Multiquip Quarries

ABN: 44 101 930 714

Modified "Ardmore Park" Quarry Project

Soils and Land Capability Assessment

Prepared by

Cowman Stoddart Pty Ltd

February, 2008

SPECIALIST CONSULTANT STUDIES COMPENDIUM

PART 10

Multiquip Quarries

ABN: 44 101 930 714

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Soils and Land Capability Assessment

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EXECUTIVE SUMMARY

The soils on the Project Site of the proposed "Ardmore Park" Quarry have been described and analysed to provide recommendations for soil management and to assess the likely impact of the proposed "Ardmore Park" Quarry on the soil resources on the Project Site.

The soil survey was undertaken with a backhoe in July 2003 to a depth of at least one metre. Each horizon in the soil profile was described and sampled. Representative soil samples were analysed at the Scone Research Services Centre for a range of parameters. A supplementary soil survey was undertaken in November 2004 of the southern sand extraction area supported by laboratory analysis.

The soils on the Project Site were categorised into five soil units with underlying geology being either metasediments, sand or basalt. The laboratory analyses indicate that the soils are not saline and have negligible to slight dispersion ratings. The soils formed on the basalt are well structured and naturally fertile while the other soils have a sandier texture and would respond to fertilisers.

Soil landscape mapping has been recently prepared for the area as it is within the Sydney Catchment Authority's (SCA) hydrological catchment. Extracts of this study have been used in the report and assistance of DIPNR staff is acknowledged. The two soil landscapes mapped on the Project Site relate to the basalt and sand resource. The results of the soil survey and laboratory analyses are consistent with the features of the SCA mapping.

The soil erodibility factor was calculated with the soils generally rated as "moderately" erodible. Existing soil erosion is minor due to soil conservation earthworks, conservative land use, natural soil fertility and stability, and gentle terrain.

The suitability of the soil for rehabilitation has been considered. Recommendations have been made for earthmoving and stockpiling the different soil horizons. Soil conservation measures appropriate to the site have been discussed.

Land capability mapping prepared by the former Department of Land & Water Conservation was studied as was land suitability mapping prepared by NSW Agriculture.

It is concluded that the Project Site does not create technical difficulties in erosion control and rehabilitation due to the favourable topography and soils. However, it is within a water catchment area and it is essential that runoff flowing off the property is of good quality. Soil erosion and sediment control plans should be prepared for each stage and be approved prior to commencement.

FOREWORD

The following report was prepared in 2004 to accompany a development application for the "Ardmore Park" Quarry submitted in January 2005. It was determined that the modified "Ardmore Park" Quarry Project had not been varied sufficiently to warrant any revision to this report.

It is noted that some references and figures within this report reflect the "Ardmore Park" Quarry proposal as submitted in January 2005.

1 INTRODUCTION

Multiquip Quarries ("Multiquip") proposes to develop and operate a sand and hard rock quarry on the "Ardmore Park" property, approximately 4km south of the village of Bungonia. Cowman Stoddart Pty Ltd has been commissioned by R.W. Corkery & Co. Pty. Limited to undertake an assessment of the soils present on the site of the proposed "Ardmore Park" Quarry and identify the rural land capability class. The assessment incorporates a study of soils on the "Ardmore Park" property originally commenced for a poultry farm proposal, however, for the purpose of this report, limits the assessment to the soils of the proposed areas of disturbance and immediate surrounds (herein referred to as the "Project Site" – see **Figure 1**).

The report presents the results of the soil survey and laboratory analyses completed from representative locations on the Project Site. Relevant information on the land capability and agricultural suitability of the Project Site and "Ardmore Park" property in general is provided along with recommended soil management practices.

2 DESCRIPTION OF THE PROJECT SITE AND THE PROPOSAL

2.1 The Project Site and Study Area

For the purposes of this report, the area incorporating the proposed development is referred to as the Project Site. The Project Site covers a total area of 185ha and incorporates selected areas within Lot 24 DP 1001312, a property owned by CEAL Limited, trading as Multiquip Quarries for the proposed development.

The Study Area for the soils and land capability assessment corresponds to the Project Site. The bulk of the soil sampling undertaken for the assessment was performed at the time of the poultry farm proposal and as such, several sampling points are located outside the Project Site. These sampling points are considered representative of the soils of the bulk of the Project Site / Study Area with additional sampling undertaken (see Section 4.1) to ensure all soils within the Study Area were identified and described.

The geology of the Study Area consists of Tertiary basalt across the northeast and Devonian metasediments across the southwest. The vegetation over the basalt is almost completely cleared and used for grazing and other farming pursuits. The metasediments still retain some of the original native forest, particularly on several low knolls.

2.2 The Proposed Quarry Development

The proposed "Ardmore Park" Quarry, would incorporate an extraction area of approximately 59 hectares, with additional disturbance associated with the construction of processing areas, water management structures and an internal road network increasing this area of disturbance to 76 hectares (**Figure 2**). The extracted sand and hard rock (basalt) resources would be processed on the Project Site to produce various quality sand, aggregate and road building materials for use in the growing construction markets of Sydney, Canberra and Goulburn.

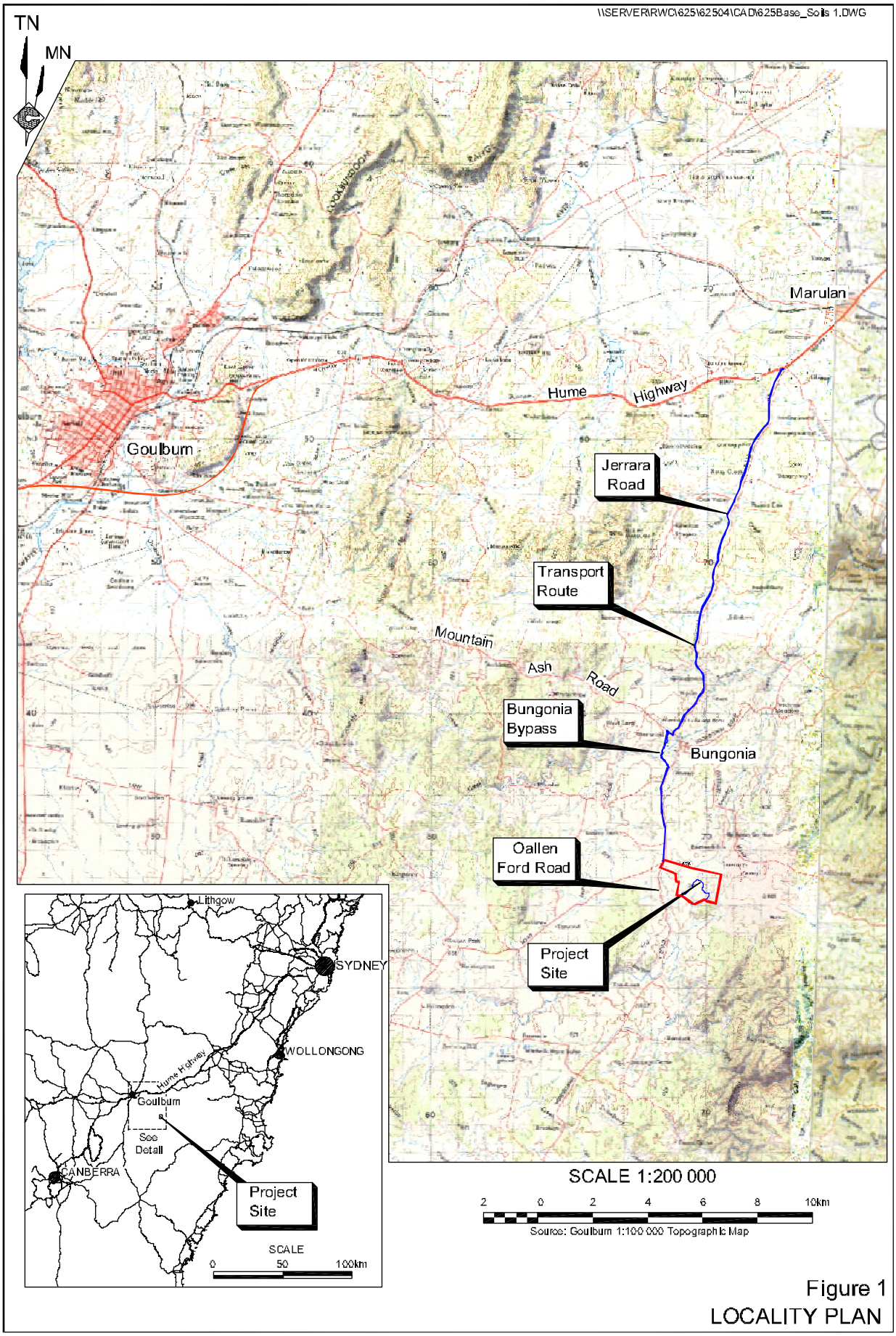

Figure 1
LOCALITY PLAN

Extraction of the sand would be undertaken by conventional methods. Topsoil would be removed and stockpiled using a bulldozer, and the weathered basalt overburden ripped, removed and stockpiled for use in the construction of on-site roads, bund walls, water management structures, rehabilitation and other works. The exposed sand would be excavated using an excavator and transported by truck to one of two sand processing plants. The extracted sand would be processed both by simple screening and size reduction using a dry processing plant, and by washing to remove finer material. The proposed location of the processing plants, product stockpiles and other infrastructure is shown on **Figure 2**. Some existing agricultural dams would be enlarged and used for the deposition of silt and clarification of water.

The extraction of the competent basalt would be undertaken using an excavator/truck/front-end loader operation with no drilling and blasting required. Topsoil and subsoil present above the basalt and sand would be cleared and stockpiled for future use in rehabilitation and the limited quantities of overburden produced used in ongoing infrastructure and rehabilitation works. The processing plant and product stockpiles would be located adjacent to the extraction area and utilise existing topography to maximise the efficiency of processing operations.

3 SOIL LANDSCAPE MAPPING

Soil landscapes are areas of land with unique landform features and characteristic soil types. Because landscapes and their soils are formed by the same natural processes, soil landscapes are closely linked to other natural features such as vegetation, geology and hydrology. **Figure 3** presents a map of soil landscapes for the local area surrounding the Project Site.

The map which has been prepared for this area is part of a project to map the soil landscapes for the Sydney Catchment Authority's (SCA's) hydrological catchments. The purpose of the project is to gain soil information for the whole catchment in order to allow for better land management by SCA.

Soil surveying was conducted by former NSW Department of Land & Water Conservation (now Department of Infrastructure, Planning and Natural Resources) Soil Surveyors on to 1:25 000 scale base maps. Soil profiles were described and sampled in various representative locations, subject to access and ground conditions. The laboratory results included in the survey provide an indication of typical soil properties and are a guide for specific land uses.

The three soil landscapes that have been mapped on the Project Site are presented on **Figure 3**, namely:

- REiv Inverary: This covers the majority of the quarry site and all of the basalt and central sand extraction area.

  Landscape summary

  Small residue plateaus and associated slopes on Tertiary basalts in the Bungonia Hills Physiographic Region. Productive landscape with fertile soils and low erosion. Mainly improved pasture for beef cattle and sheep grazing. Minor production of fodder crops. Minimal erosion, soils are quite stable.

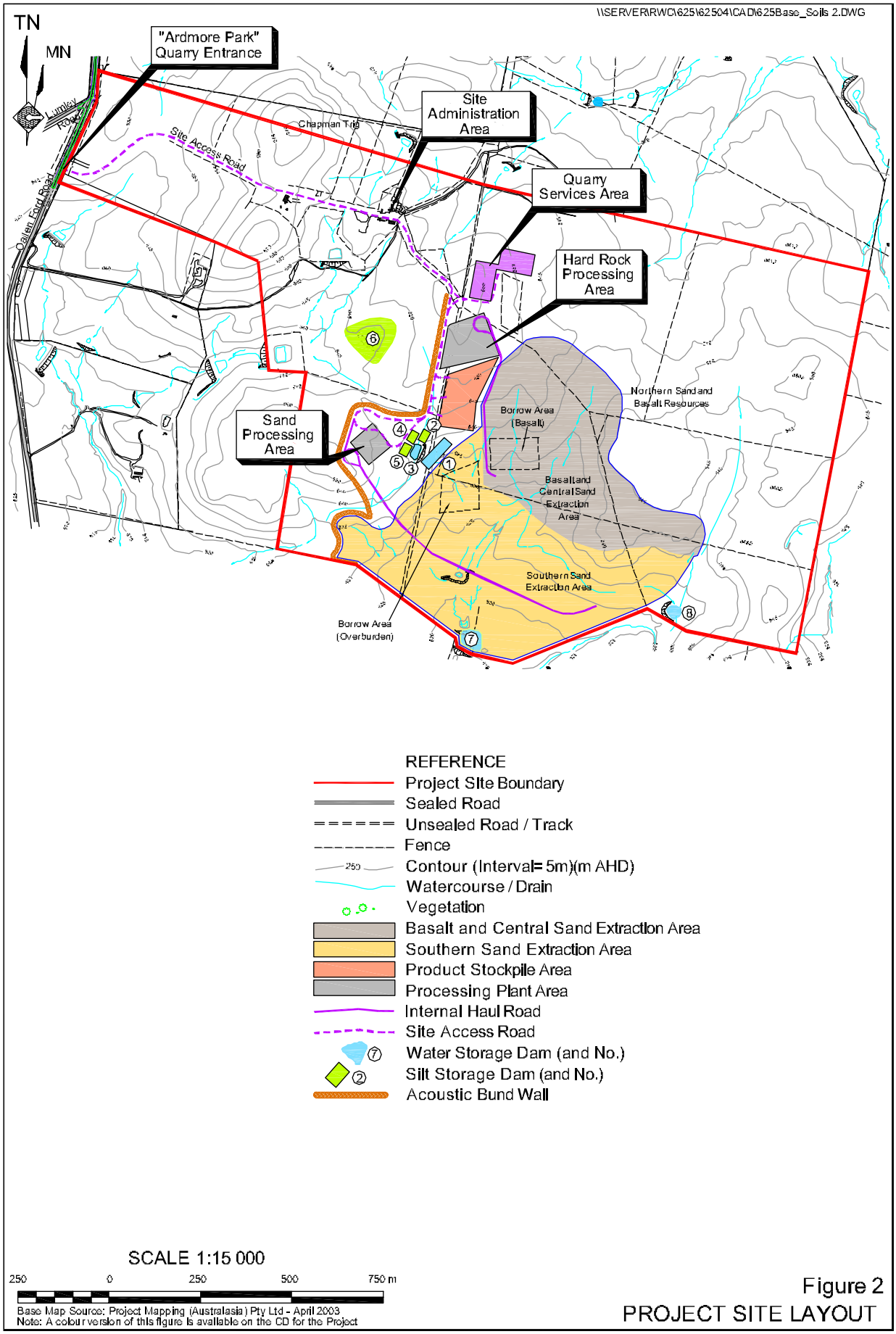

Figure 2
PROJECT SITE LAYOUT

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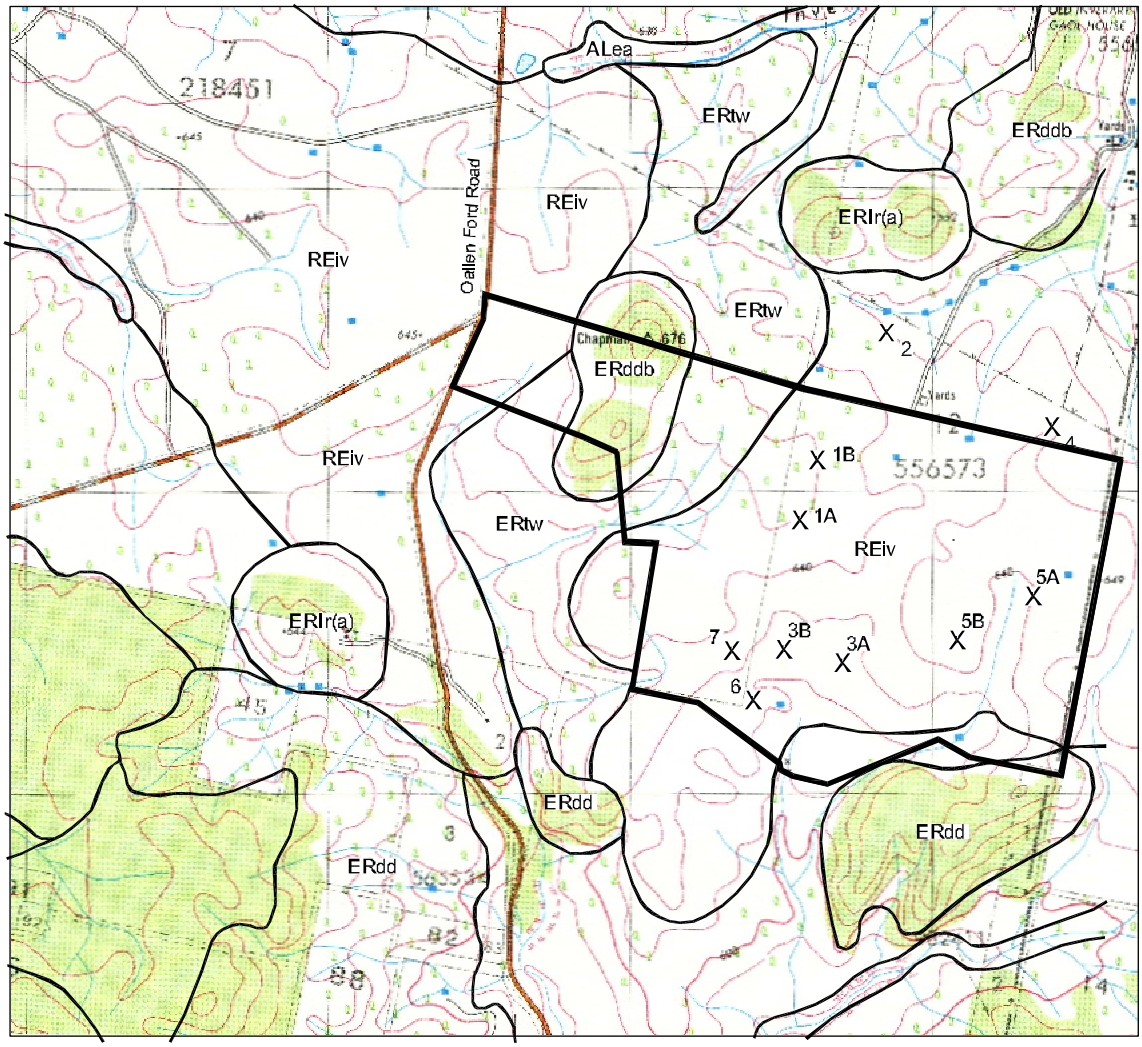

REFERENCE

	Project Site Boundary
X 3A	Soil Sample Location
	Soil Landscape Boundary
REiv	Inverary
ERtw	Tarrawarra
ERdd	Durran Durra
ERddb	Durran Durra (variant b)
ERIr(a)	Larkin (variant a)
ALea	Eastfields Creek

SCALE 1:25 000

250 0 250 500 750 1000 1250 m

Base Map Source: Kooringaroo & Bungonia 1:25 000 Topographic Maps
Note: A colour version of this figure is available on the CD for the Project

Figure 3
SOIL LANDSCAPE UNITS

Soil types

Lithosols on plateaus and upper slopes. Chocolate soils on slopes. Black earths in drainage lines and small alluvial flats.

- ERtw Tarrawarra: This includes the southern sand extraction area and the metasediments to the north on which the quarry services area and hard rock processing area is proposed to be located.

  Landscape summary

  Undulating low hills on metasediments and sandstone (the poor acidic, saline and sodic soils and severe erosion associated with this soil landscape does not occur within the proposed extraction areas of the Project Site). Areas of improved pasture and natural pasture used for livestock grazing.

  Soil types

  Yellow podsolics and soloths on the metasediments. Alluvial soils on the sands.
- ERddb Durran Durra variant b: This includes the stony timbered hills through which the site access road passes.

  Landscape summary

  Low stony ridgelines and hills on metasediments in the Bungonia Hills Physiographic Region. Infertile stony landscape often left under timber.

It is noted that the low timbered knolls on the northern boundary of "Ardmore Park" are mapped as soil landscape ERIra (Larkin variant a). These are characterised by rock outcrops and shallow soils. Further north is Inverary Creek which is mapped as soil landscape ALea (Eastfields Creek). This is characterised by strong duplex soils with highly dispersible subsoils, salinity and severe gully erosion.

4 METHODOLOGY

4.1 Soil Survey

A soil survey was undertaken in July 2003 with a backhoe to a depth of approximately one metre. The intention at that time was to develop a poultry farm with poultry sheds proposed in five different locations on the property. The soil survey studied the soils at these five locations and commissioned a range of laboratory analyses to assist in the survey.

Following the discovery of a significant sand and basalt resource on the "Ardmore Park" property, the proposal to develop a poultry farm was withdrawn and replaced with the current proposal to develop and operate the "Ardmore Park" Quarry. As a result, a number of additional laboratory tests and a supplementary soil survey of the southern sand extraction area was undertaken in November 2004. **Figure 4** presents the location of all soil pits surveyed.

The soil sampled from each of the soil pits was categorised into soil units based on the soil type and underlying geology. The A and B Horizons for each soil unit were described along with a description of depth, colour and texture.

4.2 Laboratory Analysis

Representative samples from each of the soil units identified were sent to the Scone Research Services Centre Laboratory for analysis of chemical and physical characteristics. The analyses included tests for soil erodibility.

5 RESULTS AND DISCUSSION

5.1 Soil Unit Description

5.1.1 Introduction

Based on an assessment of soil type and underlying geology, the soil of the Project Site has been categorised into five soil units (soil unit A to soil unit E). Each soil unit is described in sub-sections 5.1.2 to 5.1.6.

5.1.2 Soil Unit A

Formed on Ordovician metasediments and identified at soil pits 1 and 2. Decomposing shale and backhoe refusal at 110 cm.

Typical Soil Profile:

A1 Horizon

Depth	:	0 - 10 cm
Colour	:	10 YR 2/2 Very dark brown
Texture	:	Loamy sand. Weak structure.

A2 Horizon

Depth	:	10 - 35 cm
Colour	:	10 YR 4/4 Dark yellowish brown
Texture	:	Sandy loam. Weak structure.

B Horizon

Depth	:	35 - 110 cm
Colour	:	10 YR 5/6 Strong brown
Texture	:	Medium clay

Project Site Location: This is a duplex soil which occurs over part of the basalt and central sand extraction area as well as the proposed processing plant, administration and quarry services area.

Soil type: Yellow podsolic soil.

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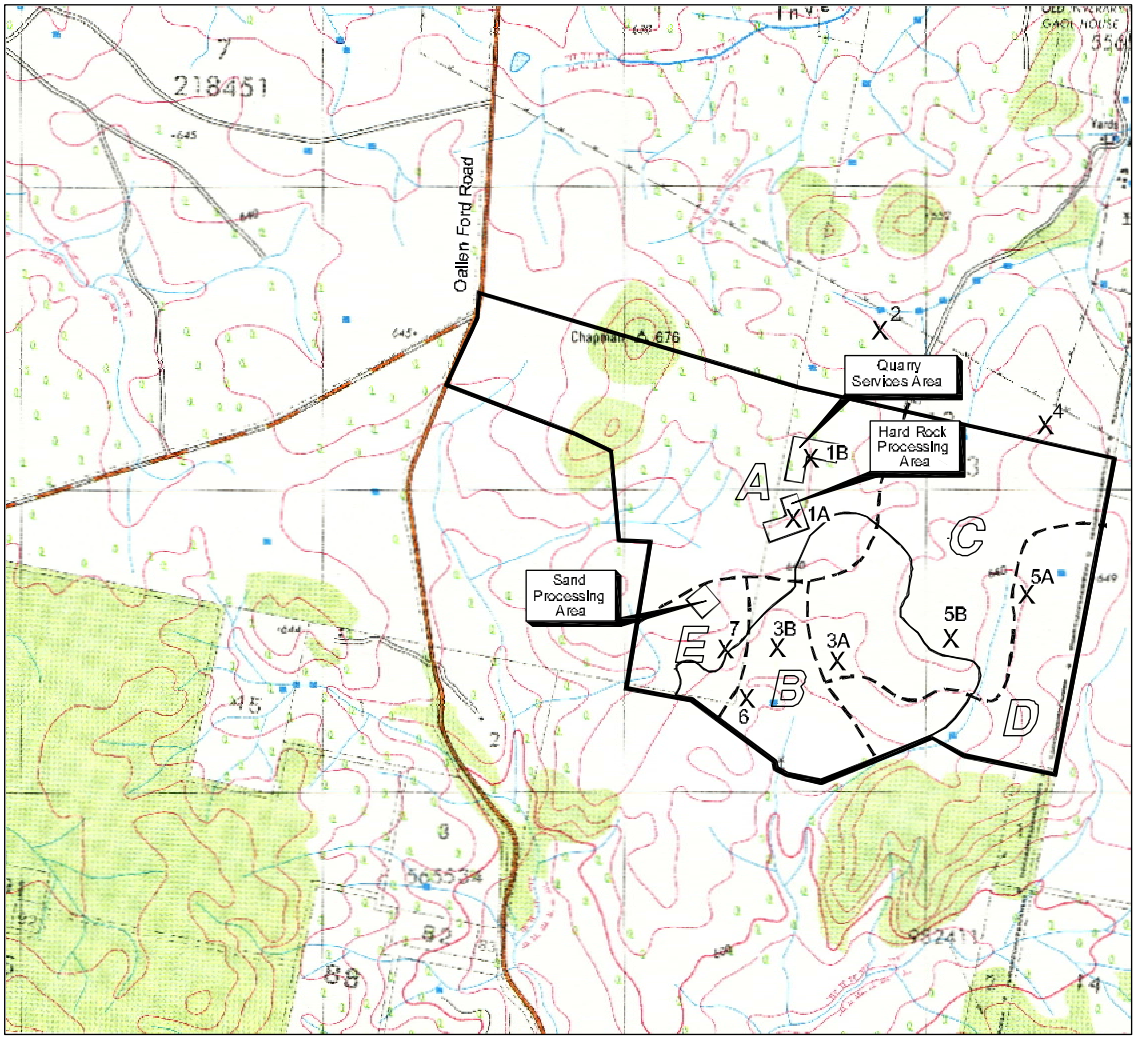

REFERENCE
Project Site Boundary
Extraction Area Boundary
3A Soil Pit
A Soil Unit
Soil Unit Boundary

SCALE 1:25 000

250 0 250 500 750 1000 1250 m

Base Map Source: Kooringaroo 1:25 000 Topographic Map
Note: A colour version of this figure is available on the CD for the Project

Figure 4
SOIL MAPPING UNITS
AND SOIL PIT LOCATIONS

5.1.3 Soil Unit B

Identified at soil pits 3b and 6 within the southern sand extraction area.

Typical Soil Profile:

A Horizon

Depth	:	0 - 20 cm
Colour	:	10 YR 3/3 Dark brown
Texture	:	Loam (well structured)

B1 Horizon

Depth	:	20 - 50 cm
Colour	:	7.5 YR 3/2 Dark brown
Texture	:	Clay loam

B2 Horizon

Depth	:	50 - 120 cm
Colour	:	10 YR 5/4 Yellowish brown
Texture	:	Sandy loam

Project Site Location: Southern sand extraction area (Stages 1, 3 and 4).

Soil type: Alluvial soil.

5.1.4 Soil Unit C

Formed on Tertiary basalt and identified at soil pits 3a, 4 and 5b. Stone throughout soil profile. Weathered basalt and backhoe refusal at 100 - 130 cm.

Typical Soil Profile:

A Horizon

Depth	:	0 - 20 cm
Colour	:	10 YR 3/2 Very dark greyish brown
Texture	:	Clay loam (well structured)

B1 Horizon

Depth	:	20 - 60 cm
Colour	:	10 YR 5/6 Yellowish brown
Texture	:	Heavy clay

B2 Horizon

Depth	:	60 - 130 cm
Colour	:	10 YR 5/3 Brown
Texture	:	Heavy clay

Project Site Location: Predominantly basalt and central sand extraction area, but includes Stage 5 of southern sand extraction area.

Soil type: Chocolate Soil

5.1.5 Soil Unit D

Formed on Tertiary basalt and identified at soil pit 5A.

Typical Soil Profile:

A Horizon

Depth	:	0 - 20 cm
Colour	:	10 YR 3/3 Dark brown
Texture	:	Heavy clay (well structured)

B Horizon

Depth	:	> 20 cm
Colour	:	10 YR 2/1 Black
Texture	:	Heavy clay

Project Site Location: Eastern property boundary and southern footslopes. Includes a part of Stage 6 of the southern sand extraction area.

Soil type: Black earth, well structured cracking clay soils with a self mulching surface.

5.1.6 Soil Unit E

Identified at soil pit 7.

Typical Soil Profile:

A Horizon

Depth	:	0 - 20 cm
Colour	:	10 YR 3/3 Brown
Texture	:	Sandy loam

B Horizon

Depth	:	> 20 cm
Colour	:	10 YR 5/2 Greyish brown
Texture	:	Loamy sand

Project Site Location: Parts of Stages 1 and 2 of the **s**outhern sand extraction area and southwestern corner of the Project Site.

Soil type: Alluvial soil

5.2 Laboratory Analyses

5.2.1 Introduction

The complete results of the laboratory analysis performed on representative soil samples is provided as **Appendix 1**. The following sub-sections summarise the results for the chemical and physical characteristics (see Section 5.2.2) and soil erodibility (see Section 5.2.3) of the Project Site soils.

5.2.2 Chemical and Physical Characteristics

5.2.2.1 Electrical Conductivity (EC)

The electrical conductivity of the saturated extract is a measure of soil salinity. **Table 1** presents the salinity of soils, as defined by EC range and their affect on vegetation.

Table 1
Soil Salinity Levels

Rating	ECe ds/m	Effect on Plants
Non-saline	< 2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of sensitive crops affected
Moderately saline	4 – 8	Yields of many crops affected
Highly saline	8 – 16	Only tolerant crops yield satisfactorily
Extremely saline	> 16	Only very tolerant crops yield satisfactorily

Tables 2 and **3** present the salinity levels of soil samples from the soil pits in June 2003 (**Table 2**) and November 2004 (**Table 3**).

Table 2
Soil Salinity (June 2003)

Lab No.	Soil Unit	Location & Horizon		EC (ds/m)	Multiplier Factor	ECe (ds/m)
1	A	Soil Pit 1	A1	0.15	17	2.55
2		Soil Pit 1	A2	0.08	11	0.88
3		Soil Pit 1	B	0.11	7	0.77
4		Soil Pit 2	A1	0.15	11	1.65
5		Soil Pit 2	A2	0.05	11	0.55
6		Soil Pit 2	B1	0.11	7	0.77
7		Soil Pit 2	B2	0.06	7	0.42
9	B	Soil Pit 3	A	0.11	9	0.99
10		Soil Pit 3	B1	0.08	9	0.72
11		Soil Pit 3	B2	0.07	11	0.77
17	C / D	Soil Pit 5	A	0.08	6	0.48
18		Soil Pit 5	B1	0.06	6	0.36
19		Soil Pit 5	B2	0.06	6	0.36

Table 3
Soil Salinity (November 2004)

Lab No.	Soil Unit	Location & Horizon		EC (ds/m)	Multiplier Factor	ECe (ds/m)
1	B	Soil Pit 6	A	0.08	9	0.72
2		Soil Pit 6	B	0.05	7	0.35
3	E	Soil Pit 7	A	0.07	11	0.77
4		Soil Pit 7	B	0.05	11	0.55

The topsoil at the quarry services area (soil unit A) is slightly saline (2.55ds/m) but the lower horizons at this location are not saline. The soils at all other locations of the proposed quarry are not saline. This is also apparent from ground observations and from studying air photos of the "Ardmore Park" property and surrounding lands.

5.2.2.2 Soil pH (1:5 water)

To determine the relative acidity/alkalinity of the five soil units, pH values were measured. **Table 4** presents the results of pH analysis.

Table 4
Soil pH

Lab No.	Soil Unit	Location & Horizon		pH	Interpretation
June 2003					
1	A	Soil Pit 1	A1	5.5	Strongly acid
2		Soil Pit 1	A2	5.2	Strongly acid
3		Soil Pit 1	B	4.7	Very strongly acid
4		Soil Pit 2	A1	5.3	Strongly acid
5		Soil Pit 2	A2	6.0	Moderately acid
6		Soil Pit 2	B1	6.8	Neutral
7		Soil Pit 2	B2	7.7	Mildly alkaline
9	B	Soil Pit 3	A	6.0	Moderately acid
10		Soil Pit 3	B1	6.5	Slightly acid
11		Soil Pit 3	B2	7.3	Neutral
17	C / D	Soil Pit 5	A	5.9	Moderately acid
18		Soil Pit 5	B1	7.3	Neutral
19		Soil Pit 5	B2	8.3	Moderately alkaline
November 2004					
1	B	Soil Pit 6	A	5.5	Strongly acid
2		Soil Pit 6	B	6.6	Neutral
3	E	Soil Pit 7	A	5.8	Moderately acidic
4		Soil Pit 7	B	6.0	Moderately acidic

Soil Unit A: The soil in soil unit A (soil pit 1) is strongly acidic and would benefit from agricultural lime applied at 1 tonne/ha. No earthworks are proposed in the area of soil pit 2 but the topsoil is also strongly acidic and plant growth would be enhanced with agricultural lime.

Soil Unit B: An alkaline trend in soil pH is identified with no lime required for optimum plant growth.

Soil Unit C/D: An alkaline trend in soil pH is identified with no lime required for optimum plant growth.

Soil Unit E: The topsoil of soil unit E is moderately to strongly acidic and vegetation would benefit from agricultural lime applied at 1 tonne/ha.

5.2.2.3 Phosphorus (Bray)

The topsoil of soil unit A is satisfactory but soil units B and C have low levels of phosphorus in the topsoil. Phosphorus fertiliser should be used in any rehabilitation programme for optimum plant growth. Analyses of phosphorus levels for soil units D and E were not performed.

5.2.2.4 Sodicity

Sodicity is the level of exchangeable sodium cations in the soil. **Table 5** presents the sodicity of representative soil samples.

Table 5
Sodicity

Lab No.	Soil Unit	Location and Horizon		Exchangeable Sodium	Sodicity Rating
4	A	Soil Pit 2	A1	3%	Non-sodic
5		Soil Pit 2	A2	4%	Non-sodic
6		Soil Pit 2	B1	13%	Highly sodic
7		Soil Pit 2	B2	6%	Marginally sodic
9	B	Soil Pit 3	A	2%	Non-sodic
17	C	Soil Pit 5	A	2%	Non-sodic
18		Soil Pit 5	B1	1%	Non-sodic
19		Soil Pit 5	B2	4%	Non-sodic

The B1 horizon of soil unit A (soil pit 2) is highly sodic but no earthworks are proposed in that area and it is outside the Project Site boundary. Soil units B and C are non-sodic which is a desirable feature. Analyses for sodicity were not performed for soils units D and E.

5.2.2.5 Potassium (K)

Table 6
Potassium Levels in Topsoil

Lab No.	Soil Unit	Location and Horizon		Concentration	Rating	% CEC
4	A	Soil Pit 2	A1	0.3	Low	6%
9	B	Soil Pit 3	A	1.0	High	4%
17	C	Soil Pit 5	A	0.6	Moderate	2%

The desirable range for plant productivity is 1 – 5% of the Effective Cation Exchange Capacity and the levels are in this range. Analyses for Potasium were not performed for soils units D and E.

5.2.2.6 Calcium (Ca)

Table 7
Calcium Levels in Topsoil

Lab No.	Soil Unit	Location and Horizon		Concentration	Rating	% CEC
4	A	Soil Pit 2	A1	3.1	Low	61%
9	B	Soil Pit 3	A	16.6	High	64%
17	C	Soil Pit 5	A	21.3	Very High	61%

The desirable range for plant productivity is 65 – 80% of the Effective CEC and the levels are slightly below this range. An application of agricultural lime would increase the calcium level. Analyses for calcium were not performed for soils units D and E.

5.2.2.7 Magnesium (Mg)

Table 8
Magnesium Levels in Topsoil

Lab No.	Soil Unit	Location and Horizon		Concentration	Rating	% CEC
4	A	Soil Pit 2	A1	1.0	Low	20%
9	B	Soil Pit 3	A	7.8	High	30%
17	C	Soil Pit 5	A	12.4	Very High	35%

The desirable range for plant productivity is 10 – 15% of effective CEC. Thus the levels are high and the addition of agricultural lime would be desirable to reduce Mg as a percentage of CEC. Analyses for Magnesium were not performed for soils units D and E.

5.2.2.8 Emerson Aggregate Test (EAT)

This is a measure of soil dispersibility or soil structural stability.

Table 9
EAT in Quarry Areas

Lab No.	Soil Unit	Location and Horizon		EAT	Dispersion Rating
9	B	Soil Pit 3	A	8/3 (1)	Negligible
10		Soil Pit 3	B1	5	Slight
11		Soil Pit 3	B2	5	Slight
17	C	Soil Pit 5b	A	8/3 (1)	Negligible
18		Soil Pit5b	B1	3 (1)	Slight
19		Soil Pit 5b	B2	3 (1)	Slight

Table 10
Supplementary Analyses

Lab No.	Soil Unit	Location and Horizon		EAT	Dispersion Rating
1	B	Soil Pit 6	A	3 (1)	Slight
2		Soil Pit 6	B	5	Slight
3	E	Soil Pit 7	A	8/3 (1)	Negligible
4		Soil Pit 7	B	3 (1)	Slight

The soils of the Project Site are stable which is a desirable characteristic.

It is noted from the laboratory results that the soil of soil unit A (soil pit 1) incorporating the quarry services area is also stable. Analysis of EAT was not performed for soil unit D.

5.2.2.9 Dispersion Percentage

The dispersion percentage results correspond with the EAT figures above. With the exception of soil pit 2 of soil unit A (albeit an area in which no disturbance is proposed) which displays a highly dispersible subsoil, the soils have negligible to slight dispersion ratings with none of the analyses exceeding 25%.

5.3 Soil Erodibility

5.3.1 Introduction

Soil erodibility is the susceptibility of a soil to detachment and transportation of soil particles by erosive agents (Houghton & Charman, 1986). It is based solely on soil properties.

The soil erodibility factor (K) is calculated in the laboratory and provides a soil erodibility rating which can be used to compare different soils. The K factor is an input for the Universal Soil Loss Equation (USLE).

Table 11
Soil Erodibility Classes

Rating	K factor
Very low	0.00 – 0.01
Low	0.01 – 0.02
Moderate	0.02 – 0.04
High	0.04 – 0.06
Very high	> 0.06

5.3.2 Existing Soil Erosion

Existing erosion on the Project Site is minor due to conservative land use and erosion control earthworks. Gully erosion has occurred in the past but this has been stabilised with the aid of gully control structures including farm dams, contour banks and a pasture improvement program.

This stable landscape on the basalt soils is quite apparent on air photos and is in contrast to the active sheet and gully erosion on the less fertile soil types on nearby properties.

As stated in the Soil Landscape Mapping of SCA described in Section 3, *"Productive landscape with fertile soils and low erosion .... Minimal erosion, soils are quite stable."*

5.3.3 Laboratory Results

The natural fertility of the basalt soils and favourable soil properties are evident in the laboratory analysis with eight of the nine soil samples being rated in the "moderate" soil erodibility classes and one in the "low" soil erodibility class. The laboratory results are provided as **Appendix 1**.

6 STRIPPING SUITABILITY OF PROJECT SITE SOILS

6.1 Introduction

The Project Site is currently used for grazing by sheep and cattle on improved pasture. It is intended that the existing land capability would be restored after extraction from the proposed quarry is completed. For that to happen, it is important that the topsoil in particular, and some subsoil is preserved for rehabilitation purposes.

The soil survey indicates that the topsoil across the Project Site has a uniform depth of 20 cm. However, the subsoil below the topsoil varies considerably in depth to basalt rock and sand.

6.2 Soil Characteristics/General Suitability

6.2.1 Topsoil

The topsoil for soil unit's B, C and D, ie. that formed on basalt[1], is well structured and naturally fertile. It is not dispersive and the soil aggregates are stable and well drained. It is an excellent material for revegetation and should be stockpiled for rehabilitation purposes or preferably directly transferred wherever possible . The topsoil on soil unit E is more sandy and has a weaker structure than the clay loam topsoils. However it is also essential that it be retained for rehabilitation.

The topsoil on soil unit A (eg. soil pit 1A) is shallower (10 cm) and has a weak structure similar to soil unit E. It should be stripped and stockpiled separately from the A2 horizon which has a high proportion of gravel. The natural fertility and microbial activity is concentrated in the topsoil and it has the most value for rehabilitation.

The stable structure of the topsoil means that it is unlikely to be hardsetting in stockpiles and when re-spread on the final landform. This would increase the soil permeability which would improve plant growth and reduce soil erosion hazard. A further beneficial implication is that dust generation during handling of the soil would be reduced by the stability of the aggregates.

The natural fertility of the topsoils would make revegetation in the stockpiles and on the final landform a relatively simple process.

6.2.2 Subsoil

The heavy clay subsoils formed on the Tertiary basalt (soil units B, C and D[1]) are a sharp contrast to the loamy sands of the southern sand extraction area (soil unit E). The clay subsoils have high water-holding capacity and revegetation would be less susceptible to extended dry seasonal conditions once it has become established. The sandy subsoils would dry out more quickly and would generate more dust while being handled and in stockpiles.

Both subsoils are suitable for use in a rehabilitation programme but their different characteristics should be recognised. It is intended to strip an average thickness of 0.5 m of subsoil from the site for stockpiling and reuse.

The medium clay subsoil of Soil Unit A is also suitable for earthworks and quarry rehabilitation due to its stable aggregated nature. However, it is highly acidic and agricultural lime should be spread prior to topsoiling.

6.3 Stripping Recommendations

Within the proposed extraction areas, it is intended to use a bulldozer to push the soil into windrows for removal by front end loader and trucks. It is essential that the plant operators be given clear instructions to keep the topsoil separate from the subsoil.

[1] The clay subsoils of soil units B and D are a result of weathering Tertiary basalt

On some areas, the topsoil and subsoil are easily differentiated by colour (eg. soil unit C) and on other areas by texture (eg. soil unit E). However, there are other areas (soil unit D) where the topsoil gradually becomes subsoil. The simplest advice is that the top 15 – 20 cm is topsoil with subsoil beneath the topsoil.

The topsoil is of most value in rehabilitation as it is the soil horizon most suitable for supporting plant growth and should be preserved. There is never too much topsoil.

7 HANDLING STRIPPED SOILS

7.1 Earthmoving Procedures

It is desirable to rip the heavy textured topsoil of soil units B, C and D (to 20 cm depth) to break up the soil and allow for easier pushing into windrows. This procedure is less likely to destroy the soil structure than simply using a dozer on the undisturbed soil surface, although it is not necessary to rip the lighter textured soil of soil units A and E.

The windrowed soil would be loaded onto trucks by front-end loader, and when not transferred directly to areas of rehabilitation activities, transported to the nominated soil stockpile areas. The stockpiles would have a maximum height of 2 metres and left with a rough surface to assist in rainfall infiltration and seed germination.

The stockpiles should not be compacted as it is essential to preserve the structure of the soil aggregates and biological activity within the topsoil.

After the topsoil has been removed, the extraction areas should be ripped again with the bulldozer, and the subsoil to a depth of 0.5 m windrowed and removed by front-end loader for immediate use in the construction of dam walls, water management structures, acoustic bund walls, internal haul roads and backfilling completed sections of the proposed quarry.

There should be no need for excess subsoil to be stockpiled on the existing ground surface. However, if this need does arise, then the topsoil on the stockpile site should be stripped and preserved. The location of subsoil stockpiles should be clearly identified on a plan such that they are not confused with topsoil. Any stockpile that is to be retained in excess of 3 months should be seeded with a cereal crop, such as Japanese Millet or Ryecorn, or pasture mix to reduce erosion potential and dust generation, and maintain biological activity. Any long term subsoil stockpile should be topsoiled to assist with revegetation. Batters should not exceed a horizontal:vertical ratio of 3:1.

7.2 Soil Conservation Measures

The favourable features of the Project Site which would assist soil erosion and sediment control are:

- small catchment area;
- absence of perenniel watercourses;
- gentle slopes;
- stable soils; and
- dense groundcover.

However the Project Site is within the catchment of the Shoalhaven River which is part of the Sydney Water Catchment area. For that reason alone, it is imperative that sediment-laden runoff does not leave the Project Site.

Stage 1 of the proposed quarry includes the construction of a large dam in an existing drainage line on the southern boundary of the Project Site (Dam 7). All water from the proposed quarry would flow through this dam before leaving the Project Site. As such it is an ideal point for monitoring of water quality to determine whether soil conservation earthworks and revegetation in the catchment are satisfactory.

The main principle of soil conservation in quarry design is to separate the clean runoff from dirty runoff and treat the runoff accordingly. To this end, the areas of active extraction should be minimised and rehabilitation should be progressive through the life of the proposed quarry.

Areas which would generate dirty runoff should be isolated by the use of bund walls and contour banks to reduce the volume of sediment laden runoff.

Stockpiles should be created with batters not exceeding 3:1 and should be revegetated as soon as possible. Runoff from these areas should pass through temporary sediment control barriers (eg. Silt fence) to minimise the sediment flowing through the dams.

The gentle grade of the lower slopes near the southern boundary would allow runoff diversion to be modified frequently to meet the changing nature of the proposed quarry. Considering the low – moderate soil erodibility, grades of 1% in bare earth channels should be satisfactory for diversion banks without scouring.

The use of low cost products such as Jute Mesh would assist in pasture establishment in channels and also serve as a filter for sediment in runoff. However efforts should be made to establish a grass cover on all bare earth channels (and banks) even if it is only a short term (3 month) feature. Pasture seed is cheap and short term diversions/waterways/stockpiles have a habit of becoming long term features.

In conclusion, the Project Site does not provide technical difficulties in erosion control due to the favourable topography and soils. However, it is within a water catchment area and it is therefore essential that runoff flowing off the property is of good quality. Soil erosion and sediment control plans should be prepared for each stage and be approved prior to commencement.

8 SITE (LAND) CAPABILITY

8.1 Rural Land Capability

8.1.1 Methodology

The Department of Infrastructure, Planning and Natural Resources (DIPNR) uses an eight class system to map rural lands in New South Wales. It is based on an assessment of the biophysical characteristics of the land, the extent to which these would limit a particular type of land use, and the current technology that is available for land management.

The classification also incorporates an assessment of the soil erosion hazards, with emphasis on a 'safe' level of land use, thus avoiding environmental problems caused by soil erosion and sedimentation.

Ultimately, the land capability classes categorise the land in terms of its general limitations and outline the types of land use appropriate for a particular area of land and the types of land management practices needed to prevent soil erosion and maintain the productivity.

A brief summary of the classes is as follows.

- Classes I, II and III – land suitable for regular cultivation.
- Classes IV and V – land suitable for grazing and occasional cultivation.
- Class VI – land suitable for grazing with no cultivation.
- Class VII – land best protected by forest.
- Class VIII – land unsuitable for agriculture.

The land capability classification also provides a standard by which to judge rehabilitation work.

The advantage of this system is that it results in a reasonably uncomplicated map but one which indicates the suitability of each area for particular uses. It ignores the management preferences of previous land owners, although soil degradation and erosion due to over-utilisation in the past are taken into account in assessing the land's current ability to support various uses.

The land capability map provides a record of the condition of the land prior to quarrying. It has a secondary benefit as a planning tool in deciding what proportions of the disturbed area should be returned to various uses.

8.1.2 Mapping

A perusal of the relevant 1:25 000 land capability map indicates that the entire area to be disturbed by the proposed quarry has been mapped as Class IV land. While this is assessed as generally correct, it should be noted that land along the southern boundary of the Project Site has been affected by gully erosion in the past which has now been stabilised (see Section 5.3.2). As such, this land would be more accurately described as Class V. The eroded areas would be more fragile than the other grazing lands due to the historical soil erosion and this should be considered in the quarry design. For example, the old contour banks on the lower slopes are still serving a useful role in protecting the land below them and should not be removed until other banks have been constructed to reduce the length of overland flow.

Table 12 presents a summary of Class IV and Class V land, as identified on the Project Site.

Table 12
Rural Land Capability

Land Classification and Soil Conservation Practices				Interpretations and Implications
SUITABLE FOR GRAZING	Occasional Cultivation	IV	Soil conservation practices such as pasture improvement, stock control, application of fertiliser 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.
		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 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.

8.2 Agricultural Land Suitability

8.2.1 Methodology

Department of Primary Industries (Agriculture) (DPI (Agriculture)) uses a 5 class system to classify land in terms of its suitability for general agricultural use. This is a hierarchical system whereby Class I is the best agricultural land grading through to Class 5 land which is unsuitable for agriculture. Classes 1, 2 and 3 are generally grouped as prime crop and pasture land.

8.2.2 Mapping

Mapping has recently been undertaken for the Goulburn 1:100 000 sheet and it appears that the Project Site has been mapped as Class 4 land. A more accurate assessment would be that the basalt derived soils of soil units B, C and D on the gently sloping land are Class 3 while soil units A and E and the steeper lands are Class 4.

The essential characteristics of these classes are described as follows:

> ***Class 3****: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of edaphic or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.*

***Class 4**: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.*

9 CONCLUSION

A soil survey of the proposed "Ardmore Park" Quarry has been undertaken with emphasis on the proposed areas of soil disturbance. The soils have been classified into five soil units (A – E) based on soil type and underlying geology. The soils of the basalt and central sand extraction area are formed on basalt which has resulted in friable, naturally fertile loam topsoils overlying clay subsoils and weathered basalt. The soils were analysed at the Scone Research Centre for a range of parameters and an interpretation of the results has been prepared. The soils do not exhibit parameters which cause concern for quarry rehabilitation and revegetation. Soil salinity, extreme acidity and high dispersibility were not encountered.

The soils of the southern sand extraction area have a more coarse texture with sand deposits near the surface. As with the basalt derived soils, soil salinity, extreme acidity and high dispersibility was not encountered.

Soil landscape mapping recently prepared for the Sydney Catchment Authority was studied and the survey found to be consistent with that mapping.

The soil erodibility factor was calculated with the soils generally rated as "moderately" erodible. Existing soil erosion is minor due to soil conservation earthworks, conservative land use and natural soil fertility.

The suitability of the soil for rehabilitation has been considered. Recommendations have been made for earthmoving and stockpiling the different soil horizons. Soil conservation measures appropriate to the site have been discussed.

Land capability mapping prepared by DIPNR (formerly the Department of Land & Water Conservation) was studied as was land suitability mapping prepared by DPI (Agriculture).

It is concluded that the site does not create technical difficulties in erosion control and rehabilitation due to the favourable topography and soils. However, it is within a water catchment area and it is essential that runoff flowing off the property is of good quality. Soil erosion and sediment control plans should be prepared for each stage and be approved prior to commencement.

REFERENCES

Charman, P.E.V., Murphy, B.W., 2000 *Soils: their properties and management; 2nd ed*., Soil Conservation Service of NSW.

Emery, K.A., (undated) – Rural Land Capability Mapping, Scale 1: 100 000. Soil Conservation Service of New South Wales, Sydney.

Hannan, J.C., 1995 *Mine Rehabilitation - A handbook for the Coal Mining Industry*. NSW Minerals Council.

Hazelton, P.A. & Murphy, B.W., ed., 1992 What Do All the Numbers Mean? A Guide for the Interpretation of Soil Test Results. Dept Conservation & Land Management.

Houghton, P.D. and Charman, P.E.V., 1986 *Glossary of Terms used in Soil Conservation,* Soil Conservation Service of NSW, Sydney.

Appendix 1

Laboratory Analysis

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Department of Lands

Soil Services Division

SOIL TEST REPORT

Page 1 of 4

Scone Research Service Centre

REPORT NO:	SCO03/194R3
REPORT TO:	Peter Cowman Cowman Stoddart Pty Ltd PO Box 738 Nowra 2541
REPORT ON:	Nineteen soil samples Ardmore Park
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	13 October 2004
METHODS:	Information on test procedures can be obtained from Scone Research Service Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED.
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL.

G. Holman
(Technical Officer)

Gundy Road Scone NSW 2337 P.O. Box 283 Scone NSW 2337 DX 4206
Telephone (02) 65451666 Facsimile (02)65452520

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No.: SCO03/194R3
Client Reference: Peter Cowman
Cowman Stoddart Pty Ltd
PO Box 738
Nowra 2541

Lab No	Method	P7B/1 Particle Size Analysis (%)						P8A/2	P9B/2	P7C/1 Particle Size Analysis – mechanical dispersion (%)					
	Sample Id.	clay	silt	vf sand	cf sand	c sand	gravel	D (%)	EAT	clay	silt	vf sand	cf sand	c sand	gravel
1	Area 1 A1	8	9	29	21	32	1	0	8/3(1)	4	1	33	31	30	1
2	Area 1 A2	13	7	15	12	19	34	25	3(1)	10	4	16	16	20	34
3	Area 1 B	66	5	6	4	19	<1	6	5	30	23	18	8	21	<1
9	Area 3 A	23	30	21	8	18	nt	6	8/3(1)	17	28	25	11	19	nt
10	Area 3 B1	64	18	9	4	4	1	12	5	28	12	28	12	19	1
11	Area 3 B2	10	9	14	5	34	28	22	5	10	7	17	8	30	28
12	Area 4 A	42	30	17	6	4	1	4	8/3(1)	25	25	23	9	17	1
13	Area 4 B1	66	16	9	5	4	0	22	3(2)	38	16	21	14	11	0
14	Area 4 B2	24	18	13	5	40	0	14	5	15	16	19	10	40	0

nt = not tested

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

SCO03/194R3
Peter Cowman
Cowman Stoddart Pty Ltd
PO Box 738
Nowra 2541

Lab No	Method	C6A/2	P2B/2	P3A/1	P13A/3
	Sample Id.	OC (%)	LL (%)	PL (%)	USCS
1	Area 1 A1	5.21	39	34	SC
2	Area 1 A2	1.30	20	15	GC-SC
3	Area 1 B	0.72	74	29	CH
9	Area 3 A	2.46	nt	nt	nt
10	Area 3 B1	1.18	nt	nt	nt
11	Area 3 B2	0.40	nt	nt	nt
12	Area 4 A	3.90	64	34	CH
13	Area 4 B1	1.80	99	36	CH
14	Area 4 B2	0.86	59	33	CH

nt = not tested

SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No.: SCO03/194R3
Client Reference: Peter Cowman
Cowman Stoddart Pty Ltd
PO Box 738
Nowra 2541

Lab No	Method	C1A/4	C2A/3	C5A/3 CEC & exch. cations (me/100g)						C8A/2	C8B/1		P9B/2	
	Sample Id.	EC (dS/m)	pH	CEC	Na	K	Ca	Mg	Al	P (mg/kg)	P sorp (mg/kg)	P sorp index	EAT	Texture
1	Area 1 A1	0.15	5.5	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	loamy sand
2	Area 1 A2	0.08	5.2	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	sandy loam
3	Area 1 B	0.11	4.7	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt	medium clay
4	Area 2 A1	0.15	5.3	7.2	0.2	0.3	3.1	1.0	0.5	37	nt	nt	8/3(1)	sandy loam
5	Area 2 A2	0.05	6.0	4.6	0.2	0.1	1.9	0.9	0	nt	95	1.0	3(1)	sandy loam
6	Area 2A B1	0.11	6.8	16.0	2.1	0.1	0.5	8.8	0	nt	578	3.8	2(1)	medium clay
7	Area 2 B2	0.06	7.7	26.0	1.6	0.1	9.5	10.9	0	nt	277	2.3	2(3)	medium clay
9	Area 3 A	0.11	6.0	30.0	0.5	1.0	16.6	7.8	0	9	nt	nt	8/3(1)	light clay
10	Area 3 B1	0.08	6.5	nt	nt	nt	nt	nt	nt	nt	nt	nt	5	clay loam
11	Area 3 B2	0.07	7.3	nt	nt	nt	nt	nt	nt	nt	nt	nt	5	sandy loam
17	Area 5B A	0.08	5.9	38.9	0.8	0.6	21.3	12.4	0	6	nt	nt	8/3(1)	heavy clay
18	Area 5B B1	0.06	7.3	34.8	0.5	0.2	18.9	13.2	0	nt	295	2.4	3(1)	heavy clay
19	Area 5B B2	0.06	8.3	53.9	2.2	0.1	25.3	22.8	0	nt	406	2.9	3(1)	heavy clay

nt = not tested

END OF TEST REPORT

Department of Lands

Peter Cowman
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Nowra 2541

Scone Research Service Centre
Gundy Road Scone NSW 2337
P O Box 283 Scone NSW 2337
Tel: (02) 6545 1666
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6 August 2004

Lab No: SCO03/194

Dear Mr Cowman

Analysis of fourteen soil samples – Ardmore Park

The soil erodibility factor (K) has been determined for 6 soil samples analysed at the Scone Research Service Centre (SCO03/194R1). The soil erodibility factor was determined and rated according to Rosewell (1993). The surface soil structure (SS) was assumed to be medium or coarse granular and the profile permeability (PP) was assumed to be slow.

Lab. No.	Sample Id.	Soil Erodibility Factor	
		K	Rating
1	Area 1 A1	0.019	low
2	Area 1 A2	0.032	moderate
3	Area 1 B	0.037	moderate
12	Area 4 A	0.027	moderate
13	Area 4 B1	0.027	moderate
14	Area 4 B2	0.037	moderate

This interpretation is based on the sample supplied being representative and literature guidelines. If you have any queries please contact me on (02) 65451666.

Yours sincerely
SR Young
SR Young
Laboratory Manager - Soil Services

Reference:

Rosewell, CJ (1993) SOILOSS A program to assist in the selection of management practices to reduce erosion. Department of Land and Water Conservation, Gunnedah.

Department of Lands

Soil Services Division

Page 1 of 1

Peter Cowman
Cowman Stoddart Pty Ltd
PO Box 738
Nowra 2541

Our Ref: SCO03/194R2

Ardmore Park

Lab No	Sample Id	Soil Erodibility Factor	
		K	Rating
9	Area 3 A	0.038	moderate
10	Area 3 B1	0.032	moderate
11	Area 3 B2	0.027	moderate

This interpretation is based on the sample supplied being representative and literature guidelines.

G. Holman
(Technical Officer)

1 October 2004

Reference:
Rosewell, C J (1993) SOILOSS A program to assist in the selection of management practices to reduce erosion. Department of Land and Water Conservation, Gunnedah

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Department of Lands

Soil Services Division

SOIL TEST REPORT

Scone Research Service Centre

REPORT NO:	SCO04/269R1
REPORT TO:	Peter Cowman Cowman Stoddart Pty Ltd PO Box 738 Nowra 2541
REPORT ON:	Four soil samples Ardmore Park
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	11 November 2004
METHODS:	Information on test procedures can be obtained from Scone Research Service Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED

G Holman
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SOIL AND WATER TESTING LABORATORY
Scone Research Service Centre

Report No: SCO04/269
Client Reference: Peter Cowman
Cowman Stoddart Pty Ltd
PO Box 738
Nowra 2541

Lab No	Method	C1A/4	C2A/3	P9B/2	
	Sample Id	EC (dS/m)	pH	EAT	Texture
1	Ardmore Park Site 6 A	0.08	5.5	3(1)	clay loam
2	Ardmore Park Site 6 B	0.05	6.6	5	medium clay
3	Ardmore Park Site 7 A	0.07	5.8	8/3(1)	sandy loam
4	Ardmore Park Site 7 B	0.05	6.0	3(1)	sandy loam

END OF TEST REPORT