not hydrophobic; *abrupt to:-*

Layer 4 – (always present) B1 horizon (33cm to 183cm thick) – light to medium clay or medium to heavy clay; few to many roots present; usually no lime present, sometimes stains and concretions evident; no manganese present; pH 7.0 to 8.5, sometimes 9.0 to 10; gravel absent or occasional to common rounded and angular gravel to 5cm; not bleached; usually **whole coloured**; brown (7.5YR5/4), dark greyish brown (10YR4/2), light brownish grey (10YR6/2), light yellowish brown (10YR6/4), yellowish red (5YR 5/6) dry; brown (7.5YR4/3,10YR5/3), dark brown (7.5YR3/2), red (2.5YR4/6), reddish brown (5YR4/4), strong brown (7.5YR 4/6), very dark greyish brown (10YR3/2) moist; **occasionally mottled dry / whole coloured moist,** brown (7.5YR5/3, 7.5YR5/4), yellowish red (5YR4/6) dry; peds usually rough / smooth-faced, occasionally peds rough-faced or smooth-faced, highly pedal (100%), polyhedral, <5mm to 20mm in size; strong to very strong consistency dry; not hydrophobic; *abrupt, diffuse, gradual, sharp to:-*

Layer 5 – (always present) B2.1 horizon (12cm to 183cm thick) – sandy clay loam, sandy clay, medium clay, medium to heavy clay; few roots present; lime absent or stains and concretions present; manganese absent or concretions sometimes present; pH9.0 to 10, sometimes 6.0; gravel occasionally absent, usually common, rounded and angular to 2cm; not mottled, not bleached; brown (7.5YR5/4), light grey (10YR7/2), light yellowish brown (10YR6/4), yellowish brown (10YR5/4) dry; brown (7.5YR4/4, 7.5YR5/3, 7.5YR5/4), dark brown (7.5YR3/2) moist; peds rough-smooth faced, sometimes rough-faced, highly pedal (100%), polyhedral (occasionally angular blocky), <5mm to 15mm in size; very firm to very strong consistency dry; not hydrophobic; *abrupt, diffuse or gradual to:-*

Layer 6 – (occasionally present) B2.2 horizon (46cm to 48cm thick) – gritty light clay to medium to heavy clay; few roots; lime present as nodules or absent; no manganese present; pH 9,0; not mottled; not bleached; pale brown (10YR 6/3) to light brown (7.5YR6/4) dry; yellowish brown (10YR 5/4) to brown (7.5YR4/3) moist; much rounded and angular gravel to 2cm; peds rough-smooth faced or smooth-faced, highly pedal (100%), polyhedral/platy 5mm to 20mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to diffuse to bedrock or lower horizon:-*

Layer 7 – (usually present) B3 horizon (30cm to 183cm thick) – sand, clayey sand, sandy clay loam; few roots present or roots absent; lime absent; manganese usually absent, stains sometimes present; pH 6.5 to 7.0 to 9.5 to 10; gravel occasionally absent, usually a layer of mixed sand and rounded or angular gravel to 1cm to 4cm, gravel sometimes absent; not mottled; not bleached; brown (10YR5/3, 7.5YR5/4), light yellowish brown (10YR6/4), pale brown (10YR6/3) dry; brown (7.5YR4/3, 7.5YR4/4), dark brown (7.5YR3/3), dark greyish brown (10YR4/2) moist; usually massive, fabric rough; sometimes, peds rough-smooth faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; very firm to strong consistency dry.

5.1.3 Soil Mapping Unit 4 – Clay Soils

5.1.3.1 "Plain English" Description:

Level plain locations.

Soil to 250cm deep; surface condition soft or self mulching/cracked; surface stone absent or a small amount present.

Topsoil – 15cm to 39cm thick; light clay to medium clay; roots common to many; no manganese present; no lime present; pH 6.5 to 7.0; gravel absent or some present to <1cm, grit often present; not mottled; not bleached.

Subsoil – usually three subsoil horizons identified in sample pits; B horizon subsoils generally comprised of medium or medium to heavy clay; occasionally with coarser textured layers as bands in other horizons or at the base of the profile. Gravel usually absent through the profile although some layers are gritty.

5.1.3.2 Technical Description (based on test pits):

(a) Australian Soil Classification Name: Grey Vertosol

(b) Field Description:

Surface condition soft or self mulching / cracked; surface stone absent or a small amount present.

Layer 1 – (always present) A horizon (15cm to 39cm thick) – light clay to medium clay; roots common to many; no manganese present; no lime present; pH 6.5 to 7.0; gravel absent or some present to <1cm, grit often present; not mottled; not bleached; brown (7.5YR4/2, 7.5YR5/2) dry; dark brown (7.5YR3/2), very dark grey (7.5YR3/1) moist; peds rough-smooth faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; very firm to very strong consistency dry; not hydrophobic; *abrupt, gradual or sharp to:-*

Layer 2 – (always present) B1 horizon (26cm to 57cm thick) – medium cal to medium to heavy clay; roots few or common to many; lime absent or some concretions present; no manganese present; pH 8.0 to 9.5 to 10; no gravel observed, some grit present; not mottled; not bleached; brown (10YR5/3, 7.5YR4/3, 7.5YR5/2), dark greyish brown (10YR4/2) dry; brown (7.5YR4/2), dark brown (7.5YR3/2), reddish brown (5YR4/3), very dark grey (7.5YR3/1) moist; peds rough-smooth faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

Layer 3 – (always present) B2.1 horizon (38cm to 121cm thick) – medium clay; medium to heavy clay, sometimes discrete gritty layers present; few to many roots, sometimes absent; many lime concretions present; manganese absent or present as stains and concretions; pH 9.0 to 10; usually no gravel present, sometimes lenses of grit evident or rounded gravel <1cm present; not mottled; not bleached; brown (7.5YR4/3, 7.5YR5/3, 7.5YR5/4), pink (7.5YR7/4) dry; brown (7.5YR4/2, 7.5YR4/3, 7.5YR4/4, 7.5YR5/3) moist; peds rough-smooth faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; very firm to very strong consistency dry; not hydrophobic; *clear, diffuse or gradual to:-*

Layer 4 – (always present) B2.2 horizon (30cm to 108cm thick) – light clay or medium clay; roots absent or few roots present; lime concretions present, sometimes lime absent; manganese stains and concretions present or absent; pH 9.0 to 9.5 to 10; no gravel present; not mottled; not bleached; brown (7.5YR5/3), light brown (7.5YR6/3), very pale brown (10YR7/4) dry; brown (7.5YR4/4, 7.5YR5/3) moist; peds rough-smooth faced, highly pedal (100%), polyhedral to polyhedral/platy, <5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *end of record or diffuse to lower horizon:-*

Layer 5 – (rarely present) B3 horizon (recorded 50cm thick) – clayey sand; no roots observed; no lime present; no manganese present; pH 8.5 to 9.0; grit present, pockets of white sand in bottom of layer; not mottled; not bleached; light brown (7.5YR6/3) dry; brown (7.5YR4/4) moist; fabric rough; massive; not hydrophobic.

5.2 Soil Laboratory Analysis

Ten samples from two soil profiles were selected for laboratory analysis at the Department of Lands Soil and Water Testing Laboratory at Scone.

The tests performed aimed at assessing the potential erodibility of the soils (Particle Size Analysis (PSA), Dispersion % (D%), Emerson Aggregate Test (EAT) and Electrical Conductivity (EC).

5.2.1 Physical and Chemical Analyses

Tables 1a and **1b** show the results obtained from laboratory analysis of the samples from the two pits.

6 DISCUSSION OF SOIL ANALYSES

6.1 Physical Attributes

The laboratory analysis results contained in **Table 1a** and **1b** are important in assessing the erodibility of the soil units found within the transport route Study Area.

The three tests (Particle Size Analysis, Dispersion %, Emerson Aggregate Test) carried out on samples from each of the horizons within the seven selected soil profiles, when considered together, provide a good indication of the soil's likely behaviour in relation to the erosive forces encountered in the field.

Table 1a
Physical Laboratory Analysis Data for Selected Soil Profiles
Whole Soil Particle Size Analysis – 1

PIT	LAYER	TEXTURE (fine earth)#	DEPTH (cm)	PSA % CLAY	PSA % SILT	PSA % FINE SAND	PSA% COARSE SAND	PSA % TOTAL SAND	PSA % GRAVEL
PIT 53	1	Loamy sand	0-23	8	17	35	40	75	<1
	2	Loamy sand	23-43	10	18	39	32	71	1
	3	Clay	43-76	38	6	25	31	56	<1
	4	Clay loam	76-220	28	20	37	14	51	1
	5	Sandy loam	220-250	17	7	39	35	74	2
PIT 56	1	Clay loam	0-39	29	21	39	10	49	1
	2	Clay	39-88	59	20	19	2	21	<1
	3	Clay loam	88-126	29	17	37	15	52	2
	4	Silty clay loam	126-192	31	25	32	9	41	3
	5	Silt loam	192-242	8	8	9	60	69	15

Note: PSA = Particle Size Analysis # texture based on laboratory measurements

Table 1b
Physical Laboratory Analysis Data for Selected Soil Profiles
Whole Soil Particle Size Analysis – 2

PIT	LAYER	TEXTURE (fine earth)#	DEPTH (cm)	D %	D% level of dispersion	EAT	EAT level of dispersion
PIT 53	1	Loamy sand	0-23	50	Moderate to high	3(1)	Slight
	2	Loamy sand	23-43	55	High	3(1)	Slight
	3	Clay	43-76	30	Moderate	3(2)	Slight
	4	Clay loam	76-220	29	Slight	4	Negligible
	5	Sandy loam	220-250	40	Moderate	4	Negligible
PIT 56	1	Clay loam	0-39	41	Moderate to high	2(1)	Moderate to high
	2	Clay	39-88	68	Very high	1	Very high
	3	Clay loam	88-126	65	High	2(2)	High
	4	Silty clay loam	126-192	48	Moderate	2(2)	High
	5	Silt loam	192-242	88	Very high	2(3)	Very high

Notes: D = Dispersion EAT = Emerson Aggregate Test # texture based on laboratory measurements

5.2.2 Particle Size Analysis

The Particle Size Analysis (PSA) test shows the amounts of gravel, clay, silt, fine sand and coarse sand contained within each sample.

The results shown in **Table 1a** and **1b** are those contained in the laboratory test report. From this data it is evident that all soils analysed contain relatively low levels of gravel.

The texture class of each soil layer is determined by analysis of the material (fine earth fraction) that is less than 2mm in size – ie. The sample from each tested horizon with the gravel removed. The calculated texture of the fine earth fraction of each of the layers tested in the laboratory is shown in **Table 1a**.

It should be noted that the field textures of almost all layers of the two profiles that were examined indicated that the soils were generally more clayey than was shown in the laboratory analyses.

5.2.3 Dispersion Percentage

The Dispersion Percentage (D%) test indicates the proportion of the soil material less than 0.005mm in size that will disperse on wetting (i.e. the clay and some of the silt fractions).

Hazelton and Murphy (in press) provide the following guides to the interpretation of D% values (**Table 2**).

Table 2
Interpretation of Dispersion Percentage Values

(after Hazelton and Murphy, in press)

D% Value	Dispersion Rating
< 6	Negligible
6 – 30	Slight
30 – 50	Moderate
50 – 65	High
> 65	Very high

In interpreting the results of the values of dispersion percentage obtained in laboratory testing it is important to consider other related soil attributes such as the Particle Size Analysis (PSA) and Emerson Aggregate Test (EAT) data.

Soil horizons with high clay contents and high Dispersion % values will be more dispersive in practice than those with a high Dispersion % value and a low clay content in the soil.

The D% values shown in **Table 1b** indicate that the topsoils showed relatively high dispersibility as measured by this procedure, ranging from medium to high. Any topsoil stockpiles that are created should be suitably stabilized.

The subsoil D% values usually ranged from moderate to very high. Many of the subsoils contain moderate to high levels of clay and this fact undoubtedly makes them more dispersive that the analyses indicate – although for many this is difficult since they already exhibit moderate to high values.

Given these indications of dispersibility, the erosion potential is undoubtedly high for any areas of exposed subsoil.

Consequently, appropriate measures need to be taken to protect any stockpiles of stripped subsoil that may be established during and after the construction of the proposed road. The same material, when respread, should be afforded rapid protection from soil erosion in the form of topsoil and vegetative cover.

5.2.4 Emerson Aggregate Test

This test provides a measure of the coherence of soil aggregates when they are immersed in water. Natural peds are used (Houghton and Charman, 1986) and the method used by the Department of Land and Water Conservation to determine the Emerson Class Number is fully described in Craze et al (1993).

Basically, the degree of soil aggregate stability increases from Class 1 through to Class 8. Classes 2 and 3 have a number of subclasses based on the degree of dispersion.

Aggregates in Emerson Classes 1 and 2 are generally regarded as being unstable while those in Classes 4 to 8 are considered to be stable.

Hazelton and Murphy (in press) present a summary of the Emerson Aggregate Classes. This is contained in **Table 3.**

Table 3
Comparison of Aggregate Dispersibility and Emerson Aggregate Classes (after Hazelton and Murphy, in press)

Aggregate Dispersibility	Emerson Aggregate Classes*
Very High	1 and 2(3)
High	2(2)
High to Moderate	2(1)
Moderate	3(4) and 3(3)
Slight	3(2), 3(1) and 5
Negligible / Aggregated	6,7,and 8

*** NOTE** – the subclasses of the Emerson Aggregate Test (EAT) Classes are as follows:
(1) slight milkiness immediately adjacent to the aggregate
(2) obvious milkiness, less than 50% of the aggregate affected
(3) obvious milkiness, more than 50% of the aggregate affected
(4) total dispersion, leaving only sand grains (NB – Class 2(4) is equivalent to Class 1)

The EAT data in **Table 1** show that all layers of SMU 3 have low dispersibility while the topsoil layer of SMU 4 has moderate to high dispersibility.

The subsoil horizons of SMU 4 soils have a high to very high dispersibility rating.

Based on this data, the dispersibility of the subsoil material in SMU 4 makes it essential that any exposed subsoil is adequately protected from soil erosion in any stockpile and in the rehabilitation stage.

6.2 Soil Chemical Attributes

Laboratory testing of the samples extended only to an examination of the electrical conductivity. Soil pH was measured in the field using the Raupach method. The results of the laboratory analyses and the field pH measurements are contained in **Table 4.**

Table 4
Chemical Analyses Laboratory Analysis Data for Selected Soil Profiles

PIT	LAYER	TEXTURE (fine earth)#	DEPTH (cm)	pH *	EC (dS/m)#
PIT 53	1	Loamy sand	0-23	4.5	0.03
	2	Loamy sand	23-43	6.0	0.10
	3	Clay	43-76	8.0	0.09
	4	Clay loam	76-220	9.5-10	0.20
	5	Sandy loam	220-250	9.5-10	0.18
PIT 56	1	Clay loam	0-39	6.5	0.10
	2	Clay	39-88	8.5	0.75
	3	Clay loam	88-126	9.5-10	0.81
	4	Silty clay loam	126-192	9.5-10	0.85
	5	Silt loam	192-242	8.5-9.0	0.48

6.2.1 Soil pH

In general, the pH (water) range in most soils is between 4.0 and 8.5 although pH values above and below this range are measured at times (Glendinning, 1990).

This range of soil pH levels is generally accepted as being one that is suitable for plant growth.

The pH 6.0 to 6.5 range is usually regarded as the optimum for growth of most plants and there are some more serious impacts on the growth of many species at the lower, or acid, end of the range.

As the pH scale (between 0 and 14) is a logarithmic one, a soil with a pH of 5.0 is ten times as acid as a soil of pH 6.0 and 100 times as acid as one with a pH of 7.0.

Perusal of the data in the pH column in **Table 4** indicates that the uppermost soil layer had a pH within the acceptable range although one had a pH of 4.5 which is marginal. However, when the topsoil pH values for the remaining sample pits are considered, the values were generally in the 6.0 to 7.0 range making the pH 4.5 reading somewhat atypical.

The lower horizons were generally very alkaline and outside the range acceptable for plant growth.

6.2.2 Electrical Conductivity

Soil salinity is a measure of the presence of water-soluble salts, mainly of sodium, calcium and magnesium in the soil solution. These salts may be chlorides, sulfates or carbonates and can have a major impact on plant growth if they occur in sufficiently large quantities.

The level of salinity in a soil sample is determined by measuring the electrical conductivity (EC) of a 1:5 soil / water suspension.

As the published salinity tolerance data for crops and pastures is based on the electrical conductivity of a saturated extract of the soil solution, a series of conversion factors, based on the estimated water holding capacity of soil sample, are used to convert the measured EC value to one for the conductivity of the saturated extract (EC_e).

The electrical conductivity of the 1:5 soil / water suspension and that of the saturated extract are measured in units called deciSiemens / metre (dS/m).

The measured level of electrical conductivity of the 1:5 soil / water suspension is multiplied by the appropriate factor in **Table 5** (extracted from Hazelton and Murphy, in press) based on the measured soil texture.

Table 5
Texture Class Multipliers for Calculating EC_e Values

Soil Texture Class	Multiplier Factor
loamy sand, clayey sand, sand	23
sandy loam, fine sandy loam, light sandy clay loam	14
loam, loam fine sandy, silt loam, sandy clay loam	9.5
clay loam, silty clay loam, fine sandy clay loam, sandy clay, silty clay, light clay	8.6
light medium clay	7.5
medium clay	5.8
heavy clay	5.8

Table 6 shows the calculated EC_e values for the samples analysed in the laboratory and shows the salinity status of the various horizons based on these EC_e values.

Table 6
Calculated EC_e Values and Salinity Status for Selected Soil Profiles

PIT	LAYER	TEXTURE (fine earth)#	DEPTH (cm)	EC (dS/m)#	MULTI-PLIER	CALCULATED EC_e	SOIL SALINITY STATUS
PIT 53	1	Loamy sand	0-23	0.03	23	0.69	Non-saline
	2	Loamy sand	23-43	0.10	23	2.30	Slight salinity
	3	Clay	43-76	0.09	8.6	0.77	Non-saline
	4	Clay loam	76-220	0.20	8.6	1.72	Non-saline
	5	Sandy loam	220-250	0.18	14	2.52	Slightly saline
PIT 56	1	Clay loam	0-39	0.10	8.6	0.86	Non-saline
	2	Clay	39-88	0.75	8.6	6.45	Moderately saline
	3	Clay loam	88-126	0.81	8.68	6.97	Moderately saline
	4	Silty clay loam	126-192	0.85	8.6	7.31	Moderately saline
	5	Silt loam	192-242	0.48	9.5	4.56	Moderately saline

Hazelton and Murphy (in press) note that EC_e values below 2.0 indicate non-saline horizons while values between 2 and 4 indicate slight salinity. Values between 4 and 8 indicate moderate salinity while those between 8 and 16 indicate high salinity.

The data in **Table 6** indicate that the topsoil materials within the two SMUs are non-saline.

The subsoil of profile 53 shows negligible to slight salinity, but the subsoil in profile 56 is moderately saline in all horizons. **This level of salinity warrants caution in the ultimate use of any subsoil material stripped from the SMU 4 area.**

Although not tested for sodicity because of the proposed limited depth of disturbance, these soils may well exhibit sodic properties as well as salinity based on soil tests from similar soils at the proposed East Boggabri Coal Mine site (see GCNRC, 2005a).

6.2.3 Likelihood of Encountering Acid Sulfate Soils

Acid sulfate soils are basically confined to coastal estuarine floodplain areas in New South Wales.

These soils are extremely acidic soil layers that develop as a consequence of the aeration of soil materials that are rich in iron sulfides, primarily pyrite (FeS).

When drainage or excavation brings these previously waterlogged soil layers into contact with oxygen, the pyrite is oxidised to form sulfuric acid.

If the production of acid exceeds the neutralising capacity of the particular soil such that the pH falls below 4.0, these soils are known as acid sulfate soils.

The soils at the transport route Study Area almost universally increase in alkalinity with depth (often to pH 9.5 – 10) and are not waterlogged. There is a considerable quantity of neutralising capacity in all soils at the site.

As a consequence of these features and the fact that the site is not located on a coastal estuarine floodplain it is extremely unlikely that any acid sulfate soils will impact in any way on the mine during its working life or on the success of subsequent rehabilitation.

6.3 Erosion Potential

6.3.1 General Observations

The soils within the transport route Study Area are currently stable except for some gully erosion along Bollol Creek.

Groundcover varies over the transport route Study Area with most areas supporting a good cover of native and naturalised species or improved pastures.

6.3.2 Solioss Program

An appropriate method of assessing the erosion hazard associated with the soils of the transport route Study Area is to use the Soiloss computer program devised by Rosewell and Edwards (1988) and updated by Rosewell (1993).

This program computes soil loss values for a given site under various land uses and climatic (rainfall) conditions and so provides an indication of erosion hazard.

Soiloss is based on the Universal Soil Loss Equation or USLE described by Wischmeier and Smith (1978) and subsequently updated as the Revised Universal Soil Loss Equation or RSLE (Renard et al, 1993).

The USLE is

$$A = R * K * L * S * P * C$$ where

A is the average annual soil loss (tonnes / hectare)
R is the rainfall erosivity factor, a measure of the erosive power of the rain
K is the soil erodibility factor, a measure of the resistance of the soil to erosion
L is the slope length factor
S is the slope steepness factor
P is the support practice factor, a measure of the effect on erosion of soil conservation measures such as contour cultivation and bank systems
C is the crop and cover management factor

In using Soiloss, the rainfall erosivity factor is obtained from maps provided with the program manual (Rosewell, 1993).

Soil erodibility is either estimated from details of the soil type and soil surface texture by comparison with a table of soils presented by the program or is derived from a knowledge of soil particle size analysis, organic matter content, surface soil structure and profile permeability.

Slope length and steepness factors are derived from field measurements and / or examination of topographic maps or airphotos.

The support practice factor is estimated by the program from a description of the land management practices in use, details of cultivation direction and information on bank systems if these are present.

To determine the value of the 'K' factor for use in the program, a generic or standard method can be utilised from within the program to indicate the likely soil losses from a range of crop rotations and management practices.

In addition, a more detailed approach can be used to determine likely soil loss given the availability of precise detail relating to sowing dates, cultivation practices etc.

Provision is made within the program for estimating soil loss from areas with a range of non-arable uses.

Table 7 provides details of the calculated erodibility values (K) and erodibility ratings for topsoils and subsoils from a selection of soil profiles in the transport route Study Area.

Table 7
Soil Erodibility Values and Ratings for a Selection of Soils

SOIL and' SMU	PIT NUMBER	TOPSOIL LAYER (cm)	TOPSOIL 'K' RATING	SUBSOIL LAYER (cm)	SUBSOIL 'K' RATING	AVERAGE 'K' RATING (WHOLE SOIL)	ERODIBILITY
"duplex" SMU 3	56	0-39	0.016 low	39-88	0.014 low	0.015	low
"clay" SMU 4	53	0-23	0.035 moderate	43-76	0.016 low	0.026	moderate

The erodibility estimates contained in **Table 7** for the three basic soil types recorded from the transport route Study Area have been calculated using part of the overall Soiloss program capability and the Particle Size Analysis and other data for three typical soil profiles at the transport route Study Area.

The only value for which estimates were used in the calculations were those for organic matter %.

After a perusal of the data for this variable for topsoils in the Soil Landscapes report for the adjoining Curlewis 1:100 000 scale map sheet area (Banks, 1995), the values for Fullwoods Road (2.5%) and Yarraman (1.6%) Soil Landscapes were chosen as being likely to be similar to the values for the two SMUs identified in the transport route Study Area.

Likewise values of 0.4% for Fullwoods Road and 1.4% for Yarraman Soil Landscapes subsoils were chosen and used in the Soiloss model.

The Erodibility classes used were < 0.020 = LOW; 0.020 – 0.040 = MODERATE; > 0.040 = HIGH.

The data in **Table 7** show that the Soiloss program predicts that SMU 3 has a MODERATE erodibility while SMU 4 has a LOW erodibility.

Because of the MODERATE erodibility of the soils in SMU 3 as assessed by the Soiloss analysis, they should be managed carefully during the stripping and rehabilitation stages to ensure that soil structure damage is minimal and that they are suitably protected by vegetation or some other medium at all times.

This erodibility constraint, when considered with the measured high pH and relatively high dispersibility in the subsoil materials, indicates that the subsoil materials will have to be very carefully managed during the life of the mine.

For the SMU 4 soil type, the Soiloss model does not take into account the salinity and sodicity values that make the subsoil of this soil type more unstable and less hospitable to plant growth. Hence these aspects need to be taken into account when any of this material is stripped.

7 STRIPPING SUITABILITY OF SOIL MATERIALS

7.1 Introduction

An approach has been developed by Elliott and Veness (1981) to determine the stripping suitability of soil materials found at a site where stripping of upper soil layers is required. The key used in this method of stripping suitability assessment is contained in **Appendix 2**.

This method has been used in the present study.

The basis for the Elliott and Veness approach is that not all soil material that might be available for topdressing of disturbed sites is suitable for agricultural or pastoral use: some may be poorly structured, too sandy or ravely or too poorly drained to allow a stabilising vegetative cover to develop.

In their work, Elliott and Veness established that there are a number of critical soil physical attributes that can be used to distinguish between suitable and unsuitable topdressing materials. These are:

(a) soil structure;
(b) soil macrostructure;
© soil coherence;
(d) soil texture; and
(e) the force necessary to disrupt peds.

NOTE: The following descriptions of soil materials are based on the detail gained from all 11 profiles sampled in the field.

7.2 Important Soil Stripping Issues

These stripping recommendations are based on a maximum stripping depth of 60cm.

The proponent has indicated that the proposed transport route road surface will approximate the current soil level throughout its length and that the road will remain in place as two sections of private road after it ceases to be used for the transportation of coal.

Because of this, there is no need to retain the topsoil and subsoil on site for later use in rehabilitation.

The topsoil will be removed and used for purposes determined by the proponent and the relevant landholders.

Similarly with the subsoil, the material will not be stockpiled but used as determined between the proponent and landholders. However, it should be emphasized that the subsoil material from the SMU 4 area should be removed from the site and preferably used as a lower subsoil material on areas being rehabilitated at the proposed East Boggabri or Whitehaven Coal Mines because of the dispersive, saline nature of the material and its possible sodicity.

If this material is used on-farm there may well be continuing instability and revegetation problems.

7.3 Stripping Recommendation for SMU 3

7.3.1 Layer 1

Surface stone usually absent*;* sandy clay loam; silty clay loam; silty clay; many roots present; no lime present; no manganese present; pH 5.0 to 6.0, occasionally 4.5; gravel absent or more usually some gravel present, rounded, angular or flat to 3cm; not mottled; not bleached; brown (7.5YR4/3, 10YR5/3), light brownish grey (10YR6/2) dry; brown (10YR5/3), light brownish grey (10YR6/2), dark reddish grey (5YR 4/2) moist; peds rough-faced or rough / smooth-faced; highly pedal (100%); polyhedral; <5mm to 15mm in size; firm to very strong consistency, sometimes weak to firm dry; usually hydrophobic or slightly so.

Suitability Assessment: mainly structure grade 3; coherent dry, mottles absent; macrostructure suitable; force to disrupt peds generally suitable; texture suitable; layer contains some gravel; pH levels suitable; salt content suitable.

This material is suitable for topsoiling on the basis of the Elliott and Veness key.
The material also contains valuable seed, organic matter, nutrient reserves and has other favourable attributes.

This allows it to be stripped and used as topsoil provided suitable stripping methods are used (discussed later in this report).

> **Recommendation** – Strip all of the Layer 1 topsoil to a depth of 15cm. Although there is some variation in soil texture within this SMU, the soil material from all parts of the SMU 3 area can be mixed and used for whatever end use is proposed.

7.3.2 Layer 2

sandy clay loam; silty clay loam; silty clay; light, medium, medium to heavy clay; usually many roots present, sometimes few; usually no lime present, sometimes lime stains and concretions present; no manganese present; gravel absent or some gravel rounded, angular and flat to 3cm; not mottled; occasionally bleached; brown (10YR5/3, 7.5YR5/3, 7.5YR5/4), dark greyish brown (10YR4/2), light brown (7.5YR6/3), light brownish grey (10YR6/2), very pale brown

(10YR7/3) dry; brown (10YR5/3, 7.5YR4/3, 7.5YR4/4), dark brown (7.5YR3/2, 7.5YR3/3), very dark greyish brown (10YR3/2) moist; peds rough-faced or rough- smooth faced; highly pedal (100%); polyhedral; <5mm to 20mm in size; firm to strong consistency dry, occasionally weak; sometimes hydrophobic or slightly so.

Suitability Assessment: mainly structure grade 3; coherent dry, mottles absent; macrostructure suitable; force to disrupt peds suitable; texture suitable; layer contains little gravel; pH levels generally suitable although some areas have pH levels of up to 9.5 to 10; the extensive mixing of material during stripping and reuse should result in generally lower composite pH levels; salt content suitable.

This material is suitable for use as subsoil on the basis of the Elliott and Veness key. This allows it to be stripped and stockpiled as subsoil provided suitable stripping methods are used (discussed later in this report).

> **Recommendation** – Strip all of the Layer 2 subsoil to a depth of 45cm below the base of Layer 1 – ie. A total depth from the surface of 60cm. Although there is some variation in soil texture within this SMU, the subsoil material from all parts of the SMU 3 area can be mixed.

7.3.3 Layer 3

This will remain intact under the proposed road.

7.3.4 Important Note on the Remainder of the Profile

There is one issue that would need to be addressed in relation to this layer in the area near Bollol Creek which is at the northern end of the proposed transport route. In profile 48 free water was intersected at about 240cm depth in sand.

A similar profile exists at the site of profile 49 though no free water was encountered.

This indicates that caution should be exercised to ensure the continued stability of the surface of the proposed road – particularly during wet periods.

7.4 Stripping Recommendations for SMU 4

7.4.1 Layer 1

Surface condition self mulching, sometimes soft; surface stone usually absent; Light clay, light to medium clay, medium clay; no lime present; no manganese present; pH 6.5 to 7.0; usually some grit or small rounded gravel <1cm present, sometimes absent; not mottled; not bleached; brown (7.5YR4/2, 7.5YR5/2) dry; dark brown (7.5YR3/2), very dark grey (7.5YR3/1) moist; peds rough-smooth faced, highly pedal (100%); polyhedral; <5mm to 20mm in size; very firm to very strong consistency dry; not hydrophobic

Suitability Assessment: mainly structure grade 3; coherent dry, mottles absent; macrostructure suitable; force to disrupt peds generally suitable; texture suitable; layer contains some gravel; pH levels suitable; salt content suitable.

This material is suitable for topsoiling on the basis of the Elliott and Veness key.

The material also contains valuable seed, organic matter, nutrient reserves and has other favourable attributes.

This allows it to be stripped and used as topsoil provided suitable stripping methods are used (discussed later in this report).

> **Recommendation** – Strip all of the Layer 1 topsoil to a depth of 15cm. Although there is some variation in soil texture within this SMU, the soil material from all parts of the SMU 4 area can be mixed and used for whatever end use is proposed.

7.4.2 Layer 2

Light clay, light to medium clay, medium clay; few to many roots present; usually no lime present, sometimes lime concretions present; no manganese present; pH 6.5 to 7.0 to 9.5 to 10; often no gravel, sometimes some rounded gravel to <1cm present; not mottled; not bleached; brown (10YR5/3, 7.5YR4/2, 7.5YR4/3, 7.5YR5/2), dark greyish brown (10YR4/2) dry; brown (7.5YR4/2), dark brown (7.5YR3/2), reddish brown (5YR4/3), very dark grey (7.5YR3/1) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 20mm in size; very firm to very strong consistency dry; not hydrophobic.

Suitability Assessment: mainly structure grade 3; coherent dry, mottles absent; macrostructure suitable; force to disrupt peds suitable; texture suitable; layer contains little gravel; pH levels generally suitable although some areas have pH levels of up to 9.5 to 10; the extensive mixing of material during stripping and reuse should result in generally lower composite pH levels; salt content is not suitable.

This material is possibly suitable for traditional use as subsoil on the basis of the Elliott and Veness key. However, the levels of soil salinity and possible sodicity indicate that this material should not be used for any purpose where it is at or near the soil surface – nor should it be stockpiled as it will pose surface stability and sediment loss problems.

The material is highly dispersive and this combined with salinity levels indicates that the best course of action in dealing with this material would be to firstly minimise the amount stripped. Secondly the material that is stripped should be removed to either East Boggabri or to Whitehaven and used as a layer under the subsoil prior to rehabilitation.

> **Recommendation** – Strip all of the Layer 2 subsoil to a depth of 45cm below the base of Layer 1 – ie. A total depth from the surface of 60cm or a lesser depth if this is possible. Remove the material and use as outlined above.

7.4.3 Layer 3

This will remain intact under the proposed road.

8 HANDLING STRIPPED SOILS

8.1 General Issues

Stripping of topsoil and subsoil materials is proposed for those sections of the transport route Study Area to be used for the development of the proposed transport route.

It is appropriate to consider, in this report, the techniques for handling the soil materials that are to be stripped and then reused. The recommendations made are based on an interpretation of the results of soil survey on the transport route Study Area and the associated laboratory analysis data.

As a general rule in soil stripping, the weaker (more sandy) the *in-situ* structure of the soil being removed, the more care that is required in all phases of handling. The soil needs to be handled (disturbed) as little as possible to minimise mechanical damage to soil structure that will be detrimental to rapid establishment of ground cover once rehabilitation works commence.

In fact the most suitable approach to handling stripped soils in this situation is to transfer the material direct from the transport route to the end-use site.

There have been a number of studies in the past relating to the impact of the stripping of soils associated with mining and similar activities.

Working of soils in situations where the soil moisture content is unfavourable can have detrimental impacts on soil structure (Elliott and Veness, 1985; Hunter and Currie, 1956). There are also unfavourable effects related to mixing of soil materials with different fertility levels, textures and other critical soil properties.

8.2 Earthmoving Procedures

As mentioned previously, the topsoils and subsoils to be moved within the transport route Study Area generally have good structure.

However, improper or excessive handling of the material during the stripping and stockpiling operation has the potential to destroy the soil structure by mechanically breaking down the soil aggregates that are present.

Notwithstanding the comments above, the generally good structure grades of both topsoils and subsoils will allow the stripping operation to be carried out using machines such as open-bowl scrapers.

Even so, care should be taken also to ensure that topsoils are not stripped when they are too moist as greater damage will occur at this time.

Similar precautions should be taken with the subsoils.

9 LAND CAPABILITY AND AGRICULTURAL LAND SUITABILITY

9.1 Methodology

Houghton and Charman (1986) in their "Glossary of Terms Used in Soil Conservation" define land capability as follows.

> "The ability of land to accept a type and intensity of use permanently, or for specified periods under specific management, without permanent damage."

They further note that land capability is "…an expression of the effect of biophysical land resources, including climate, on the ability of land to sustain use without damage under various uses such as crop production requiring regular tillage, grazing, woodland or wildlife. Land capability involves consideration of:

- the various land resources;
- the production to be obtained from the land;
- the activities or inputs required to achieve that production;
- the risks of damage to the land, on-site or off-site, resulting from those activities; and
- the inter-relations of the above."

Houghton and Charman note that land capability is taken into account in determining land suitability – another form of land classification relating to use for various purposes.

Land that is used beyond its capability ultimately loses its productive capacity as a consequence of exhaustion of soil nutrient supplies or the development of various forms of land degradation.

The land capability classification system used in New South Wales has been described by Emery (undated) and is a modification of the system devised and used by the former USDA Soil Conservation Service in the United States of America.

Emery's paper (in its Table 1) contains details of the Land Capability legend used on land capability maps prepared by the former Soil Conservation Service of New South Wales (now DIPNR).

This shows the hierarchical classification used in the eight class system based on the management and protection needs of different types of land ranging from land needing no special soil conservation works or practices (Class 1) through to land that is unsuitable for agricultural or pastoral production (Class 8).

Emery's table also shows two other land capability classes – Mining and Urban land use – and also deals with class subscripts used to further subdivide some capability classes. The information presented by Emery is contained in **Appendix 3**.

9.2 Land Capability and Agricultural Land Suitability Classification of the Transport Route Study Area

9.2.1 Introduction

It should be noted that both the NSW Soil Conservation Service (DIPNR) Land Capability mapping and the Agricultural Land Suitability mapping of NSW Department of Primary Industries (Agriculture) were carried out at a very different scale to that of the present study and in most cases the assessments were subjected to only limited field checking.

As a consequence, there are often differing assessments that result from more detailed examination of relatively small study areas.

9.2.2 Land Capability

9.2.2.1 Land Capability as Mapped by DIPNR

The 1: 100 000 scale Land Capability map of the Boggabri map sheet area prepared by the former Soil Conservation Service of NSW (DIPNR, Parramatta – GIS) shows the transport route Study Area to comprise Classes II, III and IV land.

The level plain areas are mapped as Class II land (*land capable of being regularly cultivated using strip cropping, conservation tillage and adequate cropping rotations*) by DIPNR.

The lower slope areas at the Whitehaven and East Boggabri ends of the route are mapped as Class III lands (*land suited to regular cultivation provided it is suitably protected by soil conservation measures and practices*) by DIPNR.

The area along the Driggle Draggle Creek near Whitehaven is mapped as Class IV land (*land not capable of being regularly cultivated but suitable for grazing with occasional cultivation; and requiring soil conservation practices such as pasture improvement, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture*) by DIPNR.

9.2.2.2 Current Assessment

After a stereoscopic interpretation of airphotos of the site and field assessments during the vegetation and soil survey, it is evident that DIPNR mapped Class II, III and IV lands are correctly mapped except for the area on either side of Bollol Creek that should be mapped as Class IV instead of Class II land.

The only reservation about the mapping provided by DIPNR is that the SMU 3 soils along the transport route are duplex and potentially erodible by wind if not managed properly. This does not warrant their reallocation to Class III but signals their potential vulnerability under agricultural land use rather than the currently proposed use as a transport route.

The land capability classes for the transport route Study Area as mapped in the present study are shown in **Figure 2**.

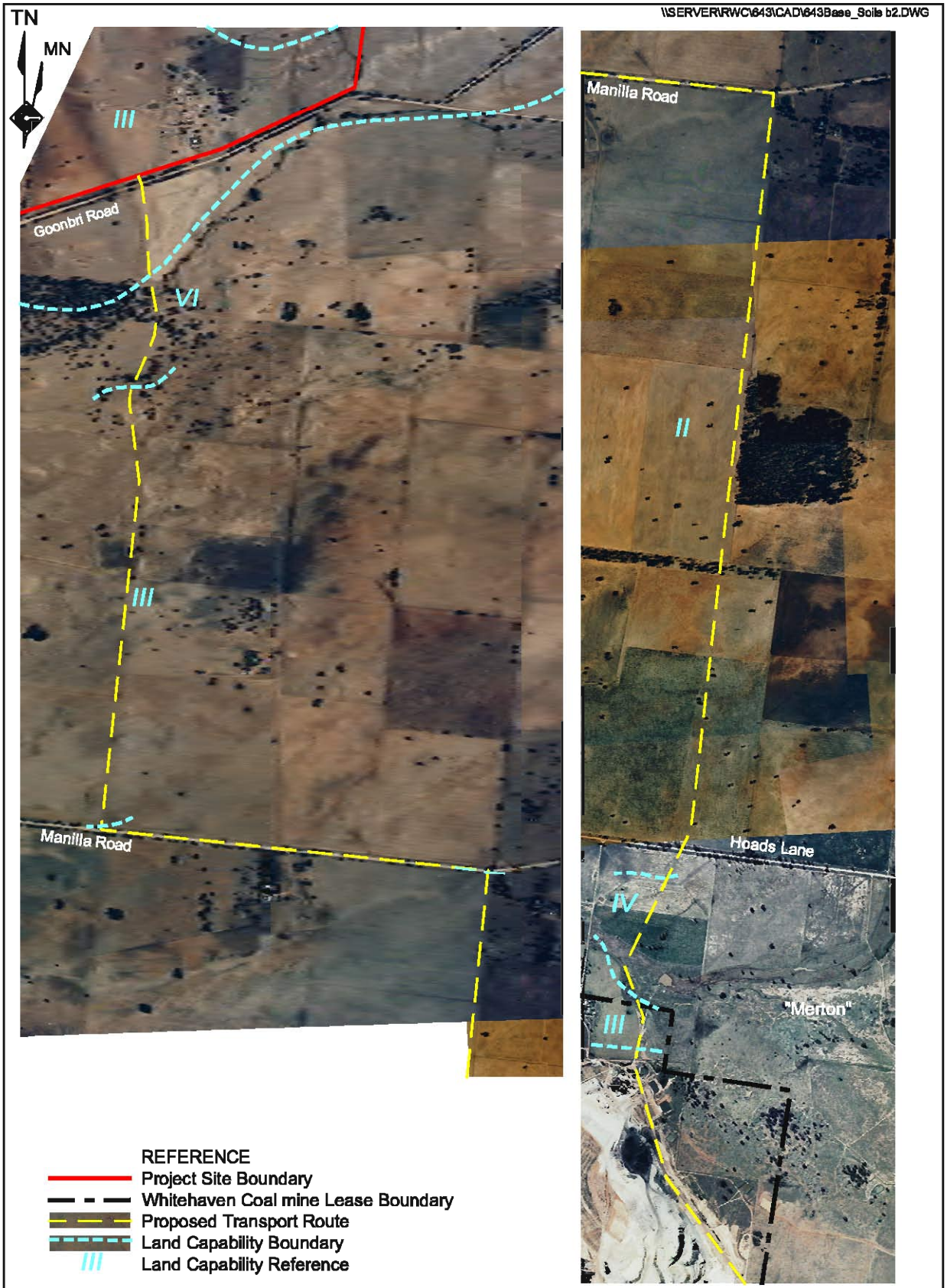

Figure 2
LAND CAPABILITY OF THE TRANSPORT ROUTE STUDY AREA

9.2.3 Agricultural Land Suitability Classification

9.2.3.1 NSW Agriculture Assessment

Information supplied by NSW Department of Primary Industries (Agriculture) at Gunnedah (Kelly Hudson, pers.comm.) indicates that the Department has classified the lands of the transport route Study Area using its agricultural land suitability system.

The maps showing the transport route Study Area indicate that the lands are mainly Class 3 with a small area of Class 2 land.

The Class 3 land is located on the lower slopes at the East Boggabri and Whitehaven ends of the proposed Transport route as well as on the more elevated floodplain lands (associated with SMU 3).The Class 2 lands are associated with the lower lying floodplain land in the southern part of the proposed route. This area approximates the area of SMU 4 land.

The NSW Department of Primary Industries (Agriculture) Land Suitability classification defines these land classes as follows:

- Class 2 lands are arable land suited suitable for regular cultivation for crops but not suited to continuous cultivation. This land class has a moderate to high suitability for agriculture but edaphic (soil) factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.

- Class 3 lands are grazing lands or those well suited to pasture improvement. These lands have a moderate productivity and may be cultivated or cropped in rotation with pasture although soil and environmental constraints (eg. erosion hazard and soil structure breakdown) limit productivity.

9.2.3.2 Current Assessment

A more detailed study of the transport route Study Area indicates that the Class 2 and Class 3 lands shown in the NSW Department of Primary Industries (Agriculture) mapping is correct in a general sense. This classification recognizes the limitations of the duplex soils of SMU 3 by classifying them as Class 3.

The agricultural land suitability classes for the transport route Study Area as mapped in the present study are shown in **Figure 3**.

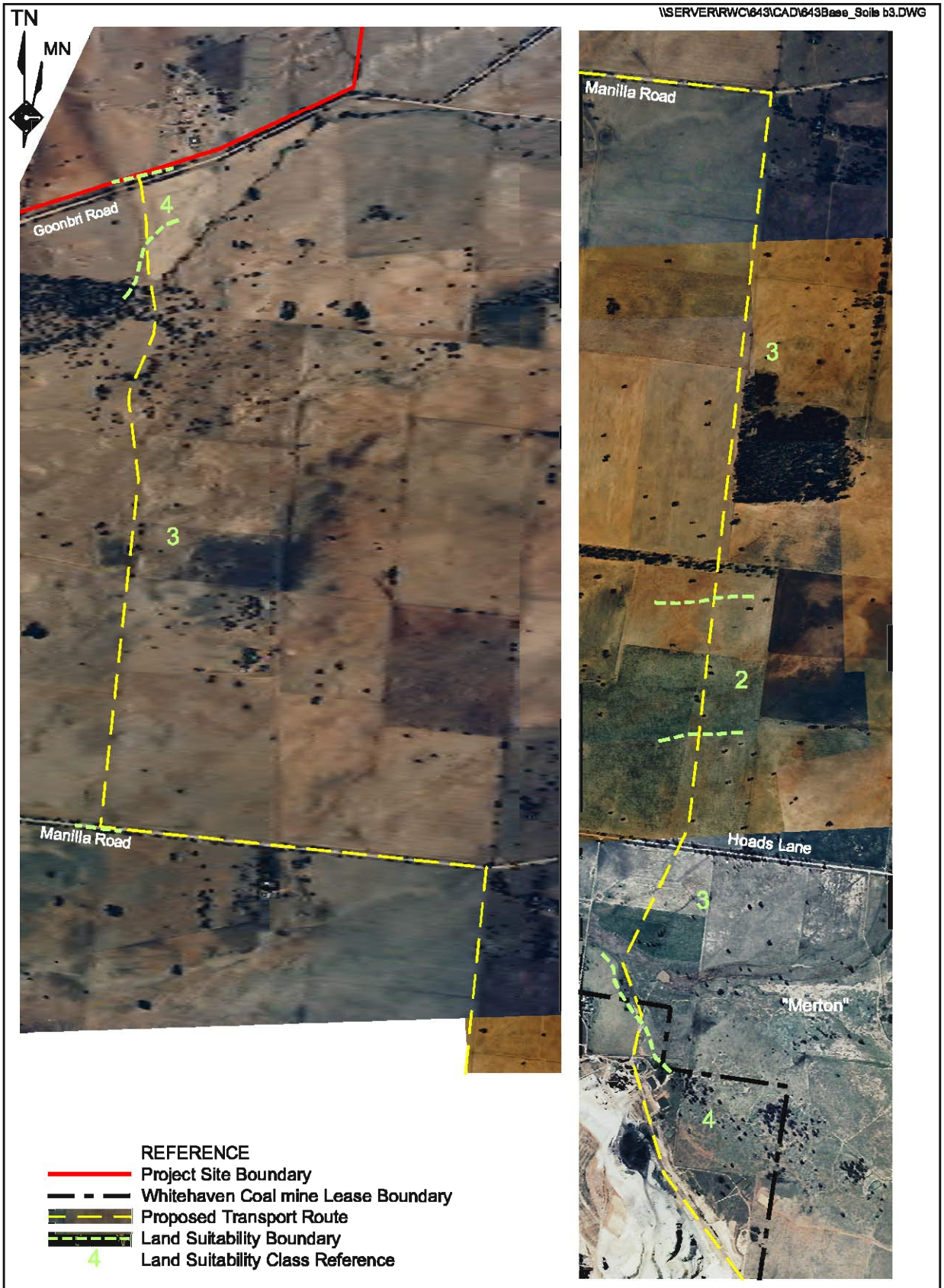

Figure 3
AGRICULTURAL LAND SUITABILITY OF THE TRANSPORT ROUTE STUDY AREA

10 CONCLUSION

Soils in the transport route Study Area have been described and two Soil Mapping Units have been identified.

The physical and chemical attributes of the soils of the transport route Study Area have been quantified through a combination of field assessment and laboratory testing and indicate the following.

- The soils are currently relatively stable but have a generally low to moderate erodibility rating as determined using the laboratory data obtained from samples from the transport route Study Area in the SOILOSS computer model.
- The soils have a generally high structure grade and so can be stripped and respread using scrapers.
- For SMU 3 and SMU 4 the topsoil material (to 15cm depth) can be reused as topsoil.
- The subsoil from SMU 3 can be used as material for such appropriate on-farm works as may be agreed between the proponent and landholders.
- Stripping of subsoil from SMU 4 should be limited to the minimum depth possible because of the salinity and dispersibility (and possible sodicity) exhibited by this material.
- The subsoil from SMU 4 should be transported to Whitehaven or East Boggabri and buried under the subsoil material being used in rehabilitation of the final landscape.
- All soils will be subject to structural degradation if worked when too moist.

Depth of stripping recommendations have been provided. The land capability (Classes II, III and IV) and agricultural land suitability (Classes 2 and 3) of the transport route Study Area in the pre-disturbance state has been determined.

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Appendices

Appendix 1 **Soil Profile Descriptions**

Appendix 2 **Topsoil Stripping Suitability Key (After Elliott and Veness, 1981)**

Appendix 3 **Basis of Land Capability Classification (After Emery, Undated)**

Appendix 4 **Glossary of Terms**

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APPENDIX 1

Soil Profile Descriptions

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Profile 47, Level plain location. *Surface condition hard setting, Surface stone absent.*

0-32cm; silty clay loam; many roots present; no lime present, no manganese present, pH 5.0; some gravel rounded and angular 2cm to 3cm; not mottled; not bleached, brown (10YR5/3) dry, brown (7.5YR4/3) moist; peds rough-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; firm consistency dry; hydrophobic; *abrupt to:-*

32-60cm; sandy clay loam; many roots present; no lime present, no manganese present, pH 6.0; some gravel rounded to 2cm; not mottled; not bleached, brown (7.5YR5/3) dry, dark brown (7.5YR3/2) moist; peds rough-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; very firm to strong consistency dry; not hydrophobic; *sharp to abrupt to:-*

60-81cm; medium to heavy clay; many roots present; no lime present, no manganese present, pH 8.0; some gravel rounded to 3cm; not mottled; not bleached, light yellowish brown (10YR6/4) dry, brown (7.5YR4/3) moist; peds rough-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

81-109cm; sandy clay loam; few roots; no lime present, no manganese present, pH 6.0; some gravel rounded to 2cm; not mottled; not bleached, light grey (10YR7/2) dry, brown (7.5YR5/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; very firm consistency dry; not hydrophobic; *diffuse to:-*

109-157cm; gritty light clay; few roots; no lime present, no manganese present, pH 9.0; much rounded and angular gravel to 2cm; not mottled; not bleached, light brown (7.5YR6/4) dry, brown (7.5YR4/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral/platy, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to diffuse to:-*

157-252cm; light to medium clay; no roots observed; no lime present, no manganese present, pH 9.0; much angular gravel to 2cm; not mottled; not bleached, brown (10YR5/3) dry, brown (7.5YR4/3) moist; peds rough-smooth faced, highly pedal (100%), polyhedral/platy, <5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic.

Profile 48, Level plain location. *Surface condition hard setting. Surface stone absent.*

0-20cm; silty clay; roots common; no lime present, no manganese present, pH 6.0; some angular flat gravel to 1cm; not mottled; not bleached, light brownish grey (10YR6/2) dry, very dark greyish brown (10YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong consistency dry; slightly hydrophobic; *gradual to:-*

20-80cm; light to medium clay; few roots; no lime present, no manganese present, pH 7.0; occasional gravel rounded <1cm; not mottled; not bleached, light brownish grey (10YR6/2) dry, brown (10YR5/3) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *diffuse to:-*

80-147cm; sandy clay; few roots; no lime present, manganese concretions present, pH 9.0; gravel common rounded to 3cm; not mottled; not bleached, light yellowish brown (10YR6/4) dry, brown (10YR5/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; strong consistency dry; not hydrophobic; *abrupt to:-*

147-250cm; sand; few roots; no lime present, no manganese present, pH 6.5; mix of layers and pockets of sand and gravel rounded 1cm to 3cm; not mottled; not bleached, pale brown (10YR6/3) dry, brown (10YR4/3) moist; fabric rough, massive, not hydrophobic.

Profile 49, Level plain location. *Surface condition hardsetting, Surface stone absent.*

0-19cm; silty clay; many roots present; no lime present, no manganese present, pH 6.0; no stones observed; not mottled; not bleached, light brownish grey (10YR6/2) dry, very dark greyish brown (10YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong consistency dry; slightly hydrophobic; *abrupt to:-*

19-53cm; medium to heavy clay; many roots present; no lime present, no manganese present, pH 8.5; some gravel <1cm; not mottled; not bleached, dark greyish brown (10YR4/2) dry, very dark greyish brown (10YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 10mm to 15mm in size; strong consistency dry; not hydrophobic; *gradual to:-*

53-171cm; medium to heavy clay; few roots present; no lime present, no manganese present, pH 9.0; gravel common rounded and angular to 2cm; not mottled; not bleached, yellowish brown (10YR5/4) dry, brown (7.5YR5/4) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

171-250cm; clayey sand; few roots present; no lime present, manganese stains present, pH 9.0; sand layer with occasional gravel to 3cm; not mottled; not bleached, light yellowish brown (10YR6/4) dry, dark greyish brown (10YR4/2) moist; fabric earthy-rough, massive. not hydrophobic.

Profile 50, Low rise location. *Surface condition soft, Surface stone absent.*

0-16cm; silty clay loam; many roots present; no lime present, no manganese present, pH 6.0; some gravel rounded, angular and flat to 3cm; not mottled; not bleached, brown (10YR5/3) dry, very dark greyish brown (10YR3/2) moist; peds rough-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; slightly hydrophobic; *clear to:-*

16-43cm; sandy clay loam; many roots present; no lime present, no manganese present, pH 6.5; gravel rounded and angular to 2cm common; not mottled; bleached, very pale brown (10YR7/3) dry, brown (7.5YR4/3) moist; peds rough-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; firm consistency dry; not hydrophobic; *abrupt to:-*

43-135cm; medium to heavy clay; few roots present; no lime present, no manganese present, pH 8.5; gravel rounded and angular to 5cm common; mottled; not bleached, 60% brown (7.5YR5/4) 40% brown (7.5YR5/3) dry, 100% reddish brown (5YR4/4) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; strong consistency dry; not hydrophobic. *abrupt to:-*

135-250cm; sand; few roots present; no lime present, no manganese present, pH 7.0; variable layers of sand with gravel rounded to 4cm common; not mottled; not bleached, brown (7.5YR5/3) dry, dark brown (7.5YR3/3) moist; fabric earthy, massive, not hydrophobic.

Profile 51, Level plain location. *Surface condition soft , Surface stone absent.*

0-24cm; light to medium clay; many roots present; no lime present, no manganese present, pH 7.0; some rounded gravel to <1cm; not mottled; not bleached, brown (7.5YR5/2) dry, dark brown (7.5YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; very firm consistency dry; not hydrophobic; *sharp to:-*

24-50cm; medium clay; roots common; no lime present, no manganese present, pH 8.0; no gravel observed; not mottled; not bleached, brown (10YR5/3) dry, reddish brown (5YR4/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong consistency dry; not hydrophobic; *gradual to:-*

50-171cm; medium clay; few roots present; many lime concretions present, manganese stains present, pH 9.0; no gravel observed; not mottled; not bleached, brown (7.5YR5/4) dry, brown (7.5YR4/4) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; strong consistency dry; not hydrophobic; *diffuse to:-*

171-260cm; light clay; few roots present; no lime present, some manganese stains present, pH 9.0; no gravel observed; not mottled; not bleached, very pale brown (10YR7/4) dry, brown (7.5YR4/4) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong consistency dry; not hydrophobic.

Profile 52, Level plain location. *Surface condition hardsetting, Surface stone absent.*

0-23cm; sandy clay loam; many roots present; no lime present, no manganese present, pH 6.0; some gravel rounded <1cm to 2cm; not mottled; not bleached, brown (10YR5/3) dry, dark brown (7.5YR3/3) moist; peds rough-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; firm consistency dry; not hydrophobic; *abrupt to:-*

23-67cm; medium clay; few roots present; lime stains and concretions present, no manganese present, pH 9.5 to 10; some rounded gravel <1cm, grit; not mottled; not bleached, brown (7.5YR5/4) dry, brown (7.5YR4/4) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 20mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

67-250cm; medium to heavy clay; few roots present; main lime zone, stains and concretions, no manganese present, pH 9.5 to 10; occasional gravel angular to 2cm; not mottled; not bleached, brown (7.5YR5/4) dry, dark brown (7.5YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic.

Profile 53, Level plain location. *Surface condition firm to hardsetting, Some surface stone present.*

0-23cm; sandy clay loam; many roots present; no lime present, no manganese present, pH 4.5; some gravel to 1cm; not mottled; not bleached, brown (7.5YR5/3) dry, dark brown (7.5YR3/3) moist; peds rough-faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; weak to firm consistency dry; hydrophobic; *sharp to:-*

23-43cm; sandy clay loam; few roots present; no lime present, no manganese present, pH 6.0; no gravel observed; not mottled; not bleached, light brown (7.5YR6/3) dry, brown (7.5YR4/4) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; very firm to strong consistency dry; not hydrophobic; *sharp to:-*

43-76cm; light medium clay; few roots present; no lime present, no manganese present, pH 8.0; no gravel observed; not mottled; not bleached, yellowish red (5YR4/6) dry with brown (7.5YR5/4) coating on peds, red (2.5YR4/6) moist; peds rough-smooth faced, highly pedal (100%), polyhedral, 5mm to 20mm in size; strong to very strong consistency dry; not hydrophobic; *sharp to:-*

76-220cm; medium clay; few roots present; lime stains and nodules present, no manganese present, pH 9.5 to 10; no gravel observed; not mottled; not bleached, brown (7.5YR5/4) dry, brown (7.5YR4/4) dry, peds rough / smooth faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

220-250cm; sandy clay loam; no roots observed; no lime present, no manganese present, pH 9.5 to 10; no gravel observed; not mottled; not bleached, brown (7.5YR5/4) dry, brown (7.5YR4/4) dry, peds rough / smooth faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; very firm to strong consistency dry; not hydrophobic.

Profile 54, Level plain location. *Surface condition self mulching, Surface stone absent.*

0-30cm; medium clay; many roots present; no lime present, no manganese present, pH 6.5; grit present; not mottled; not bleached, brown (7.5YR5/2) dry, dark brown (7.5YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 20mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

30-87cm; medium to heavy clay; many roots present; some lime concretions present, no manganese present, pH 9.5 to 10; no stones/gravel observed; not mottled; not bleached, brown (7.5YR4/3) dry, brown (7.5YR4/2) moist; peds rough-smooth faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

87-220cm; medium clay; few roots present; some lime concretions present, no manganese present, pH 9.5 to 10; grit and gravel to 5cm; not mottled; not bleached, brown (7.5YR4/2) dry, brown (7.5YR4/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; strong to very strong consistency dry; not hydrophobic; *diffuse to:-*

220-250cm; medium clay; few roots present; main zone of lime concretions, manganese stains and concretions present, pH 9.5 to 10; some grit present; not mottled; not bleached, brown (7.5YR5/3) dry, brown (7.5YR5/3) moist, peds rough / smooth-faced, highly pedal (100%), polyhedral/platy, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic;

Profile 55, Level plain location. *Surface condition self mulching/cracked, Small amount of surface stone.*

0-15cm; light clay; roots common; no lime present, no manganese present, pH 6.5 to 7.0; no stones/gravel observed; not mottled; not bleached, brown (7.5YR5/2) dry, dark brown (7.5YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *abrupt to:-*

15-45cm; medium to heavy clay; few roots present; no lime present, no manganese present, pH 8.5; grit present; not mottled; not bleached, dark greyish brown (10YR4/2) dry, dark brown (7.5YR3/2) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

45-139cm; medium clay; few roots present; lime concretions present, manganese stains present, pH 9.5 to 10; no stones observed; not mottled; not bleached, brown (7.5YR5/3) dry, brown (7.5YR4/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; very firm to strong consistency dry; not hydrophobic; *clear to:-*

139-142cm; gritty medium clay; few roots present; lime concretions common, manganese concretions present, pH 9.5 to 10; lense of angular grit <1cm mixed with clay; not mottled; not bleached, brown (7.5YR5/3) dry, brown (7.5YR4/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; firm to very firm consistency dry; not hydrophobic; *clear to:-*

142-250cm; medium clay; few roots present; lime concretions present, no manganese present, pH 9.5 to 10; no stones observed; not mottled; not bleached, light brown (7.5YR6/3) dry, brown (7.5YR5/3) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, 5mm to 15mm in size; strong consistency dry; not hydrophobic.

Profile 56, Level plain location. Su*rface condition self mulching/cracked, Surface stone absent.*

0-39cm; light to medium clay; many roots present; no lime present, no manganese present, pH 6.5; some grit present; not mottled; not bleached, brown (7.5YR4/2) dry, very dark grey (7.5YR3/1) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; very firm to strong consistency dry; not hydrophobic; *gradual to:-*

39-88cm; medium clay; few roots present; lime concretions present, no manganese present, pH 8.5; no stones observed; not mottled; not bleached, brown (7.5YR5/2) dry, very dark grey (7.5YR3/1) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, 5mm to 10mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

88-126cm; medium to heavy clay; no roots observed; lime concretions present, no manganese present, pH 9.5 to 10; some rounded gravel to 1cm; not mottled; not bleached, pink (7.5YR7/4) dry, brown (7.5YR5/3) moist; peds rough / smooth faced, highly pedal (100%), polyhedral, <5mm to 15mm in size; strong to very strong consistency dry; not hydrophobic; *gradual to:-*

126-192cm; medium clay; no roots observed; lime concretions present, no manganese present, pH 9.5 to 10; no stones observed; not mottled; not bleached, light brown (7.5YR6/3) dry, brown (7.5YR5/3) moist; peds rough / smooth-faced, highly pedal (100%), polyhedral, <5mm to 10mm in size; strong to very strong consistency dry; not hydrophobic; *diffuse to:-*

192-242cm; clayey sand; no roots observed; no lime present, no manganese present, pH 8.5 to 9.0; grit present, pockets of white sand in bottom of layer; not mottled; not bleached, light brown (7.5YR6/3) dry, brown (7.5YR4/4) moist; fabric rough, massive, not hydrophobic.

Profile 57 (previous Whitehaven soil survey profile) – Midslope location; *Surface condition loose*

0–20cm – sandy clay loam; brown (7.5YR 4/3) dry; dark reddish grey (5YR 4/2) moist, to some small gravel < 5mm; pH 6.0; highly pedal (100%), peds rough faced, angular blocky, < 5mm to 15mm, coherent, weak to firm consistence airdry; roots common; *clear to:-*

20–44cm – sandy clay loam; brown (7.5YR 5/4) dry; reddish brown (5YR 4/4) moist; gravel to 5mm; pH 7.5; highly pedal (100%), peds rough faced, angular blocky, < 5mm to 15mm, coherent, consistence strong airdry; roots present; *clear to:-*

44–60cm – medium to heavy clay; yellowish red (5YR 5/6) dry; strong brown (7.5YR 4/6) moist; small gravel present; pH 9.0; highly pedal (100%), peds smooth faced, angular blocky, 5mm to 20mm, coherent, consistence strong airdry; roots present; lime nodules present; *clear to:-*

60–72cm – medium to heavy clay; brown (7.5YR 5/4) dry and moist; some gravel to 5mm to 15mm; pH 9.0; highly pedal (100%), peds rough faced, angular blocky, <5-15mm, coherent, consistence strong (5) airdry; roots present; lime nodules plentiful; *gradual to:-*

76–122cm – medium to heavy clay; pale brown (10YR 6/3) dry; yellowish brown (10YR 5/4) moist; gravel to 10mm; pH 9.0; highly pedal (100%), peds smooth faced, angular blocky, 10mm to 20mm, coherent, consistence strong (5) airdry; roots present to 110cm depth; lime nodules plentiful; *diffuse to bedrock*.

APPENDIX 2

Topsoil Stripping Suitability Key

(after Elliott and Veness, 1981)

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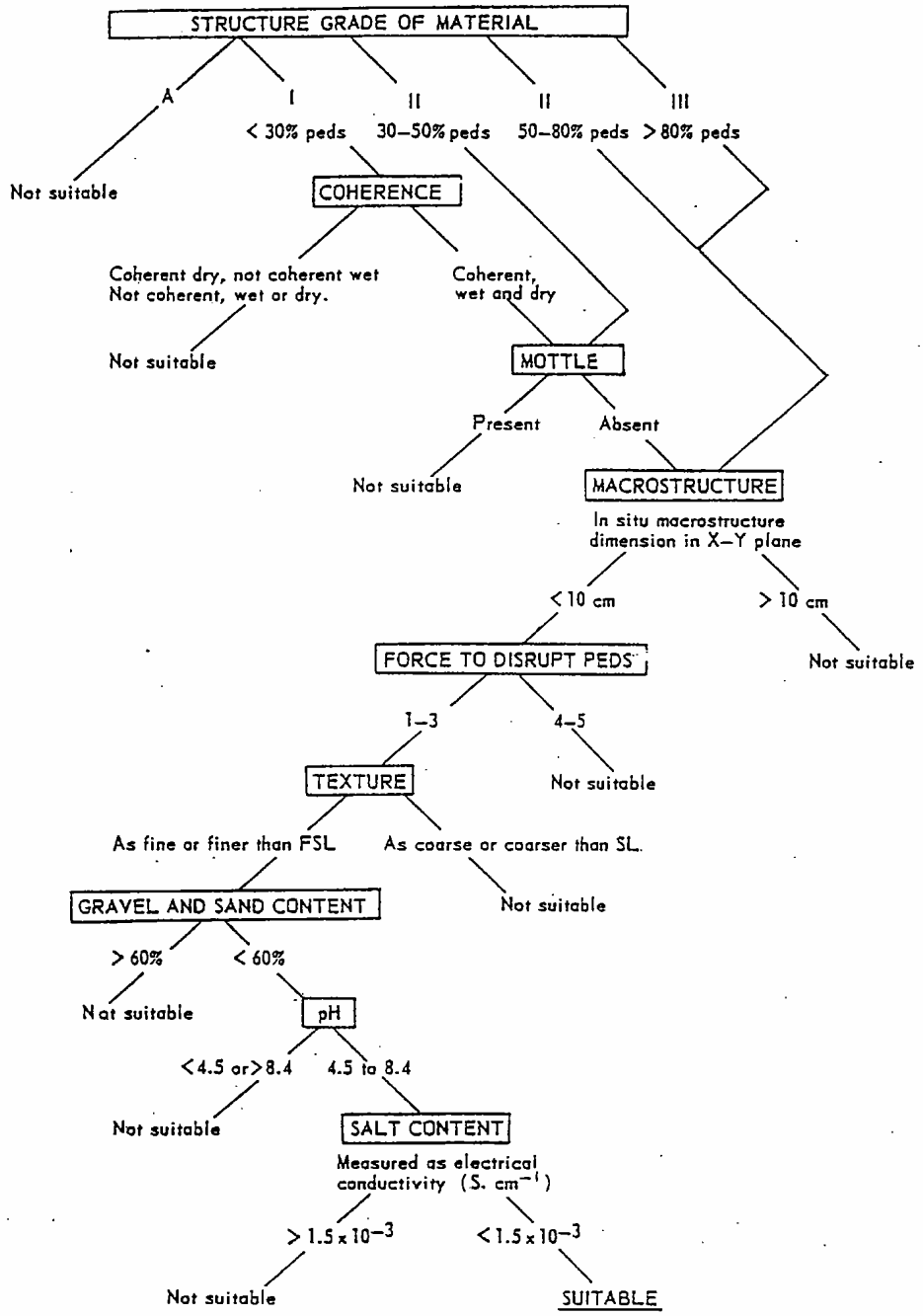
Procedure for the selection of material for use in topdressing of disturbed areas.



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APPENDIX 3

Basis of Land Capability Classification

(after Emery, undated)

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Table 1 *Land Capability Map Legend*

LAND CLASSIFICATION AND SOIL CONSERVATION PRACTICES				INTERPRETATIONS AND IMPLICATIONS
SUITABLE FOR REGULAR CULTIVATION		I	No special soil conservation works or practices.	Land suitable for a wide variety of uses. Where soils are fertile, this is land with the highest potential for agriculture, and may be cultivated for vegetable and fruit production, cereal and other grain crops, energy crops, fodder and forage crops, and sugar cane in specific areas. Includes "prime agricultural land".
		II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.	Usually gently sloping land suitable for a wide variety of agricultural uses. Has a high potential for production of crops on fertile soils similar to Class I, but increasing limitations to production due to site conditions. Includes "prime agricultural land".
		III	Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.	Sloping land suitable for cropping on a rotational basis. Generally used for the production of the same type of crops as listed for Class I, although productivity will vary depending upon soil fertility. Individual yields may be the same as for Classes I and II, but increasing restrictions due to the erosion hazard will reduce the total yield over time. Soil erosion problems are often severe. Generally fair to good agricultural land.
SUITABLE FOR GRAZING	Occasional Cultivation	IV	Soil conservation practices such as pasture improvement, stock control, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture.	Land not suitable for cultivation on a regular basis owing to limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Comprises the better classes of grazing land of the State and can be cultivated for an occasional crop, particularly a fodder crop, or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
		V	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.	Land not suitable for cultivation on a regular basis owing to considerable limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Soil erosion problems are often severe. Production is generally lower than for grazing lands in Class IV. Can be cultivated for an occasional crop, particularly a fodder crop or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms" adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
	No Cultivation	VI	Soil conservation practices including limitation of stock, broadcasting of seed and fertilizer, prevention of fire and destruction of vermin. May include some isolated structural works.	Productivity will vary due to the soil depth and the soil fertility. Comprises the less productive grazing lands. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
OTHER		VII	Land best protected by green timber.	Generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire. Destruction of trees is not generally recommended, but partial clearing for grazing purposes under strict management controls can be practised on small areas of low erosion hazard. Where clearing of these lands has occurred in the past, unstable soil and terrain sites should be returned to timber cover.
		VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.	Land unusable for agricultural or pastoral uses. Recommended uses are those compatible with the preservation of the natural vegetation, namely: water supply catchments, wildlife refuges, national and state parks, and scenic areas.
		U	Urban areas	
		M	Mining and quarrying areas.	

CLASS SUBSCRIPTS	SPECIAL USES
c	Terrain developed for a specific crop (capability class range IV to VII) as a result of the combination of particular soil, terrain, climatic and economic conditions. The class includes such crops as grapes, bananas, avocados and pineapples.
d	Terrain developed for intensive agricultural production and associated with flood irrigation. The class includes land developed for cotton and rice production.

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APPENDIX 4

Glossary of Terms

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apedal - describes a soil in which none of the soil material occurs in the form of peds in the moist state. Such a soil is without apparent structure and is typically massive or single-grained.

consistence - the degree of resistance to deformation or rupture exhibited by a soil.

fabric - the appearance of a soil when examined with a 10x hand lens with the similarities and differences between samples being based on presence or absence of ped, lustre (or its absence of the ped surfaces and the presence, size and arrangement of voids within the soil sample.

horizon - a layer of soil material within a soil profile with distinct characteristics and properties that are produced by soil forming processes, and that are different from those of the layers above and below.

hydrophobic - describes soils that are water repellent and that resist wetting when dry. Drops of water do not spread spontaneously over their surface and into the pores.

lateritic - describes soil layers comprised of iron-rich material, often concentrated in separate nodules(gravel) or as masses of individual nodules cemented together.

massive - the condition of a soil layer in which the layer appears as a coherent or solid mass that is largely devoid of peds.

ped - an individual natural soil aggregate or unit of structure.

structure - describes the combination or spatial arrangement of primary soil particles (clay, silt, sand, gravel) into aggregates such as peds or clods and their stability to deformation.

texture - the coarseness or fineness of soil material as it affects the behaviour of a moist ball of soil when pressed between the thumb and forefinger. It is generally related to the proportion of soil particles of differing sizes (sand, silt, clay and gravel) in a soil but is influenced by the organic matter content as well.

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