# Wandoan Coal Project Geology, mineral resources, overburden and soils impact assessment

November, 2008

Wandoan Joint Venture

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# Glossary

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| A horizon | See topsoil. |
| Acid generating potential | Potential of spoil material to form acid conditions when oxidised (i.e. contact with air). |
| Alluvium | Any stream laid sediment deposit found in a stream channel and in low parts of a stream valley subject to flooding. |
| Anthropogenic | Caused or influenced by humans. |
| Australian Height Datum (AHD) | A level datum, uniform throughout Australia, based on an origin determined from observations of mean sea level at tide gauge stations, located at more than 30 points along the Australian coastline. |
| Borehole | A hole produced in the ground by drilling or driving. |
| Bushland | A functional, multi layered, semi-natural plant community including a permanent tree layer, natural or established (e. g. on spoil). The area would be capable of sustaining flora and fauna habitats. |
| California bearing ratio (CBR) | A measure of the bearing capacity of a soil obtained from a standard soil penetration resistance test. |
| CHPP | Coal handling and preparation plant |
| Chromosol | Soils with strong texture contrast between A horizons and B horizons, in which the B horizons are not strongly acid and are not sodic, as defined by Isbell (1998). |
| Clay | Particles with a diameter less than 0.002 mm (McDonald *et al.*1998). |
| Competent spoil | Non acid, non dispersive durable spoil with potential characteristics to resist erosion. |
| Competent rock | Rock that is considered suitable for the intended use. |
| Cover material | Soil or other suitable plant growth medium placed on reshaped spoil surfaces; typically non crusting and low salinity. |
| Dermosol | Soil with a structured B2 horizon and lacking strong texture contrast between the A and B horizons, as defined by Isbell (1998). |
| Diversions/diversion channels | Structures for the controlled re-direction of drainage lines and watercourses around open cut pits and infrastructure areas. |
| DTPA | Diethylene triamine pentaacetic acid. A chemical used for the extraction of metal ions during chemical analysis. |
| Dyke | Sheet-like igneous intrusion cross cutting bedding planes, commonly sub-vertical. |
| EC | Electrical conductivity, a measure of the dissolved salts in a substance. |
| Erosional stability | The ability of a rehabilitated area to resist the natural forces of soil erosion. |
| Externally drained | Rainfall runoff water that reports to the external environment of a structure via local drainage systems. |
| Feldspar | A group of abundant rock forming minerals of the general formula MAI (Al, $Si)_3O_8$, where M can be potassium (K), sodium (Na), calcium (Ca), barium (Ba), rubidium (Rb), strontium (Sr) or iron (Fe). |
| FoS | Factor of Safety |
| Functional vegetation | Vegetation that consists of species able to survive and regenerate under specific conditions, providing soil erosion control and fauna habitat. |
| Geochemistry | The chemical characteristics of a soil or rock material. |
| Geomorphology | Study of the characteristics, origin and development of land forms and the processes that act on them. |
| Geotechnical stability | Resistance of a natural slope or earth structures to mass movement and erosion. |

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| Gilgai | The phenomena of an irregular land surface with mounds and depressions formed due to clay horizons shrinking and swelling with alternate drying and wetting cycles. |
| Graded banks | Cross slope earthen banks constructed on reshaped spoil areas, typically at horizontal intervals of approximately 50 m and 1 to 1.5% longitudinal gradient, to reduce the effective slope length and control the runoff flow rate. |
| Holocene | The most recent epoch of geological time. |
| Hostile spoil | Acid, sodic or saline spoil deleterious to seed emergence, geotechnical and geochemical stability of spoil. |
| Incident register | A database of environmental incidents, causes and remedial actions. |
| Internal drainage | Drainage of rainfall runoff from reshaped spoil areas confined and ponded within the spoil area. |
| Leaching profile | Vertical change in chemical concentrations down the soil profile due to leaching. |
| MLA | Mine Lease Application |
| NATA | National Association of Testing Authorities Australia |
| Overburden | The soil or other mineral matter which has to be removed to gain access to the underlying material. |
| PAWC | Plant available water capacity. |
| Plan | Set of actions required to ensure the achievement of a stated objective/program. |
| Plant growth medium | Material which is typically non crusting and has low salinity levels, in which plant seed will germinate and establish. |
| Policy | Stated commitment to achieving objectives. |
| Program | Management supported work commitment, budget and time frame to achieve a stated objective. |
| Quaternary | The geological period of time from the present to two million years ago. |
| Refuse dump | Site to be used for the permanent placement of waste. |
| Rehabilitation | Reshaping of a disturbed area to a geotechnically and geochemically stable condition, followed by revegetation. |
| Regulated waste | Non-domestic waste as defined in Schedule 7 of the *Environment Protection (Waste) Regulation 1998*, (whether treated or immobilised) and includes:<br>▪ for an element — any chemical compound containing the element<br>▪ anything that has contained the waste. |
| Regional ecosystems | A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil, As defined by Sattler & Williams (1999) in *The Conservation Status of Queensland's Bioregional Ecosystems*. |
| Revegetation | Establishment of suitable plant species to support the agreed post mining land use and control soil erosion to sustainable levels. |
| Rock mulch | Durable or competent rock purposely placed on an area under rehabilitation to provide additional resistance to erosion. |
| Sand | Natural mineral particles with a diameter between 0.02 mm to 2.0 mm (McDonald *et al.*1998) |
| Saline | Presence of salts, in water or spoil, generally undrinkable or in sufficient concentration to impair plant growth. |
| Sediment dams | Large impoundment structures used to retain rainfall runoff to allow settlement of suspended particles, prior to discharge. |
| Sill | Sheet-like igneous intrusion within coal seams or along bedding planes. |
| Silt | Mineral particles with a diameter between 0.002 mm to 0.02 mm (McDonald *et al.*1998) |

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| Silt traps | Small impoundment structures built within a drainage line, which retard water flow and allow suspended solids to settle out. |
| Sodic | A soil is considered sodic when the exchangeable sodium percent (ESP) is greater than six. Sodic conditions usually result in clay dispersion and surface crust formation. |
| Sodosol | Soils with a strong texture contrast between A horizons and sodic B horizons with are not strongly acid, as defined by Isbell (1998). |
| Soil | That part of the upper weathered layer of the earth's crust which can support plant growth |
| Soil horizons | Soil horizons as defined by McDonald *et al.* (1998) are:<br>O — surface layer dominated by organic material in varying stages of decomposition<br>A — one or more surface mineral horizons with some organic accumulation<br>A1 — mineral horizon at or near the surface with some accumulation of humified organic matter. It is usually darker than underlying horizons<br>A2 — mineral horizon having less organic matter, sesquioxides and/or silicate clay than immediately adjacent horizons. It is usually paler in colour than the A1 or B horizon.<br>A3 — transition horizon between the A and B horizons, which is similar to the A horizon<br>B — one or more mineral soil layers characterised by a concentration of silicate clay, iron, aluminium and/or organic material; and/or a differing structure, consistence or colour of the A horizon.<br>B1 — transitional horizon between the A and B horizon which is similar to the B horizon<br>B2 — horizon dominated by an illuvial, residual or other concentration of silicate clay, iron, aluminium and/or humus, and/or maximum development of pedological organisation.<br>B3 — transitional horizon between the B and C horizon which is similar to the B horizon<br>C — consolidated and unconsolidated material below the A and B horizon. Usually partially weathered and little affected by pedological processes. |
| Spoil area | Area where overburden has been dumped. |
| Sump | Temporary excavation for the storage of water. |
| Subsoil | The B horizon within the soil profile which lies immediately below the topsoil or A horizon. The subsoil is not enriched with organic material as is the topsoil. It may also be subject to clay and/or salt accumulation. |
| Suitably qualified person | A person whose professional training or experience is relevant to the matter being considered (EPA 2007) |
| t | Tonne |
| Tension cracks | Cracks at the ground surface which occur due to tensional forces in the soil or rock mass. |
| Test pit | An excavation for examination of subsurface soil conditions |
| Topsoil | The uppermost horizon (or A horizon) of the soil profile which usually contains the organic matter, biota and a concentration of the nutrients. |
| Exploration track | Temporary vehicle traffic route used for exploration or infrequent access from which topsoil has not been removed. |
| Vertosol | Clay soil with shrink swell properties as defined by Isbell (1998) |
| Waters | River, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, bed and bank of any waters, dams, non-tidal or tidal waters or any part-thereof. |

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| Wetland | Area where natural flow has been permanently interrupted and will remain as a feature of the landform after mining. |
| WJV | Wandoan Joint Venture |

# Executive summary

This geology, mineral resources, overburden and soils assessment was undertaken to assess and define the existing land-related site characteristics that may impact on or be impacted by the Wandoan Coal Project (the Project), to assess the soil and overburden management requirements and reuse potential.

The soils, overburden, and land suitability assessment comprised a review of available published data, field investigation, laboratory testing, classification and mapping of soils, and a land suitability assessment. A laboratory testing program was carried out to determine chemical and physical characteristics of soils and overburden relevant for land suitability assessment, construction design and rehabilitation.

The Project area is located in an area mainly underlain by the Jurassic age Injune Creek Group rocks and Tertiary to Quaternary alluvium and consists of two land resource areas (LRA), Brigalow Uplands and Poplar Box Alluvia. The Brigalow Uplands LRA consists of undulating hills at a surface elevation (RL) of approximately 250 m to 295 m Australian height datum (AHD) with slope gradients generally less than 4%. The Poplar Box Alluvia LRA consists of alluvial floodplains of the various creeks that traverse the Project area, with an RL of approximately 230 m to 250 m and a slope of less than 2%, and a typical floodplain width of between 500 m and 2 km.

Eight soils were identified within the Project area, including cracking and non-cracking clays on the undulating hills and uniform and texture contrast soils on the floodplain. Subsoils over much of the project area are alkaline, sodic and dispersive and will require specific management techniques such as minimising exposure to prevent erosion, including tunnel erosion. Soils identified as most susceptible to erosion include Cheshire, Woleebee and Teviot.

It is anticipated that most topsoil from the proposed disturbance area will be recovered and made available for use in rehabilitation of disturbed areas. Limited topsoil depths will be available for stripping due to rockiness in some soils, and slope gradient may impact the ease of stripping on steeper slopes.

Based on the former Taroom Council Planning Scheme (2006) and the results of the field investigations, the undulating hills within the Project area are classed as good quality agricultural land (QGAL).

A land suitability assessment for dry land cropping, and beef cattle grazing was carried out for the project area. Comparisons of pre and post mine land suitability classes indicate a reduction in Class 3 dry land cropping and Class 2 beef cattle grazing. Large portions of the disturbed areas, including infrastructure areas and spoil piles, are anticipated to be rehabilitated to Class 3 beef cattle grazing, which is equivalent to Class C QGAL.

# 1. Introduction

## 1.1 Project background

The Wandoan Coal Project (the Project) comprises the development of thermal coal resources situated immediately west of the Wandoan township, located in the Dalby Regional Council local government area. The Project is located approximately 350 km northwest of Brisbane and 60 km south of Taroom as shown in Figure 1-1. The coal reserves for this Project are covered by three Mineral Development Licences (MDLs 221, 222 and 223). Three mining lease applications (MLAs 50229, 50230 and 50231), have been made to the government covering the MDLs and surrounds, as shown in Figure 1-2. The coal resources are proposed to be developed as an open cut mine with related infrastructure. The mining of the coal resources will be undertaken using a combination of truck, shovel, dozer and dragline mining equipment. Coal will be mined at a rate of around 30 million tonnes per annum (Mtpa) run of mine (ROM) coal. The coal will be crushed, sized and washed before being transported by rail to port facilities in the Gladstone area.

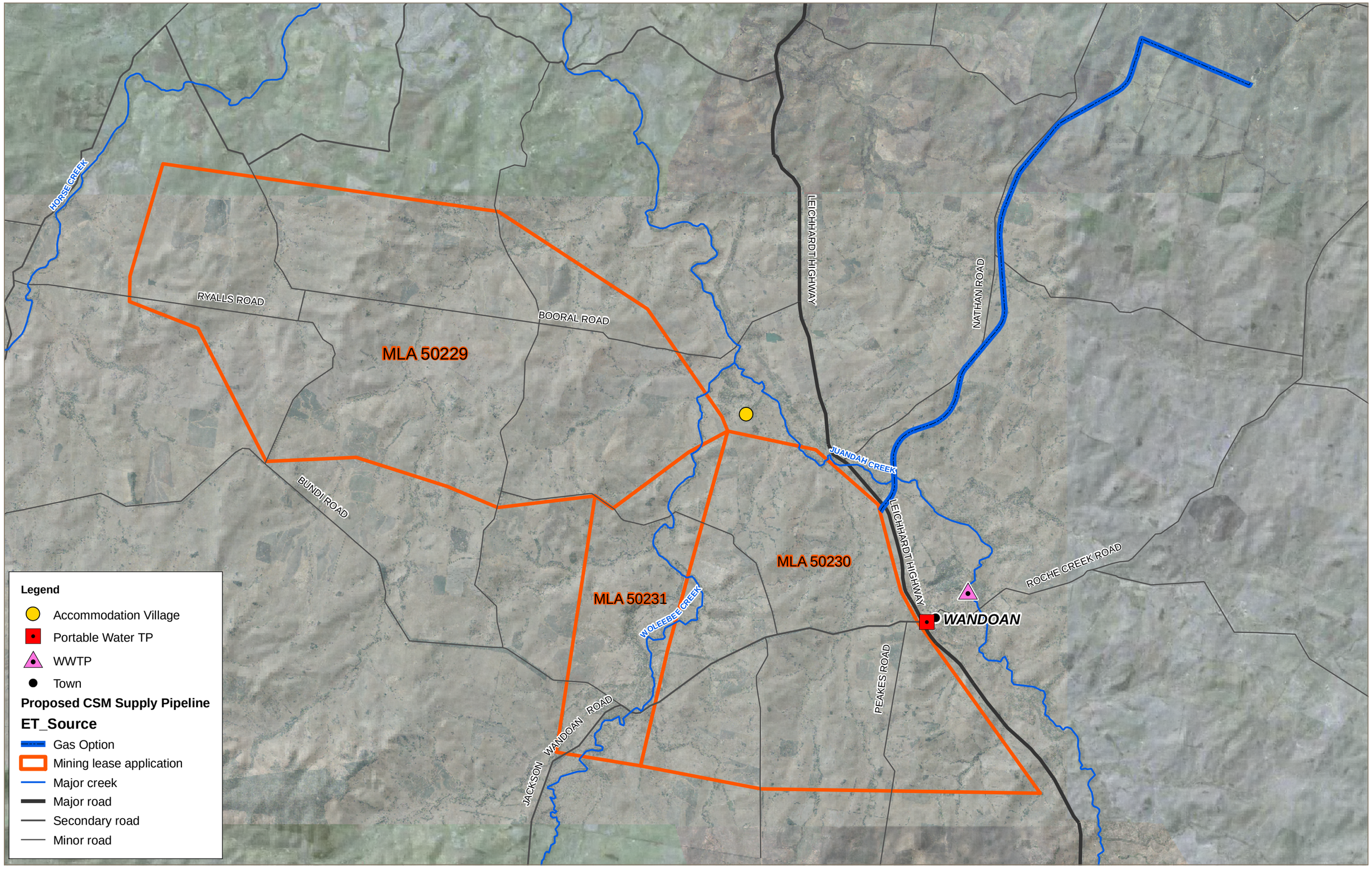
The Project will be developed by the Wandoan Joint Venture (WJV). The joint venture partners are Xstrata Coal Queensland Pty Ltd (XCQ), ICRA RPW Pty Ltd and Sumisho Coal Australia Pty Ltd.

The Project was declared a significant project for which an EIS is required by the Coordinator-General in December 2007.

## 1.2 Description of study area

The study area for this geology, mineral resources, overburden and soils assessment includes the three mining lease applications and the footprint of off-lease infrastructure including accommodation facilities proposed to house the majority of the workforce, waste water treatment plant, potable water treatment plant and coal seam methane gas supply pipeline (refer Figure 1-2).

The study area is located in a landscape that has been highly modified by past land uses particularly agriculture (i.e. grazing and cropping). Vegetation in the local area is therefore highly fragmented and relictual (i.e. <10% retained). The hydrology on the Project area is dominated by a number of ephemeral creeks flowing north into Juandah Creek and into the Dawson River further downstream.




J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 1-2 Project Area.mxd

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006)

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0 1 2 3 4 5
Kilometers

Figure 1-2
Project Area

# 2. Methodology of assessment

## 2.1 Relevant legislation and guidelines

### 2.1.1 State planning policy 1/92: Development and conservation of agricultural land 1992

State planning policy 1/92 is based on the principle that land suitable for agricultural purposes is limited in Queensland, and that suitable 'good quality' land should be protected for agricultural uses.

The state planning policy makes allowances for developments on high quality agricultural land where the project provides an overriding public benefit and there are no other suitable sites for the purpose.

The state planning policy 1/92 is largely implemented at the local government level, and requires local governments to include maps of good quality agricultural land (GQAL) in their planning schemes.

### 2.1.2 Planning guidelines: The identification of good quality agricultural land, 1993

The planning guidelines assists in the implementation of state planning policy 1/92, through the provision of a methodology for assessing and identifying agricultural land classes and subsequently GQAL.

Under the planning guidelines, land is classified into classes, ranging from Class A being cropping land with moderate to no production limitations, to Class D being land not suitable for agriculture due to extreme limitations. Which agricultural land classes are considered GQAL within each local government areas was established during the preparation of the planning guidelines in 1993, based on publicly available land resource mapping such as Department of Primary Industries manuals and CSIRO reports. The planning guidelines acknowledge that much of this mapping is at a broad scale, and that site-specific assessments may be needed to confirm the distribution of QGAL.

### 2.1.3 Environmental Protection (Water) Policy 1997

The Environmental Protection (Water) Policy (EPP (Water)) is a policy under the *Environmental Protection Act 1994*. The policy defines and protects environmental values of Queensland waterways.

Under Section 32 of the EPP (Water) it is an offence to allow sand, silt or mud to accumulate in a waterway or where it could wash into a waterway unless it is permitted by an Environmental Authority.

### 2.1.4 Land suitability classification for cropping and grazing in the semi-arid sub-tropics of Queensland

The land suitability classification system used in this assessment was produced by the Department of Mines and Energy in 1995, and provides a framework for the assessment of the suitability of land for cropping and grazing purposes, based on a range of soil and landscape characteristics. The guidelines were prepared for use in relation to mining and exploration projects for the assessment of pre-disturbance and post-disturbance land capability, but have now been widely adopted as a tool to assess land use potential relating to a range of infrastructure projects.

### 2.1.5 Draft guidelines for the assessment and management of contaminated land in Queensland

The draft guidelines for the assessment and management of contaminated land in Queensland were prepared to assist in the implementation of the *Environmental Protection Act 1994.* The draft guidelines contain trigger values for various contaminants including heavy metal concentrations that may indicate a hazard to human or environmental health, and above which site specific investigations are required.

### 2.1.6 Guideline 18 Rehabilitation requirements for mining projects (EPA 2008)

Guideline 18 was developed by the Environmental Protection Agency (EPA) to assist mining companies to establish rehabilitation outcomes and strategies, for the planning, operational and final rehabilitation stages of a mine. The guideline outlines rehabilitation goals, objectives and outcomes that are likely to be satisfactory to the EPA, and how the EPA accesses whether rehabilitation strategies are satisfactory.

## 2.2 How the study was conducted and information obtained

The soils, overburden, and land suitability assessment comprised a review of available published data, field investigation, laboratory testing, classification and mapping of soils, and a land suitability assessment. A laboratory testing program was carried out to determine chemical and physical characteristics of soil and overburden relevant to:

- characterisation of soil types
- land suitability assessment
- available topsoil types and suggested stripping depths
- erosion potential of various topsoil, subsoil and overburden materials
- acid generation potential and heavy metal content of overburden materials
- suitability of overburden for use as a capping layer and growth medium.

### 2.2.1 Review of existing information

Previous investigations that provided information for this report regarding soil, overburden and landscape characteristics include:

- Slater, B, Bell, L and Whiteman, P (1980). Wandoan Coal — Resources for Land Rehabilitation. Progress report on the Research for Brigalow Mines Pty Ltd. University of Queensland Department of Agriculture
- Slater, B, Bell, L and Whiteman, P (1983). Land Evaluation of Potential Coal Mine Areas at Wandoan, Queensland. University of Queensland Department of Agriculture
- Gray, H.J and Macnish, S.E (1985) Land Management Field Manual Wandoan District
- Forster, B.A (1985). Evaluation of Agricultural Land in Taroom Shire
- CSR Coal Division (1986). An Assessment of Overburden Rehabilitation Properties of the Wandoan Coal Project
- Slater, B (1986). Edaphic Properties of Soil and Overburden from a Potential Coal Mine near Wandoan, Queensland. University of Queensland Department of Agriculture
- Godfrey, N (1992). EPC 157 Wandoan March 1992 Drilling Program Slake Testing Report
- Envirosciences Pty Limited (1992). Land Capability and Use. Austinvale and Frank Creek Coal Deposit Areas, Wandoan. MIM Holdings Limited
- MIM Holdings Limited (1997). Consideration of Rehabilitation Strategies Associated with the Austinvale Coal Deposit, Wandoan, Queensland
- Golders Associates 2008 Pty Ltd, Report on Geotechnical Evaluation for Open Pit Mining, Wandoan Coal Project, Wandoan, Queensland (Draft).


### 2.2.2 Field assessment

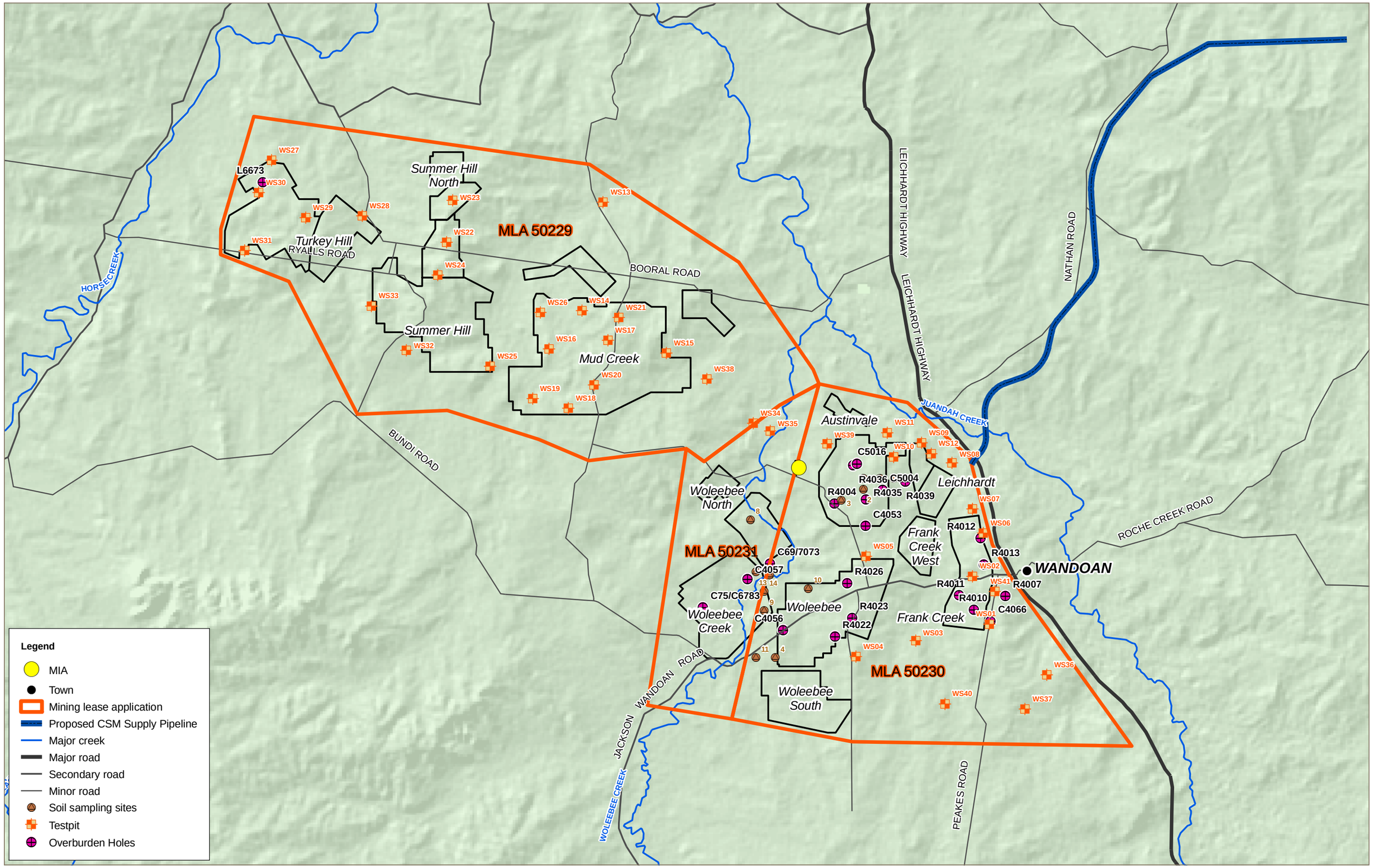
The field work for the soils and land resources investigation was undertaken from 23 to 28 July 2007 and comprised:

- excavation and sampling of 41 test pits within the MLAs (numbered WS01 to WS41)
- walk-over survey.

The field work for the overburden investigation was undertaken in April 2008, and comprised drilling and sampling of rock cores from four boreholes that were drilled as part of the wider exploration activities.

#### Soil test pits

Locations of test pits were selected based on existing soil mapping, geological and topographic features of the landscape and proposed layout of the mining operations. The locations were selected to allow sampling of various soils within the landscape features and at multiple positions in the landscape. These locations are shown on Figure 2-1.




J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 2-1 Test Pit and test bore locations .mxd

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006)

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0 1 2 3 4 5
Kilometers

Figure 2-1-V1.3:
Figure 2-1 Test pit and test bore locations

Test pits WS01 to WS38 and WS40 were excavated using a Caterpillar backhoe using a 0.45 m wide bucket. Test pits WS39 and WS41 were excavated by hand shovel.

All test pits were excavated to between 0.4 m and 2.3 m in depth. Selected disturbed samples of surface and subsurface soils were obtained at regular intervals or at a change of strata for material identification and laboratory testing purposes.

Locations of test pits were surveyed by use of a Garmin hand held GPS unit and checked against site features and map readings. The accuracy of this surveying method is considered to be within approximately 7 m in plan.

Test pit log records are attached in Attachment A, together with a set of explanatory notes, which define the terms and symbols used in their preparation. Topsoil (A1 and A2) consistency descriptions used in this report are in accordance with those used in Australian Soil and Land Survey, Field Handbook (McDonald *et al*. 1990).

#### Overburden boreholes

Locations of boreholes were selected based on existing exploration data and on location of proposed mining infrastructure and elements. These locations are shown on Figure 2-2.

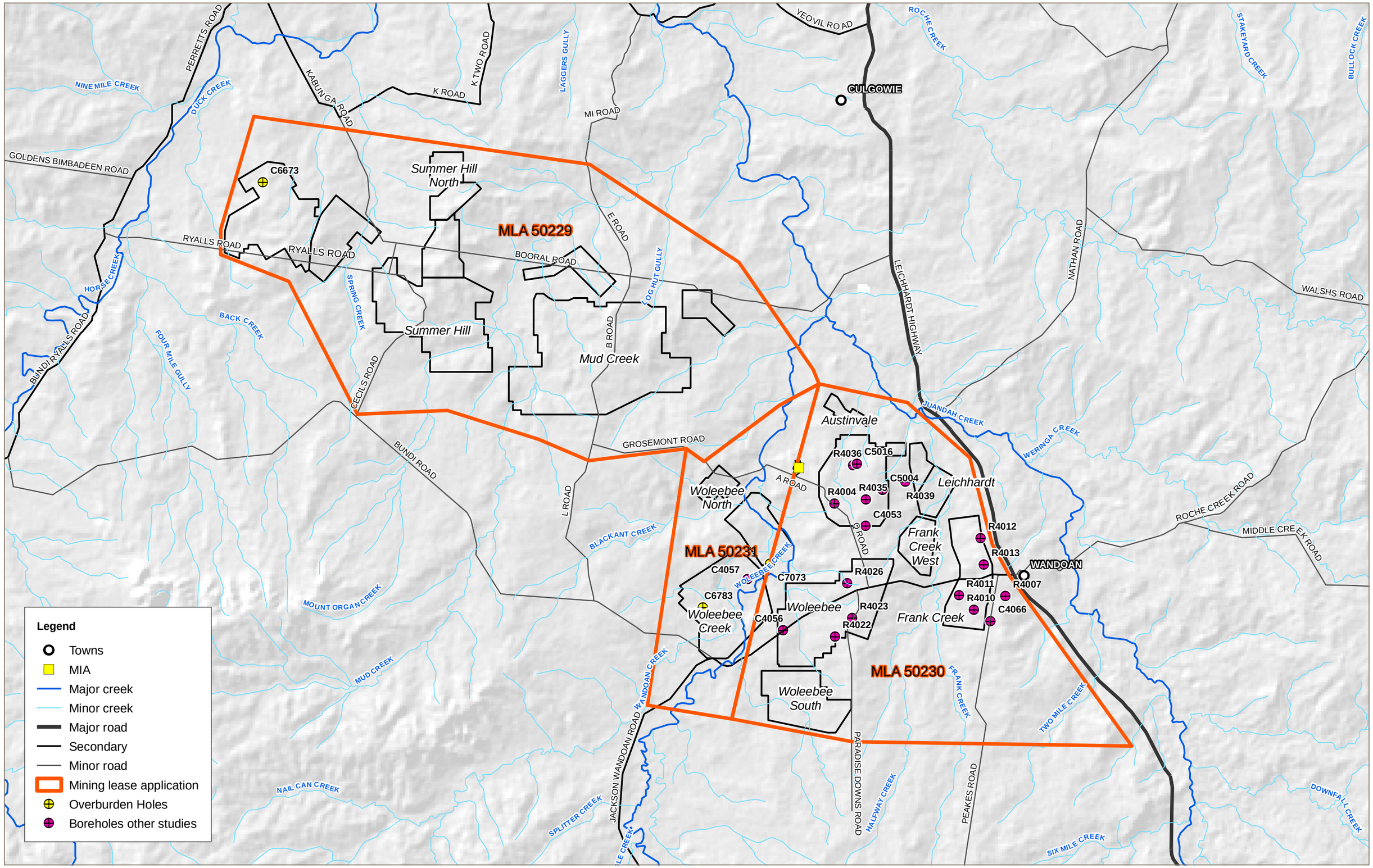
Boreholes were drilled to between 39 m and 112 m in depth as a component of the mine geotechnical and exploration investigation program. Fifteen samples of overburden and interburden were obtained from selected depths from the four boreholes for material identification and laboratory testing purposes. Borehole logs are shown in Attachment B.

### 2.2.3 Laboratory testing

Selected rock and near-surface soil samples were tested in a NATA registered laboratory for physical and chemical properties to aid delineation of individual soil types, to assess suitability of soils for future rehabilitation purposes, and to assess overburden and interburden properties relevant to mine spoil stockpile management and rehabilitation.

The method used for each analysis is included in brackets below:

- Emerson class number, (Australian Standard AS 1289. 3.8.1-2006)
- exchangeable sodium percentage (ESP) — ESP is a measure of the sodicity of soils. Chemically exchangeable sodium can weaken the bonds between and within clay particles thus acting as a dispersing agent. Soils with an ESP of more than 15% are considered dispersive and soils with an ESP less than 5% are commonly considered as non-dispersive. (Australian Laboratory Services ‘in-house’ methods) ESP is calculated after determination of major cations, such as sodium, potassium, calcium and magnesium.
- cation exchange capacity (CEC) — the soil’s capacity to hold nutrients is estimated by CEC. Low values (below five) indicate the soil has low fertility and prone to leaching and therefore is likely to be a poor growth medium requiring nutrient application (Australian Laboratory Services ‘in-house’ methods)
- conductivity (EC), pH, sulfate as $SO_4$, chloride, total nitrogen, total phosphorous, organic carbon, water soluble nitrogen, DTPA soluble iron, manganese, copper and zinc content (Australian Laboratory Services ‘in-house’ methods)




J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 2-1 Test Pit and test bore locations .mxd

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006)

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0 1 2 3 4 5
Kilometers

Figure 2-2
Bore hole locations

- net acid generation at pH7 (NAG); pH after oxidation; Acid production potential (APP); Acid neutralising capacity (ANC); Net acid producing potential (NAPP) (Miller (1998), US EPA 600/2-78/054, and Coastech Research methods)
- heavy metals — arsenic, cadmium, chromium, copper, lead, nickel, zinc (US EPA, SW 846, Method 6010).

Detailed laboratory test result sheets are attached in Attachment C.

### 2.2.4 Soil mapping and classification

Classification of soils for the Project area was based on field observations, laboratory analytical data, aerial photography, the findings of geotechnical investigations (PB 2008), and published soil classification data as listed in Section 2.2.1 of this report. Mapping included reference to soil profiles published in Slater (1986) and Gray and Macnish (1985). Soil log profiles within the Project area from Slater 1986 are included in Attachment D.

The adopted soil classification system is based on the Australian Soils Classification (Isbell 1996). Where soil descriptions correlate with soil types in the references in Section 2.2.1, soil names from these references have been adopted.

### 2.2.5 Overburden assessment

Findings from the overburden laboratory analysis and previous investigations (e.g. CSR Coal Division 1986, Godfrey 1992, Slater 1986) were assessed in relation to the potential for acid mine drainage, heavy metal contamination and erosion.

The potential for acid drainage was based on the requirements of the *Assessment and Management of Acid Drainage* (Department of Mines and Energy 1995b).

Heavy metal concentrations within the overburden were assessed against the *Draft Guidelines for the Assessment of Contaminated Land in Queensland* for environmental investigation levels and health-based investigation levels (Department of the Environment 1998).

### 2.2.6 Land suitability assessment

A land suitability assessment was carried out over the Project area based on the requirements of the *Attachment 2 of Land Suitability Assessment Techniques* (Department of Mines and Energy 1995a). The Project area was assessed for its suitability for various uses including dry-land cropping and cattle grazing on improved pasture. The criteria used for assessing the suitability of land for specific agricultural uses are included in Attachment E. The land was then classified into one of five land suitability classes for each potential land use assessed, relating to the land use limitations.

The land classes are shown below:

- Class 1 — suitable land with negligible limitations and is highly productive requiring only simple management practices
- Class 2 — suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use

- Class 3 — suitable land with moderate limitations — land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use
- Class 4 — marginal land with severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long-term
- Class 5 — unsuitable land with extreme limitations that preclude its use.

The findings of the land suitability assessment were then assessed against the GQAL mapping under the former Taroom Shire Council Planning Scheme (Taroom Shire Council 2006) to assess the accuracy of the GQAL mapping.

A land suitability assessment was then conducted on the proposed final landform. However, developments in mine rehabilitation techniques, changes in legislative requirements and other developments not foreseen in this report could influence the proportion of various land suitability classes that can be achieved through rehabilitation over the life of the Project.

## 2.3 Limitations

The assessment has been based on the excavation of 41 test pits and four boreholes, field observations, and review of existing information (including 13 test pits and five boreholes reported by Slater (1986), three boreholes reported by Godfrey (1992), four boreholes by MIM Mining (1997) and 22 boreholes reported by CSR coal division within the current Project area).

Soils have been classified into broad soil types. Soils are not discrete units, and variation of properties will occur within each of these soil types. The scale of mapping also will not identify small isolated occurrences of difference soils within each mapped unit.

Boundaries between soil units have been assigned based on test pit profiles and landscape features such as topography, gradient and drainage lines. Soil boundaries are not discrete, and may grade between soil types over a distance of a few hundred metres, in these areas soils could display properties of all adjacent soil types.

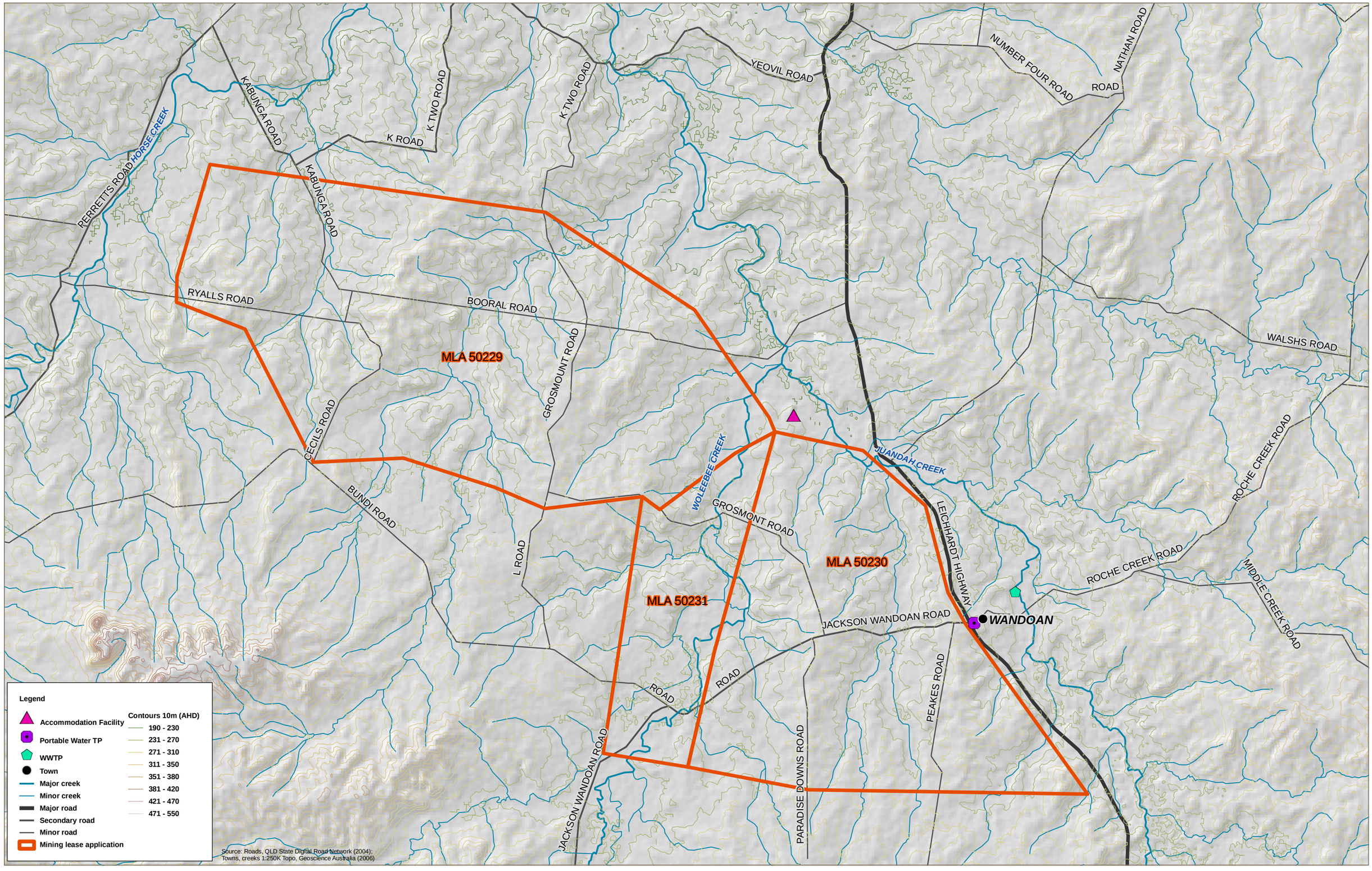
The overburden assessment has been conducted to provide a broad overview of overburden properties within the Project area to identify potential risk during operation and rehabilitation of the mine. The assessment does not detail the horizontal or vertical distribution of overburden substrates (e.g. siltstone, mudstone), and does not differentiate the properties of individual substrates. Ongoing assessment work during the operational phase of the Project, such as overburden sampling and testing for material characterisation will be required to adequately delineate various overburden units which may occur locally and may require different management techniques.

# 3. Existing environment

## 3.1 Topography

The contour map of the Project area is shown on Figure 3-1. Two main terrain elements were identified in the Project area:

- alluvial floodplains of Woleebee Creek, Juandah Creek, Frank Creek, Mud Creek, Spring Creek, and their tributaries (refer Photo 3-1). These floodplains vary in width from less than 500 m to about 2 km, and generally have a very gentle slope towards the creek channel and downstream, generally less than 2%. This landscape unit occurs at a reduced level (RL) between approximately 230 m to 250 m Australian height datum (AHD). The floodplains have largely been cleared for agricultural uses, including beef cattle grazing and limited fodder cropping on the floodplain edges. Remnant riparian vegetation is present along the creek lines.
- low undulating hills, with an RL of between 250 m and 295 m AHD make up the majority of the Project area. Slopes are generally less than 4%, but up to 15% gradient for upper slopes in the western portion of the study area. The undulating hills are generally at a higher altitude to the south of the Project area than to the north (refer Figure 3-1). This is due to a regional slope away from the Great Dividing Range, in the south, towards the Dawson River Valley in the north. The undulating terrain has largely been cleared for agricultural uses, with fodder crops on the flatter gradients, and beef cattle grazing on steeper slopes (refer Photo 3-2 to Photo 3-4). Common fodder crops include oats, wheat and leucaena (*Leucaena leucocephala*). Grain cropping used to be prevalent over this area, but has been greatly reduced during the past 20 years, reportedly due to changed rainfall patterns and economic conditions.

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Kilometres

Figure 3-1:
Site Topography

**Photo 3-1: Floodplain of Frank Creek near test pit WS12**

**Photo 3-2: Cleared grazing land on the upper slopes of the undulating terrain in the western portion of the Project area, near test pit WS22**

**Photo 3-3: Undulating terrain in the eastern portion of the Project area, near test pit WS04. Note cropping on the Frank Creek floodplain in the background**

**Photo 3-4: Undulating terrain in the central portion of the Project area, near test pit WS21. Note change in gradient between lower slope in the foreground and upper slope in the back**

## 3.2 Vegetation

The study area is located in a landscape that has been highly modified by past land uses including agriculture (i.e. grazing and cropping). Vegetation in the local area is therefore highly fragmented and relictual (<10% retained).

The floodplains of the Project area generally comprise of agricultural land, with riparian vegetation along the drainage lines, including poplar box (*Eucalyptus populnea)* open forest to woodland.

The undulating hills in the MLA areas are characterised by agricultural land, with remnant and non-remnant Brigalow (*Acacia harpophylla*) communities and small fragments of non-remnant semi-evergreen vine thicket. Non-agricultural vegetation predominately occurs within road reserves and along creek lines. A detailed description of the vegetation in the project area is found in Chapter 17 Ecology of the EIS.

## 3.3 Geology

### 3.3.1 Regional geology

The Project area is located within the Surat Basin, an eastern lobe of the Great Artesian Basin. The Surat Basin contains up to 2,500 m depth of sediments comprised mainly of Jurassic age clastic sedimentary rocks of inferred terrestrial origin and early Cretaceous age marine beds (Green and Chestnutt, 2007).

The geological history of the Wandoan region is based on deposition of sedimentary material, chemical and physical alteration, uplift and subsequent erosion. During the mid to late Triassic, freshwater streams deposited sand over much of the region. This was followed by a period of widespread erosion in the late Triassic, and then a cyclic period of fluvial sedimentation followed by erosion between the early Jurassic and early Cretaceous. Extensive coal deposits formed during middle Jurassic time.

Since the late Jurassic, the Surat Basin has been relatively stable. A marine transgression in the early Cretaceous was the last major sedimentary episode, after which the sea withdrew during the late Cretaceous.

Deep weathering of the land surface occurred during the Tertiary Period, however subsequent erosion has since stripped most of this profile from the northern areas of the Surat Basin (Slater 1986). South of Wandoan large areas of deeply weathered material form plateaus along the Great Dividing Range, and mesa topography elsewhere.

### 3.3.2 Local geology

The Wandoan Joint Venture has conducted detailed studies of the geology of the Wandoan region including photogeological interpretation (Snodin 2004). This photogeological mapping supports, but is more detailed than, the Geological Survey of Queensland's 1:250,000 series Roma and Taroom sheets. The geologic units in the Wandoan region occur in generally west-north-west to east-south-east trending bands. Geology of the Project site comprise the following main geological units:

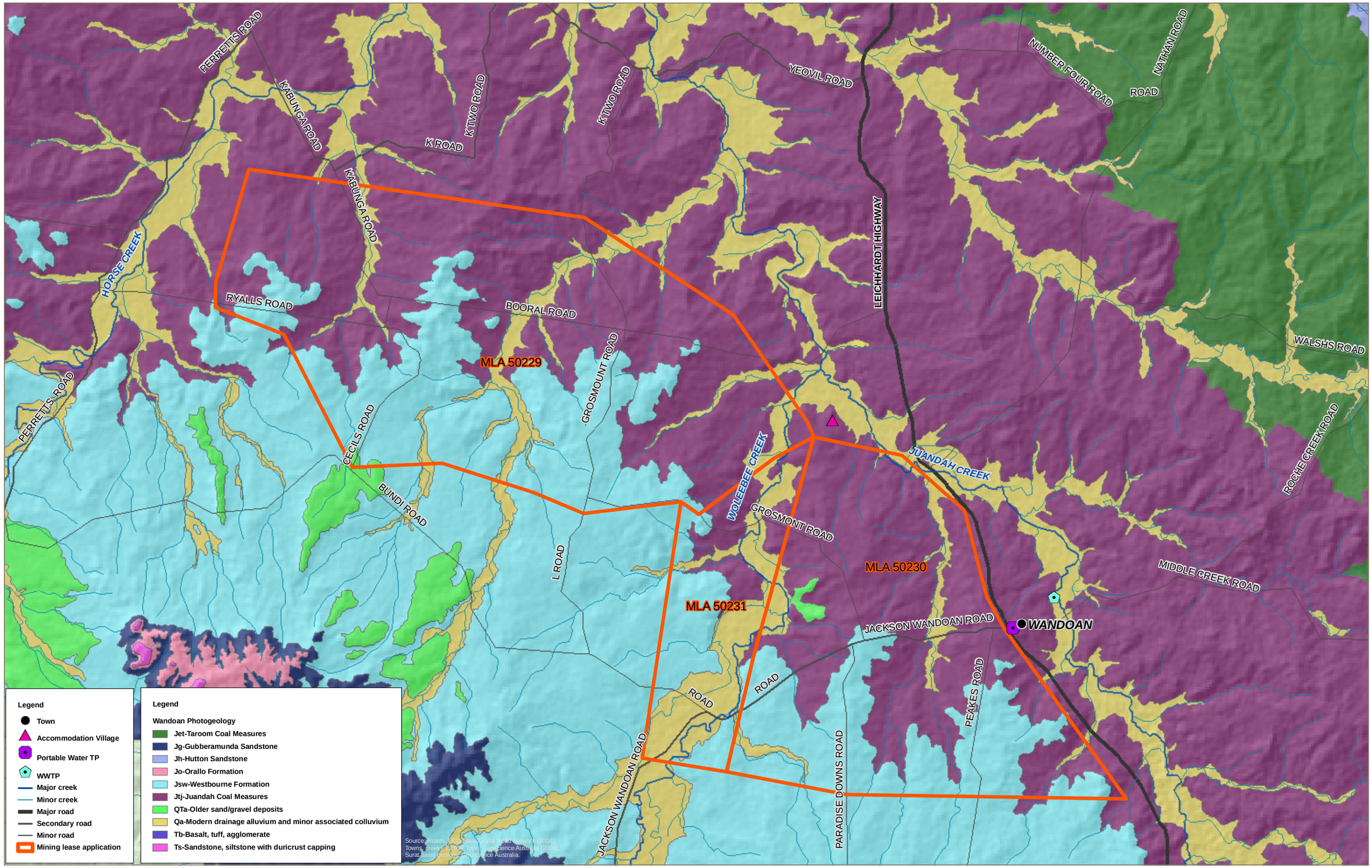
- quaternary age alluvium
- middle to upper Jurassic age Injune Creek Group , which, within the Project area consists of:
  - the Westbourne Formation (siltstone, mudstone and fine grained sandstone)
  - the Springbok Sandstone (friable sandstone with beds of mudstone and thin coal seams near its base)
  - the Juandah Coal Measures
  - the Tangalooma Sandstone
  - Taroom Coal Measures at depth.

A map illustrating the geology of the Project area is shown on Figure 3-2, and a schematic cross sections provided in Figure 3-3 and Figure 3-4. The boundary between the Westbourne Formation and Tangalooma Sandstone, and Springbok Sandstone and Juandah Coal Measure were found to be indistinct by Snodin (2004) based on a review of aerial photography. For this purpose, these strata have been mapped together in Figure 3-3. The field investigation carried out for this assessment confirmed the presence of the above units. Detailed stratigraphic columns are provided in Figure 3-5. A photo illustrating the typical near surface geological profile in the area is shown in Photo 3-5.

#### Quaternary alluvium

The source material of the Quaternary age alluvium along the drainage lines is anticipated to be the Injune Creek Group rocks for the shorter drainage lines, including Frank Creek, Spring Creek, Mud Creek and their associated tributaries. The alluvium of these creeks largely comprises sandy clay materials.

The longer Woleebee Creek has a higher discharge and flows through the Orallo Formation and Gubberamunda Sandstone that is further upstream from the Project site. Floodplain sediments along Woleebee Creek are influenced by these geological units and the higher discharge in this creek, and are mainly clayey sands.

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Kilometres

Figure 3-2:
Regional geology

### Injune Creek Group

The Injune Creek Group includes the Westbourne Formation, Walloon Subgroup and Springbok Sandstone.

The Walloon Subgroup incorporates the Juandah Coal Measures, Tangalooma Sandstone and the Taroom Coal Measures.

The Juandah Coal Measures contain the economic coal reserves of the Project, and comprise medium to coarse grained lithic sandstone, siltstone, mudstone and coal seams. The particle size generally increases with depth (Slater 1986). The coal seams are relatively flat, with a regional dip of approximately zero to two degrees to the south-west (Golder Associates 2008), with localised steeper dips. Geotechnical drilling has identified the following seam groups within the Wandoan MLAs (also refer Figure 3-5):

#### *Kogan*

The Kogan coal seams generally occur in the southern portion of the MLAs and at shallower depths. The group consists of approximately seven seams, each of which generally vary in thickness between 0.1 m and 5.0 m.

#### *Macalister Upper*

The Macalister Upper coal seams occur below the Kogan seams. The group consists of approximately five seams, each of which generally vary in thickness between 0.05 m and 4 m.

#### *Macalister Lower*

The Macalister Lower coal seams occur below the Macalister Upper seams. The group consists of approximately six seams, each of which generally vary in thickness between 0.01 m and 3.0 m.

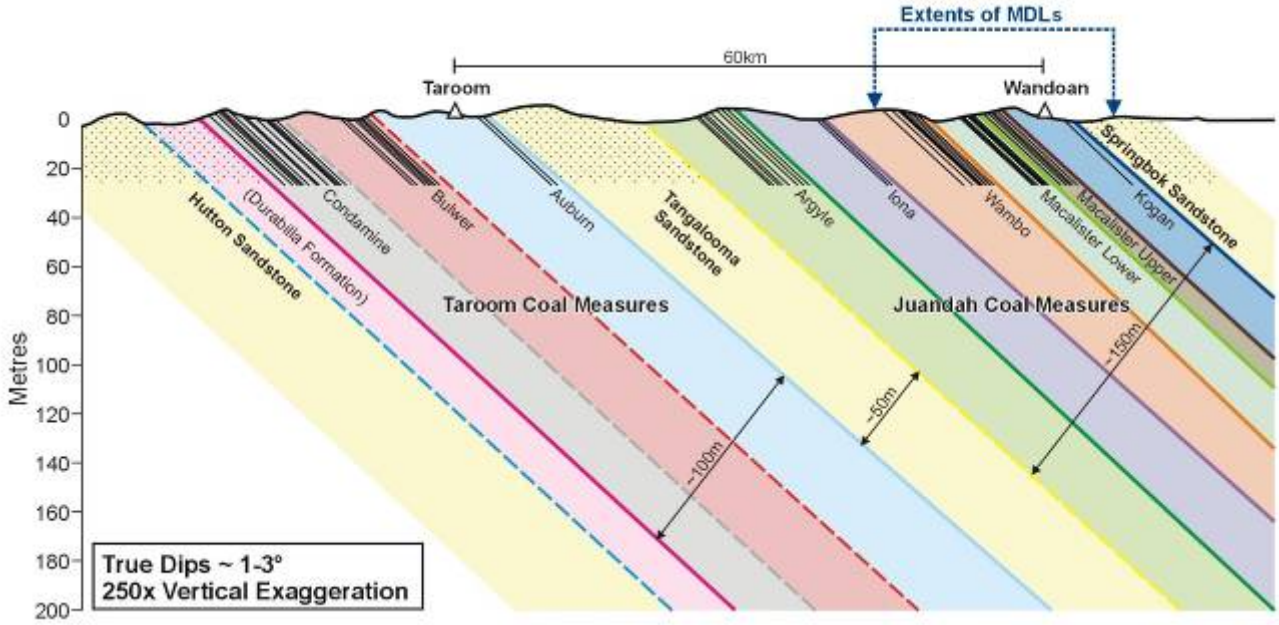
#### *Wambo*

The Wambo coal seams occur at shallower depths in the northern portion of the MLAs and below the Macalister Lower seams in the rest of the MLAs. The seam consists of approximately seven seams, each of which generally vary in thickness between 0.1 m and 3.0 m.

## 3.4 Mineral resources

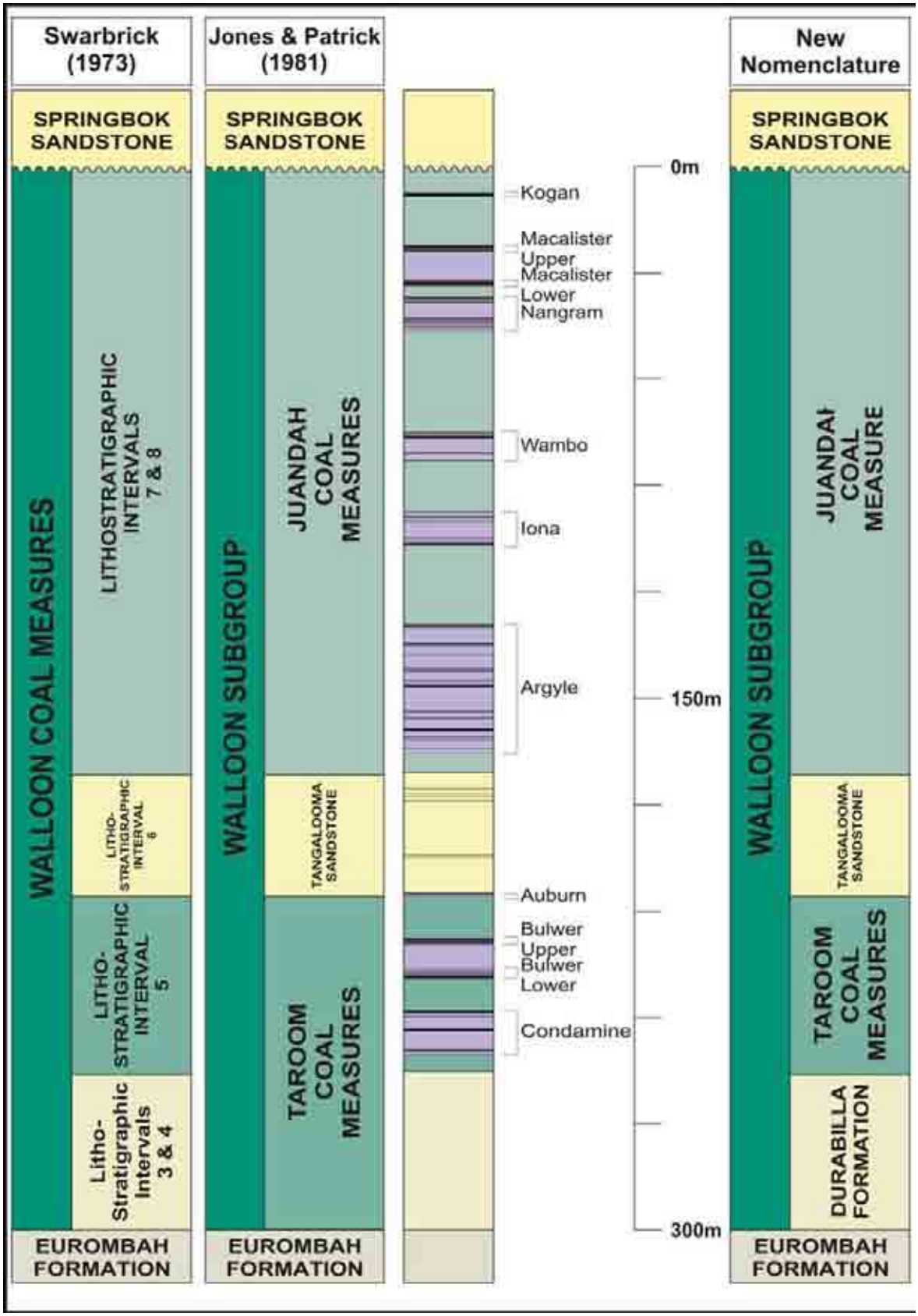
A number of individual coal tenures are present within the Project area as shown on Figure 3-6. Exploration permits for coal (EPC), mineral development leases (MDLs) and mining lease applications (MLAs) over these deposits are held by the WJV. The Project will involve the extraction of coal from these tenements, which are:

- EPC787 (granted), EPC792 (granted), EPC859 (granted) and EPC1143 (granted)
- ML50229 (application), ML50230 (application) and ML50231 (application)
- MDL221 (granted), MDL222 (granted) and MDL223 (granted).




Source: Green and Chestnut 2007

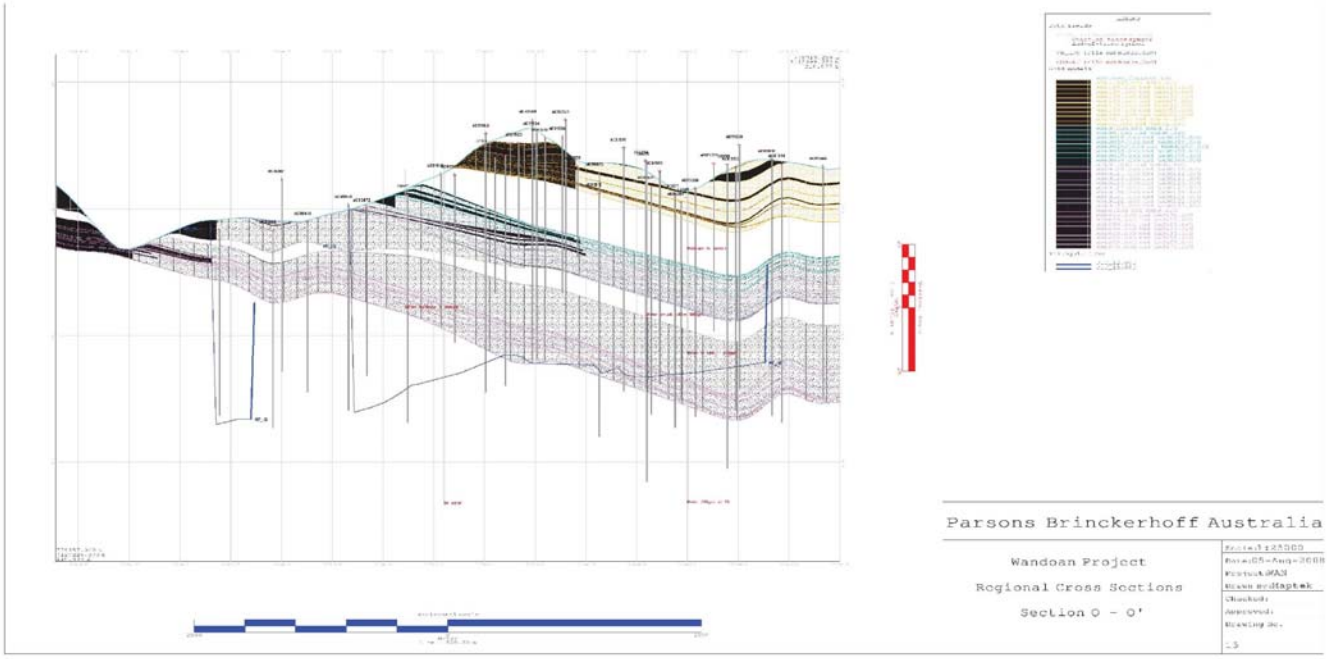
**Figure 3-3: Cross section of the Injune Creek Group**

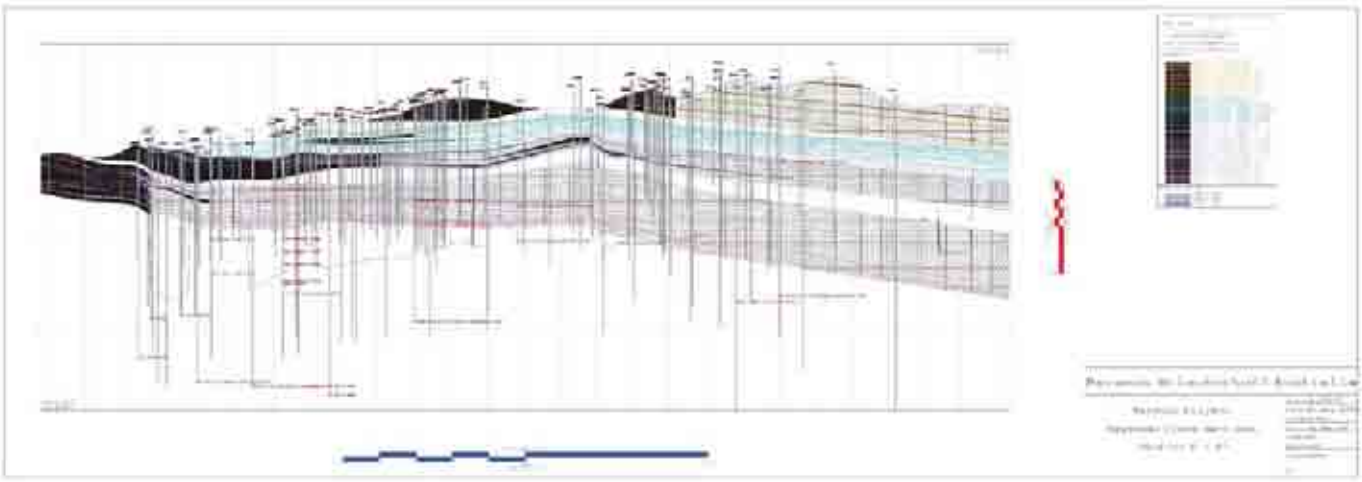


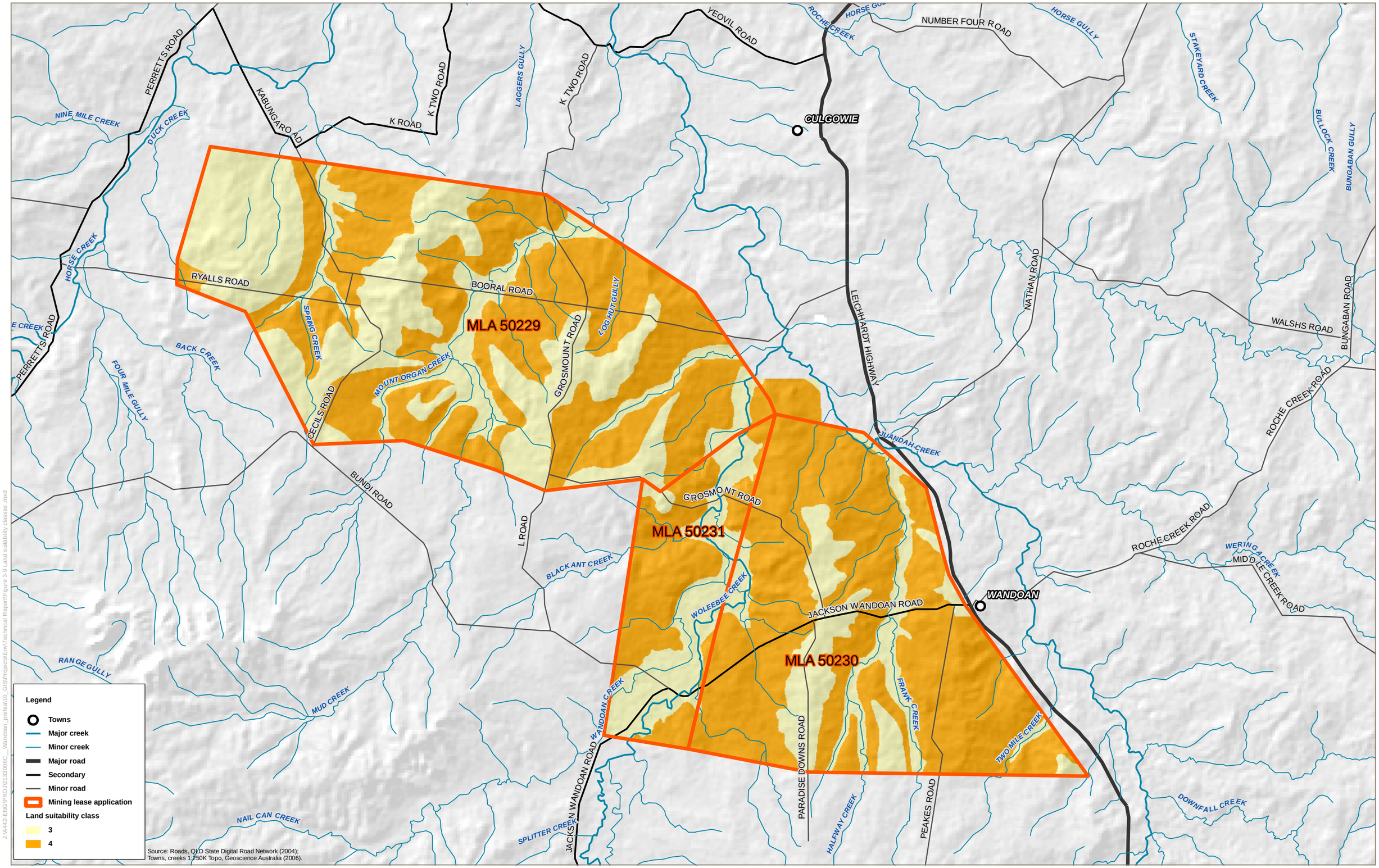

Source: Green and Chestnut 2007.

**Figure 3-4: Stratigraphy of the Walloon Subgroup**

**Figure 3-5: Representative stratigraphical columns**






J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 3-9 Land suitability classes .mxd

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Figure 3-6
Land Suitablility classes for dry land cropping

**Photo 3-5: Road cutting on Booral Road showing thin topsoil overlying weathered siltstone that is overlying weathered sandstone. Photograph taken near test pit WS22**

No mineral exploration permits or leases exist over the Project area. A petroleum lease (PL171, held by Roma Petroleum NL), intersects the southern portion of MLA 50230. No pits or infrastructure are currently proposed within the area of PL171.

A number of exploration permits for petroleum (EPP) exist over the Project area (refer Figure 3-6). These EPPs are summarised below:

- EPP867 (application) held by Paillard Energy Pty Ltd
- EPP869 (application) held by Bow Energy Resources Ltd
- EPP852 (granted), held by Pure Energy Resources Limited
- EPP870 (application) held by Pure Energy Resources Limited
- EPP768 (granted) held by BNG (Surat) Pty Ltd
- EPP606 (granted) held by Origin Energy CSG Limited
- a small portion of EPP810 (granted) held by Arrow Energy Ltd
- a small portion of EPP868 (application) held by Vamgas Pty Ltd
- a small portion of EPP692 (granted) held by Origin Energy CSG Limited
- a small portion of EPP 651 (granted) held by Queensland Gas Company Limited.

According to the Department of Mines and Energy's Interactive Resource and Tenure maps (http://www.webgis.dem.qld.gov.au accessed on 1 August 2008), two exploration boreholes have previous been drilled within the Project area, both in the southern portion of MLA 50230. Well 55 was drilled in 1962 for petroleum, with no hydrocarbons located.

Well 58380 was drilled in 2002 for coal seam gas, also with no gas located. Further details are available from company report numbers 897 and 37652 respectively from the Department of Mines and Energy's Queensland Digital Exploration Reports System (QDEX).

## 3.5 Geomorphology

Drainage over the Project area is generally towards the north, with sediment from the Great Dividing Range in the south slowly transported by the creeks via the floodplains towards the Dawson River, located to the north of the Project.

The narrow floodplains, gentle slopes, bedrock controlled channels and confined meanders of drainage lines suggest the landscape within the Project area is geologically young. The ephemeral creeks are slowly cutting into and eroding the undulating hills, with lateral erosion of the valleys being the main large-scale landscape altering activity, together with channel deepening. Temporary deposition of eroded material occurs on the narrow floodplains. Erosion rates are anticipated to be low due to the relatively dry climate and low topographic gradient. Most erosion will occur during infrequent high rainfall events.

## 3.6 Overburden

Overburden in the vicinity of the Project has previously been investigated by CSR Coal Division (1986), Godfrey (1992), Slater (1986) and Golders Association (2008) (refer Figure 2–2).

Overburden in the Austinvale and Woleebee areas consist mostly of sandstone, siltstone, mudstone, claystone and coal, with minor ironstone. Upward fining sequences are common, and vertical and lateral changes of facies were observed.

The average depth of overburden is about 23.0 m in the Austinvale area, with about 1.2 m soil. In the Woleebee area the average depth of overburden is 26.0 m, with soil to about 3.2 m The depth of the weathering ranges from 10.0 m to 15.0 m in the eastern portion of the Project area, and from 8.0 m to 25.0 m in the western portion of the Project area.

Slater (1986) concluded that the siltstones and the lithic or feldspathic sandstones would undergo rapid weathering to produce soil material high in clay content and possibly dispersive.

### 3.6.1 Acid production potential

The oxidation of sulfidic material is a natural process resulting from the exposure of minerals such as pyrite (iron sulfide) to atmospheric conditions (Environment Australia 1997), and is calculated as the acid producing potential in kg $H_2SO_4$/t. This process can be accelerated during mining operations if large volumes of sulfidic material are exposed. The resulting acidity may also dissolve metals within overburden rock. Transport by water can generate highly acidic runoff with high concentrations of dissolved salts of heavy metals.

Carbonate minerals and exchangeable bases, on the other hand, have the ability to neutralise acid (calculated as the acid neutralising capacity in kg $H_2SO_4$/t). Carbonate minerals (mainly calcite, aragonite and dolomite) have the most significant acid neutralising capacity.

The net acid producing potential (NAPP), is the difference between the acid producing potential and the acid neutralising capacity of a material. NAPP gives an indication of a materials potential to generate acid. A positive result shows acid generation potential and a negative result indicates that the material is non-acid producing (Department of Mines and Energy 1995b).

Net acid generation (NAG) differs from the acid producing potential in that it measures the actual acid production and neutralisation of material, as opposed to the total theoretical potential. NAG provides an indication of the potential for acid generation following exposure and weathering of material, and can be used to confirm the NAPP.

Results from previous studies (CSR Coal Division 1986, Slater 1983, Godfrey 1992) and the current assessment (refer Table 3-1 and Attachment H) indicate overburden has a negative NAPP, meaning the maximum theoretical acid production will be less than the theoretical capacity of the rock to neutralise the produced acid, such that any acid forming overburden will be neutralised by non-acid forming overburden, with no net acid generation expected.

**Table 3-1: Acid generation and neutralisation potential in overburden samples analysed for this study**

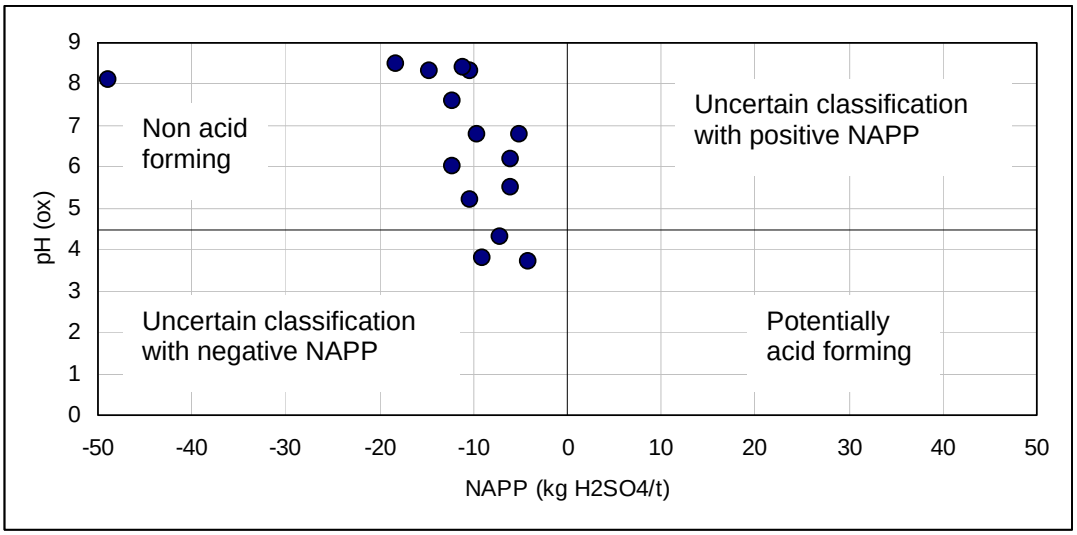
| Parameter | Range in values encountered | |
|---|---|---|
| | Weathered rock | Fresh rock |
| pH | 9.2 – 9.9 | 9.7 – 10.4 |
| Net Acid Production Potential (kg $H_2SO_4$/t) | -14.6 – -10.4 | -48.8 – -4.1 |
| Electrical conductivity (µS/cm) | 763 – 1080 | 280 – 1020 |
| Net acid generation (pH 4.5) (kg $H_2SO_4$/t) | <0.1 | <0.1 – 11.7 |
| Net acid generation (pH 7.0) (kg $H_2SO_4$/t) | <0.1 | <0.1 – 62.2 |
| pH after oxidation | 8.3 | 3.7 – 8.5 |
| Acid neutralising capacity (kg $H_2SO_4$/t) | 10.7 – 15.6 | 6.0 – 50.0 |
| Total Sulfur (%) | 0.01 – 0.03 | 0.03 – 0.14 |

Net acid generation results indicate that when exposed to oxidising conditions (pH 4.5) most overburden material will not generate acid or the generated acid will be neutralised by materials present in the rock. The fresh rock layers adjacent to coal seams have a higher sulphur content than the general overburden sampled, and have the potential to be highly acidic after oxidation (pH less than 4), and result in net acid generation. These results are supported by the findings of Slater (1986) and CSR Coal Division (1986). The presence of organic matter, including non-pyritic sulphur and iron carbonate, results in uncertainty in calculated sulphur content, ANC and NAG results in the rock adjacent coal seams, suggesting a greater acid producing potential that is actually present (Miller 2008).

CSR Coal Division (1986) undertook pyrite spot testing at sixteen sites and did not detect significant levels of pyrite in any samples. Sampling at five sites identified between 2 kg to 87 kg of calcium carbonate equivalent per tonne of overburden, with a mean level of 27 kg per tonne.

Figure 3-7 displays a chart of overburden characteristics and resulting potential for acid production for samples tested as part of the current investigation. All samples have negative

NAPP, and therefore plot in the left side of the diagram in Figure 3-7. The samples with a pH(ox) less than 4.5 have low sulphur content, and therefore plot typical of organic acid effects on samples with minor or no acid rock drainage potential (Miller, 2008).




Source: after Miller 2008

**Figure 3-7: Classification of acid production potential**

The very low NAPP of -48.8 for one sample in Figure 3-7, with a corresponding ANC of 50 is indicative of higher than typical carbonate content. This sample was from fresh sandstone at a depth of approximately 28.5 m in borehole C7073.

The studies therefore suggest the overburden has a low acid producing potential.

### 3.6.2 Heavy metals

The National Environment Protection (Assessment of Site Contamination) Measure 1999 (National Environment Protection Council 1999) contains trigger "investigation level" concentrations for various heavy metals. If concentrations are higher than the investigation level, there is the potential for contamination and further assessment is required to identify the contamination risk. The overburden samples were assessed against the environmental investigation levels and health-based investigation levels to provide an indication of the potential for overburden dumps to be a source of heavy metal contaminated leachate, based on the concentrations in the in-situ overburden material.

Relevant environmental and health-based investigation measures are provided in Table 3-2 below.

**Table 3-2: Investigation thresholds for heavy metal contaminants in soil**

| Substance | Background levels mg/kg | Environmental investigation level mg/kg | Health-based investigation level[1] mg/kg |
|---|---|---|---|
| Arsenic | 1–50 | 20 | 100 |
| Cadmium | 1 | 3 | 20 |
| Copper | 2–100 | 100 | 1000 |

| Substance | Background levels mg/kg | Environmental investigation level mg/kg | Health-based investigation level[1] mg/kg |
|---|---|---|---|
| Chromium (III) | 5–1000 | 400 | 12%[2] |
| Chromium (VI) | - | 1 | 100 |
| Lead | 2–200 | 600 | 300 |
| Nickel | 5–500 | 60 | 600 |
| Zinc | 10–300 | 200 | 7000 |

Source: National Environment Protection Council 1999, Table 5-A.

Notes: 1. based on 'Standard' residential use as defined in Department of the Environment 1998. This includes garden/accessible soil (home-grown produce contributing less than 10% of fruit and vegetable intake; no poultry); this category includes children's day-care centres, preschools and primary schools.

2. % of total chromium in all speciations.

The Department of the Environment (1998) recommend a site specific assessment of land with levels above the environmental investigation level, and remediation or a detailed environmental and health risk assessment if levels are above the health based investigation levels.

The laboratory results for heavy metal analysis in overburden are provided in Attachment G and a summary is provided in Table 3-3. As shown in Table 3-3, heavy metal concentrations within the overburden are below the concentrations requiring investigating under the National Environment Protection (Assessment of Site Contamination) Measure 1999 (National Environment Protection Council 1999).

**Table 3-3: Heavy metal concentrations in overburden samples**

| Substance | Number of samples analysed | Minimum concentration (mg/kg) | Maximum concentration (mg/kg) | Samples exceeding environmental investigation level[1] |
|---|---|---|---|---|
| Arsenic | 15 | <5 | 6 | None |
| Cadmium | 15 | <1 | <1 | None |
| Copper | 15 | 12 | 45 | None |
| Total chromium | 15 | <2 | 10 | None[2] |
| Lead | 15 | 8 | 24 | None[3] |
| Nickel | 15 | 2 | 12 | None |
| Zinc | 15 | 5 | 133 | None |

1. based on 'Standard' residential use as defined in Department of the Environment 1998. This includes garden/accessible soil (home-grown produce contributing less than 10% of fruit and vegetable intake; no poultry); this category includes children's day-care centres, preschools and primary schools.
2. chromium testing did not differentiate speciations
3. health based investigation levels for lead are lower than the environmental investigation level. No samples exceeded the health based investigation levels for lead.

The studies therefore suggest there is a low potential for overburden dumps to be a source of heavy metal contaminated leachate.

### 3.6.3 Nutrients and trace elements

The nutrient and trace element content of overburden material relates to the suitability of the material for use as a plant growth medium. Table 3-4 contains suggested values for various parameters in soil and overburden that are suitable for plant growth. Values outside the suggested critical values may result in toxicities, or shortages in essential nutrients required for plant growth. Further soil nutrient ratings, including nutrient ratings for electrical conductivity, are provided in Attachment F.

**Table 3-4: Criteria for suggested nutrient availability in soils and overburden**

| Parameter | Suggested critical values |
|---|---|
| pH | 5.5–8.5 |
| Exchangeable calcium (meq/100 g) | 1.2 |
| Exchangeable magnesium (meq/100 g) | 0.4–0.8 |
| Exchangeable potassium (meq/100 g) | 0.2–0.3 |
| Sulfate (mg/kg) | 15 |
| Extractable Iron (mg/kg) | 2.5–4.5 |
| Extractable manganese (mg/kg) | 2 |
| Extractable copper (mg/kg) | 0.2 |
| Extractable zinc (mg/kg) | 0.5–1.0 |

Source CSR Coal Research (1986) Table 5.3

The nutrient and trace element concentrations of overburden from the eastern portion of the MLAs have previously been investigated by CSR Coal Division (1986) and Slater (1986). Nutrient and trace elements were also investigated in this study. Nutrient and trace element concentrations from the previous and current assessment are presented in Table 3-5 to Table 3-7.

**Table 3-5: Overburden nutrient parameters from Slater (1986)**

| Parameter | Weathered siltstone | Fresh siltstone | Weathered sandstone | Fresh sandstone |
|---|---|---|---|---|
| pH | 5.3 | 9.5 | 8.3 | 10.0 |
| Electrical conductivity (µS/cm) | 490 | 390 | 340 | 480 |
| Exchangeable calcium (meq/100 g) | 6.7 | 11.7 | 17.5 | 29.2 |
| Exchangeable magnesium (meq/100 g) | 6.8 | 5.9 | 5.5 | 7.7 |
| Exchangeable potassium (meq/100 g) | 0.33 | 0.38 | 0.2 | 0.46 |
| Exchangeable sodium (meq/100 g) | 9.3 | 7.7 | 9.6 | 17.4 |
| Cation exchange capacity (meq/100 g)[1] | 33.6 | 24.6 | 20.8 | 23.6 |
| Exchangeable sodium percentage (%)[2] | 40.2 | 30.0 | 29.3 | 31.8 |
| Organic carbon (%) | 0.12 | 0.78 | 0.03 | 0.47 |
| Organic nitrogen (mg/kg) | 2.4 | 1.2 | 0.4 | 0.4 |
| Nitrate nitrogen (mg/kg) | 2.4 | 1.2 | 0.4 | 0.4 |
| Extractable Iron (mg/kg) | 24 | 16 | 7 | 13 |
| Extractable manganese (mg/kg) | 4 | 5 | 5 | 3 |
| Extractable copper (mg/kg) | 1.6 | 5.5 | 1.0 | 3.7 |
| Extractable zinc (mg/kg) | 1.6 | 5.5 | 1.0 | 3.7 |

Source: After Slater 1986, Table 4.3

1. Cation exchange capacity established through measurement, and therefore does not equal the sum of exchangeable calcium, magnesium, potassium and sodium
2. Exchangeable sodium percentage calculated as exchangeable sodium concentration divided by the sum of exchangeable calcium, magnesium, potassium and sodium, then multiplied by 100.

**Table 3-6: Overburden nutrient parameters from CSR Coal (1986)**

| Parameter | >70% sandstone | Siltstone | >70% siltstone/coal and sandstone | >70% sandstone and siltstone (more sandstone than siltstone) | >70% sandstone and siltstone (more siltstone than sandstone) | Siltstone and coal |
|---|---|---|---|---|---|---|
| pH | 6.8 | 6.4 | 9.2 | 8.8–9.6 | 9.3–10.0 | 7.8 |
| Electrical conductivity (µS/cm) | 660 | 720 | 640 | 700–830 | 450–960 | 260 |
| Exchangeable calcium (meq/100 g) | 6.59 | 5.58 | 35.61 | 12.77–16.60 | 12.83–21.70 | 5.49 |
| Exchangeable magnesium (meq/100 g) | 5.14 | 5.85 | 3.72 | 2.68–5.59 | 1.75–4.85 | 4.03 |
| Exchangeable potassium (meq/100 g) | 0.17 | 0.20 | 0.06 | 0.35–0.53 | 0.20–0.57 | 0.25 |
| Exchangeable sodium (meq/100 g) | 5.56 | 7.83 | 9.35 | 9.36–13.05 | 7.00–28.63 | 2.72 |
| Cation exchange capacity (meq/100 g)[1] | 23 | 19 | 49 | 29–32 | 34–44 | 12 |
| Exchangeable sodium percent (%)[2] | 31.8 | 40.2 | 19.2 | 29.2–45.2 | 20.7–65.4 | 21.8 |
| Organic carbon (%) | 1.3 | 0.2 | 0.1 | 1.2–1.8 | 0.6–1.0 | 0.2 |
| Organic nitrogen (mg/kg) | | | | | | |
| Nitrate nitrogen (mg/kg) | 5.3 | 1.2 | 4.4 | 2.3–6.8 | 2.4–3.6 | 0.1 |
| Extractable Iron (mg/kg) | 62 | 39 | 3 | 13–17 | 12–15 | 72 |
| Extractable manganese (mg/kg) | 30 | 9 | 3 | 6–12 | <1–8 | 32 |
| Extractable copper (mg/kg) | 1.1 | 1.3 | 0.2 | 0.8–0.9 | 0.2–0.7 | 0.4 |
| Extractable zinc (mg/kg) | 1.9 | 0.9 | 0.4 | 1.4–4.1 | 1.6–1.8 | 0.8 |

Source: After CSR Coal Division 1986, Table 5.4.

1. Cation exchange capacity established through measurement, and therefore does not equal the sum of exchangeable calcium, magnesium, potassium and sodium
2. Exchangeable sodium percentage calculated as exchangeable sodium concentration divided by the sum of exchangeable calcium, magnesium, potassium and sodium, then multiplied by 100.

**Table 3-7: Overburden nutrient parameters from this study**

| Parameter | Range in values encountered | |
|---|---|---|
| | Weathered rock | Fresh rock |
| pH | 9.2–9.9 | 9.7–10.4 |
| Electrical conductivity (µS/cm) | 763–1080 | 280–1020 |
| Exchangeable calcium (meq/100 g) | 15.5–15.6 | 2.8–22.3 |
| Exchangeable magnesium (meq/100 g) | 8.9–10.5 | 0.8–5.4 |
| Exchangeable potassium (meq/100 g) | 0.50–0.58 | 0.46–0.97 |
| Exchangeable sodium (meq/100 g) | 8.02–9.81 | 8.82–24.0 |
| Cation exchange capacity (meq/100 g)[1] | 34.6 | 16.8–42.4 |
| Exchangeable sodium percent (%)[2] | 23.2–28.3 | 40.0–71.2 |

1. Cation exchange capacity established through calculation as the sum of exchangeable calcium, magnesium, potassium and sodium
2. Exchangeable sodium percentage calculated as exchangeable sodium concentration divided by the sum of exchangeable calcium, magnesium, potassium and sodium, then multiplied by 100.

The overburden has very low organic matter and nitrogen content. The pH of overburden was found generally to be alkaline, with some siltstone and sandstone samples acidic (Slater located this acidic siltstone under the Rolleston soil profile, which occurs within the Brigalow Uplands LRA as discussed in Section 3.7.2 of this report). The concentration of exchangeable cations is low, and is dominated by calcium and sodium.

Electrical conductivity levels were medium to high, and trace elements (iron, manganese, copper, zinc) levels medium to high.

### 3.6.4 Dispersion, slaking and erosion potential

When environmental factors (e.g. vegetation cover, climate etc) are equal, the erosion potential of stockpiled overburden is dependant upon the chemical and physical characteristics of the material.

Dispersion and slaking both result in erosion. Slaking is the breakdown of a material's structure when exposed to water (e.g. fragmentation matrix breakdown). Dispersion is the transformation of a solid material into a colloid when in contact with water.

The potential for slaking and dispersion was assessed by Golders Associates (2008). This assessment found that clay rich, slake prone rocks are present throughout the overburden and interburden across the Project area, although some non-slaking materials were encountered. These findings support the findings of Godfrey (1992).

The results of Golders Associates assessment indicate that the slaking material is a high plasticity clay, with poor engineering properties.

CSR Coal Division (1966) tested both the general dispersive potential of overburden and the potential for failure by tunnel erosion when used for earthworks. Most overburden was found to be highly dispersive, with some siltstone/sandstone materials dispersive (overburden with more than 70% sandstone and siltstone, with more siltstone than sandstone) or non-dispersive (overburden with more than 70% siltstone/coal and sandstone, with more

siltstone/coal than sandstone). All materials tested were found to be highly susceptible to tunnel erosion.

Dispersion is caused by chemically exchangeable sodium dominated clays that form weak bonds between individual clay particles and layers within the clay minerals, thus acting as a dispersing agent. Soils with an exchangeable sodium percent (ESP) of more than 15% are considered dispersive and soils with an ESP less than 5% are commonly considered as non-dispersive. The current study found ESP values of 23 to 28 for weathered rock and 40 to 71 for fresh rock, indicating the overburden will be highly dispersive. These findings are in accordance with those by Slater (1986), who found sodium as the dominant base cation, and ESP values of 14 to 34.

### 3.6.5 Fossil material

As discussed in Section 3.3.2, the coal measures of interest to the Project and the overlying rock is Jurassic age and of sedimentary origin. There is therefore a potential for fossil species to be present.

Fossilised leaf impressions were identified in some sandstone samples collected as part of the geotechnical investigations for the Project (e.g. borehole C7073), however, based on the rare occurrence of location of significant dinosaur fossils, the potential for location of significant fossils is expected to be low.

## 3.7 Soils

### 3.7.1 Land resource areas

Land resource areas (LRAs) are reoccurring landscape units with similar geology, landforms, soils and vegetation associations. They are used to simplify and aid quick field identification of land resource unit mapping and subsequent management.

The Wandoan District Land Management Field Manual (Gray and Macnish 1985) identified two LRAs in the Project area. These previously identified LRAs are shown in Table 3-8. The Evaluation of Agricultural Land in the former Taroom Shire local government area (Forster 1985), identified similar LRA, but named the LRA 'Wandoan' and 'Juandah', as opposed to Grey and Macnish's 'Brigalow Uplands' and 'Poplar Box Alluvia' respectively.

**Table 3-8: Identified land resource areas**

| LRA | Landform | Soil type | Common soils | Vegetation | Land use |
|---|---|---|---|---|---|
| Brigalow Uplands | Undulating plains with broad ridges and low hills, on sandstones and shales | Grey and brown non-cracking and gilgaied cracking clays; shallow sandy and loamy soils on ridges and some texture contrast soils | Rolleston (including, Rolleston Family), Teviot Downfall, Cheshire, Kinnoul | Brigalow open forest and softwood scrub. Brigalow open forest with either poplar box or belah or Dawson gum or bauhinia. Scattered wilga and softwood scrub species frequently occur | Predominantly winter grain cropping with occasional summer cropping. Grazing of native and improved pastures |

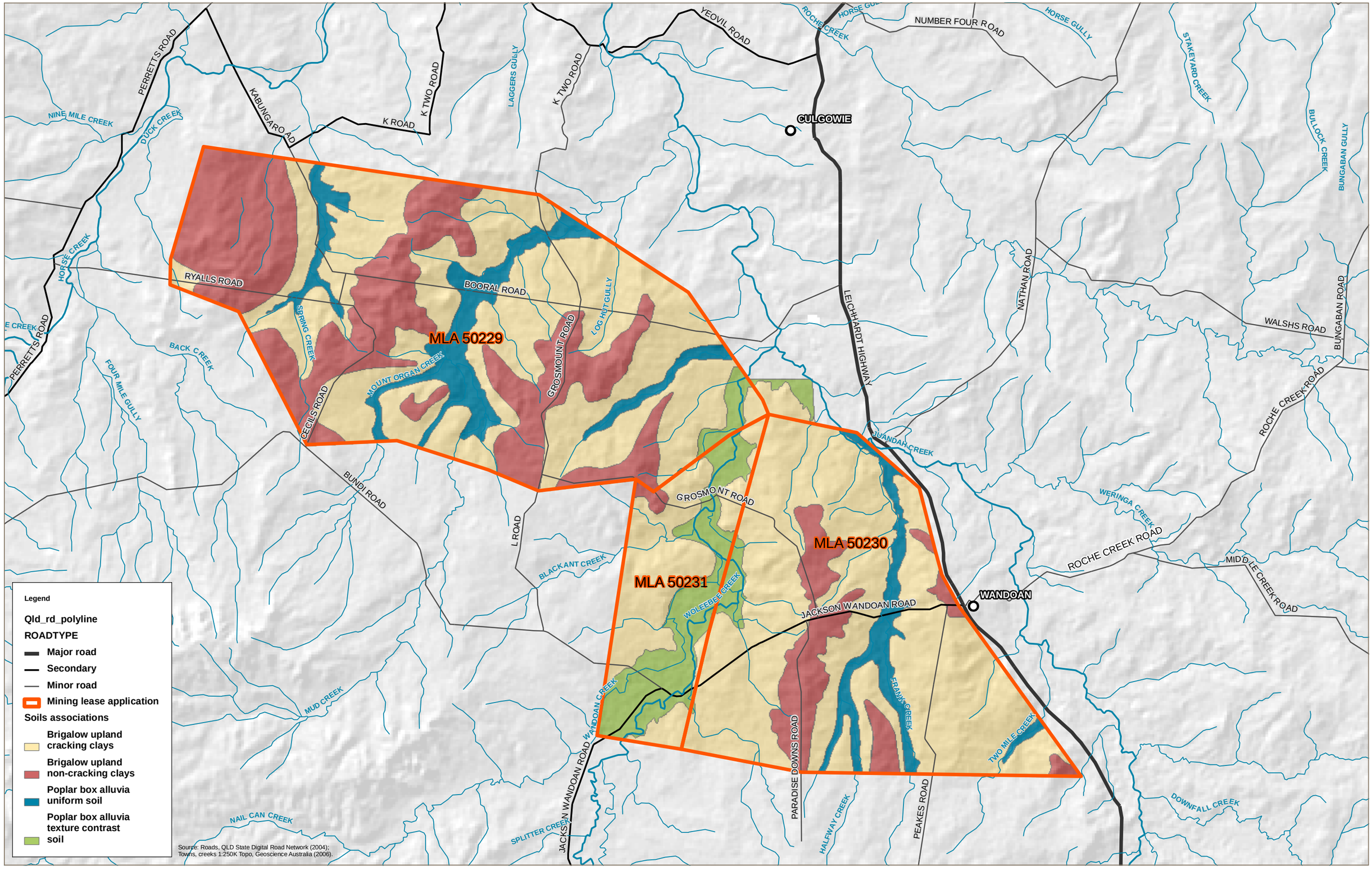
| LRA | Landform | Soil type | Common soils | Vegetation | Land use |
|---|---|---|---|---|---|
| Poplar Box Alluvia | Floodplains of generally narrower width than Coolibah LRA; often associated with active secondary stream channels; mixed and sandy alluvia | Predominantly deep, cracking, grey clays and loams, texture contrast soils | Juandah, Retro | Predominantly poplar box grassy woodland. Scattered false sandalwood and softwood scrub species frequently occur | Predominantly winter grain cropping and grazing of native and improved pastures. Summer cropping is difficult. Moderate flooding hazard |

Source: After Grey and Macnish 1985, Map 3

### 3.7.2 Soil description and mapping

Based on the field investigation and review of existing information, eight different soils types, developed on various landforms and geology, were identified in the Project area. These soils correlate with the seven common soils shown in Table 3-8 above, and an additional soil type also identified by Slater (1986). The soils are discussed in the following sections and presented on Figure 3-8. A number of additional soil types identified by Slater 1986 (refer Attachment D) have been considered sub-varieties of the soils identified in this report, and have not been mapped separately.

Soils with similar physical or chemical properties have been grouped together as soil associations as shown in Figure 3-8 to make the map easier to use and more practical for soil management planning. A key has been provided in Figure 3-9 to aid in the identification of each soil type within the soil associations (and also when in the field). While Figure 3-8 shows discrete boundaries between soil types, the soils actually grade into each other (i.e. properties of both soils occur) over a distance of a few hundred metres. Abrupt boundaries between soils types generally do not occur in the Project area, except along drainage lines. Anthropogenic impacts to soils, which have altered the observed soil profiles, were identified in the Project area, and are discussed below.

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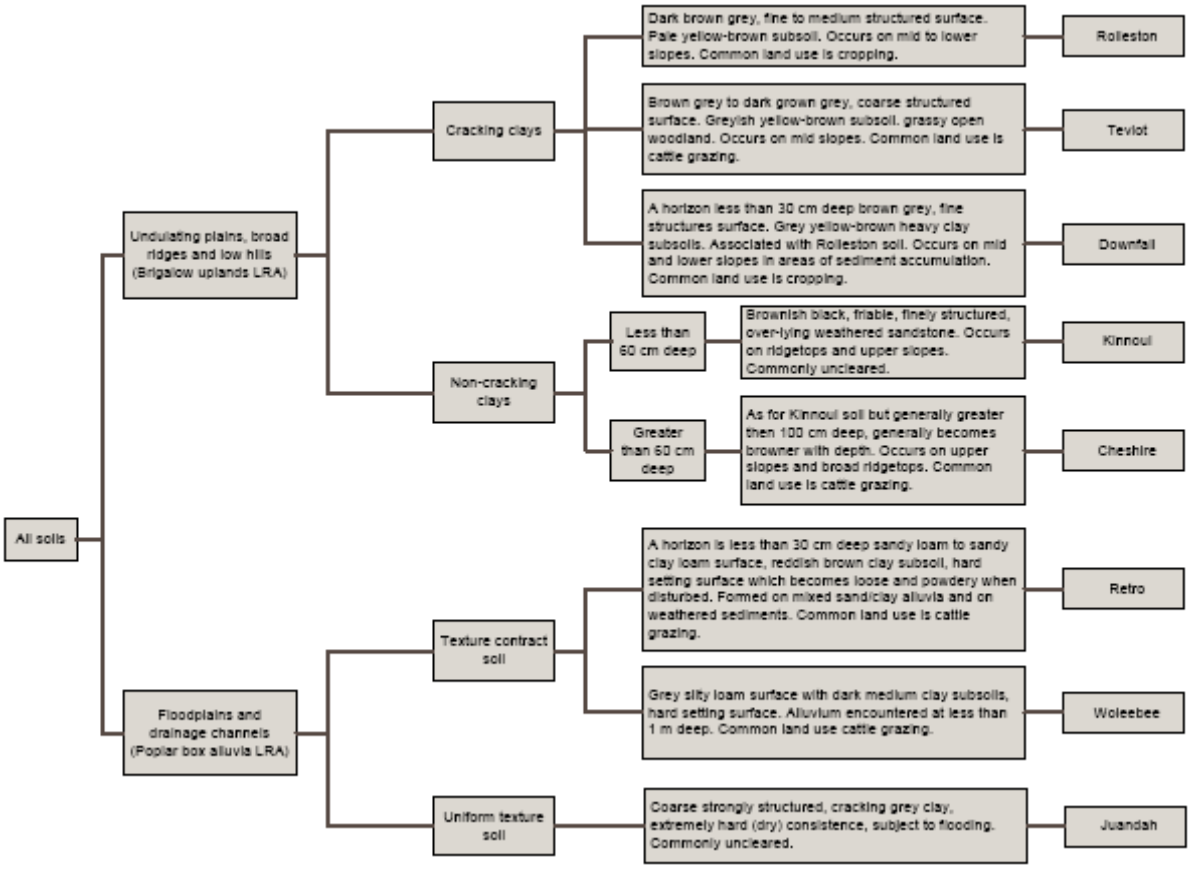
0 2 4 6 8 10
Kilometres

Figure 3-8
Soil associations with the MLA.




Based on Appendix II, Grey and Macnish 1985

**Figure 3-9: Key to soils in the Project area**

## Anthropogenic impacts to soil

Soils in the Wandoan area have been subject to anthropogenic influences that will have altered the natural soil structure. As a result, soils described in the sections below may not represent soils in their 'natural' condition.

The practice of blade ripping (i.e. running a metal blade at a depth of approximately 0.2 m beneath the soil surface) is commonly practiced in the area to control brigalow regrowth and also function as a water erosion control measure. Anecdotal evidence from landowners in the area indicates that blade ripping is conducted at 10 to 20 year intervals. Photo 3-6 shows a recently blade ripped field. Although blade ripping is not intended to turn the soil, the practice will have altered the approximate top 0.2 m of the soil profile. The practice has the potential to produce a more diffuse boundary between sub-soils and surface soils and to mix sub-soil components into the surface soils. Blade ripping made the field identification of gilgai terrain difficult, and, as a result, this landscape characteristic has not been used in the identification of various soils.

The occurrence of buffel grass (*Cenchrus ciliaris*) was observed to have an impact on the soil profile, with an apparent correlation between the depth of the A1 horizon and the buffel

grass rooting depth. At sites where this grass was encountered the A1 soil horizon was generally not more than approximately 5 cm.

In previously cultivated areas the soil structure, especially in the A1 and/or A2 horizons, are generally disturbed by the agricultural activities. The A1 horizon in the following photographs may have been influenced by the above anthropogenic activities, and will have been disturbed during test pit excavation.

**Photo 3-6: Effects of blade ripping on surficial soils near WS22**

An explanation of the ratings used for the description of chemical properties of the soils (e.g. high, medium, low), are provided in Attachment F, and are based on Biggs, Coutts and Harris (1999).

## Brigalow uplands soils

### *Cheshire*


**Photo 3-7: Typical profile of the Cheshire soil (WS27)**

Cheshire soils occur on steeper gradient upper slopes (up to 3%) within the Brigalow Uplands — Non Cracking Clays association as shown in Figure 3-8 (test pits WS24, WS27, WS33, WS38 and Sites 6 and 7 from Slater 1986). These soils have largely been cleared and are used for cattle grazing of native pastures. The soils are shallow, non-cracking uniform clays. Under the Australian Soil Classification, this soil is a brown dermosol.

The topsoil is approximately 0.4 m to 0.6 m deep, and consists of dark, sandy clay to light clay, with a fine structure and a mildly alkaline pH. The topsoil has low to moderate salinity (measured as electrical conductivity, EC) and a non-dispersive A1 horizon, tending to a dispersive A2 horizon. The A1 horizon has medium nitrogen and phosphorus availability, and approximately 3% organic carbon.

The B horizon consists of a brown to grey-brown medium clay, with calcareous concretions. This horizon tends yellow-brown at less than approximately 1.0 m depth and the sub-soil is strongly alkaline, highly saline and dispersive throughout the B and C horizons. Weathered sandstone or siltstone is typically encountered within 1.0 m to 1.5 m depth.

### *Kinnoul*


**Photo 3-8: Typical profile of the Kinnoul soil (WS21)**

Kinnoul soil occurs on ridgetops and upper slopes within the Brigalow Uplands — Non Cracking Clays association shown in Figure 3-8, and is commonly covered by regrowth brigalow softwood scrub. Test pits WS04, WS05, WS07, WS16, WS17, WS21, WS22, WS25, WS29, WS30 and WS40 were excavated in areas covered by this soil. It is a shallower version of Cheshire, and often grades into Cheshire on upper slopes. Under the Australian Soil Classification, this soil is a brown dermosol.

The topsoil is approximately 0.3 m to 0.4 m deep and consists of a dark, sandy clay or light clay, with a well developed blocky structure, neutral to mildly alkaline pH and low to moderate salinity (EC) and is considered non-dispersive. The topsoil has low to medium nitrogen and phosphorus availability, and approximately 3 to 3.5% organic carbon.

The B horizons consist of brown and blocky light clay, with mild alkalinity, low to moderate salinity and low dispersivity, increasing to strongly dispersive with depth. Calcareous concretions are generally absent, but may be present on slopes where the soil grades into other soil types, or in areas of poorer drainage. Weathered sedimentary rock is generally encountered within 0.75 m depth. The yellow-brown lower sub-soil encountered in Cheshire is generally poorly developed in this soil.

### *Downfall*

Downfall soil occurs on mid to lower slopes of approximately 2% grade in areas of sediment/slopewash accumulation within the Brigalow Uplands — Cracking Clays

association, and is typically used for dryland grain farming. Test pits WS11, WS20, WS26, WS32, and Sites 4 and 8 from Slater (1986) encountered this soil. The soil is uniform cracking clay and under the Australian Soil Classification it is a brown vertosol.

The topsoil (A1) is shallow, only about 0.05 m to 0.15 m depth, and consists of a neutral brown-grey clay of medium plasticity, with a fine granular structure, neutral to mildly alkaline pH, low salinity and dispersive. The topsoil has low nitrogen and phosphorus availability and approximately 2% organic carbon. The A2 horizon is generally absent.

The upper B horizons consist of a medium to heavy clay with fine blocky peds, slightly alkaline pH, dispersive and traces of calcareous concretions. The lower subsoils are dispersive grey and/or yellow-brown heavy clays with strongly alkaline pH. Weathered sandstone or colluvium is typically encountered at greater than 1.5 m depth.

### *Teviot*

Teviot soil occurs on gently inclined midslopes with a gradient of 1% to 3%, within the Brigalow Uplands — Cracking Clays association, and is typically used for cattle grazing of native pastures.


**Photo 3-9: Typical profile of the Teviot soil (WS23)**

This uniform cracking clay soil was encountered in test pits WS01, WS06, WS15, WS23, WS28, WS36 and Site 2 from Slater (1986) and under the Australian Soil Classification this soil is a brown vertosol.

The topsoil is approximately 0.2 m deep and consists of brown-grey to dark brown-grey clay with neutral to slightly alkaline pH, low salinity and non-dispersive. The topsoil has medium nitrogen and phosphorus availability and approximately 2-3% organic carbon.

The B horizon comprises high plasticity clay with strong blocky peds and is dispersive. The lower sub-soil consists of strongly dispersive grey-yellow-brown clay, and appears highly susceptible to tunnel erosion if exposed. Weathered sandstone is typically encountered within 1.0 m to 1.5 m depth. Subsoils are moderately alkaline, with a consistent pH values throughout the B and C horizons. Salinity is moderate in the B horizon, and increases with depth.

### *Rolleston*

The Rolleston soil occurs on mid and lower slopes within the Brigalow Uplands — Cracking Clays association on land with a slope of approximately 1 to 4%. This soil, encountered in test pits WS03, WS08, WS09, WS14 and Sites 3 and 5 from Slater (1986), is typically used for dryland grain cropping. Under the Australian Soil Classification this uniform cracking clay soil is classed as a brown dermosol.


**Photo 3-10: Typical profile of the Rolleston soil (WS09)**

The topsoil is approximately 0.2 m deep and comprises non-dispersive to dispersive dark brown-grey heavy clay with blocky peds, slightly alkaline pH and low salinity. The topsoil has low to medium nitrogen and phosphorus availability and low organic carbon content. An A2 horizon may be absent.

The B horizon consists of dispersive, high plasticity clay with strong blocky peds and calcareous concretions. The lower sub-soil is strongly acidic or strongly alkaline pale yellow-brown to yellow-orange and strongly dispersive, with weathered sandstone or siltstone encountered at depths greater than 1.5 m.

## Poplar box alluvia soils

### *Juandah*

Juandah soils occur on flat floodplains with less than 1% gradient within Poplar Box Alluvia — Uniform Soils, as shown on Figure 3-8. These soils, encountered in test pits WS12, WS31, WS35, WS37 and Site 12 from Slater (1986) are deep uniform clays developed on alluvium and are typically used for cattle grazing.


**Photo 3-11: Typical profile of the Juandah soil (WS12)**

The topsoil is approximately 0.5 m deep and comprises high plasticity dark brown-grey clay with granular to blocky structure and a hardsetting surface where disturbed by agriculture. The topsoil has neutral pH and low salinity, with low to medium nitrogen and phosphorus availability. The A1 horizon is non-dispersive, with a dispersive A2 horizon.

The B horizon consists of dispersive high plasticity dark brown-grey clay, with coarse blocky to massive structure, slight to moderately alkaline pH and low to medium salinity. Subsoils grade to yellow-brown massive, alkaline, clays. The soil profile is generally greater than 1.5 m deep, and underlain by alluvium.

Under the Australian Soil Classification this uniform cracking clay soil is classed as a brown vertosol.

### *Woleebee*

Woleebee soil occurs on the floodplains of Woleebee and Juandah Creeks within Poplar Box Alluvia — Texture Contrast Soils, as shown on Figure 3-8 (test pit WS19 and Site 11 from Slater (1986)). The soils are texture contrast soils developed on alluvium and are typically used for cattle grazing.

The topsoil is approximately 0.15 m deep and comprises grey silt loam. It is dispersive, has a neutral pH, low to medium salinity, and low organic carbon content.

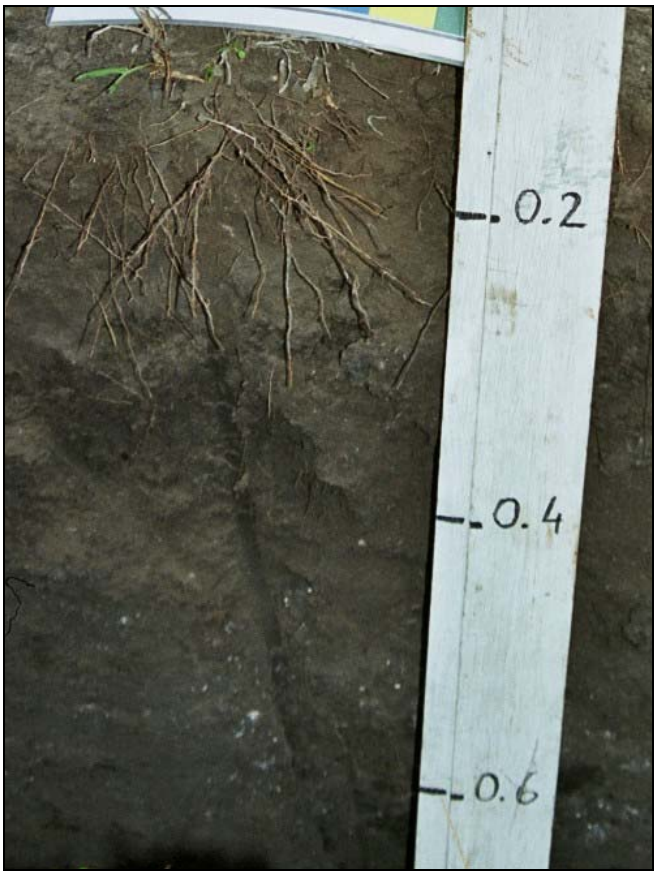



**Photo 3-12: Typical profile of the Woleebee soil (WS19)**

The B horizon comprises strongly dispersive dark medium clay, with layered alluvium encountered at less than 1.0 m depth. The pH and salinity increase with depth to strongly alkaline and medium to high salinity from approximately 0.5 m depth.

Under the Australian Soil Classification this texture contrast soil is classed as a brown sodosol.

### *Retro*

The Retro soils occur on gently undulating floodplains with slopes of less than 0.5% within Poplar Box Alluvia — Texture Contrast Soils, as shown on Figure 3-8, and are typically uncleared, with grassy open woodland of poplar box and sandalwood (test pits WS13, WS34, and Sites 9 and 13 from Slater (1986)). The soils are deep texture contrast soils, developed over weathered sedimentary rock or colluvium, but within the floodplain of the streams and under the Australian Soil Classification, it is classed as a brown chromosol.

The A1 horizon is approximately 0.15 m deep and consists of a non-dispersive dark brown-grey clay-loam with neutral pH and low salinity. The topsoil has low to medium nutrient availability, with medium to high organic carbon content and is commonly underlain by a bleached, pale orange, A2 horizon.

The B horizon consists of non-dispersive, high plasticity, dark brown heavy clay with medium sized blocky peds. Calcareous concretions may be present, and the soil has an alkaline pH. The lower sub-soil is dispersive, brown, heavy clay, grading to weathered sediments or colluvium at approximately 1.0 m depth.

## 3.8 Land suitability assessment

A land suitability assessment of parts of the Wandoan region has previously been conducted by Forster (1985), Slater (1986) and Enviroscience (1992). Forster's assessment was conducted at an LRA scale, and classed the Brigalow Upland soils (with a slope of up to 6%) as arable and the Poplar Box Alluvia soils as marginally arable land. Slater assessed each soil type, classifying land as Classes 2, 3 and 4. Enviroscience's assessment classifies the land covered by the Project as Class 3 and Class 4 land for cropping. The above assessments were conducted prior to the release of Land Suitability Assessment Techniques (Department of Mines and Energy 1995a), and do not meet the current requirements within this guideline.

The land suitability classes for the current assessment were derived from a combination of the identified soil types and geomorphic/topographic position, and not simply a reflection of spatial distribution of the various soils. Tables showing the classes assigned for each criteria are provided in Attachment E. The land suitability class for a soil/landscape position relates to the highest (i.e. poorest) ranking criteria for the assessment.

Land suitability maps of the Project area for dry land cropping and beef cattle grazing are shown in Figure 3-10 and Figure 3-11 respectively.

The findings of this assessment correlate well with the findings of Forster, Slater and Enviroscience, with the Project area mainly classified as Class 3 and Class 4 for dry land cropping.

The soils of Cheshire and Kinnoul, which occur on the upper slopes, have been classified as Class 3 due to high erosion potential by surface runoff and the presence of alkaline subsoils that results in low nutrient availability. Alluvial soils are rated Class 3 due to the potential of flooding.

MLA 50229

MLA 50231

MLA 50230

CULGOWIE

WANDOAN

YEOVIL ROAD

NUMBER FOUR ROAD

PERRETTS ROAD

KABUNGA ROAD

K ROAD

K TWO ROAD

LAGGERS GULLY

ROCHE CREEK

HORSE GULLY

STAKEYARD CREEK

BULLOCK CREEK

BUNGABAN GULLY

NINE MILE CREEK

DUCK CREEK

HORSE CREEK

RYALLS ROAD

BOORAL ROAD

SPRING CREEK

LOG HUT GULLY

MOUNT ORGAN CREEK

GROSMOUNT ROAD

CECILS ROAD

BACK CREEK

FOUR MILE GULLY

LEICHHARDT HIGHWAY

NATHAN ROAD

WALSHS ROAD

BUNGABAN ROAD

ROCHE CREEK ROAD

QUANDAH CREEK

BUNDI ROAD

GROSMONT ROAD

L ROAD

BLACK ANT CREEK

WOLEEBEE CREEK

JACKSON WANDOAN ROAD

WANDOAN CREEK

PARADISE DOWNS ROAD

FRANK CREEK

TWO MILE CREEK

PEAKES ROAD

HALFWAY CREEK

DOWNFALL CREEK

WERINGA CREEK

MIDDLE CREEK ROAD

RANGE GULLY

MUD CREEK

NAIL CAN CREEK

SPLITTER CREEK

Legend

- Towns
- Major creek
- Minor creek
- Major road
- Secondary
- Minor road
- Mining lease application

Land suitability class

- 3
- 4

Source: Roads, QLD State Digital Road Network (2004);
Towns, creeks 1:250K Topo, Geoscience Australia (2006).

J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 3-9 Land suitability classes .mxd

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0 2 4 6 8 10
Kilometres

Figure 3-10
Land Suitablility classes for dry land cropping

MLA 50229
MLA 50231
MLA 50230
CULGOWIE
WANDOAN
YEOVIL ROAD
NUMBER FOUR ROAD
PERRETTS ROAD
KABUNGA ROAD
K ROAD
K TWO ROAD
LAGGERS GULLY
ROCHE CREEK
HORSE GULLY
STAKEYARD CREEK
BULLOCK CREEK
BUNGABAN GULLY
NINE MILE CREEK
DUCK CREEK
HORSE CREEK
RYALLS ROAD
BOORAL ROAD
SPRING CREEK
LOG HUT GULLY
GROSMOUNT ROAD
LEICHHARDT HIGHWAY
NATHAN ROAD
WALSHS ROAD
BUNGABAN ROAD
BACK CREEK
FOUR MILE GULLY
MOUNT ORGAN CREEK
CECILS ROAD
JUANDAH CREEK
ROCHE CREEK ROAD
GROSEMONT ROAD
BUNDI ROAD
L ROAD
BLACK ANT CREEK
WOLEEBEE CREEK
JACKSON WANDOAN ROAD
WERINGA CREEK
MIDDLE CREEK ROAD
WANDOAN CREEK
FRANK CREEK
TWO MILE CREEK
PARADISE DOWNS ROAD
HALFWAY CREEK
PEAKES ROAD
DOWNFALL CREEK
MUD CREEK
NAIL CAN CREEK
SPLITTER CREEK

**Legend**

- Towns
- Major creek
- Minor creek
- Major road
- Secondary
- Minor road
- Mining lease application

**Land suitability class**

- 2

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006).

J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 3-10 Land suitability classes for beef cattle grazing .mxd

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0 2 4 6 8 10
Kilometres

Figure 3-11
Land suitability classes for beef cattle grazing

Downfall, Teviot and Rolleston soils, occurring on the lower slopes, were rated as Class 4 due to high alkalinity within 0.6 m of the soil surface resulting in nutrient deficiency. Some cropping currently occurs within this Class 4 land, however, long term sustainability is limited due to low nutrient and high alkalinity conditions, shallow rooting depth, and heavy application of fertilisers.

Small portions of land on the upper margins of the floodplains with alluvial soils, but impacted by flood to a lesser extent, are considered to be Class 2 land for dryland cropping.

All land in the Project area is considered to be Class 2 for beef cattle grazing.

## 3.9 Good quality agricultural land

In accordance with Section 2 and Attachment 2 of '*The Planning Guidelines: The Identification of Good Quality Agricultural Land*' (Department of Primary Industries and Department of Housing, Local Government and Planning Queensland 1993), agricultural land Classes A, B and C are considered GQAL in the area formerly known as the Taroom Shire local government.

Agricultural land Classes A, B and C are defined as:

- Class A: crop land — land that is suitable for current and potential cropping with limitations to production which range from none to moderate level
- Class B: limited crop land — land that is marginal for current and potential cropping due to severe limitations, and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered for cropping
- Class C: pasture land — land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production, but some areas may tolerate a short period of ground disturbance for pasture establishment.

GQAL mapping of the Project area under the Taroom Shire Planning Scheme, is shown in Figure 3-12, and indicates that all the Project area occurs within the mapped GQAL area. This QGAL distribution is taken from the LRA scale mapping of the area by Foster (1985), and does not take into consideration the variability of soil properties within each LRA identified in the current assessment.

The findings of this land suitability assessment presented in Section 3.8 indicate greater than 'moderate' limitations to dryland cropping for areas over the lower slopes of the Brigalow Upland Soils. Consequently, the findings of this assessment suggest a different distribution of GQAL than the Taroom Shire Planning Scheme, with Class B agricultural land as a more appropriate classification for the lower slopes these areas, and the floodplains and upper slopes being Class A, as shown by land suitability Class 4 and 3 respectively in Figure 3-11.

## 3.10 Soil conservation plans

Soil conservation plans can be developed by the Department of Natural Resources and Water for individual properties or a collection of neighbouring properties to manage water runoff flow. These plans are generally prepared at the request of landowners, and consist of a map and specification for soil conservation measures and practices to control erosion. Plans can also be approved under the *Soil Conservation Act 1986*.

Sixteen properties in the Project area have registered soil conservation plans with the Department of Natural Resources and Water (refer Table 3-9). None of the plans are 'approved soil conservation plans' under the *Soil Conservation Act 1986,* and as such there is no legislated requirement to negotiate any alteration or removal of soil conservation measures on these properties with the Department of Natural Resources and Water. Additional properties may have implemented soil conservation works (e.g. contour banks) without having registered a soil conservation plan.

The soil conservation plans show a preferred, or recommended, layout of soil conservation works used to control erosion, principally on cultivation land; however, the plans may not necessarily reflect what has actually been implemented on the ground.

**Table 3-9: Soil conservation plans**

| Soil Conservation Plan No. | Approved Y/N | Lot/Plan description | Comments |
|---|---|---|---|
| SC345036 | N | Lot 38 CP899702 | |
| SC345024 | N | Lot 29 FT467 | |
| SC345024 | N | Lot 25 FT481 | |
| SC345002 | N | Lot 29 FT490 | |
| SC345034 | N | Lot 34 FT490 | |
| SC345096 | N | Lot 40 FT503 | |
| SC345208 | N | Lot 42 FT505 | |
| SC345033 | N | Lot 53 FT505 | Topography only |
| SC345019 | N | Lot 51 FT507 | |
| SC345001 | N | Lot 50 FT508 | |
| SC345084 | N | Lot 58 FT556 | |
| SC345022 | N | Lot 36 FT575 | |
| SC345228 | N | Lot 37 FT575 | |
| SC345695 | N | Lot 3 FT695 | |
| SC345049 | N | Lot 86 FT782 | |
| SC345034 | N | Lot 35 FT987 | |

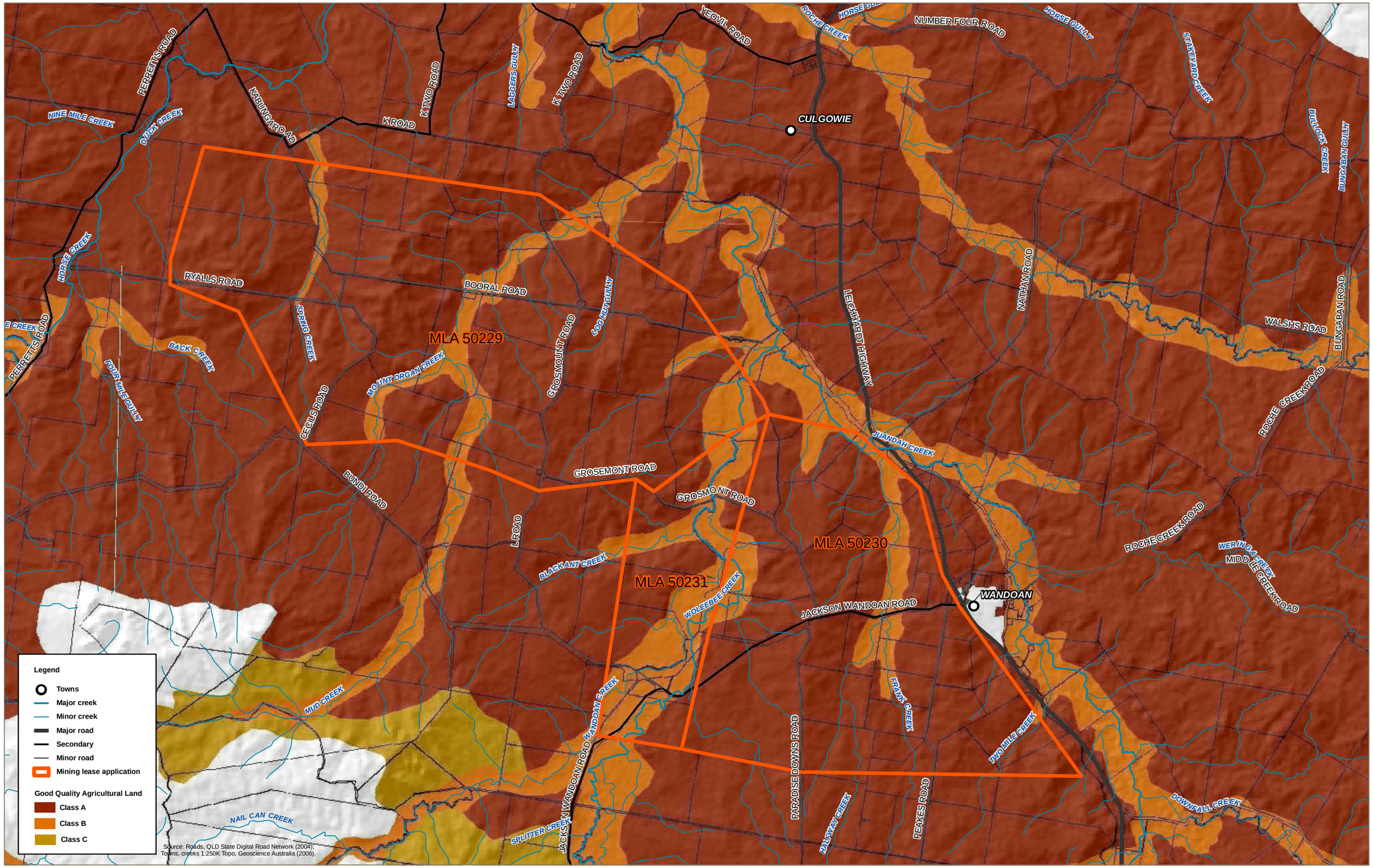


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Figure 3-12

Good quality agricultural land

# 4. Description of proposed development

The Wandoan Coal Project involves the development of fifteen pits over an expected lifespan of 30 years. Mining will occur by strip mining. Overburden will generally be removed by dragline, although some truck and shovel removal may occur. Coal will be removed by truck and shovel.

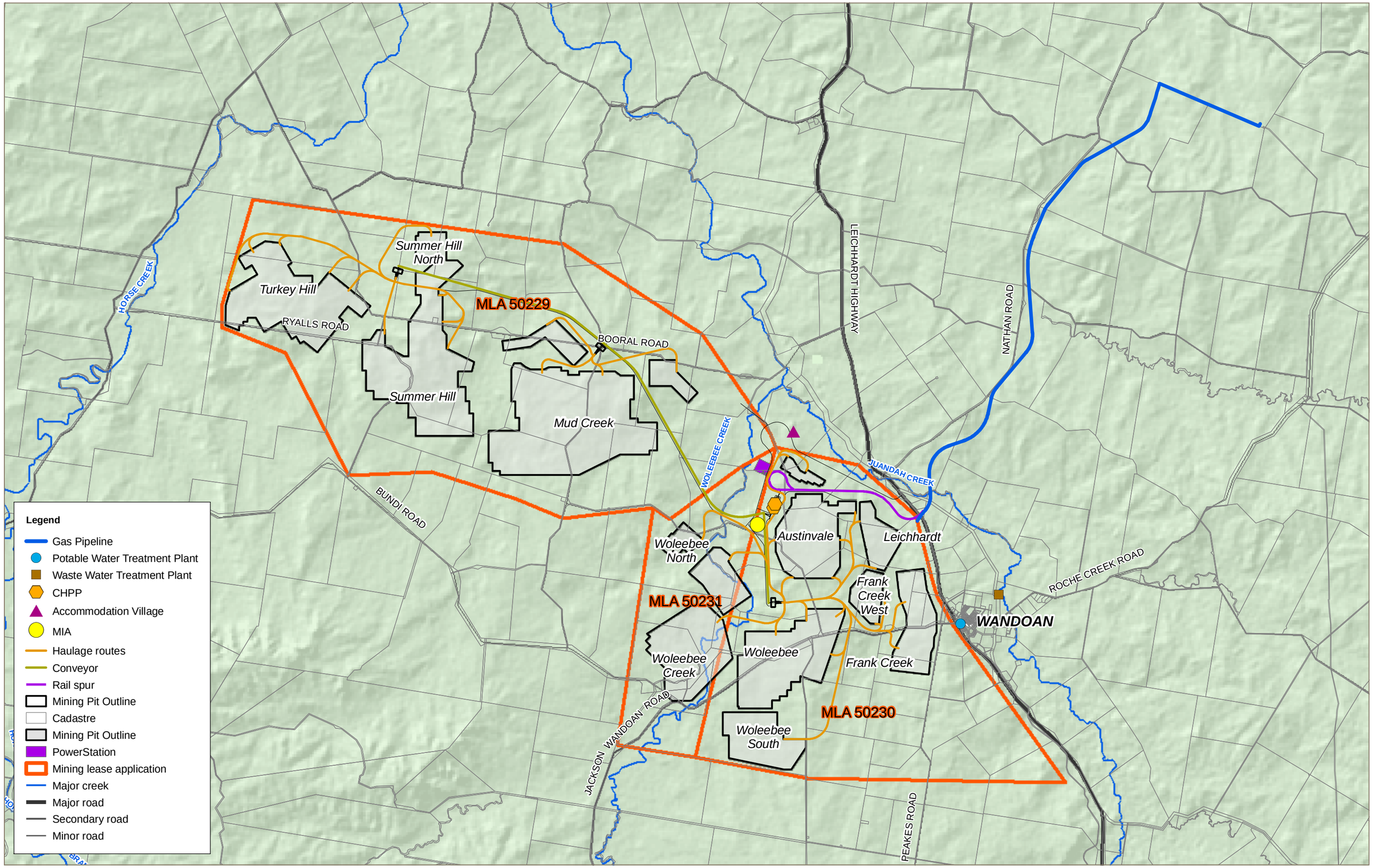
In addition to mine pits, the Project includes various items of infrastructure as described in Chapter 6 of the EIS, and shown in Figure 4-1. Construction of this on-MLA and off-MLA area infrastructure will generally involve topsoil stripping, cutting, filling and benching.

Mining pits will be excavated to a maximum depth of between 25 m and 60 m, dependent upon the depth of the coal seams. Prior to the initial box cut, vegetation will be cleared, and topsoil will be stripped and stockpiled for use in future rehabilitation and revegetation. Initial box-cut strips in each pit are generally proposed to be 60 m wide.

Subsequent mining strips will be approximately 80 m wide, with overburden being placed in the preceding strip void. Partings and course rejects will be used as fill between the overburden stockpiles. Overburden stockpiles will be levelled out and shaped to provide a gently undulating landform. Given the low strip ratios, the final landform is anticipated to be similar to the existing topography, with around 5 m, and a maximum of 25 m increased elevation compared to existing landform. Rehabilitation and revegetation of the landform is anticipated to commence within two years following a pit strip being mined.

Typically a single final void will remain after completion of mining for each pit. The final void will be formed by reducing the outer/boxcut slopes and adjacent overburden stockpiles to a maximum of 15% gradient to infill the void, bringing the pit floor up towards natural topographical surface. Depths of final voids will vary with the volume of material available at each pit for infilling. The proposed landform at Year 30 is provided in Figure 4-2. This landform is not the final landform, as available coal resources is expected to result in mining continuing beyond the term of the mining lease currently being sought for approval. A final landform will be developed for approval by relevant administrative bodies closer to the proposed closure of the mine.

Following the completion of mining of the Austinvale North pit in approximately Year 2, this pit will be used for tailings disposal. Once the Austinvale North pit is filled, tailings placement will occur in the Austinvale Pit, which is expected to have capacity to accept tailings over the remaining life of the mine.



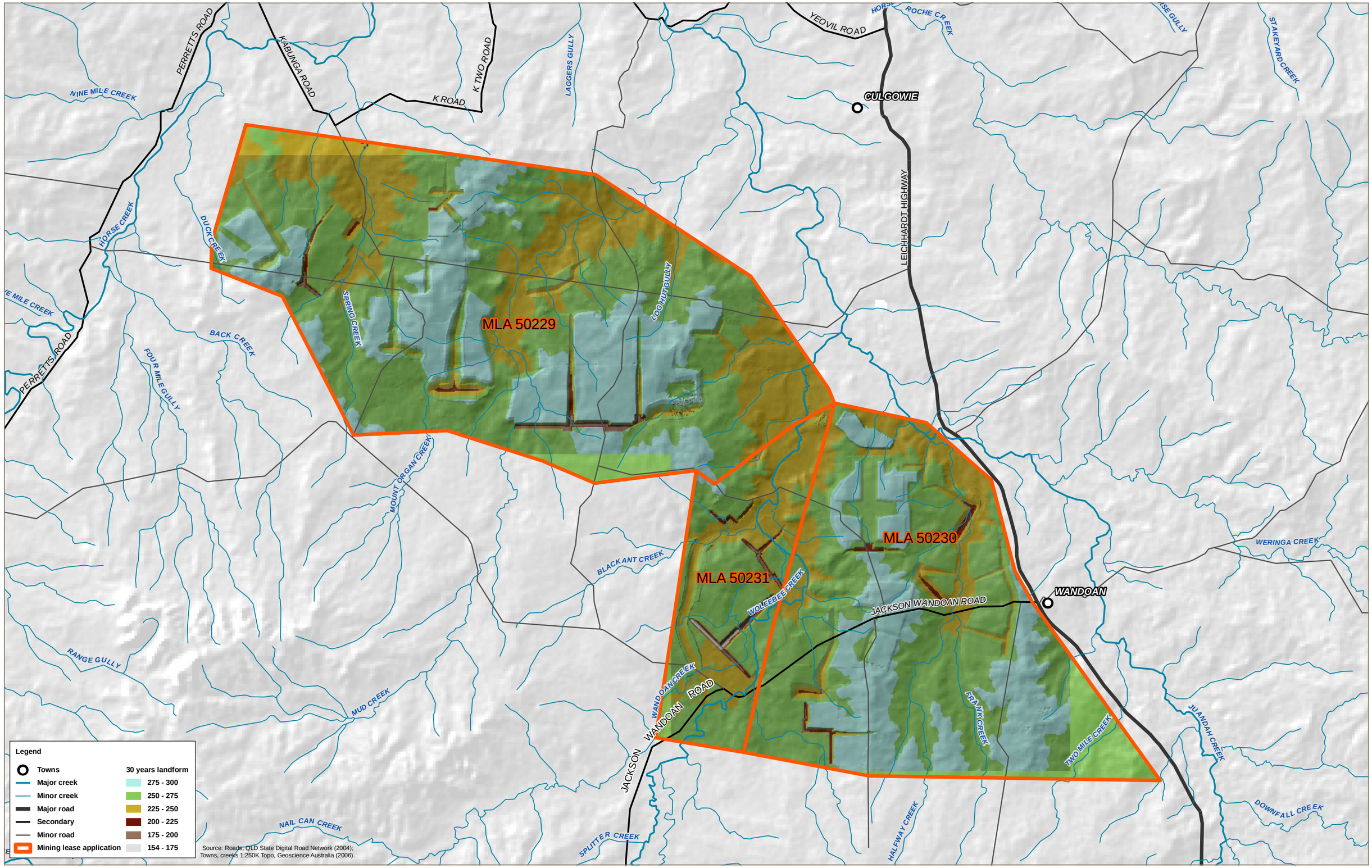

J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 2-1 Test Pit and test bore locations .mxd

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006)

Connell Wagner

0 1 2 3 4 5
Kilometers

Figure 4-1
Proposed Infrastructure and mining pits




PARSONS BRINCKERHOFF

0 2 4 6 8 10
Kilometres

Figure 4-2:
Proposed 30 year landform

# 5. Potential impacts

## 5.1 Topography

As discussed in Section 3.1, the site currently consists of low undulating hills with concave slopes generally less than 4% but with up to 15% gradient for a few upper slopes, and alluvial floodplains varying in width between 500 m and 2 km.

The mining activities will result in topographical changes to the Project area during mine operation and post-mining, through the removal of existing topographical relief during overburden stripping and mining, the creation of new topographic highs through the placement of spoil strips and spoil dumps, and topographic lows in the form of voids. Changes to the location and width of the floodplains will also occur as a result of mining and creek diversions.

## 5.2 Overburden

Overburden and interburden material was assessed for acid mine drainage, heavy metal leaching and erosion potential in relation to mine spoil piles (as stockpile capping or rock cladding layer), and suitability as a sub-soil growth medium in stockpile capping layers.

### 5.2.1 Acid production potential

The overburden and interburden rocks are generally not acid forming material (refer Table 3-1) and therefore not expected to pose a risk of acid mine drainage.

Borehole logs show some coal seams to be pyritic, and layers of overburden adjacent to coal seams could contain pyrite and have a total sulphur content higher than the bulk samples tested. These pyritic layers could produce some acid drainage if they were concentrated near the surface of the spoil. The ANC of the rocks in the spoil is anticipated to neutralise all acid produced by overburden and interburden material as discussed in Section 3.6.1, and therefore the potential impact from acid production is considered very low.

### 5.2.2 Heavy metals

Heavy metal concentrations in all overburden samples tested were below environmental investigation levels (refer Table 3-2 and Table 3-3). The excavation and stockpiling of overburden expected to have low risk of producing heavy metal contamination by leachate seepage or surface runoff from the overburden stockpiles.

### 5.2.3 Growth medium potential

Overburden material was found to have low nutrient and organic matter content. The dispersive nature of the overburden, combined with the low organic matter content, is anticipated to result in a hard setting surface crust. Untreated, this crust will limit seedling emergence and water infiltration and will increase overland surface runoff during rain events increasing the risk of sheet flow and gully erosion.

Glasshouse trials of buffel grass, wheat and siratro on various overburden substrate were conducted by Slater (1986). Slater found that generally, even when nutrient deficiencies were overcome by fertiliser addition, other overburden properties such as moisture holding capacity, pH, salinity and sodicity, remained hostile to plants.

The results of these trials suggest weathered sandstone has similar growth medium potential as subsoils. Fresh sandstone was able to support buffel grass growth when high rates of fertiliser were applied. Fresh and weathered siltstones were found to be poor growth media due to high salinity and alkalinity. Wheat and siratro germination and growth rates were poor on all overburden samples.

Given the findings of these trials, mitigation measures for improving growth medium potential are discussed in Section 6.

### 5.2.4 Dispersion, slaking and erosion potential

When environmental factors (e.g. vegetation cover, climate etc) are equal, the erosion potential of stockpiled overburden is dependent on the chemical and physical characteristics of the material and the topography (natural or created) of the terrain.

As discussed in Section 3.6.3, much of the overburden has high sodium content, and therefore will readily disperse when left exposed on the soil surface or otherwise exposed to water, which will lead to erosion, including tunnel erosion.

The overburden also has medium to high salinity (measured as EC), as discussed in Section 3.6.4. Moderate or higher salinity generally increases erosion potential indirectly by making it more difficult for plants to take on water, thereby reducing establishment and growth rates of some plants (Henderson 2008). The greater the period bare spoil is exposed, the higher its erosion potential.

## 5.3 Uncovering fossil material

There is potential for fossilised material to be discovered during drilling, excavation and mining activities. These activities have the potential to damage or destroy fossils.

Most fossils uncovered by the mining activities will be common. The significance of a fossil is not indicated by the fossil size, with fossils such as budding plants, uncommon plants or insects being of interest to the Queensland Museum. See Section 6.3 of this report which deals with the measures to be implemented upon the discovery of fossil materials.

## 5.4 Soils

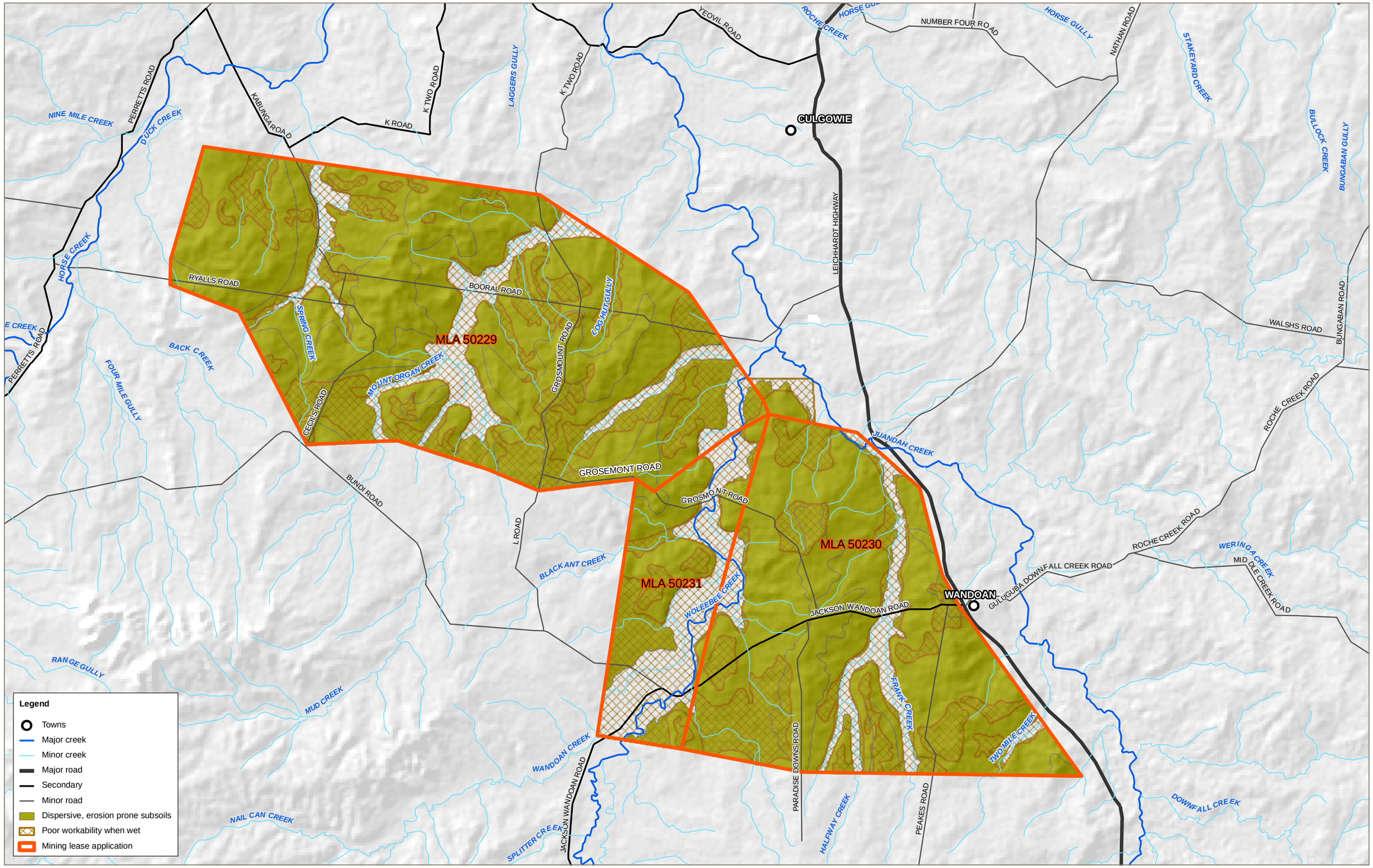
### 5.4.1 Alkalinity, sodicity and dispersivity

Cheshire, Woleebee, Rolleston and Teviot soils have moderate to extreme alkalinity and sodicity within the subsoils and are strongly dispersive. All other subsoil within the Brigalow Uplands LRA can be considered dispersive to a lesser extent (refer Figure 5-1).

Alkaline and sodic soils are generally dispersive, and have high erosion potential if exposed (refer Photo 5-1 and Photo 5-2). Sodic, alkaline soils are also poor plant growth mediums due to low nutrient availability, and should not be used as such in rehabilitation of disturbed

areas. The topsoil portion of these soils, as shown in Photo 5-1, is suitable for use in rehabilitation.

**Photo 5-1: Tunnel erosion in dispersive soils on the bank of an ephemeral drainage line near WS09**




J:\A442-ENG\PROJ\2133006C__Wandoan_prefea\10_GIS\Projects\Env\Technical Report\Figure 5-1 Soil management considerations.mxd

Source: Roads, QLD State Digital Road Network (2004); Towns, creeks 1:250K Topo, Geoscience Australia (2006).

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0 1 2 3 4 5
Kilometers

Figure 5-1
Soil management considerations

### 5.4.2 Erosion

All soils in the Project area will be subject to erosion if vegetation is removed and rehabilitation is not undertaken within an appropriate timeframe.

Soils most susceptible to wind erosion are soils with sandy or loamy topsoils, which include the alluvial soils of Woleebee and Retro.

Soils most susceptible to erosion by flowing water are those with dispersive (sodic) topsoil or upper subsoil as discussed in Section 5.4.1 above. Soils on steep and moderate upper slopes, as occur on the undulating terrain and spoil piles, have higher risk from erosion by water than soils on gentle slopes and floodplain.

Exposure of dispersive subsoils as described in Section 5.4.1 has the potential to cause gully erosion problems, even if only small areas of subsoil are exposed. Photo 5-2 illustrates gully formation on a gentle slope due to water runoff over dispersive soils. After initiation of erosion, for example after vegetation removal or ground disturbance, this erosion will continue to expand upslope and expose more dispersive soils.

**Photo 5-2: Gullyhead erosion caused by exposure of dispersive soils in drainage line on a gentle slope near WS26**

### 5.4.3 Salinity

Soil salinity in the Project area is of limited extent and is not considered a high risk. However, the subsoils of Cheshire, Teviot and Woleebee are moderately to highly saline and changes to the soil moisture regime due to vegetation removal or other impacts may increase near surface soil salinity.

## 5.5 Land use suitability

During the operation of the mine, existing land uses, such as cattle grazing and broad acre cropping, may be able to continue within the MLAs in areas not directly impacted by mining. Areas required for the operation of mining and associated activities will be excluded from agricultural purposes during the operation of the mine.

Land disturbed by mining will be rehabilitated following mining. Without mitigation measures, long term impacts to the land suitability classes, as defined in Section 3.5, are expected as follows:

- undisturbed land will be returned to (or retained in) its pre-mining land suitability class
- land used for infrastructure components of the Project (roads, MIA, etc) will have limitations related to water availability (through compaction and breakdown of the subsoil structure), and will generally be Class 4 cropping land or Class 3 cattle grazing land
- spoil stockpiles and tailings dam sites will have limitations related to water availability, salinity, gradient, erosion and nutrient content, and will generally be Class 5 cropping land or Class 4 or 5 grazing land
- final voids will be unsuitable for agricultural use (e.g. Class 5 for cropping and cattle grazing).

Planned rehabilitation and mitigation measures to obtain better land suitability classification are detailed in Section 6.

# 6. Mitigation measures

## 6.1 Topography

The design of the post-mining landform should consider, and where practicable replicate, the topographic elements discussed in Section 3.1 of this report. This does not infer that the topography should be returned to the pre-mining profile, but where hills (e.g. overburden dumps) are formed, they should be constructed to a similar height, slope angle and profile (shape) as occur naturally in the area, and if floodplains are formed as part of the final landform, they should be of similar width and slope angle to those in the Project area pre-mining if practicable. In general, these measures can be described as:

- concave slope profile
- average slope gradients of around 4% (the erosion potential of longer slopes will need to be considered)
- irregular dump shapes (e.g. with uneven heights, ridgelines and spurs)
- spoil dump relief (height) of up to 50 m between the floor of the floodplain and the hill crest
- less than 2% gradient in floodplains.

## 6.2 Overburden

### 6.2.1 Acid production potential

As discussed in Section 5.2.1 of this report, there is a low to negligible risk of development of acid mine drainage from the overburden and interburden. Despite this, the following measures should be implemented:

- laboratory characterisation of selected samples of overburden material should be conducted during overburden stripping to confirm the acid generation potential prior to removal. This characterisation should be in accordance with the *Assessment and Management of Acid Drainage* (Department of Primary Industries 1995)
- coal coarse rejects should be fully characterised and a management strategy for this material developed with regards to potential acid production potential
- layers of coal roof and floor material, partings, coarse coal rejects and any material that is visually assessed at the time of mining as containing pyrite, should be assessed for acid producing potential prior to placing within the spoil pile
- layers of coal roof and floor material, partings, coarse coal rejects and any material that is visually assessed at the time of mining as containing pyrite should not be placed near the surface of spoil stockpiles unless laboratory testing confirms that the material is non acid forming and
- any potentially acid forming material, as identified by visual assessment or laboratory characterisation, should not be used as capping material and should be buried within the waste rock dump together with waste rock that has a positive acid neutralising capacity.

### 6.2.2 Growth medium potential

As discussed in Section 5.2.3, the overburden was found to generally be a poor growth medium, but weathered and fresh sandstone has some limited potential to be used as a subsoil media to provide cover of spoil and bedding to topsoil. The following measures should be implemented in regard to overburden as growth medium:

- the use of overburden material as a topsoil should be avoided
- overburden should be capped with subsoil and topsoil prior to revegetation
- spoil dominated by siltstone and mudstone overburden should not be used as a subsoil media or placed within the rooting zone of plants
- field trials should be conducted to determine minimum topsoil cover over overburden which will provide a suitable growth medium for recommended plant communities
- further field trials should be held into the suitability of fresh and weathered sandstone as a subsoil material.

### 6.2.3 Dispersion

As discussed in Section 5.2.4, much of the overburden was found to be dispersive and erosion prone. The following measures should be implemented in regard to overburden:

- testing of dispersion and slaking potential should be conducted during overburden stripping. Less dispersive overburden should be managed for use as capping material
- appropriate designs and locations for spoil pile erosion and drainage control measures should be established based on the results of dispersion and slaking testing, spoil management plans, and through the use of drainage and erosion potential trials. Designs may include the use of ‘durable rock’ lined drains, or the encouragement of water infiltration into the spoil piles (subject to overburden characteristics)
- due to the potential susceptibility of the overburden to tunnel erosion, the detailed design and management of benches and/or contour banks on spoil slopes should consider this risk, and should be undertaken by a suitably qualified person
- trials at varying slope angles should be conducted in relation to erosion from dispersion and slaking. These trials will assist in establishing suitable final landform gradients
- sediment control structures should be used to control surface runoff from all rehabilitated and disturbed areas to reduce the amount of final sediment loads. An assessment of available technologies should be undertaken prior to selection of sediment control structures
- all out of pit spoil piles should be shaped, topsoiled and re-vegetated to reduce potential for concentration of surface runoff and erosion of spoil material
- rehabilitation strategies should be monitored and adjusted as required to reduce the risk of spoil erosion and destabilisation of spoil stockpiles.

## 6.3 Uncovering fossil material

As discussed in Section 5.3 of this report, there is potential for fossils to be located during mining activities. In the event potentially significant fossilised material is located, the following measures should be implemented:

- fossils can be sent to the Queensland Museum Geosciences unit for identification (Dr Sue Parfrey 2007, per. comm., 25 October 2007)
- if potentially significant fossils, such as large dinosaur bones, are discovered during mining activities, then work in the vicinity of the find should stop, to preserve the potential fossil, while the Queensland Museum is immediately alerted to the find.

## 6.4 Soils

### 6.4.1 Dispersivity and erosion

As discussed in Section 5.4.2 of this report, Cheshire, Woleebee, Rolleston and Teviot soils have moderate to extreme alkalinity and sodicity within the subsoils and are strongly dispersive. All other subsoils within the Brigalow Uplands LRA can be considered dispersive to a lesser extent, and all soils will erode if vegetation is removed and rehabilitation is not undertaken within an appropriate timeframe (refer Figure 5-1). Generally wind and water erosion control measures should be applied to all soils in the Project area, which include:

- a sediment and erosion control plan should be prepared and implemented prior to the commencement of construction and mining, specifying the locations and types of sediment and erosion control measures to be used
- design of all drainage around proposed structures and permanent landforms should consider the presence of dispersive soils and apply suitable erosion reduction methods. All disturbed areas should be revegetated, or covered with material that has low erosion potential, to minimise the potential for erosion
- for disturbed or cleared land, including infrastructure areas:
  - unnecessary exposure of alkaline or sodic subsoils (e.g. Cheshire, Woleebee, Rolleston and Teviot) should be avoided, and should be limited to the minimal amount of time practicable. Any exposure should be covered with non-dispersive soil or other suitable material to minimise the infiltration of water into these soils. Sub-soils from these areas should be buried within the spoil stockpiles and covered in accordance with site spoil management procedures
  - clear the minimal amount of vegetation (including grass cover) required for Project works
  - minimise disturbance of the ground layer of vegetation by controlled operation of machinery and equipment selection
  - site drainage, erosion and sediment controls should be implemented and in place prior to, or as soon as possible, following the removal of vegetation
  - water runoff should be directed around topsoil stockpile areas using diversion bunds, contours, and catch drains as appropriate
  - divert clean water away from disturbed areas
  - revegetate exposed soils as soon as practical after works have been completed. This includes the rehabilitation of spoil dumps
  - use watering trucks during windy conditions for dust suppression

- install erosion and sediment control measures on disturbed natural or constructed slopes to minimise erosion and sediment released into waterways. This is especially important for soils with dispersive subsoils (e.g. Cheshire, Woleebee, Rolleston and Teviot).

- for infrastructure areas:
  - a sediment and erosion control plan should be prepared for each area of infrastructure to be constructed. This plan should specify the locations and types of sediment and erosion control measures to be used
  - minimise areas cleared during earthworks, by delineating areas to be cleared with survey markers or other suitable marking
  - install sediment traps and silt fences or other suitable sediment control measures where appropriate
  - confine traffic to maintained roads
  - minimise slope grade within infrastructure areas where possible based on results of geotechnical data obtained during detailed design phase
  - construct hardstands from erosion resistant material
  - install scouring protection works in drains and intensely gullied areas adjacent to proposed infrastructure
  - revegetate disturbed areas surrounding infrastructure sites
  - control drainage and divert away from infrastructure.
- for stockpiles:
  - long-term stockpiles of topsoil and overburden should be planted with vegetation to minimise entrainment of soil particles into the air and minimise erosion through raindrop impact
  - when areas with topsoil susceptible to wind erosion (e.g. Woleebee and Retro) are stripped and stockpiled, even if for only a few months, the stockpiles should be covered by grass, other vegetation, geofabric or less erosive topsoil to minimise wind erosion
  - divert clean water from areas upslope of all topsoil, subsoil and spoil stockpiles around stockpile areas using contour banks or diversion channels, thereby reducing water flowing into the stockpile area
  - all topsoil, subsoil and spoil stockpiles should be bunded by earthen bunds or similar, with sediment traps or similar features installed downslope of stockpiles to prevent eroded sediment entering waterways.
- dispersive, clayey soils are suitable for use as embankment materials for water management structures, provided strict construction quality control measures are implemented
- gypsum or lime should be used in the treatment of sodic alkaline soils to improve geotechnical characteristics.

### 6.4.2 Salinity

As discussed in Section 5.4.3 of this report, high salinity levels are toxic to many plant species, and rehabilitation of saline soils can be difficult and costly. The following measures should be applied in relation to soil salinity:

- the topsoil of Teviot is saline and generally should not be used as a topsoil layer in rehabilitation. Should this soil be used in rehabilitation, it will require the use of salt tolerant vegetation species
- the subsoils of Cheshire, Teviot and Woleebee are saline and should be buried within spoil stockpiles and covered with materials that are more stable. The subsoils of Cheshire and Woleebee should not be used in rehabilitation.

### 6.4.3 Compaction

The compaction of soil increases the potential for rainwater induced erosion, and reduces seed germination and root establishment of vegetation. The following measures should be applied in relation to compaction:

- compaction of topsoil can be reduced by selection of appropriate earthmoving machinery when working with these soils (i.e. light weight vehicles with large wheel/track size)
- soils that will be trafficked or compacted during the operation of the mine should have water control and sediment containment measures installed to minimise potential erosion and sediment entering into waterways
- previously compacted areas that are to be rehabilitated should be remediated by ripping the top layer of soil/overburden material, and then applying layers of subsoil and topsoil as required to establish a suitable plant growth environment. The depth of ripping/reworking required is dependent on the impact, and should be assessed at the time or rehabilitation
- ripping the top layer of soil breaks down the soil structure, and as a result protection of these areas from re-compaction (i.e. vehicles or grazing animals) after ripping is required to allow the soil structure to reform.

### 6.4.4 Topsoil reuse

Topsoils and subsoils are anticipated to be stripped from all disturbed areas and should be stockpiled for use in rehabilitation of disturbed areas. Suggested stripping depths and identified constraints for various encountered soil types are provided in Table 6-1 below.

**Table 6-1: Topsoil stripping depths and potential constraints for reuse**

| Soil type | Surface soil composition | Topsoil stripping depth (m) | Subsoil stripping depth (m from surface) | Potential constraints |
|---|---|---|---|---|
| Cheshire | Light clay | 0.4 | — | ▪ highly alkaline and saline subsoil<br>▪ dispersive subsoil |
| Kinnoul | Clay | 0.3 | 0.5 | ▪ low nutrient availability in topsoil<br>▪ dispersive subsoil<br>▪ shallow soil depth |
| Downfall | Clay | 0.15 | 0.5 | ▪ shallow topsoil depth<br>▪ dispersive subsoil |
| Teviot | Clay | 0.2 | 0.6 | ▪ dispersive subsoil<br>▪ moderately alkaline and saline |
| Rolleston | Clay | 0.2 | 0.6 | ▪ alkaline<br>▪ topsoil potentially dispersive<br>▪ dispersive subsoil |
| Juandah | Clay | 0.1 | 1.0 | ▪ dispersive A2 horizon<br>▪ poor workability when wet |
| Woleebee | Silty loam | 0.15 | — | ▪ shallow topsoil depth<br>▪ dispersive topsoil and subsoil<br>▪ highly alkaline and saline subsoils<br>▪ low nutrients and organic matter<br>▪ poor workability when wet |
| Retro | Clay loam | 0.15 | 1.0 | ▪ shallow topsoil depth<br>▪ poor workability when wet |

An estimate of the volumes of topsoil available on site for use in rehabilitation is provided in Table 6-2, based on the predicted area of disturbance occurring within each soil association (refer Section 3.7.2 for a definition of the soil associations). Topsoil stripping may be affected by localised topographic constraints such as incised gullies and shallow soil depth, especially in the upper slope area of the undulating terrain. However, it is anticipated that most topsoil from the proposed disturbed areas will be recovered and will be available for use in rehabilitation of disturbed areas. Based on experience from other similar projects and field observations the calculated volumes have been reduced by 20% to account for topographic or other restriction on winning of topsoil.

**Table 6-2: Topsoil availability**

| Soil association | Surface composition | Topsoil stripping depth (m)* | Subsoil stripping depth (m)* | Approximate volume of topsoil available ($m^3$) | Approximate volume of subsoil available ($m^3$) |
|---|---|---|---|---|---|
| Brigalow uplands cracking clays (Downfall, Teviot, Rolleston) | Clay | 0.2 | 0.6 | 1,107 | 3,320 |
| Brigalow uplands non-cracking clays (Cheshire, Kinnoul) | Clay to light clay | 0.3 | 0.6 | 993 | 1,986 |
| Poplar box alluvia uniform soils (Juandah) | Clay to clay loam | 0.15 | 1.0 | 57 | 378 |
| Poplar box alluvial texture contrast soils (Woleebee, Retro) | Silty loam | 0.15 | 1.0 | 105 | 700 |
| **Total** | | | | **2,261** | **6,383** |

Note: * Topsoil and subsoil depths provided in the table are indicative only for the soil associations. The stripping of soil should be based on the soil depths provided in Table 6-1.

Considering the topsoil and subsoil properties and volumes identified above, the following measures should be applied in relation to topsoil:

- topsoil should be stripped separately from subsoil and stockpiled during clearing
- topsoil should be stored in stockpiles no more than 2 m–3 m high to retain seed germination potential (EPA 2001)
- topsoil should be stored for the shortest period practicable, and/or reused as soon as possible to maximise the retention of the seed bank in the soil
- the placement of topsoil should consider the landscape position the topsoil was stripped from, with soils of the undulating topography (Brigalow uplands cracking clays and non-cracking clays), used on slopes and hilltops, and the alluvial soils (Juandah, Woleebee and Retro) used in lower slopes and areas where water accumulation may occur
- the stripping of topsoil should be incorporated into a 'permit to disturb' system to ensure suitable topsoil and subsoil are salvaged prior to disturbance
- a site topsoil register should also be developed for the Project, recording the locations and volumes of topsoil stockpiles.

### 6.4.5 Soil conservation plans

As discussed in Section 3.10 of this report, no approved soil conservation plans are present in the Project area. Although there are no approved plans, the following measure should be undertaken in regard to existing soil conservation measures:

- existing soil conservation measures should be retained and maintained where they currently exist and the land is not required for mining activities.

## 6.5 Construction materials

Mine infrastructure works will include water management structures (dams, levees etc.), haul roads, and a mine infrastructure area. Most of these structures will require embankment and bulk fill material, but material quality requirements range widely.

Embankment materials for water management structures should generally have high clay content, intermediate plasticity and low dispersibility. Bulk fill for roads and industrial structures will require physical characteristics that would make them withstand loads and remain durable in service.

Alluvial soils encountered to about 2 m–3 m depth, and potentially present to greater depths along the creeks, comprise clay, silty and sand with minor gravel. Field observations indicate that the near surface sandy and silty clays of this sequence are of high plasticity and potentially high shrink-swell potential.

Residual soils encountered on the lower slopes in the undulating terrain were generally pale grey or pale brown silty/sandy clays of intermediate plasticity and high dispersion potential (Photo 5-1).

Clayey soils with a liquid limit less than about 70% and low to moderate dispersion potential (Emerson class number 4 or higher) could be considered for dam and levee embankment construction.

Based on available data, the alluvial soils are considered more suitable than the residual soils for water retaining structures, as they are less likely to be dispersive. Physical and chemical characteristics of soils considered for these structures will need to be confirmed for each potential borrow area.

Interbedded sandstone and siltstone excavated from road cuttings and quarried from number of pits in the area, is used by local authorities for construction of sealed and unsealed road. This material that occurs throughout the site appears to be suitable for use as bulk fill and sub-base for sealed roads, hardstands and pads. It is not considered suitable for use as base layer for sealed roads or trafficking layer of unsealed roads due to the presence of high plasticity fines, low durability of gravel fraction and estimated relatively low California bearing capacity (CBR) value (PB 2007). Base quality pavement materials are expected to be sourced off-site from third parties.

## 6.6 Post mining land use

Post mining land uses are proposed to generally consist of beef cattle grazing and nature conservation. The post mining land suitability classes proposed to be established for this Project at a minimum are:

- undisturbed land returned to (or retained in) its pre-mining land suitability class, and should be able to be used for beef cattle grazing or dry land cropping as existed prior to mining
- land used for infrastructure components of the Project (roads, MIA etc) should be returned to Class 4 cropping land or Class 3 grazing land, and generally be able to be used for beef cattle grazing

- spoil stockpiles and tailing dam sites be returned to Class 4 cropping land or Class 3 grazing land, and generally be able to be used for low stock rates of beef cattle grazing, or alternatively for nature conservation
- final voids will be unsuitable for agricultural use (e.g. Class 5 for cropping and cattle grazing), and should be investigated for alternative beneficial uses such as wetlands or recreational facilities.

The general parameters that need to be met to achieve land suitability Class 4 for cropping and Class 3 for cattle grazing are presented in Table 6-3. These parameters have been extracted out of Department of Mines and Energy guidelines (1995a), and are not site specific or a complete list of parameters required to be met to obtain land use suitability. Site specific studies and trials should be conducted to confirm appropriate parameters.

**Table 6-3: General limitations for Class 4 cropping and Class 3 beef cattle grazing**

| Limitation | Cropping | | Beef cattle grazing | |
|---|---|---|---|---|
| | Class 3 | Class 4 | Class 2 | Class 3 |
| Water availability | PAWC 100–125 mm | PAWC 75–100 mm | PAWC 100–125 mm | PAWC 75–100 mm |
| Nutrient deficiency | Bicarbonate P 5–10 ppm and Exchangeable K ≤0.3 meq. % or pH <5 60–90 cm below surface or pH >9 60–90 cm below surface | Bicarbonate P <10 ppm and Exchangeable K ≤0.3 meq. %, and Exchangeable Ca <3 meq.%, or pH <5 30–60 cm below surface, or pH >9 30–60 cm below surface | Eucalypt vegetation and downs with Bicarbonate P >10 ppm | Bicarbonate P 5–10 ppm except sands and loams at least 75 cm deep or overlying rock at shallow depth |
| Salinity | Rootzone EC 0.3–0.9 mS/cm or Rootzone Cl 600–900 ppm | Rootzone EC 0.9–1.2 mS/cm, or Rootzone Cl 900–1,500 ppm | Rootzone EC 0.15–0.3 mS/cm or Rootzone Cl 300–600 ppm | Rootzone EC 0.3–0.9 mS/cm or Rootzone Cl 600-900 ppm |
| Rockiness | 20–50% surface cobble (6–20 cm diameter) and rock outcrop | 50–90% surface cobble and rock outcrop, or 20–50% stone and boulders (>20 cm diameter) | 20–50% coarse surface gravel and rock outcrop | 50–90% surface cobble and rock outcrop |
| Water erosion | Slopes 1–3% on cracking clays or Slopes 2–4% on non-sodic rigid soils or Slopes 1–2% on sodic rigid soils | Slopes 3-5% on all cracking clays or Slopes 4–6% on non-sodic rigid soils or Slopes 2–3% on sodic rigid soils | Slopes 1-3% on sodic rigid soils or Slopes 3–6% on cracking clays, or Slopes 3–12% on non-sodic rigid soils | Slopes 3–6% on sodic rigid soils or Slopes 6–9% on cracking clays, or Slopes 12–20% on non-sodic rigid soils |

Source: After Department of Mines and Energy 1995a

Expected changes in pre- and post-mine land suitability areas for the Project site are shown in Table 6-4 below, based on the areas of disturbance and post-mining land classes discussed above. The areas of pre and post mine land suitability classes are approximations only as rehabilitation methods will impact the land suitability, and the mine layout may be further refined during the detailed design process.

**Table 6-4: Estimated pre- and post-mine land suitability areas**

| Land suitability class | Estimated area of land | | | |
|---|---|---|---|---|
| | Pre-mining dry land cropping (ha) | Post-mining dry land cropping* (ha) | Pre-mining beef cattle grazing (ha) | Post-mining beef cattle grazing* (ha) |
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 32,191 | 19,793 |
| 3 | 12,564 | 4,833 | 0 | 10,946 |
| 4 | 19,627 | 25,906 | 0 | 0 |
| 5 | 0 | 1,452 | 0 | 1,452 |

Note: * assume 30 year mine life

Comparing pre and estimated post mine land suitability class areas, the largest reduction will occur from Classes 3 and 4, for dry land cropping to Classes 4 and 5, with approximately 1,452 ha of Class 5 land. For beef cattle grazing there will be a reduction in land class from Class 2 to Class 3 with the total estimated area of Class 5 land the same as for dry land cropping. The anticipated changes for beef cattle grazing are considered acceptable as the land area will remain largely available for the activity for which it is considered suitable at present.

Land currently classified as Class 3 for dry land cropping, which will be disturbed by mining operations, will not be suitable for cropping in the post mine period but will largely be suitable as pasture land, therefore remaining in agricultural use.

If the Project is wholly or partially aimed at a returning land to an agricultural post-mining land use, returning the land to Class 4 cropping or Class 3 beef cattle grazing will result in a lower value land use, and so would not be an ideal outcome under the rehabilitation strategy. If agricultural land-use is part of the rehabilitation strategy then activities should aim to return land occupied by infrastructure and low gradient stockpile slopes to Class 3 cropping or Class 2 beef cattle grazing. Limitations that need to be met to obtain this land suitability are contained in Table 6-4. Site specific investigations will need to be undertaken to define whether these limitations can practically be developed for the final landform as the Project progresses.

Ideally, where the landform and the land class limitation characteristics can be met, the preferred post mining land uses proposed to be established are:

- land used for infrastructure components of the Project (roads, MIA etc) should be returned to Class 3 cropping land or Class 2 grazing land, and generally be able to be used for beef cattle grazing

- flatter gradient sections of spoil stockpiles and tailing dam sites should be returned to Class 3 cropping land or Class 2 grazing land, and generally be able to be used for beef cattle grazing. Steeper gradient spoil slopes should be used for nature conservation.

As an alternative to returning the post-mine land use to agricultural purposes, a nature conservation land use could be adopted. The establishment of native vegetation would be easier to establish, result in a lower maintenance and a lower erosion risk, and have higher potential to become sustainable. A nature conservation land use would result in a reduction in a net loss of Class B agricultural land in the region. Nature conservation land use should be further investigated for final slopes above 20% gradient.

## 6.7 Final landform design

The Project rehabilitation design for the outer/boxcut spoil slopes, low wall of the final voids, and highwall slopes should be based on the recommendation of a suitably qualified person to reduce the risk of long term geotechnical instability.

### Final voids

Final mining voids will exist as part of the post-mining landform. It is estimated that fifteen void areas will be present at Year 30, occupying approximately 1,452 ha. The banks of the final void (i.e. the highwall, lowwall and endwalls) will be reshaped to achieve long term geotechnical stability.

The final voids are not proposed to be used for agricultural purposes, due to steep gradients and potential to fill with water, but may be used for nature conservation or other beneficial uses such as wetlands or recreational facilities. Final landform slopes greater than 20% should be vegetated with native vegetation, based on Department of Mines and Energy guidelines (1995a).

The coal seam should be covered using pre-strip overburden from adjacent overburden stockpiles. Voids should be partially filled.

The final slope gradients of each void, including the outer boxcut spoil slopes, low wall of the final voids, and highwall slopes should be assessed and recommended by a suitably qualified person based on the risk of long term geotechnical instability. The assessment can be based on the preliminary investigations undertaken by Golders Associates (2008), and should consider the implications of the final voids filling with water, and the proximity of final voids to creek and drainage lines.

### Infrastructure areas and roads

Following decommissioning, infrastructure areas and roads should be returned to the pre-mining landform where practicable. Where this is not practicable, bench cuts should be removed and any steep grades reduced, and the landform returned to a similar profile of landforms in the region (as defined in Section 3.1).

The post mining land use of areas containing infrastructure or roads is proposed to be beef cattle grazing and dry land cropping, as occurs in the area pre-mining. The Project should therefore aim to return infrastructure areas to the same land suitability class as existed pre-mining, or at a minimum, one land suitability class less than the existing pre-mining class.

### Spoil dumps and tailing disposal facilities

Spoil dumps should be progressively rehabilitated over the life for the mine, and rehabilitation should commence within two years of the land becoming available for rehabilitation. The tailings disposal facilities should be rehabilitated within two years of reaching capacity and no longer being required for tailings disposal. Spoil dumps and tailings disposal facilities should be reshaped to stable landforms in accordance with Section 6.1, and considering Table 6-3 and Table 6-4. Generally the final gradient should be less than 15%.

The post mining land use of spoil dumps and tailings disposal facilities is proposed to be beef cattle grazing, with native vegetation on steeper slopes and other areas in which trials show cattle grazing to be unsustainable.

Spoil dumps should aim to be returned to the highest available land suitability class applicable for the given slope gradient, as outlined in Section 6.5.2. This will be Class 2 to Class 4 grazing land, or Class 3 to Class 5 cropping land, dependent on slope gradient.

Final landform slopes greater than 20% should be vegetated with native vegetation.

### Creek diversions

Creek diversions will be retained following mine closure. The initial design of the creek diversion structures has incorporated stability and long term sustainability requirements, and ongoing monitoring during operation of the mine, as detailed in Chapter 11 of the EIS and associated technical reports. At the conclusion of mining, the creek diversions should be left in a stable and sustainable condition in line with the requirements.

## 6.8 Rehabilitation

Rehabilitation is an integral part of the mine closure operation that commences at the start of the mining operation. As such, rehabilitation requirements must be addressed during the construction, operation and closure phases of the Project. Rehabilitation should be planned and undertaken in accordance with Guideline 18 Rehabilitation requirements for mining projects (EPA 2008) and as detailed below.

### 6.8.1 Rehabilitation hierachy

The Queensland Environmental Protection Agency has developed a rehabilitation hierarchy (EPA 2008). The rehabilitation hierarchy, in order of decreasing capacity to prevent or minimise environmental harm is:

1. Avoid disturbance that will require rehabilitation.
2. Reinstate a ‘natural’ ecosystem as similar as possible to the original ecosystem (where the project is occurring on previously natural vegetated land).
3. Develop an alternative outcome with a higher economic value than the previous land use.
4. Reinstate the previous land use (e.g. grazing or cropping).
5. Develop lower value land use.
6. Leave the site in an unusable condition or with a potential to generate future pollution of adversely affect environmental values.

Generally, strategies lower on the list will have a higher risk of causing environmental harm after the mine closes. However, a 'lower value' land use may be more sustainable in preventing off-site impacts. Leaving the site in an unstable condition or with potential to cause environmental harm will rarely be acceptable.

### 6.8.2 Rehabilitation and decommissioning strategy

Rehabilitation and decommissioning should be undertaken in accordance with Xstrata Coal's Mine Closure Planning Policy (HSEC STD3.1). The objective of rehabilitation and decommissioning is to leave the site in a clean and safe state that is sustainable and appropriate for the intended post mine use. Decommissioning must address the progressive rehabilitation of redundant infrastructure and plan for the complete rehabilitation of the residual infrastructure when coal production ceases. A decommissioning plan is recommended to be developed to address the relevant issues that will be encountered by the mine as detailed in Chapter 25 of the EIS.

#### Rehabilitation objectives

Over the life of the mine operations, detailed rehabilitation objectives should be established and maintained through consultation with the community and stakeholders, including the Environmental Protection Agency, and the Department of Natural Resources and Water. The rehabilitation objectives, and progress against these objectives, should be included in the Project's Plan of Operations.

The overriding mine close objective for the Proponent is 'to attain operationally and economically feasible closure while taking into account community priorities, environmental aspects and sustainability of not only the rehabilitation but the final land use' (May and Tiedt 2008).

The broad rehabilitation objectives related to soil, overburden and landform management for the Project are to:

- establish a permanent, stable, self sustaining vegetation complex to support the agreed post mining land use
- to create a stable landform with rates of soil erosion not exceeding the pre-mine conditions
- maintain downstream water quality, during the construction, operational and post operation phases of the Project.

#### Rehabilitation indicators

Rehabilitation indicators provide an auditable means of measuring progress towards the rehabilitation objectives. The following indicators are proposed for the Project in relation to soil and overburden properties and final landform:

- slope angle, length and profile
- rate of soil loss
- chemical properties of topsoil and growth medium within plant rooting depth (e.g. pH, salinity, sodicity, trace elements, nutrients)
- upstream and downstream surface and ground water quality (e.g. sediment load, pH, heavy metal content)

- physical properties (e.g. depth of topsoil, water infiltration, slope gradient, crusting)
- vegetation cover comparable to desired and agreed land use
- weed cover
- rehabilitation progress and success rate
- achievement of agreed final land use
- ongoing sustainability of agreed final land use.

### 6.8.3 Rehabilitation strategies

Ongoing rehabilitation should be undertaken in accordance with Xstrata Coal's Mine Rehabilitation Review Procedure (HSEC STD10.2), which has the purpose to ensure all Xstrata Coal mines have suitable rehabilitation practices and are making progress regarding these practices.

Rehabilitation strategies to be implemented to address the rehabilitation objectives and indicators include the mitigation measures covered in Section 6.3 and 6.4 of this report, and the following additional measures:

- the area of disturbed land at any one time should be minimised through planning, staged development and designation of specific site areas. The following site specific plans and procedures should be developed and incorporated into the operation of the mine:
  - erosion and sediment control plan
  - topsoil management plan, including a topsoil register
  - overburden dump construction procedure
  - rehabilitation and revegetation plan
  - stormwater management plan
  - permit to disturb system
  - final void geotechnical report.
- the landform design should accommodate spoil limitations, including slope gradient and profile
- progressive rehabilitation should be undertaken over the life of the mine, and should commence within two years of land becoming available for rehabilitation. Progressive rehabilitation of mining rock and soil wastes should consider the following techniques:
  - all rehabilitation work should be conducted by contractors so that progressive rehabilitation is not tied to the availability of mining equipment
  - the slope gradient should be determined from the results of the physical properties analysis of the spoil, and shall be based on the ability of the spoil to sustain vegetation and resist erosion
  - progressive revegetation of disturbed areas or stockpiles should be undertaken as soon as practicable
  - revegetation should use native species and species suited for particular landforms and soil types, where practicable.

- weed management should be conducted as specified in Appendix 17 Ecology of the EIS, and consider appropriate State and local legislation, policies and guidance
- revegetation should be conducted as specified in the Appendix 17 Ecology of the EIS, and consider appropriate State and local legislation, policies and guidance
- access tracks should be designed with a cross fall and shall incorporate adequate drainage to prevent erosion
- access tracks should be ripped and rehabilitated when they are no longer required
- table drains should be designed and constructed to adequately manage runoff from paved road surfaces and hardstand
- grass, root-stock, organic litter and vegetation debris should be used, where practicable, to minimise erosion potential
- clean water runoff from upstream of undisturbed areas should be directed around disturbed areas using diversion bunds and catch drains as appropriate
- training of site personnel should include the concepts of minimising land disturbance and the philosophy of the erosion and sediment control program. Training in how to implement erosion and sediment control measures should be part of the site induction and ongoing training
- during construction all excavated topsoil should be stockpiled. Stockpiled topsoils should be used as part of both post construction and progressive operational rehabilitation
- where long term stockpiles are created for progressive and post operations rehabilitation, stockpiles should be incorporated into the landscaping process and vegetated
- runoff control structures (contour banks, diversion banks and grassed waterways and similar structures) should be implemented to control erosion and sedimentation in disturbed areas where the ground is left bare for a period of time before full rehabilitation
- a period of time will be required following rehabilitation to allow for development of protective vegetation cover, to prevent surface deterioration and potential impact on downstream catchments. No agricultural activities should be carried out on rehabilitated land prior to full rehabilitation, to reduce the risk of degradation of the surface capping soil, and erosion
- caution should be applied when assessing rehabilitated spoil stockpiles for suitability of cattle grazing. Stocking levels should be correctly assessed and managed to prevent erosion of the stockpile slopes.

### 6.8.4 Rehabilitation monitoring

Monitoring and assessment of progressive rehabilitation processes should be undertaken throughout the planning, construction, operational phases of the Project. If monitoring and assessment results indicate that the objectives may not be achieved, the process should be modified.

Non-compliance with the established objectives should trigger a review of processes such as planning and design, and/or repair and maintenance of failed rehabilitation work.

As rehabilitation technologies, strategies and monitoring techniques change and are improved over time, the proponent should regularly review and update the Project's rehabilitation and monitoring procedures to include the latest processes and strategies.

### 6.8.5 Rehabilitation maintenance

Two types of rehabilitation maintenance should be performed:

- planned, progressive maintenance
- failure mitigation maintenance as required.

Progressive maintenance is planned as part of rehabilitation scheduling. It should comprise post-establishment maintenance and rehabilitation repairs that are necessary following the initial construction and establishment of each rehabilitated area. If required adjustments to the rehabilitation planning processes should be undertaken if recurring problems or issues emerge.

Following initial rehabilitation, new processes such as erosion, soil formation, vegetation cover and infiltration rates will develop on the modified landform. These processes may be sustainable in the long term, or more likely they may represent an intermediate stage before final landforms/ecosystems are achieved.

Progressive maintenance activities should be scheduled to transfer intermediate landforms into permanent, long term stable landforms. The type of mitigation maintenance activities that will achieve this outcome may include removal of graded banks and repair of areas where hostile spoil is exposed.

Failure mitigation should be carried out where the established landforms are not achieving sustainable objectives. The aim of the monitoring and maintenance program is to identify any systematic issues that may result in broad scale failure of rehabilitated areas. Failure in this sense is defined as non-achievement of the rehabilitation objectives using the rehabilitation indicators as outlined above.

# 7. Residual impacts

Following mitigation, the residual impacts are anticipated to be as follows:

- change to the land use, both during the mine operation and post-mining. The main post mining land uses are envisaged to be cattle grazing and nature conservation
- reduction in areas of land suitability classes from Class 3 pre-mining to Class 4 post-mining for dry land cropping and Class 2 to Class 3 for beef cattle grazing
- redistribution of existing landforms but maintaining general topographic character
- diversion of sections of a number of creeks that traverse the MLAs, including change in landscape form
- addition of final voids into the landscape. These may fill up with water and become wetlands or farm dams.

# 8. Conclusions

This study has identified and mapped the broad soil types and characterised overburden material within the Wandoan Coal Project area. Based on existing literature and findings of the field assessment, the Project contains a number of different soils derived from sedimentary or alluvial parent material.

Overburden in the Project area is not anticipated to be acid forming or pose a risk of heavy metal contamination. The overburden is sodic and dispersive, and will require specific management techniques to control the erosion potential. The overburden also has some limitations in regard to use as growth medium, including pH, salinity, sodicity and moisture holding capacity. Siltstone and mudstone dominated overburden should not be placed within the rooting depth of vegetation. Rehabilitation planning should take into considerations these overburden characteristics as these materials are to form the substrate for future vegetation. Selection of revegetation strategies, including species mix, provision of growth media, early stage plant support and ecosystem panning, should be adjusted to enable successful and sustainable revegetation of these areas.

Alternatively, some areas may require engineering solutions to achieve long term geotechnical stability.

Subsoils over much of the Project area are alkaline, sodic and dispersive (refer Figure 5-1), and will require specific management techniques, such as minimising exposure, to prevent erosion including tunnel erosion. Soils most susceptible to erosion include Cheshire, Woleebee, Rolleston and Teviot.

It is anticipated that most topsoil from the proposed disturbed areas will be recovered and will be available for use in rehabilitation. Depth limitations exist in some soils, and slope gradient may impact the ease of stripping on steeper slopes.

Based on the Taroom Shire Planning Scheme (2006) and results of the field investigations, the undulating hills within the Project area are classed as good quality agricultural land (GQAL).

A land suitability assessment for dry land cropping, and beef cattle grazing was carried out for the Project area. It is expected that the Project will reduce areas of Class 3 dry land cropping and Class 2 beef cattle grazing. Large portions of the disturbed areas, including infrastructure areas and spoil piles are anticipated to be rehabilitated to Class 3 beef cattle grazing, and the final land use is suggested as a combination of cattle grazing and nature conservation.

# 9. Summary of mitigation strategies

Recommended mitigation strategies to minimise potential impacts of the Project to soils and land resources, as previously detailed in this geology, mineral resources, overburden and soils impact assessment, are summarised below:

- design of the post-mining landform should consider, and where practicable replicate, the topographic elements of the Project area, being:
  - concave slope profile
  - average slope gradients of around 4% (the erosion potential of longer slope will need to be considered)
  - irregular dump shapes (e.g. with uneven heights, ridgelines and spurs)
  - spoil dump relief (height) of up to 50 m
  - less than 2% gradient in floodplains.
- laboratory characterisation of selected samples of overburden material should be conducted during overburden stripping to confirm the acid generation potential prior to removal. This characterisation should be in accordance with the *Assessment and Management of Acid Drainage* (Department of Primary Industries 1995)
- coal coarse rejects should be fully characterised and a management strategy for this material developed with regards to potential acid production potential
- layers of coal roof and floor material, partings, coarse coal rejects and any material that is visually assessed at the time of mining as containing pyrite, should be assessed for acid producing potential prior to placing within the spoil pile
- layers of coal roof and floor material, partings, coarse coal rejects and any material that is visually assessed at the time of mining as containing pyrite should not be placed near the surface of spoil stockpiles unless laboratory testing confirms that the material is non acid forming
- any potentially acid forming material, as identified by visual assessment or laboratory characterisation, should not be used as capping material and should be buried within the waste rock dump together with waste rock that has a positive acid neutralising capacity
- the use of overburden material as a topsoil should be avoided
- overburden should be capped with subsoil and topsoil prior to revegetation
- spoil dominated by siltstone and mudstone overburden should not be used as a subsoil media or placed within the rooting zone of plants
- field trials should be conducted to determine minimum topsoil cover over overburden which will provide a suitable growth medium for recommended plant communities
- field trials should be held into the suitability of fresh and weathered sandstone as a subsoil material
- testing of dispersion and slaking potential should be conducted during overburden stripping. Less dispersive overburden should be managed for use as capping material

- appropriate designs and locations for spoil pile erosion and drainage control measures should be established based on the results of dispersion and slaking testing, spoil management plans, and through the use of drainage and erosion potential trials. Designs may include the use of 'durable rock' lined drains, or the encouragement of water infiltration into the spoil piles (subject to overburden characteristics)
- due to the potential susceptibility of the overburden to tunnel erosion, the detailed design and management of benches and/or contour banks on spoil slopes should consider this risk, and should be undertaken by a suitably qualified person
- trials at varying slope angles should be conducted in relation to erosion from dispersion and slaking. These trials will assist in establishing suitable final landform gradients
- sediment control structures should be used to control surface runoff from all rehabilitated and disturbed areas to reduce the amount of final sediment loads. An assessment of available technologies should be undertaken prior to selection of sediment control structures
- all out of pit spoil piles should be shaped, topsoiled and re-vegetated to reduce potential for concentration of surface runoff and erosion of spoil material
- rehabilitation strategies should be monitored and adjusted as required to reduce the risk of spoil erosion and destabilisation of spoil stockpiles
- if a large potential fossil is discovered during mining activities, then work in the vicinity of the find should stop, to preserve the potential fossil, while the Queensland Museum is immediately alerted to the find
- a sediment and erosion control plan should be prepared and implemented prior to the commencement of construction and mining, specifying the locations and types of sediment and erosion control measures to be used
- design of all drainage around proposed structures and permanent landforms should consider the presence of dispersive soils and apply suitable erosion reduction methods. All disturbed areas should be revegetated, or covered with material that has low erosion potential, to minimise the potential for erosion
- for disturbed or cleared land, including infrastructure areas:
    - unnecessary exposure of alkaline or sodic subsoils (e.g. Cheshire, Woleebee, Rolleston and Teviot) should be avoided, and should be limited to the minimal amount of time practicable. Any exposure should be covered with non-dispersive soil or other suitable material to minimise the infiltration of water into these soils. Sub-soils from these areas should be buried within the spoil stockpiles and covered in accordance with site spoil management procedures
    - clear the minimal amount of vegetation (including grass cover) required for Project works
    - minimise disturbance of the ground layer of vegetation by controlled operation of machinery and equipment selection
    - site drainage, erosion and sediment controls should be implemented and in place prior to, or as soon as possible, following the removal of vegetation
    - water runoff should be directed around topsoil stockpile areas using diversion bunds, contours, and catch drains as appropriate

- divert clean water away from disturbed areas
- revegetate exposed soils as soon as practical after works have been completed. This includes the rehabilitation of spoil dumps
- use watering trucks during windy conditions for dust suppression
- install erosion and sediment control measures on disturbed natural or constructed slopes to minimise erosion and sediment released into waterways. This is especially important for soils with dispersive subsoils (e.g. Cheshire, Woleebee, Rolleston and Teviot).

- for infrastructure areas:
  - a sediment and erosion control plan should be prepared for each area of infrastructure to be constructed. This plan should specify the locations and types of sediment and erosion control measures to be used
  - minimise areas cleared during earthworks, by delineating areas to be cleared with survey markers or other suitable marking
  - install sediment traps and silt fences or other suitable sediment control measures where appropriate
  - confine traffic to maintained roads
  - minimise slope grade within infrastructure areas where possible based on results of geotechnical data obtained during detailed design phase
  - construct hardstands from erosion resistant material
  - install scouring protection works in drains and intensely gullied areas adjacent to proposed infrastructure
  - revegetate disturbed areas surrounding infrastructure sites
  - control drainage and divert away from infrastructure.
- for stockpiles:
  - long-term stockpiles of topsoil and overburden should be planted with vegetation to minimise entrainment of soil particles into the air and minimise erosion through raindrop impact
  - when areas with topsoil susceptible to wind erosion (e.g. Woleebee and Retro) are stripped and stockpiled, even if for only a few months, the stockpiles should be covered by grass, other vegetation, geofabric or less erosive topsoil to minimise wind erosion
  - divert clean water from areas upslope of all topsoil, subsoil and spoil stockpiles around stockpile areas using contour banks or diversion channels, thereby reducing water flowing into the stockpile area
  - all topsoil, subsoil and spoil stockpiles should be bunded by earthen bunds or similar, with sediment traps or similar features installed downslope of stockpiles to prevent eroded sediment entering waterways.
- dispersive, clayey soils are suitable for use as embankment materials for water management structures, provided strict construction quality control measures are implemented

- gypsum or lime should be used in the treatment of sodic alkaline soils to improve geotechnical characteristics
- the topsoil of Teviot is saline and generally should not be used as a topsoil layer in rehabilitation. Should this soil in rehabilitation, it will require the use of salt tolerant vegetation species
- the subsoils of Cheshire, Teviot and Woleebee are saline and should be buried within spoil stockpiles and covered with materials that are more stable. The subsoils of Cheshire and Woleebee should not be used in rehabilitation
- compaction of topsoil can be reduced by selection of appropriate earthmoving machinery when working with these soils (i.e. light weight vehicles with large wheel/track size)
- soils that will be trafficked or compacted during the operation of the mine should have water control and sediment containment measures installed to minimise potential erosion and sediment entering into waterways
- previously compacted areas that are to be rehabilitated should be remediated by ripping the top layer of soil/overburden material, and then applying layers of subsoil and topsoil as required to establish a suitable plant growth environment. The depth of ripping/reworking required is dependent on the impact, and should be assessed at the time or rehabilitation
- ripping the top layer of soil breaks down the soil structure, and as a result protection of these areas from re-compaction (i.e. vehicles or grazing animals) after ripping is required to allow the soil structure to reform
- topsoil should be stripped separately from subsoil and stockpiled during clearing
- topsoil should be stored in stockpiles no more than 2 m–3 m high to retain seed germination potential (EPA 2001)
- topsoil should be stored for the shortest period practicable, and where possible reused within six months of stripping to maximise the retention of the seed bank in the soil
- the placement of topsoil should consider the landscape position the topsoil was stripped from, with soils of the undulating topography (Brigalow uplands cracking clays and non-cracking clays), used on slopes and hilltops, and the alluvial soils (Juandah, Woleebee and Retro) used in lower slopes and areas where water accumulation may occur
- the stripping of topsoil should be incorporated into a ‘permit to disturb’ system to ensure suitable topsoil and subsoil are salvaged prior to disturbance
- a site topsoil register should also be developed for the Project, recording the locations and volumes of topsoil stockpiles
- topsoil should be stripped to depths as shown in Table 9-1.

**Table 9-1: Topsoil stripping depths and potential constraints for reuse**

| Soil type | Surface soil composition | Topsoil stripping depth (m) | Subsoil stripping depth (m from surface) | Potential constraints |
|---|---|---|---|---|
| Cheshire | Light clay | 0.4 | — | ▪ highly alkaline and saline subsoil<br>▪ dispersive subsoil |
| Kinnoul | Clay | 0.3 | 0.5 | ▪ low nutrient availability in topsoil<br>▪ dispersive subsoil<br>▪ shallow soil depth |
| Downfall | Clay | 0.15 | 0.5 | ▪ shallow topsoil depth<br>▪ dispersive subsoil |
| Teviot | Clay | 0.2 | 0.6 | ▪ dispersive subsoil<br>▪ moderately alkaline and saline |
| Rolleston | Clay | 0.2 | 0.6 | ▪ alkaline<br>▪ topsoil potentially dispersive<br>▪ dispersive subsoil |
| Juandah | Clay | 0.1 | 1.0 | ▪ dispersive A2 horizon<br>▪ poor workability when wet |
| Woleebee | Silty loam | 0.15 | — | ▪ shallow topsoil depth<br>▪ dispersive topsoil and subsoil<br>▪ highly alkaline and saline subsoils<br>▪ low nutrients and organic matter<br>▪ poor workability when wet |
| Retro | Clay loam | 0.15 | 1.0 | ▪ shallow topsoil depth<br>▪ poor workability when wet |

- Existing soil conservation measures should be retained and maintained where they currently exist and the land is not required for mining activities
- undisturbed land returned to (or retained in) its pre-mining land suitability class, and should be able to be used for beef cattle grazing or dry land cropping as existed prior to mining
- land used for infrastructure components of the Project (roads, MIA etc) should be returned to Class 3 cropping land or Class 2 grazing land, and generally be able to be used for beef cattle grazing
- spoil dumps should aim to be returned to the highest available land suitability class applicable for the given slope gradient. Flatter gradient sections of spoil stockpiles and tailing dam sites should be returned to Class 3 cropping land or Class 2 grazing land, and

generally be able to be used for beef cattle grazing. Steeper gradient spoil slopes should be used for nature conservation

- final voids will be unsuitable for agricultural use (e.g. Class 5 for cropping and cattle grazing), and should be investigated for alternative beneficial uses such as wetlands or recreational facilities
- final landform slopes greater than 20% should be vegetated with native vegetation
- the coal seam should be covered using pre-strip overburden from adjacent overburden stockpiles. Voids should be partially filled
- spoil dumps should be progressively rehabilitated over the life for the mine, and rehabilitation should commence within two years of the land becoming available for rehabilitation
- the tailings disposal facilities should be rehabilitated within two years of reaching capacity and no longer being required for tailings disposal
- at the conclusion of mining, the creek diversions should be left in a stable and sustainable condition
- the area of disturbed land at any one time should be minimised through planning, staged development and designation of specific site areas. The following site specific plans and procedures should be developed and incorporated into the operation of the mine:
  - erosion and sediment control plan
  - topsoil management plan, including a topsoil register
  - overburden dump construction procedure
  - rehabilitation and revegetation plan
  - stormwater management plan
  - permit to disturb system
  - final void geotechnical report.
- the landform design should accommodate spoil limitations, including slope gradient and profile
- progressive rehabilitation should be undertaken over the life of the mine, and should commence within two years of land becoming available for rehabilitation. Progressive rehabilitation of mining rock and soil wastes should consider the following techniques:
  - all rehabilitation work should be conducted by contractors so that progressive rehabilitation is not tied to the availability of mining equipment
  - the slope gradient should be determined from the results of the physical properties analysis of the spoil, and shall be based on the ability of the spoil to sustain vegetation and resist erosion
  - progressive revegetation of disturbed areas or stockpiles should be undertaken as soon as practicable
  - revegetation should use native species and species suited for particular landforms and soil types, where practicable.

- weed management should be conducted as specified in the Wandoan Coal Project Terrestrial Ecology Assessment Report, and consider appropriate State and local legislation, policies and guidance
- revegetation should be conducted as specified in the Wandoan Coal Project Terrestrial Ecology Assessment Report, and consider appropriate State and local legislation, policies and guidance
- access tracks should be designed with a cross fall and shall incorporate adequate drainage to prevent erosion
- access tracks should be ripped and rehabilitated when they are no longer required
- table drains should be designed and constructed to adequately manage runoff from paved road surfaces and hardstand
- grass, root-stock, organic litter and vegetation debris should be used, where practicable, to minimise erosion potential
- clean water runoff from upstream of undisturbed areas should be directed around disturbed areas using diversion bunds and catch drains as appropriate
- training of site personnel should include the concepts of minimising land disturbance and the philosophy of the erosion and sediment control program. Training in how to implement erosion and sediment control measures should be part of the site induction and ongoing training
- during construction all excavated topsoil should be stockpiled. Stockpiled topsoils should be used as part of both post construction and progressive operational rehabilitation
- where long term stockpiles are created for progressive and post operations rehabilitation, stockpiles should be incorporated into the landscaping process and vegetated
- runoff control structures (contour banks, diversion banks and grassed waterways and similar structures) should be implemented to control erosion and sedimentation in disturbed areas where the ground is left bare for a period of time before full rehabilitation
- a period of time will be required following rehabilitation to allow for development of protective vegetation cover, to prevent surface deterioration and potential impact on downstream catchments. No agricultural activities should be carried out on rehabilitated land prior to full rehabilitation, to reduce the risk of degradation of the surface capping soil, and erosion
- caution should be applied when assessing rehabilitated spoil stockpiles for suitability of cattle grazing. Stocking levels should be correctly assessed and managed to prevent erosion of the stockpile slopes
- monitoring and assessment of progressive rehabilitation processes should be undertaken throughout the planning, construction, operational phases of the Project
- as rehabilitation technologies, strategies and monitoring techniques change and are improved over time, the proponent should regularly review and update the Project's rehabilitation and monitoring procedures to include the latest processes and strategies.

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# Attachment A

Test pit logs

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS01**

SHEET 1 OF 3

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **23/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **23/7/07** |
| Borehole Location: | **Poorly defined gully** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 794890 N 7105594**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST / FB VL L MD D VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** grey-brown, small well developed peds, thick surface crust. | M | | | TOPSOIL<br>$A_1$<br>$A_2$ |
| | | | 0.25<br>0.30 | | D | | CH | **CLAY:** medium to high plasticity, dark grey, small well developed peds.<br>... calcareous concretioins. | | | | ALLUVIUM<br>$B_{21}$<br>$B_{22k}$<br>C |
| | | | 0.85<br>1 | | D | | CH | **CLAY with SAND:** high plasticity, dark brown-grey, fine to medium grained sand. | | | | |
| | | | 1.30 | | | | | ... colour change to yellow-brown and grey mottles with thin (10 - 30 mm thick) lenses of sandy clay. | | | | |
| | | | 2 | | | | | END OF BOREHOLE AT 1.50 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS02**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **23/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **23/7/07** |
| Borehole Location: | **EAST FACING MID SLOPE** | Recorded By: | **JAM** |
| Project Number: | **2133006A** | Log Checked By: | |

| | | | | | |
|---|---|---|---|---|---|
| Drill Model/Mounting: | **CAT 428** | Hole Angle: | **90°** | Surface RL: | |
| Borehole Diameter: | | Bearing: | **---** | Co-ords: | **E 794269 N 7107329** |

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | CH | **TOPSOIL (Clayey SILT):** brown, medium blocky peds, trace of coarse gravel size sub-rounded ferruginised rock fragments. | D | | | TOPSOIL<br>$A_1$<br>scattered rock fragments and surface shrinkage cracks |
| | | | | | | | | **Silty CLAY:** medium plasticity, brown, trace of gravel sized rock fragments. | MC<PL | | | $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | CH | **CLAY:** medium to high plasticity, brown, large blocky peds. | | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.40 | | D | | CH | **CLAY with SAND:** medium to high plasticity, yellow-brown, poorly developed medium peds, fine grained sand. | | | | $B_{22}$ |
| | | | 0.60 | | | | | ... colour change to grey with pale yellow brown. | | | | |
| | | | 0.90 | | | | | **SILTSTONE:** pale brown, extremely weathered, extremely low strength with very low to low strength gravel to cobble size ferruginised rock fragments. | | | | WEATHERED ROCK<br>R |
| | | | 1 | | | | | END OF BOREHOLE AT 1.10 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS03**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **WEST FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords:

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (Silty CLAY):** dark brown, medium to large polished peds, trace gravel size rock fragments. | M | | | TOPSOIL<br>coarse gravel fragments of mixed origin on surface<br>$A_1$ |
| | | | 0.20 | | | | CH | **CLAY:**medium plasticity, dark grey-brown, large irregular peds, trace of lithic sand, and gravel. | MC>PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.40 | | D | | | ... trace of calcareous concretion. | | | | B<<SUB>22k |
| | | | 0.60 | | D | | | ... colour change to yellow-grey, no calcareous concretion. | | | | $B_{23}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.20 | | | | | **SANDSTONE:** fine grained, pale grey, extremely weathered, extremely low strength, lithic-feldspathic. | | | | WEATHERED ROCK<br>C |
| | | | | | | | | END OF BOREHOLE AT 1.30 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.** **WS04**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **EAST-WEST TRENDING RIDGELINE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:
Borehole Diameter: Bearing: **---** Co-ords: **E 790044 N 7104409**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | | | | **TOPSOIL (Silty CLAY):** dark brown-grey, medium irregular peds, trace of fine grained sand. Thin surface crust. | D | | | TOPSOIL $A_1$ $A_2$ |
| | | | | | | | CH | **Silty CLAY:** high plasticity, dark brown, large irregular peds, trace fine grained sand. | MC<PL | | | |
| | | | 0.20 | | | | CH | **Sandy CLAY:** high plasticity, dark grey-brown, large irregular peds. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.40 | | | | CH | **CLAY with SAND:** high plasticity, grey, fine grained lithic feldspathic sand. | | | | $B_{22}$ |
| | | | 0.70 | | | | | ... colour change to brown-grey. | | | | |
| | | | 0.90 | | | | | **SANDSTONE:** medium grained, pale yellow-grey, weathered, extremely low strength. | | | | WEATHERED ROCK C |
| | | | 1 | | | | | END OF BOREHOLE AT 1.00 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS05**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **NORTH-EAST TRENDING RIDGELINE, SLOPING NORTH-WEST** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 790413 N 7108050**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (CLAY):** dark brown-grey, large blocky peds, trace gravel. | D | | | TOPSOIL; scattered rock fragments and surface shrinkage cracks<br>$A_1$<br>$A_2$ |
| | | | | | | | CH | **CLAY:** high plasticity, dark brown-grey, medium blocky peds. | | | | |
| | | | 0.20 | | D | | CH | **CLAY:** high plasticity, dark brown-grey, large blocky peds, trace gravel. | | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.55 | | D | | | ... colour change to yellow-brown, trace sand. | | | | $B_{22}$ |
| | | | 1.00 1 | | | | | **SILTSTONE:** pale yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | | | | | | END OF BOREHOLE AT 1.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS06**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **WEST FACING MID SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 794666 N 7108889**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY: FB VL L MD D VD / VS S F ST VST H | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | CH | **TOPSOIL (CLAY):** dark brown, small to medium irregular peds, trace of fine grained sand and gravel. | D | | | TOPSOIL; scattered rock fragments, thin surface crust $A_1$ $A_2$ |
| | | | | | | | | **CLAY:** high plasticity, dark brown, small well developed peds, trace of fine grained sand. | MC>PL | | | |
| | | | 0.20 | | D | | CH | **CLAY:** high plasticity, dark brown, medium blocky peds, trace of gravel. | MC~PL | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.80 | | D | | | ...colour change to brown | MC<PL | | | $B_{22}$ |
| | | | 1.00 1 | | | | | **MUDSTONE:** pale yellow, extremely weatered, extremely low strength. | | | | WEATHERED ROCK C |
| | | | | | | | | END OF BOREHOLE AT 1.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS07**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **RIDGE TOP** | Recorded By: | **JAM** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 794271 N 7109756**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Sandy Clayey SILT):** grey-brown, fine grained sand, ??? | D | | | TOPSOIL |
| | | | | | | | CH | **Silty CLAY:** high plasticity, dark brown-grey, trace of fine grained sand, small irregular peds. | MC<PL | | | $A_1$ scattered gravel and cobble size fragments $A_2$ |
| | | | 0.20 | | D | | | ... medium peds. | | | | $B_{21}$ |
| | | | 0.50 | | | | | ...colour change to pale brown | | | | $B_{22}$ |
| | | | 0.60 | | | | | **SANDSTONE:** fine grained, pale brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK |
| | | | 1 | | | | | END OF BOREHOLE AT 0.80 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS08**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **RIDGETOP IN UNDULATING TERRAIN** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 793534 N 7111428**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST / FB VL L MD D VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (Sandy CLAY):** dark grey, medium irregular peds. | M | | | TOPSOIL $A_1$ |
| | | | 0.20 | | D | | CH | **CLAY:** high plasticity, grey, medium irregular peds, trace of sand, calcareous concretion. | MC<PL | | | RESIDUAL SOIL $B_{21k}$ |
| | | | 0.60 | | | | | ... colour change to brown-grey, no calcareous concretion. | | | | $B_{22}$ |
| | | | 1.00 1 | | | | | ... colour change to pale brown-grey. | | | | $B_{23}$ |
| | | | 2 | | | | | END OF BOREHOLE AT 2.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS09**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **NORTH-WEST TRENDING RIDGELINE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 792425 N 7112161**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F FB VL L MD ST D VST H VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (Silty CLAY):** brown-grey, medium irregular peds, coarse gravel sized ferruginous sandstone fragments. | D | | | TOPSOIL<br>$A_1$<br>gravel to cobble size ferruginised sandstone on surface |
| | | | 0.20 | | D | | CL | **CLAY:** brown-grey, medium plasticity, small well developed peds, trace coarse grained gavel size rock fragments. | MC<PL | | | $A_2$ |
| | | | 0.35 | | D | | CL | **CLAY:** yellow-grey, medium plasticity, minor ped development, calcareous concretions. | | | | RESIDUAL SOIL<br>$B_{21k}$ |
| | | | 0.65 | | | | | ... no calcareous concretions. | | | | $B_{22}$ |
| | | | 0.85 | | | | | ... colour change to yellow-brown. | | | | $B_{23}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.10 | | | | | **SANDSTONE:** fine grained, yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | | | | | | END OF BOREHOLE AT 1.20 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS10**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **SOUTH-EAST FACING UPPER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 791412 N 7111655**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F FB VL L MD ST D VST VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.00 | | D | | | **TOPSOIL (Silty CLAY):** brown, large blocky peds, trace of fine grained sand. | M | | | $A_1$ gravel rock fragments on surface (sandstone and ferruginised sandstone) |
| | | | 0.20 | | D | | CH | **CLAY:** high plasticity, brown with red mottling, large well developed irregular peds, calcareous concretion, trace of fine grained gravel size ferruginised sandstone fragments. | MC<PL | | | RESIDUAL SOIL $B_{21k}$ |
| | | | 0.50 | | | | | ... colour change to red-brown, high plasticity, massive, no calcareous concretions, no rock fragments. | MC~PL | | | $B_{22}$ |
| | | | 0.80 | | | | | ... change to poorly defined peds, more intense red mottling. | | | | $B_{23}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.50 | | | | | ... colour change to red with grey mottling, coarse grained sand-gravel size rock fragments. | | | | C |
| | | | | | | | | END OF BOREHOLE AT 1.70 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS11**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **24/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **24/7/07** |
| Borehole Location: | **FIRST TERRACE ABOVE IN GULLY** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 791185 N 7112531**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | CH | **TOPSOIL (Silty CLAY):** medium plasticity, brown, small well developed peds, trace fine to medium grained sand. | M | | | TOPSOIL |
| | | | | | | | | **CLAY:** high plasticity, brown, medium blocky peds, trace fine to medium grained sand. | MC>PL | | | $A_1$ |
| | | | 0.20 | | | | | | | | | $A_2$ |
| | | | | | D | | CL | **Sandy CLAY:** medium plasticity, brown, small developed peds. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.65 | | | | CH | **Sandy CLAY:** high plasticity, brown, medium irregular peds, calcareous concretions. | | | | $B_{22k}$ |
| | | | 1 | | | | | | | | | |
| | | | | | | | | END OF BOREHOLE AT 1.30 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS12**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | XSTRATA COAL QUEENSLAND | Date Commenced: | 24/7/07 |
| Project: | WANDOAN Soil Assessment | Date Completed: | 24/7/07 |
| Borehole Location: | FLOODPLAIN, 50m FROM HALFWAY CREEK | Recorded By: | OW |
| Project Number: | 2133006A | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 792782 N 7111766**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST FB VL L MD VST D VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | | | CH | **TOPSOIL (CLAY):** dark grey, medium well developed blocky peds. | D | | | TOPSOIL; thin surface crust |
| | | | | | | | | **Silty CLAY:** high plasticity, dark grey, well developed irregular peds. | MC>PL | | | $A_1$<br>$A_2$ |
| | | | 0.50 | | | | CH | **Silty CLAY:** high plasticity, dark grey, minor ped development, calcareous concretions. | MC<PL | | | ALLUVIUM<br>$B_{21}$ |
| | | | 0.80 | | | | CH | **Silty CLAY:** medium to high plasticity, grey, trace of fine grained sand. | | | | $B_{22}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.50 | | | | | ... colour change to pale yellow-brown, calcareous concretions. | | | | $B_{23k}$ |
| | | | 1.80 | | | | CH | **Sandy CLAY:** medium to high plasticity, grey with yellow brown and black mottling, medium grained sand. | | | | C |
| | | | 2 | | | | | | | | | |
| | | | | | | | | END OF BOREHOLE AT 2.80 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS13**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **FLOODPLAIN OF MUD CREEK** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 780876 N 7120880**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (Silty CLAY):** brown-grey, small irregular blocky peds. | M | | | TOPSOIL $A_1$ |
| | | | 0.10 | | D | | CL | **Silty CLAY:** medium plasticity, brown-grey, weakly developed peds, trace fine sand. | MC<PL | | | $A_2$ |
| | | | 0.25 | | | | CH | **CLAY:** high plasticity, dark brown-grey, large weakly developed peds. | | | | ALLUVIUM $B_{21}$ |
| | | | 0.60 | | | | CH | **Sandy CLAY:** high plasticity, brown, large blocky peds, fine to medium grained sand. | | | | $B_{22}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.10 | | | | | ... colour change to yellow-grey. | | | | C |
| | | | | | | | | END OF BOREHOLE AT 1.40 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS14**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **EAST FACING MIDSLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 700107 N 7116955**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** brown-grey, medium irregular peds. | D | | | TOPSOIL; thin surface curst<br>$A_1$<br>$A_2$ |
| | | | 0.20 | | | | CH | **CLAY:** high plasticity, brown-grey, medium size moderately developed irregular peds, trace medium grained sand, calcareous concretions. | MC<PL | | | RESIDUAL SOIL<br>$B_{21k}$ |
| | | | 0.60 | | | | CH | **CLAY:** high plasticity, pale grey-brown, trace medium grained sand, trace coarse grained gravel to cobble size sub-rounded rock fragments of mixed source. | | | | $B_{22}$ |
| | | | 1 | | | | | ... colour change to yellow-brown, calcareous concretions. | | | | $B_{23k}$ |
| | | | 1.70 | | | | | **Interbedded SANDSTONE/SILTSTONE/COAL:** pale brown and black, extremely weathered, extremely low strength, blocky. | | | | WEATHERED ROCK<br>C |
| | | | 2 | | | | | END OF BOREHOLE AT 2.10 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS15**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **LOW RIDGETOP** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 703186 N 7115417**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.15 | | | | | **TOPSOIL (Sandy CLAY):** dark brown-grey, medium size well developed blocky peds, fine grained sand. | M | | | TOPSOIL $A_1$ |
| | | | | | D | | CL | **CLAY:** medium plasticity, dark grey, medium size moderately developed peds, trace of fine grained sand. | MC<PL | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.30 | | | | CH | **CLAY:** high plasticity, dark grey, weakly developed peds, trace medium grained sand. | | | | $B_{22}$ |
| | | | 0.50 | | D | | CH | **Sandy CLAY:** high plasticity, grey-brown, medium to fine grained sand. | | | | $B_{23}$ |
| | | | 0.90 | | | | | **SANDSTONE:** medium to fine grained, pale yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK C |
| | | | 1 | | | | | END OF BOREHOLE AT 1.00 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS16**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **RIDGETOP** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 778912 N 7115566**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (Silty CLAY):** dark brown-grey, small well developed blocky peds, fine grained sand. | D | | | TOPSOIL<br>pebble-cobble size rounded rock fragment on surface of mixed origin<br>$A_1$ |
| | | | 0.10 | | | | CH | **CLAY:** medium plasticity, dark brown-grey, small moderately developed peds, trace fine to medium grained sand, calcareous concretions. | MC<PL | | | $A_{21}$ |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | CH | **CLAY:** high plasticity, dark grey, medium blocky peds, trace medium grained sand. | | | | $A_{22}$ |
| | | | 0.60 | | | | | **SANDSTONE:** fine to medium grained, pale yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS17**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **EAST FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 701040**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY: VS S F ST VST H; FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Sandy CLAY):** dark grey, medium blocky peds, fine to medium grained sand. | | | | TOPSOIL<br>$A_1$ |
| | | | | | | | | **CLAY:** dark grey, small well developed irregular peds, trace of fine to medium grained sand , and calcareous concretions. | MC>PL | | | $A_{21k}$ |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | | ... trace of yellow mottling. | | | | $A_{22k}$ |
| | | | 0.50 | | | | | **SANDSTONE:** fine to medium grained, pale yellow-grey, extremely weathered, extremely low strength. | | | | C<br>WR |
| | | | 1 | | | | | END OF BOREHOLE AT 1.00 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS18**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **NORTH FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 779616 N 7113412**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Silty CLAY):** brown, moderately developed small irregular peds, trace of fine grained sand. | D | | | TOPSOIL |
| | | | | | | | | **Silty CLAY:** brown-grey, large moderately developed peds, trace fine grained sand. | MC<PL | | | $A_1$ |
| | | | | | D | | | | | | | $A_2$ |
| | | | 0.45 | | | | | **Sandy CLAY:** pale yellow-brown, massive, medium to coarse grained sand. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.60 | | | | | **SANDSTONE:** pale yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.80 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS19**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **FLOODPLAIN OF MUD CREEK** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 770320 N 7113765**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Silty CLAY):** dark grey, large weakly developed blocky peds. | D | | | TOPSOIL |
| | | | | | | | | **LOAM:** dark grey, medium size irregular peds. | MC<PL | | | $A_1$ 0.01 m crust on surface |
| | | | 0.15 | | | | CH | **CLAY:** medium plasticity, dark brown, weakly developed peds, trace of fine grained sand. | | | | $A_2$ ALLUVIUM $B_{21}$ |
| | | | 0.40 | | | | CH | **CLAY:** high plasticity, dark brown, weakly developed peds, calcareous concretions, trace of fine to medium grained sand. | | | | $B_{22k}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.20 | | | | SC | **Clayey SAND:** yellow-grey, trace of coarse grained rouned gravel. | | | | C |
| | | | 1.80 | | | | | ... colour change to dark yellow-grey with calcareous concretions. | | | | |
| | | | 2 | | | | | END OF BOREHOLE AT 2.00 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS20**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **25/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **25/7/07** |
| Borehole Location: | **EAST FACING MID SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 700546 N 7114245**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST / FB VL L MD D VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (CLAY):** brown-grey, large blocky peds, trace of fine grained sand. | D | | | TOPSOIL $A_1$ scattered cobble size rock fragments of mixed origin and cracks on surface. |
| | | | | | | | CH | **CLAY:** medium to high plasticity, brown, small well developed peds, trace of fine grianed sand. | MC~PL | | | $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.50 | | | | CH | **CLAY:** high plasticity, brown, weakly developed peds, trace of fine grained sand. | MC<PL | | | RESIDUAL SOIL $B_{21}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.70 | | | | CL | **Sandy CLAY:** medium plasticity, pale brown, fiine grained sand. | MC<PL | | | C |
| | | | 2 | | | | | | | | | |
| | | | 2.30 | | | | | ... colour change to pale yellow-brown. | | | | |
| | | | | | | | | END OF BOREHOLE AT 2.50 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS21**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **SOUTH-EAST FACING MIDSLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 701442 N 7116709**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Sandy CLAY):** dark grey, fine to medium grained sand, large blocky peds, trace coarse gravel size sub-angular rock fragments of mixed origin. | D | | | TOPSOIL |
| | | | | | | | CL | | MC<PL | | | $A_1$ |
| | | | | | D | | | **CLAY:** medium plasticity, dark grey, small irregular weakly developed peds, trace of fine to meidum grained sand. | | | | $A_2$ |
| | | | 0.30 | | | | CL | **Sandy CLAY:** medium plasticity, yellow-grey, irregular weakly developed peds. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.40 | | | | | ... colour change to pale yellow-grey. | | | | $B_{22}$ |
| | | | 0.50 | | | | | **SANDSTONE:** pale yellow-brown, extremely weathered, extremely low strength, fine to medium grained, calcareous concretions. | | | | WEATHERED ROCK C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS22**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **NORTH-WEST FACING RIDGELINE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 775195 N 7119435**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (FB VL L MD D VD / VS S F ST VST H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Sandy CLAY):** grey-brown, fine to medium grained sand, large well developed blocky peds. | D | | | TOPSOIL $A_1$ |
| | | | 0.10 | | | | | **Sandy CLAY:** brown, fine to medium grained sand, small well developed peds. | MC<PL | | | 0.01 m crust $A_2$ |
| | | | | | D | | | **Clayey SAND:** fine to medium grained, yellow-brown, weakly developed peds, trace of extremely weathered coarse gravel size sandstone fragments. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.45 | | | | | **SANDSTONE:**fine to meidum grained, yellow-brown, extremely weathered, extremely low strength, calcareous coating on fragments, trace coarse grained sand to fine gravel. | | | | WEATHERED ROCK C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.60 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS23**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **NORTH-WEST FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 775423 N 7120957**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (Sandy CLAY):** dark grey, fine grained sand, medium size well developed irregular peds. | D | | | TOPSOIL<br>$A_1$<br>0.01 m crust<br>$A_2$ |
| | | | | | | | CH | **CLAY:** medium to high plasticity, dark grey, medium size well developed irregular peds, trace fine to medium grained sand. | MC<PL | | | |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | CH | **CLAY:** high plasticity, pale brown-grey, large platy peds, trace of fine grained sand. | MC<PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.60 | | | | CH | **Sandy CLAY:** high plasticity, pale yellow-brown, coarse gravel to cobble size weathered sandstone fragments. | | | | $B_{22}$ |
| | | | 0.90 | | | | | **SANDSTONE:** fine to medium grained, pale yellow-grey, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 1.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS24**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **EAST FACING MID SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 774879 N 7118239**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST / FB VL L MD D VD H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** grey-brown, small moderately developed irregular peds, trace of fine grained sand. | M | | | TOPSOIL<br>$A_1$<br>0.01 m coarse gravel to cobble size rock fragments of mixed origin and surface crust. |
| | | | 0.10 | | | | CH | **Sandy CLAY:** medium to high plasticity, grey-brown, medium size moderately developed blocky peds, medium grained sand. | | | | $A_{21}$ |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | | ... colour change to brown. | | | | $A_{22}$ |
| | | | 0.40 | | | | CH | **Sandy CLAY:** medium to high plasticity, yellow-brown, medium size weakly developed peds, medium grained sand. | | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.65 | | | | | **SANDSTONE:** pale yellow-grey, fine to medium grained, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS25**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **EAST FACING MID SLOPE, PARALLEL TO DRAINAGE LINE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 776776 N 7114932**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (FB VL L MD D VD / VS S F ST VST H) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (Sandy CLAY):** grey, fine to medium grained sand, medium size sub-angular well developed peds. | D | | | TOPSOIL<br>$A_1$<br>gravel to cobble size rock fragments of mixed origin on surface. |
| | | | | | | | CH | **Sandy CLAY:** high plasticity, grey, medium grained sand, large moderately developed irregular peds, trace gravel size sub-angular rock fragments. | MC<PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.35 | | D | | CH | **CLAY:** high plasticity, dark grey, large moderately developed irregular peds, calcareous concretions. | | | | $B_{22k}$ |
| | | | 0.60 | | | | | **SANDSTONE:** fine to medium grained, yellow-brown, extremely weathered, extremely low strength, calacreous infill on joints. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS26**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **26/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **26/7/07** |
| Borehole Location: | **RIDGE TOP** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 778594 N 7116878**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F, FB VL L, MD D, ST VST H, VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | D | | | **TOPSOIL (CLAY):** dark grey, small well developed blocky peds, trace of fine grained sand. | D | | | TOPSOIL $A_1$ |
| | | | | | | | CH | **CLAY:** medium to high plasticity, dark grey, medium size moderately developed peds. | MC<PL | | | gravel to cobble size rock fragments of mixed origin on surface. $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.30 | | | | | **CLAY:** high plasticity, dark brown-grey, poorly developed peds. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | 0.50 | | D | | | ... colour change to brown. | | | | $B_{22}$ |
| | | | 0.80 | | | | CH | **Silty CLAY:** medium plasticity, yellow-brown, trace of fine grained sand. | | | | $B_{23}$ |
| | | | 1.00 1 | | | | | **Silty SANDSTONE:** fine grained, orange-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK C |
| | | | | | | | | END OF BOREHOLE AT 1.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS27**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH-SOUTH TRENDING RIDGELINE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 768852 N 7122409**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (CLAY):** dark grey, large well developed blocky peds, trace of fine grained sand. | D | | | TOPSOIL<br>$A_1$<br>trace of coarse gravel size rock fragments on surface. |
| | | | | | | | CH | **CLAY:** medium to high plasticity, dark grey, medium size irregular peds. | MC<PL | | | $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.60 | | | | CH | **CLAY:** high plasticity, dark grey, large blocky peds, trace of fine grained sand, trace of calcareous concretions. | | | | RESIDUAL SOIL<br>$B_{21k}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.10 | | | | | ... colour change to yellow-grey, no calcareous concretions. | | | | $B_{22}$ |
| | | | 1.20 | | | | | ... colour change to pale yellow-grey. | | | | C |
| | | | 1.30 | | | | | **SANDSTONE:** fine grained, pale yellow-grey, extremely weathered, extremely low strength. | | | | WEATHERED ROCK |
| | | | 2 | | | | | END OF BOREHOLE AT 1.50 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS28**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **EAST FACING MID SLOPE ADJACENT SPRING CREEK** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 772137 N 7120391**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** dark grey, small moderately developed irregular peds, trace of fine grained sand. | D | | | TOPSOIL<br>$A_1$<br>0.01 m crust on surface |
| | | | 0.15 | | | | CL | **CLAY:** medium plasticity, dark grey. small to medium size irregular peds, trace of fine gravel. | MC<PL | | | $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.60 | | | | CH | **CLAY:** high plasticity, grey-brown with yellow mottling, large angular peds, trace of fine to medium grained sand. | | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.70 | | | | | ... colour change to grey, trace of silty clay. | | | | $B_{22}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.50 | | | | | **SILTSTONE:** orange with grey mottling, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | | | | | | END OF BOREHOLE AT 1.70 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS29**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH FACING MID SLOPE IN WIDE GULLY** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 770090 N 7120324**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | | | | **TOPSOIL (CLAY):** dark grey, medium size moderately developed irregular peds, trace fine grained sand. | D | | | TOPSOIL<br>$A_1$<br>$A_2$ |
| | | | | | | | | **CLAY:** brown-grey, weakly developed peds. | MC<PL | | | |
| | | | 0.30 | | | | CH | **CLAY:** high plasticity, dark grey, medium size well developed blocky peds, trace of fine grained sand, trace of calcareous concretions. | | | | RESIDUAL SOIL<br>$B_{2k}$ |
| | | | 0.50 | | | | | **SANDSTONE:** fine to medium grained, yellow-grey, extremely weathered, extremely low strength, calcareous deposits on facture surfaces. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS30**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH TRENDING SHALLOW GULLY** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords:

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.05 | | | | | **TOPSOIL (CLAY):** dark grey, medium size well developed peds, trace fine grained sand. | D | | | TOPSOIL |
| | | | | | | | CL | **Silty CLAY:** medium plasticity, dark brown-grey, small well developed crumbly peds. | MC<PL | | | $A_1$ $A_2$ |
| | | | 0.30 | | | | CL | **CLAY:** medium plasticity, grey, small well developed peds, trace of fine grained sand. | | | | RESIDUAL SOIL $B_2$ |
| | | | 0.55 | | | | | **SANDSTONE:** fine grained sand-silt, grey, extremely weathered, low strength. | | | | WEATHERED ROCK C |
| | | | | | | | | END OF BOREHOLE AT 0.70 m | | | | |
| | | | 1 | | | | | | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS31**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH FACING SLOPE ADJACENT INCISED GULLY** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 767870 N 7119141**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** dark brown-grey, small to medium well developed blocky peds, trace of fine grained sand. | D | | | TOPSOIL<br>$A_1$ |
| | | | 0.20 | | D | | CL | **CLAY:** medium plasticity, dark brown-grey, small to medium size well developed irregular peds, trace of fine grained sand. | MC<PL | | | $A_2$ |
| | | | 0.30 | | | | CH | **CLAY:** high plasticity, dark grey, small irregular peds, trace of fine grained sand, calcareous concretions. | | | | RESIDUAL SOIL<br>$B_{2k}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.60 | | | | CH | **Silty CLAY:** high plasticity, yellow-brown, trace of fine grained sand. | MC<PL | | | C |
| | | | 2 | | | | | | | | | |
| | | | | | | | | END OF BOREHOLE AT 2.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS32**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **EAST FACING GENTLE SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 773743 N 7115518**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | D | | | **TOPSOIL (CLAY):** dark grey, large weakly developed blocky peds, trace of fine to medium grained sand. | M | | | TOPSOIL<br>$A_1$<br>soil surface bare and disturbed with 5mm thick crust |
| | | | 0.15 | | | | CH | **CLAY:** high plasticity, dark grey, large weakly developed peds, trace of fine to medium grained sand. | MC~PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.50 | | D | | | ... colour change to brown-grey, trace of fine to coarse grained sand. | | | | $B_{22}$ |
| | | | 0.85 | | | | CH | **CLAY:** high plasticity, yellow-brown, trace of fine to coarse grained sand, trace of fine gravel. | | | | C |
| | | | 1 | | | | | | | | | |
| | | | 1.70 | | | | | **SANDSTONE:** medium to coarse grained, pale yellow-grey, extremely weathered, extremely low strength in a clay matrix high plasticity, dark brown. | | | | WEATHERED ROCK |
| | | | 2 | | | | | END OF BOREHOLE AT 1.90 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS33**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH-EAST FACING MID SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 772471 N 7117127**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY: VS S F ST VST H; FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (CLAY):** dark brown-grey, small well developed blocky peds, trace fine grained sand. | D | | | TOPSOIL<br>$A_1$<br>scattered cobble size rock fragments of mixed origin on surface. |
| | | | | | | | CH | **CLAY:** high plasticity, grey, large well developed angular peds, trace of fine to medium grained sand. | MC<PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.40 | | D | | | ... colour change to grey-brown, calcareous concretions. | | | | $B_{22k}$ |
| | | | 0.70 | | | | CH | **CLAY:** high plasticity, brown-grey, weak ped development, trace of fine to medium grained sand. | | | | $B_{23}$ |
| | | | 0.90 | | | | | **Sandy CLAY:** yellow-grey, fine to medium grained sand. | | | | C |
| | | | 1.00 1 | | | | | **SANDSTONE:** fine to meidum grained, extremely weathered, extremely low strength. | | | | WEATHERED ROCK |
| | | | 2 | | | | | END OF BOREHOLE AT 1.20 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS34**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **NORTH FACING MID SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 786325 N 7112078**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY: VS S F ST VST H / FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | | | | **TOPSOIL (Silty CLAY):** dark brown, small well developed sub-angular peds. | | | | TOPSOIL $A_1$ |
| | | | 0.15 | | | | CL | **Silty CLAY:** medium plasticity, brown, well developed crumbly peds. | | | | RESIDUAL SOIL $B_{21}$ |
| | | | | | D | | | | | | | |
| | | | 0.45 | | | | CH | **CLAY:** high plasticity, dark grey, weakly developed peds, trace of fine to medium grained sand. | | | | $B_{22}$ |
| | | | 1 | | | | | | | | | |
| | | | 2 | | | | | | | | | |
| | | | 2.10 | | | | CL | **Sandy CLAY:** medium plasticity, brown, calcareous concretions. | | | | $B_{23k}$ |
| | | | | | | | | END OF BOREHOLE AT 2.40 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS35**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **27/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **27/7/07** |
| Borehole Location: | **FLOOD PLAIN OF WOLEEBEE CREEK** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 786940 N 7112592**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H; FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.15 | | | | | **TOPSOIL (Silty CLAY):** brown, large well developed blocky peds. | D | | | TOPSOIL $A_1$ |
| | | | | | | | CL | **CLAY:** medium plasticity, brown, moderately developed angular peds. | MC<PL | | | $A_2$ |
| | | | 0.55 | | | | CH | **CLAY:** high plasticity, dark grey, fine to medium grained sand, medium size well developed blocky peds. | | | | ALLUVIUM $B_{21}$ |
| | | | 1 | | | | | | | | | |
| | | | 1.60 | | | | | ... colour change to dark brown-grey. | | | | $B_{22}$ |
| | | | | | | | | END OF BOREHOLE AT 1.80 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS36**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **NORTH-WEST FACING UPPER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 796973 N 7103750**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | | | | **TOPSOIL (Silty CLAY):** dark grey, medium size weakly developed blocky peds. | M | | | TOPSOIL<br>$A_1$<br>soil surface bare with dry crop stalks<br>$A_2$ |
| | | | | | | | CL | **CLAY:** medium plasticity, medium size crumbly peds, trace of medium grained sand. | MC~PL | | | |
| | | | 0.40 | | | | CH | **Sandy CLAY:** medium to high plasticity, dark grey, apedal, medium to coarse grained sand, trace of angular ferruginised sandstone, trace calcareous concretions. | | | | RESIDUAL SOIL<br>$B_{21k}$ |
| | | | 0.50 | | | | | ... trace of cobble size angular ferruginised sandstone fragments. | | | | $B_{22k}$ |
| | | | 0.60 | | | | | **SANDSTONE:** fine-to-medium grained, brown-grey, extremely weathered, extremely low strength, calcareous coating on joints, trace cobble size ferruginised sandstone fragments and low strength, highly weathered sandstone fragments. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 0.90 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS37**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **NORTH-EAST FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 796181 N 7102514**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY: VS S F ST VST H; FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (CLAY):** brown-grey, small well developed irregular peds, trace coarse sand. | D | | | TOPSOIL<br>$A_1$ |
| | | | | | D | | CL | **CLAY:** medium plasticity, medium size well developed angular peds, trace of medium to coarse grained sand. | MC<PL | | | $A_2$ |
| | | | 0.45 | | D | | CH | **Sandy CLAY:** high plasticity, dark grey, weakly developed peds, fine to medium grained sand, trace of calcareous concretions. | | | | ALLUVIUM<br>$B_{21k}$ |
| | | | 0.90<br>1 | | | | | ... colour change to grey-brown, trace of coarse grained sand. | | | | $B_{22k}$ |
| | | | 1.30 | | D | | CL | **CLAY:** medium plasticity, dark brown, high organic content, trace of rootlets, trace gravel size rock fragments. | | | | C |
| | | | 2 | | | | | END OF BOREHOLE AT 2.00 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

**BOREHOLE NO.**

**WS38**

**SHEET 1 OF 1**

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **GENTLE WEST FACING LOWER SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 784637 N 7118468**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY (VS S F ST VST H / FB VL L MD D VD) | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (CLAY):** dark grey, medium size well developed peds. | M | | | TOPSOIL, surface cracks<br>$A_1$ |
| | | | | | | | CH | **CLAY:** high plasticity, grey, medium size well developed angular peds. | MC>PL | | | $A_2$ |
| | | | | | D | | | | | | | |
| | | | 0.50 | | | | CH | **CLAY:** high plasticity, brown-grey, small well developed peds. | MC<PL | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.60 | | D | | | ... gravel size ferruginised sandstone | | | | |
| | | | 0.70 | | | | | ... colour change to brown | | | | $B_{22}$ |
| | | | 1.00 1 | | | | | ... colour change to yellow-brown | | | | $B_{23}$ |
| | | | 1.70 | | | | | ... siltstone fragments, grey, extremely weathered, extremely low strength, subangular. | | | | C |
| | | | 2 | | | | | END OF BOREHOLE AT 1.80 m | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS39**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **GENTLE WEST FACING SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:
Borehole Diameter: Bearing: **---** Co-ords:

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY VS S F ST VST H / FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | | | | **TOPSOIL (CLAY):** dark grey, medium large well developed blocky peds. | D | | | TOPSOIL, 0.01 m crust<br>$A_1$ |
| | | | | | | | | **CLAY:** dark grey, medium well developed sub-angular peds. | MC<PL | | | $A_2$ |
| | | | 1 | | | | | END OF BOREHOLE AT 0.30 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS40**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **NORTH FACIING UPPER SLOPE AT TOP OF WIDE GULLY** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 793273 N 7102702**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY VS S F ST VST H FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | 0.10 | | D | | | **TOPSOIL (CLAY):**dark grey, small blocky peds, trace of fine to medium grained sand. | | | | TOPSOIL<br>$A_1$<br>scattered rock fragments of mixed origin on surface. |
| | | | | | D | | CL | **CLAY:** medium plasticity, dark grey, small to medium crumbly peds, trace fine to medium grained sand. | | | | RESIDUAL SOIL<br>$B_{21}$ |
| | | | 0.35 | | | | | ... colour change to grey-brown. | | | | $B_{22}$ |
| | | | 0.60 | | | | | **CLAY:** high plasticity, brown, weakly developed peds, trace of fine to medium grained sand. | | | | $B_{23}$ |
| | | | 0.80 | | | | | **SANDSTONE:** fine to medium grained, pale yellow mottled yellow-brown, extremely weathered, extremely low strength. | | | | WEATHERED ROCK<br>C |
| | | | 1 | | | | | END OF BOREHOLE AT 1.00 m | | | | |
| | | | 2 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# BOREHOLE ENGINEERING LOG

BOREHOLE NO.

**WS41**

SHEET 1 OF 1

| | | | |
|---|---|---|---|
| Client: | **XSTRATA COAL QUEENSLAND** | Date Commenced: | **28/7/07** |
| Project: | **WANDOAN Soil Assessment** | Date Completed: | **28/7/07** |
| Borehole Location: | **WEST FACING GENTLE SLOPE** | Recorded By: | **OW** |
| Project Number: | **2133006A** | Log Checked By: | |

Drill Model/Mounting: **CAT 428** Hole Angle: **90°** Surface RL:

Borehole Diameter: Bearing: **---** Co-ords: **E 795090 N 7106780**

| Borehole Information | | | | | | Field Material Description | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| METHOD | SUPPORT | WATER | RL(m) DEPTH(m) | FIELD TEST | SAMPLE | GRAPHIC LOG | USC SYMBOL | SOIL/ROCK MATERIAL FIELD DESCRIPTION | MOISTURE | RELATIVE DENSITY / CONSISTENCY VS S F ST VST H FB VL L MD D VD | HAND PENETROMETER (kPa) | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | | | | | **TOPSOIL (Silty CLAY):** brown, small well developed crumbly peds. | M | | | TOPSOIL $A_1$ |
| | | | 0.10 | | | | CH | **CLAY:** high plasticity, grey-brown, small well developed peds. | MC>PL | | | $A_{21}$ |
| | | | 0.20 | | | | | ... trace of fine grained sand. | | | | $A_{22}$ |
| | | | | | | | | END OF BOREHOLE AT 0.35 m | | | | |
| | | | 1 | | | | | | | | | |

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

# Attachment B

Test bore logs

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 1.00 | 1.00 | SOIL:<br>Dark brown. Extremely weathered, soft, loose, earthy. |
| | | 3.00 | 2.00 | CLAY:<br>Dark red. Extremely weathered, soft. |
| | | 5.00 | 2.00 | MUDSTONE:<br>Medium yellow. Highly weathered, soft. |
| | | 8.00 | 3.00 | MUDSTONE:<br>Medium brown and grey. Moderately weathered, soft. |
| | 255224 | 11.50 | 3.50 | SANDSTONE:<br>Medium-fine grained. Light orange and grey. Slightly weathered, soft. |
| | | ---------- Base of Weathering at 11.50m ---------- | | |
| | 255225 | 32.50 | 21.00 | SANDSTONE:<br>Carbonaceous, towards base of unit, medium and coarse grained. Light grey. Fresh, moderately hard. |
| | | 36.10 | 3.60 | COAL:<br>Minor, stony, banded. Black. Fresh, soft.<br>Towards top of unit. |
| | 255226 | 37.00 | 0.90 | CARBONACEOUS MUDSTONE:<br>Medium brown. Fresh, moderately soft. |
| | 255226 | 38.10 | 1.10 | MUDSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 40.50 | 2.40 | COAL: |
| | 255227 | 41.80 | 1.30 | SILTSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 45.20 | 3.40 | COAL:<br>Stony, banded, towards top of unit. Black. Fresh, soft. |
| | 255228 | 48.60 | 3.40 | MUDSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 49.00 | 0.40 | COAL:<br>Black. Fresh, soft. |
| | 255229 | 49.80 | 0.80 | CARBONACEOUS MUDSTONE:<br>Medium brown. Fresh, moderately soft. |
| | | 50.30 | 0.50 | COAL:<br>Black. Fresh, soft. |
| | 255230 | 51.80 | 1.50 | MUDSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 53.30 | 1.50 | COAL:<br>Black. Fresh, soft. |
| | 255231 | 54.00 | 0.70 | MUDSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 54.20 | 0.20 | COAL:<br>Black. Fresh, soft. |
| | 255232 | 60.00 | 5.80 | SILTSTONE:<br>Medium grey. Fresh, moderately hard. |
| | 255232 | 69.00 | 9.00 | MUDSTONE:<br>Carbonaceous, towards top of unit. Medium grey. Fresh, moderately hard. |
| | 255232 | 73.90 | 4.90 | SANDSTONE:<br>With hard bands, towards middle of unit, medium-fine grained. Light grey. Fresh, moderately hard. |
| | | 74.00 | 0.10 | COAL:<br>Black. Fresh, soft. |
| | 255233 | 78.00 | 4.00 | MUDSTONE:<br>Carbonaceous, towards base of unit. Medium grey. Fresh, moderately hard. |
| | | ========== TOTAL DEPTH 78M ========== | | |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | **Chip: 0m to 10.05m |
| | | 1.00 | 1.00 | SOIL: |
| | | | | Clayey. Dark grey. Weathered, soft. |
| | 352602 | 6.00 | 5.00 | SILTSTONE: |
| | | | | Light to medium orange-grey. Weathered, moderately soft. |
| | 352602 | 7.00 | 1.00 | CLAY: |
| | | | | Sooty. Dark brown. Extremely weathered, very soft. |
| | 352602 | 9.50 | 2.50 | SANDSTONE: |
| | | | | Fine grained. Light to medium orange-grey. Slightly weathered, hard. |
| | 352602 | 10.25 | 0.75 | SANDSTONE: |
| | | | | Fine grained. Light orange-grey. Slightly weathered, hard. |
| | | | | **Run #1: 10.05m to 13.13m |
| | | | | **Ran: 3.08m Rec:3.08m Loss: 0m |
| | | 11.03 | 0.78 | SANDSTONE: |
| | | | | Carbonaceous, banded. Light orange-grey. Slightly weathered, hard, erosional base, strata dipping at 3°. |
| | | ---------- Top of Kogan Seams ---------- | | |
| K | 352603 | 11.30 | 0.27 | COAL: |
| | | | | Shaley. Slightly weathered, moderately hard, erosional base, strata dipping at 3°. |
| K | 352604 | 11.32 | 0.02 | CARBONACEOUS MUDSTONE: |
| | | | | Dark brown and black. Slightly weathered, moderately soft, erosional base, strata dipping at 3°. |
| K | 352604 | 11.42 | 0.10 | CLAYSTONE: |
| | | | | Light to medium orange and cream. Slightly weathered, moderately soft, erosional base, strata dipping at 3°. |
| | | ---------- Base of Weathering at 11.42m ---------- | | |
| K | 352605 | 11.55 | 0.13 | COAL: |
| | | | | Dull lustrous. Fresh, hard, strata dipping at 3°. |
| K | 352605 | 11.57 | 0.02 | CLAYSTONE: |
| | | | | Carbonaceous, tuffaceous, lenses. Fresh, hard, strata dipping at 3°. |
| K | 352605 | 11.68 | 0.11 | COAL: |
| | | | | Dull lustrous. Strata dipping at 3°. |
| K | 352605 | 11.72 | 0.04 | STONY COAL: |
| | | | | Fresh, hard, strata dipping at 3°. |
| K | 352605 | 11.74 | 0.02 | COAL: |
| | | | | Dull lustrous. Strata dipping at 3°. |
| K | 352605 | 11.75 | 0.01 | CARBONACEOUS MUDSTONE: |
| | | | | Fresh, moderately hard, strata dipping at 3°. |
| K | 352605 | 11.98 | 0.23 | COAL: |
| | | | | Dull lustrous. Fresh, hard, strata dipping at 3°. |
| K | 352606 | 12.00 | 0.02 | CLAYSTONE: |
| | | | | Carbonaceous, tuffaceous. Dark grey. Fresh, hard, strata dipping at 3°. |
| K | 352606 | 12.10 | 0.10 | COAL: |
| | | | | Dull lustrous. Fresh, hard, strata dipping at 3°. |
| K | 352606 | 12.20 | 0.10 | COAL: |
| | | | | Dull lustrous. Fresh, hard, strata dipping at 3°. |
| K | 352606 | 12.22 | 0.02 | CLAYSTONE: |
| | | | | Carbonaceous, tuffaceous. Dark grey and black. Fresh, moderately hard, strata dipping at 3°. |
| K | 352606 | 12.42 | 0.20 | COAL: |
| | | | | Shaley, Dull lustrous. Fresh, moderately hard, strata dipping at 3°. |
| | | ---------- Base of Kogan Seams ---------- | | |
| | | ---------- Geological Thickness: 1.39 meters ---------- | | |
| | 352607 | 12.63 | 0.21 | CARBONACEOUS SILTSTONE: |
| | | | | Bands of coal. Dark dark grey to black. Fresh, moderately hard, |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | slickensided, sparse, joints at 40 - 50 degrees, strata dipping at 5°. |
| | 352607 | 12.87 | 0.24 | SILTSTONE: Light to medium grey. Fresh, hard, slickensided, sparse, joints at 30 - 40 degrees, faulted at base, strata dipping at 5°. |
| | 352607 | 13.15 | 0.28 | SANDSTONE: Fine grained. Light grey. Fresh, hard, faulted at base, strata dipping at 8°. **Run #2: 13.13m to 16.28m **Ran: 3.15m Rec:3.15m Loss: 0m |
| | 352607 | 13.33 | 0.18 | SILTSTONE: Dark grey. Fresh, moderately hard, slickensided, strata dipping at 3°. |
| | | 13.70 | 0.37 | SILTSTONE: Light to medium grey. Fresh, hard, slickensided, sparse, joints at 20 - 30 degrees, strata dipping at 3°. |
| | | 14.08 | 0.38 | SANDSTONE: Fine grained. Light grey. Fresh, hard. |
| | | 14.33 | 0.25 | SILTSTONE: Light to medium grey. Fresh, hard. |
| | | 14.37 | 0.04 | CLAYSTONE: |
| | | ---------- Top of KL seam ---------- | | |
| KL | 352608 | 14.60 | 0.23 | COAL: Bright lustrous. Fresh, hard. |
| | | ---------- Base of KL seam ---------- | | |
| | | ---------- Geological Thickness: 0.23 meters ---------- | | |
| | 352609 | 14.77 | 0.17 | MUDSTONE: Carbonaceous, banded. Dark grey. Fresh, moderately hard, slickensided, sparse, joints at 40 - 50 degrees, faulted at base, strata dipping at 3°. |
| | | ---------- Top of Macalister Upper Ply 1 ---------- | | |
| MU10 | 352610 | 15.17 | 0.40 | COAL: Bright lustrous. Fresh, hard. |
| MU10 | 352610 | 15.29 | 0.12 | STONY COAL: Towards middle of unit, lenses. Fresh, hard. |
| MU10 | 352610 | 15.55 | 0.26 | COAL: Bright lustrous. Fresh, hard. |
| MU10 | 352611 | 15.61 | 0.06 | CLAYSTONE: Tuffaceous. Light to medium cream. Fresh, hard, strata dipping at 3°. |
| MU10 | 352611 | 15.83 | 0.22 | COAL: Bright lustrous. Fresh, hard. |
| MU10 | 352611 | 15.94 | 0.11 | COAL: Dull lustrous. Fresh, hard. |
| MU10 | 352611 | 15.96 | 0.02 | CLAYSTONE: Tuffaceous, carbonaceous. Dark dark grey to black. Fresh, hard, strata dipping at 3°. |
| MU10 | 352611 | 16.12 | 0.16 | COAL: Bright lustrous. Fresh, hard. |
| | | ---------- Base of Macalister Upper Ply 1 ---------- | | |
| | | ---------- Geological Thickness: 1.35 meters ---------- | | |
| | | ---------- Top of Macalister Upper Ply 2 ---------- | | |
| MU20 | 352612 | 16.18 | 0.06 | CARBONACEOUS MUDSTONE: Lenses. Dark brown. Fresh, moderately hard, strata dipping at 3°. |
| MU20 | 352612 | 16.48 | 0.30 | COAL: Bright lustrous. Fresh, hard. **Run #3: 16.28m to 19.41m **Ran: 3.13m Rec:3.13m Loss: 0m |
| MU20 | 352612 | 16.63 | 0.15 | COAL: Bright lustrous. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| MU20 | 352612 | 16.65 | 0.02 | CARBONACEOUS MUDSTONE: Tuffaceous, lenses. Dark brown. Fresh, hard, strata dipping at 3°. |
| MU20 | 352612 | 16.80 | 0.15 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352612 | 16.86 | 0.06 | STONY COAL: Fresh, hard, strata dipping at 3°. |
| MU20 | 352612 | 16.94 | 0.08 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352612 | 17.00 | 0.06 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.02 | 0.02 | CLAYSTONE: Tuffaceous, lenses. Medium cream. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.05 | 0.03 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.20 | 0.15 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.24 | 0.04 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.33 | 0.09 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.36 | 0.03 | CARBONACEOUS SHALE: Fresh, moderately hard, strata dipping at 3°. |
| MU20 | 352613 | 17.39 | 0.03 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.42 | 0.03 | CLAYSTONE: Tuffaceous, lenses. Medium grey and cream. Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.60 | 0.18 | STONY COAL: Fresh, hard, strata dipping at 3°. |
| MU20 | 352613 | 17.65 | 0.05 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352614 | 17.72 | 0.07 | CARBONACEOUS MUDSTONE: Lenses. Dark brown. Fresh, hard, strata dipping at 3°. |
| MU20 | 352614 | 17.79 | 0.07 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352614 | 17.84 | 0.05 | CARBONACEOUS MUDSTONE: Dark brown. Fresh, moderately hard, strata dipping at 3°. |
| MU20 | 352614 | 18.04 | 0.20 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352615 | 18.14 | 0.10 | CARBONACEOUS SILTSTONE: Dark grey. Fresh, moderately hard, slickensided, abundant, horizontal joints, strata dipping at 3°. |
| MU20 | 352616 | 18.16 | 0.02 | CARBONACEOUS SILTSTONE: Calcified, lenses, coaly. Fresh, hard, strata dipping at 3°. |
| MU20 | 352616 | 18.22 | 0.06 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU20 | 352616 | 18.23 | 0.01 | CLAYSTONE: Dark brown. Fresh, moderately hard, strata dipping at 3°. |
| MU20 | 352616 | 18.27 | 0.04 | COAL: Bright lustrous. Fresh, hard. |
| | | ---------- Base of Macalister Upper Ply 2 ---------- | | |
| | | ---------- Geological Thickness: 2.15 meters ---------- | | |
| | 352617 | 18.49 | 0.22 | MUDSTONE: Medium brown and grey. Fresh, hard. |
| | 352617 | 18.55 | 0.06 | CARBONACEOUS MUDSTONE: Shaley. Dark brown and black. Fresh, moderately hard. |
| | | ---------- Top of Macalister Upper Ply 3 ---------- | | |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| MU30 | 352618 | 18.60 | 0.05 | STONY COAL:<br>Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 18.73 | 0.13 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 18.89 | 0.16 | COAL:<br>Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 18.92 | 0.03 | CLAYSTONE:<br>Lenses. Black. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.00 | 0.08 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.05 | 0.05 | COAL:<br>Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.10 | 0.05 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.12 | 0.02 | CARBONACEOUS MUDSTONE:<br>Tuffaceous. Black. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.27 | 0.15 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.32 | 0.05 | COAL:<br>Muddy. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.41 | 0.09 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°.<br>**Run #4: 19.41m to 22.48m<br>**Ran: 3.07m Rec:3.07m Loss: 0m |
| MU30 | 352618 | 19.42 | 0.01 | CARBONACEOUS MUDSTONE:<br>Lenses. Black. Fresh, hard, strata dipping at 3°. |
| MU30 | 352618 | 19.50 | 0.08 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 19.53 | 0.03 | CLAYSTONE:<br>With minor coaly wisps, shaley. Grey. Fresh, moderately hard, strata dipping at 3°. |
| MU30 | 352619 | 19.61 | 0.08 | COAL:<br>Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 19.77 | 0.16 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 19.80 | 0.03 | MUDSTONE:<br>Shaley. Dark brown and black. Fresh, moderately hard, strata dipping at 3°. |
| MU30 | 352619 | 19.83 | 0.03 | COAL:<br>Dull lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 19.86 | 0.03 | STONY COAL:<br>Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 20.02 | 0.16 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 20.04 | 0.02 | STONY COAL:<br>Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 20.06 | 0.02 | CLAYSTONE:<br>Tuffaceous. Dark grey. Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 20.09 | 0.03 | STONY COAL:<br>Fresh, hard, strata dipping at 3°. |
| MU30 | 352619 | 20.13 | 0.04 | COAL:<br>Shaley, Dull lustrous. Fresh, moderately hard. |
| MU30 | 352619 | 20.15 | 0.02 | CARBONACEOUS MUDSTONE:<br>Dark brown and black. Fresh, moderately soft, strata dipping at 3°. |
| MU30 | 352619 | 20.31 | 0.16 | COAL:<br>Dull lustrous. Fresh, moderately hard, strata dipping at 3°. |

---------- Base of Macalister Upper Ply 3 ----------

---------- Geological Thickness: 1.76 meters ----------

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | 352620 | 20.53 | 0.22 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | | 20.55 | 0.02 | COAL:<br>Bright lustrous. Fresh, moderately hard, strata dipping at 3°. |
| | | 20.83 | 0.28 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | | 21.33 | 0.50 | SANDSTONE:<br>Fine grained. Light grey. Fresh, hard, strata dipping at 3°. |
| | | 21.54 | 0.21 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | | ---------- Top of Macalister Upper Ply 4 ---------- | | |
| MU40 | 352621 | 21.66 | 0.12 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| MU40 | 352621 | 21.67 | 0.01 | CLAYSTONE:<br>Brown. Fresh, hard, strata dipping at 3°. |
| MU40 | 352621 | 21.97 | 0.30 | COAL:<br>Bright lustrous. Strata dipping at 3°. |
| MU40 | 352621 | 22.18 | 0.21 | COAL:<br>Dull lustrous, minor, muddy. Strata dipping at 3°. |
| MU40 | 352621 | 22.20 | 0.02 | CLAYSTONE:<br>Medium grey. Fresh, hard, strata dipping at 3°. |
| MU40 | 352621 | 22.23 | 0.03 | COAL:<br>Dull lustrous. Strata dipping at 3°. |
| MU40 | 352621 | 22.24 | 0.01 | CLAYSTONE:<br>Medium grey. Fresh, hard, strata dipping at 3°. |
| MU40 | 352621 | 22.29 | 0.05 | COAL:<br>Bright lustrous. Fresh, hard, sharp wavy base. |
| | | ---------- Base of Macalister Upper Ply 4 ---------- | | |
| | | ---------- Geological Thickness: 0.75 meters ---------- | | |
| | 352622 | 22.36 | 0.07 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | 352622 | 22.43 | 0.07 | SILTSTONE:<br>Sandy, lenses. Fresh, hard, strata dipping at 3°. |
| | | 22.55 | 0.12 | SANDSTONE:<br>Light grey. Fresh, hard, strata dipping at 3°.<br>**Run #5: 22.48m to 25.43m<br>**Ran: 2.95m Rec:2.95m Loss: 0m |
| | | 22.68 | 0.13 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | | 23.06 | 0.38 | SILTSTONE:<br>Light to medium grey. Fresh, hard, slickensided, sparse, joints at 40 - 50 degrees, faulted at base, strata dipping at 3°. |
| | | 23.12 | 0.06 | CARBONACEOUS SILTSTONE:<br>Dark grey. Fresh, moderately hard, slickensided, common, joints at 40 - 50 degrees, strata dipping at 3°. |
| | | 23.87 | 0.75 | SILTSTONE:<br>Light to medium grey. Fresh, hard, slickensided, sparse, joints at 40 - 50 degrees, strata dipping at 3°. |
| | | 24.15 | 0.28 | SANDSTONE:<br>Light grey. Fresh, hard, strata dipping at 3°. |
| | | 24.70 | 0.55 | SILTSTONE:<br>Carbonaceous, banded. Medium grey. Fresh, hard. |
| | | 24.85 | 0.15 | CARBONACEOUS SILTSTONE:<br>Bands of coal. Dark grey. Fresh, moderately hard, slickensided, joints at 40 - 50 degrees, strata dipping at 3°. |
| | | 25.18 | 0.33 | SANDSTONE:<br>Fine and medium grained. Light grey. Fresh, hard, strata dipping at 3°. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 25.63 | 0.45 | SILTSTONE:<br>Minor, bands of coal. Light to medium grey. Fresh, moderately hard, strata dipping at 3°.<br>**Run #6: 25.43m to 28.43m<br>**Ran: 3m Rec:2.95m Loss: 0.05m |
| | | 25.80 | 0.17 | SILTSTONE:<br>Light to medium grey. Fresh, hard, strata dipping at 3°. |
| | | ---------- Top of Macalister Lower Ply 12 ---------- | | |
| ML12 | 352623 | 25.86 | 0.06 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 25.93 | 0.07 | CLAYSTONE:<br>Tuffaceous. Light to medium cream. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.05 | 0.12 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.07 | 0.02 | CLAYSTONE:<br>Lenses. Light to medium grey and cream. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.16 | 0.09 | COAL:<br>Bright lustrous. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.23 | 0.07 | COAL:<br>Dull lustrous. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.24 | 0.01 | CLAYSTONE:<br>Tuffaceous. Light to medium orange and black. Fresh, hard, strata dipping at 3°. |
| ML12 | 352623 | 26.34 | 0.10 | COAL:<br>Dull lustrous. Fresh, hard. |
| ML12 | 352623 | 26.37 | 0.03 | STONY COAL:<br>Fresh, hard. |
| ML12 | 352623 | 26.59 | 0.22 | COAL:<br>Bright lustrous. Fresh, hard. |
| ML12 | 352623 | 26.65 | 0.06 | STONY COAL:<br>Fresh, hard. |
| | | ---------- Base of Macalister Lower Ply 12 ---------- | | |
| | | ---------- Geological Thickness: 0.85 meters ---------- | | |
| | | ---------- Top of Macalister Lower Ply 13 ---------- | | |
| ML13 | 352624 | 26.74 | 0.09 | CARBONACEOUS MUDSTONE:<br>Minor, bands of coal. Fresh, moderately soft, slickensided, sparse, joints at 40 - 50 degrees, strata dipping at 3°. |
| ML13 | 352625 | 26.90 | 0.16 | COAL:<br>Bright lustrous. |
| ML13 | 352625 | 27.10 | 0.20 | COAL:<br>Dull lustrous, muddy, banded. |
| | | ---------- Base of Macalister Lower Ply 13 ---------- | | |
| | | ---------- Geological Thickness: 0.45 meters ---------- | | |
| | 352626 | 27.25 | 0.15 | SILTSTONE:<br>Light to medium grey. Fresh, hard. |
| | | 27.52 | 0.27 | SANDSTONE:<br>Fine grained. Light grey. Fresh, hard. |
| | | 27.73 | 0.21 | SILTSTONE:<br>Minor, bands of coal, banded. Light to medium grey. Fresh, hard. |
| | | ---------- Top of Macalister Lower Ply 21 ---------- | | |
| ML21 | 352627 | 27.98 | 0.25 | COAL:<br>Bright lustrous. Fresh, hard. |
| ML21 | 352627 | 28.01 | 0.03 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard. |
| ML21 | 352627 | 28.11 | 0.10 | COAL:<br>Bright lustrous. Fresh, hard. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | ---------- Base of Macalister Lower Ply 21 ---------- | | |
| | | ---------- Geological Thickness: 0.38 meters ---------- | | |
| | 352628 | 28.24 | 0.13 | CARBONACEOUS SILTSTONE: Dark grey. Fresh, moderately hard. |
| | | 28.28 | 0.04 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| | | 28.43 | 0.15 | CARBONACEOUS SILTSTONE: Dark grey. Fresh, moderately hard, strata dipping at 3°. **Run #7: 28.43m to 31.43m **Ran: 3m Rec:3m Loss: 0m |
| | | 28.58 | 0.15 | SILTSTONE: Carbonaceous, banded. Medium grey. Fresh, hard, strata dipping at 3°. |
| | | ---------- Top of Macalister Lower Ply 22 ---------- | | |
| ML22 | 352629 | 28.63 | 0.05 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| ML22 | 352629 | 28.67 | 0.04 | STONY COAL: Fresh, hard, strata dipping at 3°. |
| ML22 | 352629 | 28.74 | 0.07 | COAL: Bright lustrous. Fresh, hard, strata dipping at 3°. |
| ML22 | 352629 | 28.75 | 0.01 | CLAYSTONE: Medium brown. Fresh, moderately hard, strata dipping at 3°. |
| ML22 | 352629 | 28.85 | 0.10 | COAL: Dull lustrous. Fresh, hard, strata dipping at 3°. |
| ML22 | 352629 | 28.86 | 0.01 | CLAYSTONE: Medium to dark brown. Fresh, moderately hard, strata dipping at 3°. |
| ML22 | 352629 | 29.04 | 0.18 | COAL: Dull lustrous. Fresh, hard. |
| ML22 | 352629 | 29.07 | 0.03 | CARBONACEOUS MUDSTONE: Lenses. Brown. Fresh, moderately hard. |
| ML22 | 352629 | 29.11 | 0.04 | COAL: Bright lustrous. Fresh, hard. |
| | | ---------- Base of Macalister Lower Ply 22 ---------- | | |
| | | ---------- Geological Thickness: 0.53 meters ---------- | | |
| | 352630 | 29.20 | 0.09 | CARBONACEOUS MUDSTONE: Minor, bands of coal. Brown. Fresh, hard. |
| | 352630 | 29.28 | 0.08 | SILTSTONE: Medium grey. Fresh, hard. |
| | 352630 | 29.31 | 0.03 | CARBONACEOUS MUDSTONE: Brown. Fresh, hard. |
| | 352630 | 29.34 | 0.03 | COAL: Dull lustrous. Fresh, hard. |
| | 352630 | 29.44 | 0.10 | CARBONACEOUS MUDSTONE: Dark brown and black. Fresh, hard. |
| | | ---------- Top of Macalister Lower Ply 23 ---------- | | |
| ML23 | 352631 | 29.61 | 0.17 | COAL: |
| | | ---------- Base of Macalister Lower Ply 23 ---------- | | |
| | | ---------- Geological Thickness: 0.17 meters ---------- | | |
| | 352632 | 29.77 | 0.16 | SILTSTONE: Light to medium grey. Fresh, hard. |
| | | 30.03 | 0.26 | SANDSTONE: Fine grained. Light to medium grey. Fresh, hard. |
| | | 30.18 | 0.15 | SILTSTONE: Light to medium grey. Fresh, hard. |
| | | 30.30 | 0.12 | CARBONACEOUS MUDSTONE: Bands of coal. Fresh, moderately hard. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 30.32 | 0.02 | COAL:<br>Bright lustrous. Fresh, hard. |
| | | 30.38 | 0.06 | SILTSTONE:<br>Light to medium grey. Fresh, hard, slickensided, sparse, joints at 40 - 50 degrees. |
| | | 30.40 | 0.02 | COAL:<br>Dull lustrous. Fresh, hard. |
| | | 30.66 | 0.26 | SILTSTONE:<br>Light to medium grey. Fresh, hard, slickensided, sparse, joints at 40 - 50 degrees. |
| | | 30.68 | 0.02 | COAL:<br>Dull lustrous. |
| | | 30.77 | 0.09 | CARBONACEOUS SILTSTONE:<br>Minor, bands of coal. Dark grey. Fresh, moderately hard. |
| | | 31.40 | 0.63 | SILTSTONE:<br>Light to medium grey. Fresh, hard. |
| | | 31.63 | 0.23 | SANDSTONE:<br>Fine grained. Light grey. Fresh, hard.<br>**Chip: 31.43m to 39.16m |
| | | 39.16 | 7.53 | SANDSTONE:<br>Fine and medium grained. Light grey. Fresh, hard. |

========== TOTAL DEPTH 39.16M ==========

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | **Chip: 0m to 33m |
| | | | | **K/MU interburden sample taken 22-23m and MU/ML interburden sample taken 27.5-28.5m.. |
| | | 22.00 | 22.00 | NOT LOGGED: |
| | 364998 | 23.00 | 1.00 | SANDSTONE: |
| | | | | Medium-fine grained. Light grey. Fresh, moderately soft. |
| | | 27.50 | 4.50 | NOT LOGGED: |
| | 364999 | 28.50 | 1.00 | SANDSTONE: |
| | | | | Fine grained. Light grey. Fresh, moderately soft. |
| | | 33.00 | 4.50 | NOT LOGGED: |
| | | | | **Run #1: 33m to 37.5m |
| | | | | **Ran: 4.5m Rec:4.16m Loss: 0.34m |
| | | 33.16 | 0.16 | SANDSTONE: |
| | | | | Very fine grained. Medium grey. Fresh, moderately hard, slickensided, R.Q.D. excellent (90 - 100%), joints at 40 - 50 degrees. |
| | | 33.90 | 0.74 | SANDSTONE: |
| | | | | Fine grained. Light grey. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | | 34.04 | 0.14 | MUDSTONE: |
| | | | | Medium grey. Fresh, moderately hard, slickensided, R.Q.D. excellent (90 - 100%), joints at 40 - 50 degrees, sharp irregular base, strata dipping at 5°. |
| | 352349 | 34.25 | 0.21 | COAL: |
| | | | | Dull lustrous, minor, stony. Black. Fresh, soft, sharp irregular base, strata dipping at 15°. Calcite (rare) in cleats. |
| | | | | Lenses. |
| | | 35.57 | 1.32 | SANDSTONE: |
| | | | | Very fine grained. Light grey. Fresh, moderately hard, sharp base, strata dipping at 5°. |
| | 352350 | 35.90 | 0.33 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 3°. Calcite (rare) in cleats. |
| | | 37.16 | 1.26 | SANDSTONE: |
| | | | | Fossiliferous, in part, towards base of unit. Leaf impressions. |
| | 352351 | 37.27 | 0.11 | CARBONACEOUS MUDSTONE: |
| | | | | Dark grey. Fresh, moderately hard, broken. |
| | 352351 | 37.50 | 0.23 | COAL: |
| | | | | Dull lustrous, minor, penny bands. Brown. Fresh, soft, broken, sharp base, strata dipping at 0°. |
| | | | | **Run #2: 37.5m to 41.5m |
| | | | | **Ran: 4m Rec:4.08m Gain: 0.08m |
| | 352352 | 37.96 | 0.46 | MUDSTONE: |
| | | | | Tuffaceous, towards base of unit, minor. Medium grey. Fresh, moderately hard, broken, sharp base, strata dipping at 0°. |
| | | | | Coaly, fragments, throughout. |
| | 352353 | 38.23 | 0.27 | COAL: |
| | | | | Minor, penny bands, towards base of unit. Black. Fresh, soft, gradational base. Calcite (abundant) in cleats. |
| | 352354 | 38.33 | 0.10 | CARBONACEOUS MUDSTONE: |
| | | | | Dark grey to black. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352355 | 38.58 | 0.25 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, gradational base. Calcite (common) in cleats. |
| | 352356 | 38.64 | 0.06 | CARBONACEOUS MUDSTONE: |
| | | | | Coaly, in part, towards top of unit. Dark brown. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352357 | 39.77 | 1.13 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft. Calcite (common) in cleats. |
| | 352358 | 40.30 | 0.53 | COAL: |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | Dull lustrous, minor, penny bands. Black. Fresh, soft, sharp base, strata dipping at 0°. Calcite (common) in cleats. |
| | | | | Towards base of unit. |
| | 352359 | 40.31 | 0.01 | CARBONACEOUS MUDSTONE: |
| | | | | Dark brown. Fresh, moderately hard. |
| | 352359 | 40.72 | 0.41 | COAL: |
| | | | | Minor, stony, banded. Black. Fresh, soft. |
| | | | | Throughout, Dull lustrous. |
| | 352360 | 40.75 | 0.03 | CARBONACEOUS MUDSTONE: |
| | | | | Tuffaceous, in part. Dark brown. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352360 | 40.79 | 0.04 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 0°. |
| | 352360 | 40.85 | 0.06 | CARBONACEOUS MUDSTONE: |
| | | | | Tuffaceous, in part. Dark brown. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352361 | 41.24 | 0.39 | COAL: |
| | | | | Stony, in part, Dull lustrous. Black. Fresh, soft. |
| | | | | Minor, penny bands. |
| | 352362 | 41.50 | 0.26 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, broken. |
| | | | | **Run #3: 41.5m to 45.5m |
| | | | | **Ran: 4m Rec:4.16m Gain: 0.16m |
| | 352363 | 42.03 | 0.53 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 0°. Calcite (abundant) in cleats. |
| | 352364 | 42.11 | 0.08 | CARBONACEOUS MUDSTONE: |
| | | | | Dark grey. Fresh, moderately hard, slickensided, R.Q.D. excellent (90 - 100%), joints at 40 - 50 degrees. |
| | 352364 | 42.19 | 0.08 | CARBONACEOUS MUDSTONE: |
| | | | | Dark grey. Fresh, moderately hard to hard, broken, sharp base, strata dipping at 0°. |
| | 352365 | 42.28 | 0.09 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 0°. Calcite (rare) in cleats. |
| | 352366 | 42.76 | 0.48 | SANDSTONE: |
| | | | | Very fine grained. Light grey. Fresh, moderately hard, slickensided, joints at 40 - 50 degrees, sharp base, strata dipping at 0°. |
| | 352367 | 42.98 | 0.22 | COAL: |
| | | | | Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 5°. Calcite (common) in cleats. |
| | | 42.99 | 0.01 | CARBONACEOUS MUDSTONE: |
| | | | | Dark grey to black. Fresh, moderately hard, sharp base, strata dipping at 5°. Cone in cone structure. |
| | | 44.46 | 1.47 | SANDSTONE: |
| | | | | Minor, carbonaceous, wisps, very fine grained. Light grey. Fresh, moderately hard. |
| | | 44.55 | 0.09 | SANDSTONE: |
| | | | | Calcified, fine grained. Light white-grey. Fresh, moderately hard to hard. |
| | | 45.40 | 0.85 | SANDSTONE: |
| | | | | Very fine grained. Light grey. Fresh, moderately hard. |
| | 365000 | 45.50 | 0.10 | SANDSTONE: |
| | | | | Fossiliferous, in part, very fine grained. Light grey. Fresh, moderately hard. Carbonaceous fragments. |
| | | | | **Run #4: 45.5m to 50m |
| | | | | **Ran: 4.5m Rec:4.6m Gain: 0.1m |
| | | 45.62 | 0.12 | MUDSTONE: |
| | | | | Medium grey. Fresh, moderately hard, sharp irregular base, strata dipping at 5°. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 45.76 | 0.14 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Fresh, moderately hard, gradational base. |
| | | 46.15 | 0.39 | MUDSTONE:<br>Medium grey. Fresh, moderately hard, sharp irregular base, strata dipping at 10°. |
| | | 46.17 | 0.02 | MUDSTONE:<br>Tuffaceous, in part. Medium brown. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352368 | 46.60 | 0.43 | COAL:<br>Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 5°. Calcite (common) in cleats. |
| | 352369 | 46.61 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard, sharp base, strata dipping at 5°. |
| | 352369 | 46.89 | 0.28 | COAL:<br>Dull lustrous. Black. Fresh, soft, sharp base, strata dipping at 0°. Calcite (common) in cleats. |
| | | 47.50 | 0.61 | MUDSTONE:<br>Medium grey. Fresh, moderately hard. |
| | | 49.50 | 2.00 | SANDSTONE:<br>Very fine grained. Light grey. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | | 49.51 | 0.01 | COAL:<br>Dull lustrous. Black. Fresh, soft. |
| | | 49.69 | 0.18 | MUDSTONE:<br>Tuffaceous, in part. Dark brown and cream. Fresh, moderately hard, sharp base, strata dipping at 0°. |
| | 352370 | 50.00 | 0.31 | COAL:<br>Dull lustrous. Black. Fresh, soft. Calcite (common) in cleats.<br>**Run #5: 50m to 53m<br>**Ran: 3m Rec:3m Loss: 0m |
| | 352371 | 50.20 | 0.20 | COAL:<br>Dull lustrous, stony. Black. Fresh, soft, broken, sharp base, strata dipping at 0°. Calcite (abundant) in cleats. |
| | 352372 | 50.50 | 0.30 | MUDSTONE:<br>Carbonaceous, in part. Dark grey. Fresh, moderately hard, broken, sharp base, strata dipping at 0°. |
| | 352373 | 50.84 | 0.34 | COAL:<br>Dull lustrous. Black. Fresh, soft, broken, sharp base, strata dipping at 0°. Calcite (common) in cleats. |
| | 352374 | 51.01 | 0.17 | MUDSTONE:<br>Medium grey. Fresh, moderately hard, broken, sharp base, strata dipping at 0°. |
| | 352375 | 51.16 | 0.15 | COAL:<br>Dull lustrous, minor, penny bands. Black. Fresh, soft, broken, sharp base, strata dipping at 0°. |
| | 352376 | 51.37 | 0.21 | MUDSTONE:<br>Medium grey. Fresh, moderately hard, broken, sharp base, strata dipping at 0°. |
| | 352377 | 51.38 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard, broken. |
| | 352377 | 51.39 | 0.01 | COAL:<br>Dull lustrous. Black. Fresh, soft, broken. |
| | 352377 | 51.42 | 0.03 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard. |
| | 352377 | 51.45 | 0.03 | COAL:<br>Dull lustrous. Black. Fresh, soft, broken. |
| | 352377 | 51.46 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard, broken. |
| | 352378 | 51.77 | 0.31 | MUDSTONE:<br>Medium grey. Fresh, moderately hard, sharp base, strata dipping |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | at 0°. |
| | 352379 | 51.85 | 0.08 | COAL:<br>Dull lustrous, stony, in part. Black. Fresh, soft, broken. |
| | 352379 | 51.88 | 0.03 | CARBONACEOUS MUDSTONE:<br>Dark brown. Fresh, moderately hard, broken. |
| | 352379 | 51.91 | 0.03 | COAL:<br>Dull lustrous. Black. Fresh, soft, broken, sharp base, strata dipping at 0°. |
| | 352380 | 52.09 | 0.18 | MUDSTONE:<br>Medium grey. Fresh, moderately hard, broken, sharp base, strata dipping at 0°. |
| | 352381 | 52.18 | 0.09 | COAL:<br>Dull lustrous. Black. Fresh, soft, broken, sharp base, strata dipping at 2°. |
| | | 53.00 | 0.82 | MUDSTONE:<br>Medium grey.<br>**Chip: 53m to 61m |
| | | 61.00 | 8.00 | NOT LOGGED: |

========== TOTAL DEPTH 61M ==========

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | **Chip: 0m to 19.5m |
| | | 1.00 | 1.00 | CLAY: |
| | | | | Black. Weathered, soft. |
| | | 2.00 | 1.00 | SANDSTONE: |
| | | | | Clayey, medium grained. Brown. Weathered, soft. |
| | | 5.00 | 3.00 | SAND: |
| | | | | Minor, clayey. Brown. Weathered, soft. |
| | | 6.00 | 1.00 | SAND: |
| | | | | Minor, quartzose, in part, medium grained. Brown. Soft. |
| | | 8.00 | 2.00 | SANDSTONE: |
| | | | | Sandy, minor, quartzose, medium grained. Grey-brown. Slightly weathered, soft. |
| | | 10.00 | 2.00 | SANDSTONE: |
| | | | | Minor, sandy, medium grained. Light grey. Slightly weathered, moderately soft. |
| | | ---------- Base of Weathering at 10.00m ---------- | | |
| | | 12.00 | 2.00 | SANDSTONE: |
| | | | | Medium grained. Light grey. Fresh, moderately hard. |
| | | 19.50 | 7.50 | SANDSTONE: |
| | | | | Medium grained. Light grey. Fresh, moderately soft. |
| | | | | **Run #1: 19.5m to 23.85m |
| | | | | **Ran: 4.35m Rec:4.05m Loss: 0.3m |
| | | 20.49 | 0.99 | SANDSTONE: |
| | | | | Abundant, coaly, wisps, medium grained. Light grey. Moderately hard, joints at 10 - 20 degrees. |
| | | 20.52 | 0.03 | CARBONACEOUS MUDSTONE: |
| | | | | Brown. Moderately hard. |
| | | 21.47 | 0.95 | SANDSTONE: |
| | | | | Abundant, coaly, wisps, medium grained. Grey. Moderately hard, sharp oblique base, strata dipping at 1°. |
| | | ---------- Top of K30 seam ---------- | | |
| K30 | 352082 | 21.50 | 0.03 | COAL: |
| | | | | Dull lustrous. |
| K30 | 352082 | 21.51 | 0.01 | CARBONACEOUS MUDSTONE: |
| | | | | Brown. Moderately hard. |
| K30 | 352082 | 22.38 | 0.87 | COAL: |
| | | | | Dull lustrous, muddy, penny bands. |
| K30 | | | | |
| | | | | Muddy, pelletal. |
| K30 | 352083 | 22.56 | 0.18 | CARBONACEOUS MUDSTONE: |
| | | | | Coaly, lenses, towards middle of unit. Dark brown. Moderately hard. |
| K30 | 352083 | 23.19 | 0.63 | COAL: |
| | | | | Mid-lustrous. |
| K30 | 352083 | 23.23 | 0.04 | COAL: |
| | | | | Mid-lustrous. Pyrite. |
| K30 | 352083 | 23.45 | 0.22 | COAL: |
| | | | | Mid-lustrous. |
| K30 | 352083 | 23.55 | 0.10 | COAL: |
| | | | | Dull lustrous. Black. |
| | | ---------- Base of K30 seam ---------- | | |
| | | ---------- Geological Thickness: 2.08 meters ---------- | | |
| | | 24.00 | 0.45 | SANDSTONE: |
| | | | | Abundant, coaly, wisps, fine grained. Dark grey. Moderately hard, joints at 10 - 20 degrees. |
| | | | | **Run #2: 23.85m to 25.85m |
| | | | | **Ran: 2m Rec:1.95m Loss: 0.05m |
| | | 24.10 | 0.10 | SANDSTONE: |
| | | | | Coaly, laminae. Dark grey. Moderately hard, broken. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 24.72 | 0.62 | MUDSTONE:<br>Minor, coaly, wisps. Grey. Moderately hard.<br>Towards top of unit. |
| | | 25.50 | 0.78 | SANDSTONE:<br>Fine grained. Light grey. Moderately hard. |
| | | 25.85 | 0.35 | CORE LOSS:<br>**Chip: 25.85m to 53m |
| | | 40.00 | 14.15 | SANDSTONE:<br>Medium-fine grained. Light grey. Moderately hard. |
| | | 42.00 | 2.00 | MUDSTONE:<br>Indurated, silty, towards top of unit. Grey. Moderately hard. |
| | | 45.00 | 3.00 | MUDSTONE:<br>Silty, sandy. Grey. Moderately hard. |
| | | 46.00 | 1.00 | MUDSTONE:<br>Minor, coaly, fragments. Dark grey.<br>Minor, carbonaceous, banded. Dark grey-brown. Moderately hard. |
| | | 47.00 | 1.00 | SANDSTONE:<br>Fine and medium grained. Grey. Moderately hard. |
| | | 49.00 | 2.00 | SANDSTONE:<br>Silty, muddy, fine grained. Grey. Moderately hard. |
| | | 53.00 | 4.00 | MUDSTONE:<br>Dark grey. Moderately hard.<br>**Run #3: 53m to 56.8m<br>**Ran: 3.8m Rec:3.72m Loss: 0.08m |
| | | 54.55 | 1.55 | MUDSTONE:<br>Siliceous, in part. Grey. Moderately hard, joints at 20 - 30 degrees. |
| | | 54.57 | 0.02 | MUDSTONE:<br>Carbonaceous, in part. Dark grey-brown. Moderately hard. |
| | | 54.58 | 0.01 | COALY MUDSTONE:<br>Black. Moderately hard. |
| | | 54.60 | 0.02 | COAL:<br>Mid-lustrous. Sharp irregular base. |
| | | 54.70 | 0.10 | MUDSTONE:<br>Grey. Moderately hard, multi-directional joints. |
| | | 54.79 | 0.09 | MUDSTONE:<br>Calcareous, carbonaceous. Hard. |
| | | 56.72 | 1.93 | MUDSTONE:<br>Minor, coaly, fragments. Grey. Moderately hard, joints at 20 - 30 degrees. |
| | | 59.00 | 2.28 | MUDSTONE:<br>Minor, coaly, fragments.<br>**Chip: 56.8m to 60.5m |
| | | ---------- Top of K50 seam ---------- | | |
| | | 60.00 | 1.00 | MUDSTONE (80%):<br>Dark grey. Moderately hard. |
| K50 | | | | COAL (20%): |
| | | 60.50 | 0.50 | MUDSTONE (50%):<br>Dark grey. Moderately hard. |
| K50 | | | | COAL (50%):<br>**Run #4: 60.5m to 65m<br>**Ran: 4.5m Rec:4.48m Loss: 0.02m |
| | | ---------- Base of K50 seam ---------- | | |
| | | ---------- Geological Thickness: 1.5 meters ---------- | | |
| | | 61.23 | 0.73 | MUDSTONE:<br>Grey. Moderately hard. |
| | | 61.26 | 0.03 | MUDSTONE: |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | Carbonaceous, in part. Dark grey. Moderately hard. |
| | | 61.28 | 0.02 | COAL: Dull lustrous. Broken. |
| | | 61.30 | 0.02 | MUDSTONE: Minor, with minor hard bands. Dark black. Moderately hard. |
| | | 61.71 | 0.41 | MUDSTONE: Grey. Moderately hard. |
| | | ---------- Top of K60 seam ---------- | | |
| K60 | 352084 | 61.72 | 0.01 | COALY MUDSTONE: Black. Moderately hard. |
| K60 | 352084 | 61.81 | 0.09 | COAL: Mid-lustrous. |
| K60 | 352084 | 61.89 | 0.08 | COAL: Dull lustrous, tending to inferior, in part. |
| K60 | 352084 | 62.03 | 0.14 | COAL: Dull lustrous. Calcite (common) in cleats. |
| K60 | 352084 | 62.07 | 0.04 | COAL: Mid-lustrous. |
| K60 | 352084 | 62.09 | 0.02 | COAL: Dull lustrous. |
| K60 | 352084 | 62.34 | 0.25 | COAL: Mid-lustrous. |
| K60 | 352085 | 62.37 | 0.03 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| K60 | 352085 | 62.40 | 0.03 | MUDSTONE: Tuffaceous, in part. Dark grey. Sharp irregular base. |
| K60 | 352085 | 62.47 | 0.07 | COAL: Dull lustrous. Sharp oblique base, strata dipping at 60°. |
| K60 | 352085 | 62.48 | 0.01 | MUDSTONE: Grey. Moderately hard, broken. |
| K60 | 352085 | 62.54 | 0.06 | COAL: Dull lustrous. Black. Sharp base. |
| | | ---------- Base of K60 seam ---------- | | |
| | | ---------- Geological Thickness: 0.83 meters ---------- | | |
| | | 63.34 | 0.80 | SANDSTONE: Fine grained. Grey. Moderately hard, joints at 20 - 30 degrees. |
| | | 64.06 | 0.72 | MUDSTONE: Joints at 40 - 50 degrees, sharp oblique base, strata dipping at 30°. |
| | | 64.09 | 0.03 | COAL: Mid-lustrous. Sharp base. |
| | | 64.98 | 0.89 | SANDSTONE: Fine grained. Joints at 10 - 20 degrees. |
| | | 65.00 | 0.02 | CORE LOSS: **Run #5: 65m to 69.5m **Ran: 4.5m Rec:4.5m Loss: 0m |
| | | 65.88 | 0.88 | MUDSTONE: Medium grey. Moderately hard. |
| | | 66.11 | 0.23 | CARBONACEOUS MUDSTONE: Dark green-grey. Moderately hard. |
| | | ---------- Top of Macalister Upper Ply 1 ---------- | | |
| MU10 | 352086 | 66.16 | 0.05 | COAL: Dull lustrous, penny bands. Black. Soft. |
| MU10 | 352086 | 66.19 | 0.03 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| MU10 | 352086 | 66.23 | 0.04 | CARBONACEOUS MUDSTONE: Abundant, coaly, lenses. Dark brown and grey. Soft. |
| MU10 | 352086 | 66.34 | 0.11 | COAL: |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | Dull lustrous. Black. Soft. |
| MU10 | 352086 | 66.35 | 0.01 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| MU10 | 352086 | 66.41 | 0.06 | COAL: Dull lustrous. Brown. Soft. |
| MU10 | 352086 | 66.42 | 0.01 | COALY MUDSTONE: Dark grey to black. Moderately hard. |
| MU10 | 352086 | 66.50 | 0.08 | COAL: Dull lustrous. Brown. Soft. |
| MU10 | 352087 | 66.54 | 0.04 | CARBONACEOUS MUDSTONE: Tuffaceous, in part. Medium brown. Moderately hard, sharp base. |
| MU10 | 352087 | 66.87 | 0.33 | COAL: Dull lustrous. Black. Soft, sharp base. Calcite (rare) in cleats. |
| | | ---------- Base of Macalister Upper Ply 1 ---------- | | |
| | | ---------- Geological Thickness: 0.76 meters ---------- | | |
| | 352088 | 67.00 | 0.13 | MUDSTONE: Tuffaceous, in part. Light to medium cream and brown. Moderately hard, sharp base. |
| | | ---------- Top of Macalister Upper Ply 2 ---------- | | |
| MU20 | 352089 | 67.12 | 0.12 | COAL: Dull lustrous. Black. Soft. Calcite (common) in cleats. |
| MU20 | 352089 | 67.14 | 0.02 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| MU20 | 352089 | 67.74 | 0.60 | COAL: Dull lustrous. Black. Soft. |
| MU20 | 352090 | 67.76 | 0.02 | MUDSTONE: Light to medium grey. Moderately hard. |
| MU20 | 352090 | 67.84 | 0.08 | COAL: Dull lustrous, penny bands. Brown. Soft. |
| MU20 | 352090 | 67.86 | 0.02 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| MU20 | 352090 | 68.37 | 0.51 | COAL: Dull lustrous. Black. Soft. |
| MU20 | 352090 | 68.39 | 0.02 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| MU20 | 352090 | 68.45 | 0.06 | COAL: Dull lustrous. Black. Soft, sharp base. |
| | 352091 | 68.88 | 0.43 | MUDSTONE: Medium grey. Moderately hard. |
| MU20 | 352092 | 68.95 | 0.07 | COAL: Dull lustrous, penny bands. Black. Soft. |
| MU20 | 352092 | 69.02 | 0.07 | CARBONACEOUS MUDSTONE: Minor, coaly, limonitic. Dark black and brown. Moderately hard. |
| MU20 | 352092 | 69.29 | 0.27 | COAL: Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| MU20 | 352093 | 69.33 | 0.04 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| MU20 | 352093 | 69.38 | 0.05 | COAL: Dull lustrous, penny bands. Brown. Soft. |
| MU20 | 352093 | 69.40 | 0.02 | CARBONACEOUS MUDSTONE: Black. Moderately hard. |
| MU20 | 352093 | 69.50 | 0.10 | COAL: Dull lustrous. Black. Soft. **Run #6: 69.5m to 74m **Ran: 4.5m Rec:4.5m Loss: 0m |
| MU20 | 352094 | 69.56 | 0.06 | COAL: Dull lustrous. Black. Soft, gradational base. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | ---------- Base of Macalister Upper Ply 2 ---------- | | |
| | | ---------- Geological Thickness: 2.56 meters ---------- | | |
| | | 69.70 | 0.14 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 70.44 | 0.74 | SANDSTONE:<br>Very fine grained. Light to medium grey. Moderately hard to hard, very fine bedding, low angle cross bedding. |
| | | 71.06 | 0.62 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 71.33 | 0.27 | MUDSTONE:<br>Medium grey. Moderately hard, broken. |
| | | ---------- Top of Macalister Upper Ply 3 ---------- | | |
| MU30 | 352095 | 71.45 | 0.12 | CARBONACEOUS MUDSTONE:<br>Dark brown-grey. Moderately hard. |
| MU30 | 352095 | 71.53 | 0.08 | COAL:<br>Mid-lustrous. Black. Soft. |
| MU30 | 352095 | 71.62 | 0.09 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Soft. |
| MU30 | 352095 | 71.71 | 0.09 | COAL:<br>Dull lustrous. Black. Soft. |
| MU30 | 352095 | 71.76 | 0.05 | COALY SHALE:<br>Abundant, coaly, tending to inferior. Dark brown and black. Soft. |
| MU30 | 352095 | 71.81 | 0.05 | COAL:<br>Mid-lustrous. Black. Soft. |
| MU30 | 352096 | 71.89 | 0.08 | MUDSTONE:<br>Tuffaceous, in part. Light brown. Moderately hard. |
| MU30 | 352096 | 72.23 | 0.34 | COAL:<br>Dull lustrous. Black. Soft. Calcite (common) in cleats. |
| MU30 | 352096 | 72.25 | 0.02 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| MU30 | 352096 | 72.75 | 0.50 | COAL:<br>Penny bands, towards middle of unit. Black. Soft. Calcite (rare) in cleats. |
| MU30 | 352097 | 72.82 | 0.07 | MUDSTONE:<br>Medium grey. Moderately hard. |
| MU30 | 352097 | 72.88 | 0.06 | COAL:<br>Dull lustrous. Black. Soft. |
| | | ---------- Base of Macalister Upper Ply 3 ---------- | | |
| | | ---------- Geological Thickness: 1.55 meters ---------- | | |
| | | 73.89 | 1.01 | MUDSTONE:<br>Medium grey. Moderately hard, slickensided, joints at 40 - 50 degrees. |
| | | 74.00 | 0.11 | MUDSTONE:<br>Medium grey. Moderately hard.<br>**Run #7: 74m to 78.16m<br>**Ran: 4.16m Rec:4.16m Loss: 0m |
| | | 77.08 | 3.08 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard, slickensided, R.Q.D. excellent (90 - 100%), low angle cross bedding, wavy bedding, gradational base. Carbonaceous wisps.<br>Very fine bedding, medium angle cross bedding. |
| | | 78.16 | 1.08 | MUDSTONE:<br>Medium grey. Moderately hard.<br>**Run #8: 78.16m to 82.5m<br>**Ran: 4.34m Rec:4m Loss: 0.34m |
| | | 78.50 | 0.34 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 78.75 | 0.25 | SANDSTONE: |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | Very fine grained. Light grey. Moderately hard to hard. |
| | | 79.30 | 0.55 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard, cross bedding, wavy bedding, gradational base. |
| | | 80.10 | 0.80 | MUDSTONE:<br>Coaly, lenses, towards middle of unit. Medium grey. Moderately hard, gradational base. |
| | | 80.90 | 0.80 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard, low angle cross bedding, gradational base. |
| | | 81.19 | 0.29 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | ---------- Top of Macalister Upper Ply 4 ---------- | | |
| MU40 | 352098 | 81.25 | 0.06 | COAL:<br>Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| MU40 | 325098 | 81.33 | 0.08 | CARBONACEOUS MUDSTONE:<br>Dark brown and black. Moderately hard, slickensided, joints at 10 - 20 degrees. |
| MU40 | 352098 | 81.49 | 0.16 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| MU40 | 352099 | 81.71 | 0.22 | COAL:<br>Dull lustrous. Brown. Soft. Calcite (rare) in cleats. |
| MU40 | 352099 | 81.75 | 0.04 | CARBONACEOUS MUDSTONE:<br>Minor, coaly, lenses. Dark brown. Moderately hard. |
| MU40 | 352099 | 82.50 | 0.75 | COAL:<br>Dull lustrous. Calcite (rare) in cleats.<br>Pyrite (rare) on bedding planes.<br>**Run #9: 82.5m to 87.5m<br>**Ran: 5m Rec:4.5m Loss: 0.5m |
| MU40 | 352100 | 83.22 | 0.72 | COAL:<br>Dull lustrous. Black. Soft. |
| MU40 | 352100 | 83.24 | 0.02 | CARBONACEOUS MUDSTONE:<br>Dark brown and black. Moderately hard. |
| MU40 | 352100 | 83.42 | 0.18 | COAL:<br>Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| MU40 | 352100 | 83.45 | 0.03 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| MU40 | 352100 | 83.53 | 0.08 | COAL:<br>Dull lustrous. Black. Soft, sharp base. |
| | | ---------- Base of Macalister Upper Ply 4 ---------- | | |
| | | ---------- Geological Thickness: 2.34 meters ---------- | | |
| | | 84.13 | 0.60 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 84.17 | 0.04 | COAL:<br>Dull lustrous. Black. Soft. |
| | | 84.49 | 0.32 | MUDSTONE:<br>Medium grey. Moderately hard, slickensided, joints at 40 - 50 degrees. |
| | | 84.50 | 0.01 | COAL:<br>Dull lustrous. Black. Soft. |
| | | 84.57 | 0.07 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 84.58 | 0.01 | COAL:<br>Dull lustrous. Black. Soft. |
| | | 84.62 | 0.04 | MUDSTONE:<br>Tuffaceous. Light cream and brown. Moderately hard. |
| | | 84.63 | 0.01 | COAL:<br>Dull lustrous. Black. Soft. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | 84.73 | 0.10 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | 84.74 | 0.01 | COAL:<br>Dull lustrous. Brown. Soft. |
| | | 86.04 | 1.30 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | ---------- Top of Macalister Lower Ply 11 ---------- | | |
| ML11 | 352101 | 86.19 | 0.15 | COAL:<br>Dull lustrous, penny bands. Black. Soft. |
| ML11 | 352101 | 86.26 | 0.07 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| ML11 | 352101 | 86.54 | 0.28 | COAL:<br>Dull lustrous. Black. Soft. |
| ML11 | 352101 | 86.55 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark brown. Moderately hard. |
| ML11 | 352101 | 86.61 | 0.06 | COAL:<br>Dull lustrous. Black. Soft. |
| | | ---------- Base of Macalister Lower Ply 11 ---------- | | |
| | | ---------- Geological Thickness: 0.57 meters ---------- | | |
| | 352102 | 86.94 | 0.33 | MUDSTONE:<br>Medium grey. Moderately hard. |
| | | ---------- Top of Macalister Lower Ply 12 ---------- | | |
| ML12 | 352103 | 87.00 | 0.06 | COAL:<br>Dull lustrous. Black. Soft. |
| ML12 | 352104 | 87.06 | 0.06 | CARBONACEOUS MUDSTONE:<br>Dark grey. Moderately hard. |
| ML12 | 352104 | 87.19 | 0.13 | COAL:<br>Dull lustrous. Black. Soft. |
| | | ---------- Base of Macalister Lower Ply 12 ---------- | | |
| | | ---------- Geological Thickness: 0.25 meters ---------- | | |
| | 352104 | 87.25 | 0.06 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| | 352105 | 87.56 | 0.31 | CARBONACEOUS MUDSTONE:<br>Tuffaceous, in part, coaly. Dark brown. Moderately hard.<br>Banded, towards middle of unit.<br>**Run #10: 87.5m to 91.7m<br>**Ran: 4.2m Rec:4.7m Gain: 0.5m |
| | | ---------- Top of Macalister Lower Ply 13 ---------- | | |
| ML13 | 352105 | 88.39 | 0.83 | COAL:<br>Dull lustrous. Black. Soft, sharp base. Calcite (rare) in cleats. |
| | | ---------- Base of Macalister Lower Ply 13 ---------- | | |
| | | ---------- Geological Thickness: 0.83 meters ---------- | | |
| | 352106 | 88.47 | 0.08 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| | | ---------- Top of Macalister Lower Ply 21 ---------- | | |
| ML21 | 352106 | 88.94 | 0.47 | COAL:<br>Dull lustrous. Black. Soft. |
| | | ---------- Base of Macalister Lower Ply 21 ---------- | | |
| | | ---------- Geological Thickness: 0.47 meters ---------- | | |
| | 352106 | 88.97 | 0.03 | CARBONACEOUS MUDSTONE:<br>Dark brown. Moderately hard. |
| | | ---------- Top of Macalister Lower Ply 22 ---------- | | |
| ML22 | 352106 | 89.11 | 0.14 | COAL:<br>Dull lustrous, penny bands, towards base of unit. Black. Soft. |
| ML22 | 352106 | 89.13 | 0.02 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| ML22 | 352106 | 89.55 | 0.42 | COAL:<br>Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| ML22 | 352107 | 89.58 | 0.03 | CARBONACEOUS MUDSTONE:<br>Abundant, coaly, limonitic. Dark brown. Moderately hard. |
| ML22 | 352107 | 90.53 | 0.95 | COAL:<br>Dull lustrous. Black. Soft. |
| ML22 | 352108 | 90.57 | 0.04 | COAL:<br>Dull lustrous, penny bands, towards top of unit. Black. Soft. |
| ML22 | 352108 | 90.58 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| ML22 | 352108 | 90.62 | 0.04 | COAL:<br>Dull lustrous. Black. Soft. Calcite (common) in cleats. |
| ML22 | 352108 | 90.63 | 0.01 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard, sharp base. |
| ML22 | 352108 | 90.89 | 0.26 | COAL:<br>Dull lustrous. Black. Soft, gradational base. Calcite (common) in cleats. |
| ML22 | 352108 | 90.97 | 0.08 | CARBONACEOUS MUDSTONE:<br>Dark grey. Moderately hard, sharp irregular base. |
| ML22 | 352108 | 91.00 | 0.03 | COAL:<br>Mid-lustrous. Black. Soft. |
| ML22 | 352108 | 91.04 | 0.04 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard, gradational base. |
| | | ---------- Base of Macalister Lower Ply 22 ---------- | | |
| | | ---------- Geological Thickness: 2.07 meters ---------- | | |
| | | 91.70 | 0.66 | SANDSTONE:<br>Fossiliferous, in part, very fine grained. Light to medium grey. Moderately hard to hard, wavy bedding.<br>**Chip: 91.7m to 99.5m |
| | | 97.00 | 5.30 | MUDSTONE:<br>Minor, carbonaceous, fragments. Medium grey. Moderately hard. |
| | | 99.50 | 2.50 | SANDSTONE:<br>Fine grained. Light grey. Moderately hard to hard.<br>**Run #12: 99.5m to 104m<br>**Ran: 4.5m Rec:4.5m Loss: 0m |
| | | ---------- Top of Macalister Lower Ply 23 ---------- | | |
| ML23 | 352109 | 99.52 | 0.02 | COAL:<br>Dull lustrous. Black. Soft. |
| ML23 | 352109 | 99.63 | 0.11 | CARBONACEOUS MUDSTONE:<br>Minor, coaly, banded. Dark brown. Moderately hard. |
| ML23 | 352109 | 99.80 | 0.17 | COALY SHALE:<br>Minor, muddy, banded. Dark black and brown. Soft. |
| ML23 | 352109 | 99.86 | 0.06 | CARBONACEOUS MUDSTONE:<br>Dark brown. Moderately hard. |
| ML23 | 352109 | 99.96 | 0.10 | COAL:<br>Dull lustrous. Black. Soft. |
| ML23 | 352109 | 100.09 | 0.13 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| ML23 | 352109 | 100.18 | 0.09 | COAL:<br>Dull lustrous. Black. Soft, gradational base. |
| | | ---------- Base of Macalister Lower Ply 23 ---------- | | |
| | | ---------- Geological Thickness: 0.68 meters ---------- | | |
| | | 101.30 | 1.12 | MUDSTONE:<br>Medium grey. Moderately hard, gradational base. |
| | | 101.50 | 0.20 | SANDSTONE:<br>Calcified, very fine grained. Light white-grey. Moderately hard to hard, gradational base. Calcite (abundant) cement. |
| | | 101.60 | 0.10 | SANDSTONE: |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | Fine grained. Light grey. Moderately hard to hard, gradational base. |
| | | 102.69 | 1.09 | MUDSTONE: Medium grey. Moderately hard, slickensided, joints at 40 - 50 degrees. |
| | | 103.15 | 0.46 | MUDSTONE: Medium grey. Moderately hard. |
| | | 103.23 | 0.08 | CARBONACEOUS MUDSTONE: Minor, coaly, banded. Dark brown. Moderately hard. |
| | | 103.58 | 0.35 | MUDSTONE: Carbonaceous, in part. Dark grey. Moderately hard. |
| | | ---------- Top of Wambo Ply 2 ---------- | | |
| W20 | 352110 | 103.60 | 0.02 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| W20 | 352110 | 103.67 | 0.07 | COAL: Dull lustrous. Black. Soft. |
| W20 | 352110 | 103.79 | 0.12 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| W20 | 352110 | 104.00 | 0.21 | COAL: Dull lustrous. Black. Soft. **Run #13: 104m to 108m **Ran: 4m Rec:4.5m Gain: 0.5m |
| W20 | 352111 | 104.19 | 0.19 | COAL: Dull lustrous. Black. Soft. |
| W20 | 352111 | 104.24 | 0.05 | CARBONACEOUS MUDSTONE: Minor, coaly, limonitic. Dark grey to black. Moderately hard. |
| W20 | 352111 | 104.50 | 0.26 | COAL: Dull lustrous. Black. Soft. |
| W20 | 352112 | 104.68 | 0.18 | CARBONACEOUS MUDSTONE: Coaly, banded, towards middle of unit. Dark grey. Moderately hard. |
| W20 | 352113 | 105.07 | 0.39 | COAL: Dull lustrous, penny bands. Brown. Soft. |
| | | ---------- Base of Wambo Ply 2 ---------- | | |
| | | ---------- Geological Thickness: 1.49 meters ---------- | | |
| | 352114 | 105.28 | 0.21 | MUDSTONE: Tuffaceous, in part. Light cream and brown. Moderately hard. |
| | | ---------- Top of Wambo Ply 3 ---------- | | |
| W30 | 352115 | 105.89 | 0.61 | COAL: Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| W30 | 352116 | 106.01 | 0.12 | CARBONACEOUS MUDSTONE: Dark grey. Moderately hard. |
| W30 | 352117 | 106.22 | 0.21 | COAL: Dull lustrous. Black. Soft. Calcite (rare) in cleats. |
| W30 | 352117 | 106.24 | 0.02 | CARBONACEOUS MUDSTONE: Dark brown. Moderately hard. |
| W30 | 352117 | 106.29 | 0.05 | COAL: Dull lustrous. Black. Soft, sharp base. Calcite (rare) in cleats. |
| W30 | 352117 | 106.36 | 0.07 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| W30 | 352117 | 106.52 | 0.16 | COAL: Mid-lustrous. Black. Soft, sharp base. |
| W30 | 352118 | 106.62 | 0.10 | CARBONACEOUS MUDSTONE: Dark grey to black. Moderately hard. |
| W30 | 352118 | 106.67 | 0.05 | COAL: Dull lustrous. Black. Soft. |
| | 352118 | 107.06 | 0.39 | MUDSTONE: Carbonaceous, towards top of unit. Medium grey. Moderately |

| STRATA/ SEAM | SAMPLE NO. | BASE (m) | THICK. (m) | LITHOLOGY DESCRIPTION |
|---|---|---|---|---|
| | | | | hard. |
| W30 | 352119 | 107.18 | 0.12 | COAL:<br>Dull lustrous. Black. Soft. |
| W30 | 352120 | 107.39 | 0.21 | MUDSTONE:<br>Dark grey. Moderately hard, broken. |
| W30 | 352121 | 107.53 | 0.14 | COAL:<br>Dull lustrous. Black. Soft, broken, sharp base. |
| | | ---------- Base of Wambo Ply 3 ---------- | | |
| | | ---------- Geological Thickness: 2.25 meters ---------- | | |
| | | 108.00 | 0.47 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard.<br>**Run #14: 108m to 112.5m<br>**Ran: 4.5m Rec:4m Loss: 0.5m |
| | | 109.56 | 1.56 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard. |
| | | 109.61 | 0.05 | COALY SHALE:<br>Black. Soft, sharp irregular base. |
| | | 110.82 | 1.21 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard, very fine bedding. |
| | | ---------- Top of Wambo Ply 4 ---------- | | |
| W40 | 352122 | 110.94 | 0.12 | COAL:<br>Dull lustrous. Brown. Soft. Calcite (rare) in cleats. |
| | | ---------- Base of Wambo Ply 4 ---------- | | |
| | | ---------- Geological Thickness: 0.12 meters ---------- | | |
| | | 111.10 | 0.16 | SANDSTONE:<br>Very fine grained. Light to medium grey. Moderately hard to hard, very fine bedding, sharp base. |
| | | 111.26 | 0.16 | SANDSTONE:<br>Medium-fine grained. Light grey. Moderately hard to hard, sharp base. |
| | | 111.33 | 0.07 | CARBONACEOUS MUDSTONE:<br>Minor, coaly, banded. Dark grey to black. Moderately hard. |
| | | 111.56 | 0.23 | MUDSTONE:<br>Medium grey. Moderately hard, broken. |
| | | 111.66 | 0.10 | CARBONACEOUS MUDSTONE:<br>Dark grey to black. Moderately hard. |
| | 352123 | 111.82 | 0.16 | COALY SHALE (50%):<br>Brown. Soft.<br>CARBONACEOUS MUDSTONE (50%):<br>Moderately hard. |
| | 352123 | 112.18 | 0.36 | COAL:<br>Dull lustrous, penny bands, towards top of unit. Brown. Soft. Calcite (rare) in cleats. |
| | | 112.50 | 0.32 | SANDSTONE:<br>Very fine grained. Light grey. Moderately hard to hard. |
| | | 112.50 | | ##V-notch 70mm @TD. sampled |
| | | ========== TOTAL DEPTH 112.5M ========== | | |

# Attachment C

Laboratory test results

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB0710108** | Page | : 1 of 16 |
| Client | : **PARSONS BRINCKERHOFF AUST P/L** | Laboratory | : Environmental Division Brisbane |
| Contact | : MS OLIVIA WHITE | Contact | : Tim Kilmister |
| Address | : GPO BOX 2907 BRISBANE QLD AUSTRALIA 4000 | Address | : 32 Shand Street Stafford QLD Australia 4053 |
| E-mail | : owhite@pb.com.au | E-mail | : Services.Brisbane@alsenviro.com |
| Telephone | : +61 07 32185438 | Telephone | : +61-7-3243 7222 |
| Facsimile | : +61 07 38314223 | Facsimile | : +61-7-3243 7218 |
| Project | : 2133006A-3011-1 | QC Level | : NEPM 1999 Schedule B(3) and ALS QCS3 requirement |
| Order number | : 58628 | | |
| C-O-C number | : 202224 | Date Samples Received | : 05-SEP-2007 |
| Sampler | : OLIVIA WHITE | Issue Date | : 21-SEP-2007 |
| Site | : Wandoan | | |
| | | No. of samples received | : 81 |
| Quote number | : BN/103/06 | No. of samples analysed | : 68 |

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

## *Signatories*

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Inorganics |
| Stephen Hislop | Senior Inorganic Chemist | Inorganics |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = Result(s) reported is calculated using analyte detections at or above the LOR. (eg. <5 + 5 + 7 = 12).

- **LCS recovery for various inorganic analyses fall outside Dynamic Control Limits. They are however within ALS Static Control Limits and hence deemed acceptable.**

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS01/0.0-0.1 | WS01/0.3-0.4 | WS01/0.9-1.0 | WS02/0.0-0.1 | WS02/0.2-0.3 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-001 | EB0710108-002 | EB0710108-003 | EB0710108-004 | EB0710108-005 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 8.4 | 8.9 | 8.4 | 7.9 | 8.9 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 164 | 1080 | 1720 | 67 | 294 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | 18.9 | 15.4 | 15.0 | 15.8 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 6.8 | 7.6 | ---- | 4.4 | 7.7 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 0.8 | 1.5 | ---- | 1.3 | 2.5 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.2 | 0.1 | ---- | 0.2 | 0.2 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 0.2 | 2.2 | ---- | 0.2 | 0.9 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 8.1 | 11.4 | ---- | 6.1 | 11.2 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | ---- | ---- | ---- | ---- | 1.6 |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | <10 | 560 | 3180 | ---- | ---- |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | 60 | 750 | 1110 | ---- | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | 1.83 | 1.68 | ---- | ---- | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | 12.0 | 6.10 | ---- | ---- | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | 67.1 | 42.3 | ---- | ---- | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | 1.50 | <1.00 | ---- | ---- | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | 9.3 | 1.4 | ---- | 1.1 | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | 3090 | 940 | ---- | 1850 | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | 3100 | 950 | ---- | 1850 | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | 394 | 198 | ---- | 418 | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | 5.1 | 2.3 | ---- | 2.8 | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID : WS02/0.4-0.5 | WS03/0.0-0.1 | WS03/0.4-0.5 | WS03/0.6-0.7 | WS04/0.0-0.1 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time : [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-006 | EB0710108-007 | EB0710108-008 | EB0710108-009 | EB0710108-010 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 9.0 | 8.6 | 9.2 | 9.3 | 7.8 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 559 | 130 | 964 | 1160 | 32 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | ---- | 19.6 | ---- | ---- | 15.0 |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 7.2 | 7.2 | 5.9 | 5.1 | 4.2 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 2.5 | 1.3 | 1.6 | 1.7 | 0.7 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.1 | 0.2 | <0.1 | 0.1 | 0.2 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 1.4 | 0.5 | 2.0 | 2.6 | 0.2 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 11.2 | 9.3 | 9.6 | 9.6 | 5.5 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | 2.3 | ---- | 3.9 | 4.6 | ---- |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | ---- | ---- | ---- | 20 |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | ---- | ---- | ---- | 50 |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | ---- | 1.4 | ---- | ---- | 16.1 |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | ---- | 690 | ---- | ---- | 1760 |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | ---- | 690 | ---- | ---- | 1770 |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | ---- | 121 | ---- | ---- | 310 |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | ---- | 1.4 | ---- | ---- | 3.0 |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS04/0.2-0.3 | WS04/0.4-0.5 | WS05/0.0-0.1 | WS05/0.2-0.3 | WS05/0.6-0.7 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-011 | EB0710108-012 | EB0710108-013 | EB0710108-014 | EB0710108-015 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 9.0 | 9.1 | 7.5 | 8.0 | 5.4 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 462 | 850 | 19 | 430 | 736 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | ---- | 10.9 | 14.0 | 18.4 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 7.4 | ---- | ---- | 3.2 | 1.8 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 1.4 | ---- | ---- | 1.8 | 1.6 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.2 | ---- | ---- | 0.1 | 0.1 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 1.3 | ---- | ---- | 1.0 | 1.4 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 10.2 | ---- | ---- | 6.1 | 4.9 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | 2.3 | ---- | ---- | ---- | 6.0 |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | 510 | 20 | 50 | ---- |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | 870 | 30 | 580 | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | ---- | 1.32 | <1.00 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | ---- | 36.9 | 19.8 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | ---- | 27.0 | 20.0 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | ---- | <1.00 | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | ---- | ---- | 1.5 | 2.1 | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | ---- | ---- | 1380 | 740 | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | ---- | ---- | 1380 | 740 | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | ---- | ---- | 202 | 138 | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | ---- | ---- | 2.7 | 1.2 | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS06/0.0-0.1 | WS06/0.2-0.3 | WS06/0.8-0.9 | WS09/0.0-0.1 | WS09/0.2-0.3 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-016 | EB0710108-017 | EB0710108-018 | EB0710108-019 | EB0710108-020 |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **7.6** | **8.6** | **8.1** | **6.9** | **9.3** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **40** | **431** | **845** | **36** | **516** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103)** | ---- | 1.0 | % | **14.0** | ---- | **13.2** | **7.5** | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | **3.6** | **7.6** | **2.4** | **0.8** | **6.5** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | **1.7** | **2.5** | **2.4** | **0.4** | **2.1** |
| **^ Exchangeable Potassium** | ---- | 0.1 | meq/100g | **0.2** | **0.2** | **0.2** | <0.1 | <0.1 |
| **^ Exchangeable Sodium** | ---- | 0.1 | meq/100g | **0.4** | **1.3** | **1.8** | **0.1** | **1.5** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | **5.9** | **11.6** | **6.8** | **1.3** | **10.2** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | ---- | **2.4** | **4.4** | ---- | **3.3** |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| **Sulphate as SO4 2-** | 14808-79-8 | 10 | mg/kg | ---- | ---- | **40** | <10 | ---- |
| **ED045: Chloride** | | | | | | | | |
| **Chloride** | 16887-00-6 | 10 | mg/kg | ---- | ---- | **1270** | <10 | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| **Copper** | 7440-50-8 | 1.00 | mg/kg | **2.06** | **1.66** | ---- | ---- | ---- |
| **Iron** | 7439-89-6 | 1.00 | mg/kg | **25.4** | **21.6** | ---- | ---- | ---- |
| **Manganese** | 7439-96-5 | 1.00 | mg/kg | **88.9** | **46.7** | ---- | ---- | ---- |
| **Zinc** | 7440-66-6 | 1.00 | mg/kg | <1.00 | <1.00 | ---- | ---- | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| **Nitrite + Nitrate as N (Sol.)** | ---- | 0.1 | mg/kg | **4.0** | ---- | ---- | **4.8** | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| **Total Kjeldahl Nitrogen as N** | ---- | 20 | mg/kg | **1470** | ---- | ---- | **1180** | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| **^ Total Nitrogen as N** | ---- | 20 | mg/kg | **1480** | ---- | ---- | **1190** | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| **Total Phosphorus as P** | ---- | 20 | mg/kg | **396** | ---- | ---- | **512** | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| **Organic Matter** | ---- | 0.5 | % | **2.3** | ---- | ---- | ---- | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS09/0.4-0.5 | WS10/0.0-0.1 | WS10/0.3-0.4 | WS11/0.05-0.1 | WS11/0.3-0.4 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-021 | EB0710108-022 | EB0710108-023 | EB0710108-024 | EB0710108-025 |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **9.3** | **8.8** | **8.8** | **8.3** | **8.4** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **942** | **100** | **91** | **93** | **149** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103)** | ---- | 1.0 | % | ---- | **15.6** | ---- | ---- | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | **5.1** | ---- | **7.3** | **6.4** | **5.9** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | **2.3** | ---- | **1.9** | **0.8** | **1.0** |
| **^ Exchangeable Potassium** | ---- | 0.1 | meq/100g | **0.1** | ---- | **0.1** | **0.1** | **0.1** |
| **^ Exchangeable Sodium** | ---- | 0.1 | meq/100g | **1.9** | ---- | **1.0** | <0.1 | **0.1** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | **9.4** | ---- | **10.3** | **7.5** | **7.1** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | **3.5** | ---- | **1.8** | ---- | **0.4** |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| **Copper** | 7440-50-8 | 1.00 | mg/kg | <1.00 | ---- | ---- | **1.25** | ---- |
| **Iron** | 7439-89-6 | 1.00 | mg/kg | **6.54** | ---- | ---- | **11.0** | ---- |
| **Manganese** | 7439-96-5 | 1.00 | mg/kg | **3.18** | ---- | ---- | **51.1** | ---- |
| **Zinc** | 7440-66-6 | 1.00 | mg/kg | <1.00 | ---- | ---- | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| **Nitrite + Nitrate as N (Sol.)** | ---- | 0.1 | mg/kg | ---- | **3.1** | ---- | ---- | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| **Total Kjeldahl Nitrogen as N** | ---- | 20 | mg/kg | ---- | **880** | ---- | ---- | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| **^ Total Nitrogen as N** | ---- | 20 | mg/kg | ---- | **890** | ---- | ---- | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| **Total Phosphorus as P** | ---- | 20 | mg/kg | ---- | **158** | ---- | ---- | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| **Organic Matter** | ---- | 0.5 | % | ---- | **2.3** | ---- | **1.9** | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS13/0.0-0.1 | WS13/0.1-0.2 | WS14/0.0-0.1 | WS14/0.3-0.4 | WS15/0.0-0.1 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-026 | EB0710108-027 | EB0710108-028 | EB0710108-029 | EB0710108-030 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 7.3 | 7.1 | 8.2 | 9.0 | 8.4 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 37 | 23 | 136 | 404 | 108 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | 7.2 | ---- | 12.8 | 13.8 | 11.5 |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 1.9 | 3.1 | 5.3 | 6.9 | ---- |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 0.4 | 0.8 | 0.5 | 1.7 | ---- |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.3 | 0.2 | <0.1 | <0.1 | ---- |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | <0.1 | 0.1 | 0.1 | 1.1 | ---- |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 2.6 | 4.3 | 6.1 | 9.9 | ---- |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | ---- | 0.6 | ---- | 2.6 | ---- |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | <10 | ---- | <10 | 240 | <10 |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | <10 | ---- | 30 | 180 | 20 |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | ---- | 2.90 | 2.00 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | ---- | 15.2 | 12.2 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | ---- | 58.3 | 19.5 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | ---- | 1.09 | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | 5.1 | ---- | ---- | ---- | 2.9 |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | 1120 | ---- | ---- | ---- | 1550 |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | 1130 | ---- | ---- | ---- | 1560 |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | 276 | ---- | ---- | ---- | 230 |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | 2.7 | ---- | 2.6 | ---- | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID : WS15/0.2-0.3 | WS15/0.4-0.5 | WS16/0.0-0.1 | WS16/0.2-0.3 | WS17/0.0-0.05 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time : [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-031 | EB0710108-032 | EB0710108-033 | EB0710108-034 | EB0710108-035 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 9.2 | 9.0 | 7.8 | 9.0 | 7.5 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 271 | 922 | 49 | 101 | 42 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | ---- | ---- | 9.4 | ---- | 11.6 |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 6.8 | 6.3 | ---- | 6.5 | ---- |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 1.3 | 1.4 | ---- | 1.6 | ---- |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | <0.1 | <0.1 | ---- | <0.1 | ---- |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 1.3 | 2.2 | ---- | 1.2 | ---- |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 9.5 | 10.0 | ---- | 9.4 | ---- |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | 2.8 | 4.9 | ---- | 2.6 | ---- |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | ---- | ---- | ---- | <10 |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | ---- | ---- | ---- | 30 |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | ---- | ---- | <1.00 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | ---- | ---- | 5.93 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | ---- | ---- | 10.7 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | ---- | ---- | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | ---- | ---- | 4.9 | ---- | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | ---- | ---- | 1120 | ---- | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | ---- | ---- | 1120 | ---- | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | ---- | ---- | 150 | ---- | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS17/0.2-0.3 | WS18/0.0-0.05 | WS18/0.3-0.4 | WS20/0.0-0.05 | WS20/0.2-0.3 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-036 | EB0710108-037 | EB0710108-038 | EB0710108-039 | EB0710108-040 |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **8.9** | **6.7** | **7.9** | **7.2** | **6.9** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **216** | **45** | **100** | **58** | **534** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103)** | ---- | 1.0 | % | ---- | **8.9** | ---- | **11.4** | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | ---- | ---- | **2.9** | **2.9** | **3.0** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | ---- | ---- | **1.2** | **1.1** | **1.6** |
| **^ Exchangeable Potassium** | ---- | 0.1 | meq/100g | ---- | ---- | **0.1** | **0.2** | **0.1** |
| **^ Exchangeable Sodium** | ---- | 0.1 | meq/100g | ---- | ---- | **0.5** | **0.3** | **1.4** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | ---- | ---- | **4.7** | **4.5** | **6.2** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | ---- | ---- | **2.2** | ---- | **4.9** |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| **Sulphate as SO4 2-** | 14808-79-8 | 10 | mg/kg | ---- | **10** | ---- | <10 | ---- |
| **ED045: Chloride** | | | | | | | | |
| **Chloride** | 16887-00-6 | 10 | mg/kg | ---- | <10 | ---- | **40** | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| **Copper** | 7440-50-8 | 1.00 | mg/kg | ---- | <1.00 | ---- | ---- | ---- |
| **Iron** | 7439-89-6 | 1.00 | mg/kg | ---- | **55.4** | ---- | ---- | ---- |
| **Manganese** | 7439-96-5 | 1.00 | mg/kg | ---- | **151** | ---- | ---- | ---- |
| **Zinc** | 7440-66-6 | 1.00 | mg/kg | ---- | **1.07** | ---- | ---- | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| **Nitrite + Nitrate as N (Sol.)** | ---- | 0.1 | mg/kg | ---- | **9.8** | ---- | **4.7** | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| **Total Kjeldahl Nitrogen as N** | ---- | 20 | mg/kg | ---- | **1380** | ---- | **1260** | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| **^ Total Nitrogen as N** | ---- | 20 | mg/kg | ---- | **1390** | ---- | **1270** | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| **Total Phosphorus as P** | ---- | 20 | mg/kg | ---- | **220** | ---- | **252** | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| **Organic Matter** | ---- | 0.5 | % | ---- | ---- | ---- | **2.0** | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS22/0.0-0.05 | WS22/0.2-0.3 | WS23/0.0-0.05 | WS23/0.2-0.3 | WS24/0.0-0.1 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-041 | EB0710108-042 | EB0710108-043 | EB0710108-044 | EB0710108-045 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 7.2 | 8.3 | 7.2 | 8.7 | 7.3 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 126 | 119 | 120 | 552 | 51 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | 14.4 | ---- | 10.7 | ---- | 6.5 |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | ---- | 7.7 | 4.1 | 7.8 | 2.2 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | ---- | 0.5 | 1.2 | 2.2 | 0.4 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | ---- | <0.1 | 0.6 | 0.2 | 0.2 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | ---- | <0.1 | <0.1 | 1.0 | <0.1 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | ---- | 8.3 | 5.9 | 11.2 | 2.8 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | ---- | 0.2 | ---- | 2.1 | ---- |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | ---- | 10 | ---- | <10 |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | ---- | 20 | ---- | <10 |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | ---- | 1.12 | <1.00 | <1.00 |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | ---- | 12.8 | 8.07 | 15.8 |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | ---- | 40.3 | 11.3 | 112 |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | ---- | 1.23 | <1.00 | <1.00 |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | 7.2 | ---- | 12.0 | ---- | 5.5 |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | 1750 | ---- | 2910 | ---- | 1210 |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | 1760 | ---- | 2920 | ---- | 1220 |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | 443 | ---- | 556 | ---- | 183 |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | 3.5 | 0.9 | 3.7 | ---- | 2.5 |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS24/0.2-0.3 | WS26/0.0-0.05 | WS26/0.2-0.3 | WS26/0.5-0.6 | WS31/0.0-0.1 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-046 | EB0710108-047 | EB0710108-048 | EB0710108-049 | EB0710108-050 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 7.0 | 6.8 | 7.4 | 6.2 | 7.3 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 36 | 79 | 123 | 333 | 40 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | ---- | 9.3 | 15.5 | ---- | 9.6 |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 4.1 | 2.3 | 2.8 | 2.1 | 3.9 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 0.6 | 0.9 | 1.0 | 1.1 | 0.6 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.1 | 0.1 | <0.1 | <0.1 | 0.1 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 0.2 | 0.3 | 0.6 | 1.0 | 0.2 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 5.0 | 3.6 | 4.4 | 4.4 | 4.9 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | 0.6 | ---- | 2.6 | 4.5 | ---- |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | <10 | <10 | ---- | <10 |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | 40 | 150 | ---- | <10 |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | <1.00 | <1.00 | ---- | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | 35.2 | 19.1 | ---- | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | 33.1 | 22.2 | ---- | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | <1.00 | <1.00 | ---- | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | ---- | 6.4 | 2.6 | ---- | 4.1 |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | ---- | 990 | 830 | ---- | 1420 |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | ---- | 1000 | 830 | ---- | 1430 |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | ---- | 224 | 108 | ---- | 286 |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | ---- | 2.4 | 1.6 | ---- | 2.8 |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID : WS31/0.2-0.3 | WS32/0.0-0.1 | WS32/0.4-0.5 | WS33/0.0-0.1 | WS33/0.4-0.5 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time : [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-051 | EB0710108-052 | EB0710108-053 | EB0710108-054 | EB0710108-055 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 8.5 | 8.2 | 8.7 | 7.7 | 9.0 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 390 | 175 | 532 | 113 | 687 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | ---- | 17.7 | 18.7 | 11.9 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 5.6 | 5.6 | 6.4 | 3.1 | 6.6 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 1.3 | 0.7 | 1.0 | 1.3 | 1.9 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.1 | 0.1 | <0.1 | 0.4 | <0.1 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 0.8 | 0.6 | 1.2 | 0.2 | 1.3 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 7.8 | 7.1 | 8.7 | 5.0 | 10.0 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | 2.0 | ---- | 2.7 | ---- | 2.6 |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | ---- | 40 | 80 | 30 | ---- |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | ---- | 90 | 380 | 30 | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | ---- | <1.00 | ---- | <1.00 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | ---- | 6.28 | ---- | 36.9 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | ---- | 17.0 | ---- | 61.7 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | ---- | <1.00 | ---- | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | ---- | 48.3 | ---- | 15.9 | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | ---- | 700 | ---- | 2220 | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | ---- | 750 | ---- | 2230 | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | ---- | 130 | ---- | 296 | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | ---- | 1.8 | ---- | 3.1 | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS34/0.0-0.1 | WS34/0.2-0.3 | WS34/0.5-0.6 | WS35/0.0-0.1 | WS35/0.2-0.3 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-056 | EB0710108-057 | EB0710108-058 | EB0710108-059 | EB0710108-060 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 7.8 | 8.3 | 8.7 | 7.2 | 6.9 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 87 | 124 | 445 | 34 | 41 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | 13.7 | ---- | ---- | 8.2 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 5.6 | 6.4 | ---- | 2.9 | 1.9 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 1.0 | 0.8 | ---- | 0.7 | 0.5 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.3 | 0.2 | ---- | 0.2 | 0.2 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 0.1 | 0.2 | ---- | 0.2 | <0.1 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 7.1 | 7.6 | ---- | 4.1 | 2.6 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | ---- | 0.6 | ---- | ---- | 0.5 |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | <10 | ---- | ---- | <10 | ---- |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | <10 | ---- | ---- | <10 | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | 1.92 | ---- | ---- | <1.00 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | 16.0 | ---- | ---- | 52.6 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | 47.8 | ---- | ---- | 83.5 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | <1.00 | ---- | ---- | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | 7.3 | ---- | ---- | 6.5 | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | 2120 | ---- | ---- | 850 | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | 2130 | ---- | ---- | 860 | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | 406 | ---- | ---- | 264 | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | ---- | ---- | ---- | 1.8 | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS36/0.0-0.01 | WS36/0.3-0.4 | WS37/0.0-0.1 | WS38/0.0-0.1 | WS38/0.4-0.5 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] |
| | | | | EB0710108-061 | EB0710108-062 | EB0710108-063 | EB0710108-064 | EB0710108-065 |
| **EA002 : pH (Soils)** | | | | | | | | |
| pH Value | ---- | 0.1 | pH Unit | 8.0 | 9.2 | 6.6 | 7.2 | 6.0 |
| **EA010: Conductivity** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 56 | 292 | 257 | 147 | 467 |
| **EA055: Moisture Content** | | | | | | | | |
| ^ Moisture Content (dried @ 103) | ---- | 1.0 | % | 15.7 | ---- | 7.0 | 20.2 | ---- |
| **ED007: Exchangeable Cations** | | | | | | | | |
| ^ Exchangeable Calcium | ---- | 0.1 | meq/100g | 3.2 | 6.4 | 2.5 | 3.4 | 2.8 |
| ^ Exchangeable Magnesium | ---- | 0.1 | meq/100g | 1.0 | 1.2 | 0.6 | 2.9 | 3.2 |
| ^ Exchangeable Potassium | ---- | 0.1 | meq/100g | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 |
| ^ Exchangeable Sodium | ---- | 0.1 | meq/100g | 0.4 | 0.8 | 0.5 | 0.5 | 1.2 |
| ^ Cation Exchange Capacity | ---- | 0.1 | meq/100g | 4.8 | 8.6 | 3.8 | 7.1 | 7.3 |
| ^ Exchangeable Sodium Percent | ---- | 0.1 | % | ---- | 1.9 | ---- | ---- | 3.3 |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| Sulphate as SO4 2- | 14808-79-8 | 10 | mg/kg | <10 | ---- | 60 | 40 | ---- |
| **ED045: Chloride** | | | | | | | | |
| Chloride | 16887-00-6 | 10 | mg/kg | 80 | ---- | 80 | 150 | ---- |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| Copper | 7440-50-8 | 1.00 | mg/kg | 1.08 | ---- | 1.11 | 2.79 | ---- |
| Iron | 7439-89-6 | 1.00 | mg/kg | 20.8 | ---- | 96.7 | 21.0 | ---- |
| Manganese | 7439-96-5 | 1.00 | mg/kg | 95.2 | ---- | 172 | 20.6 | ---- |
| Zinc | 7440-66-6 | 1.00 | mg/kg | <1.00 | ---- | 1.54 | <1.00 | ---- |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| Nitrite + Nitrate as N (Sol.) | ---- | 0.1 | mg/kg | 6.1 | ---- | 24.8 | 6.5 | ---- |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 20 | mg/kg | 1050 | ---- | 3770 | 900 | ---- |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 20 | mg/kg | 1060 | ---- | 3800 | 910 | ---- |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| Total Phosphorus as P | ---- | 20 | mg/kg | 138 | ---- | 261 | 209 | ---- |
| **EP004: Organic Matter** | | | | | | | | |
| Organic Matter | ---- | 0.5 | % | 2.1 | ---- | 5.3 | 1.8 | ---- |

## Analytical Results

Sub-Matrix: **SOIL**

| Compound | CAS Number | LOR | Unit | Client sample ID: WS38/0.6-0.7 | WS40/0.0-0.1 | WS40/0.2-0.3 | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | [ 05-SEP-2007 ] | | |
| | | | | EB0710108-066 | EB0710108-067 | EB0710108-068 | | |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **5.5** | **7.0** | **8.8** | | |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **553** | **88** | **361** | | |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103)** | ---- | 1.0 | % | ---- | **13.6** | ---- | | |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | ---- | **8.1** | **7.1** | | |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | ---- | **1.0** | **1.1** | | |
| **^ Exchangeable Potassium** | ---- | 0.1 | meq/100g | ---- | **0.2** | <0.1 | | |
| **^ Exchangeable Sodium** | ---- | 0.1 | meq/100g | ---- | **0.4** | **0.8** | | |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | ---- | **9.6** | **9.1** | | |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | ---- | ---- | **1.7** | | |
| **ED040S: Soluble Major Anions** | | | | | | | | |
| **Sulphate as SO4 2-** | 14808-79-8 | 10 | mg/kg | ---- | **30** | ---- | | |
| **ED045: Chloride** | | | | | | | | |
| **Chloride** | 16887-00-6 | 10 | mg/kg | ---- | **10** | ---- | | |
| **ED092: DTPA Extractable Metals** | | | | | | | | |
| **Copper** | 7440-50-8 | 1.00 | mg/kg | ---- | <1.00 | ---- | | |
| **Iron** | 7439-89-6 | 1.00 | mg/kg | ---- | **13.2** | ---- | | |
| **Manganese** | 7439-96-5 | 1.00 | mg/kg | ---- | **26.9** | ---- | | |
| **Zinc** | 7440-66-6 | 1.00 | mg/kg | ---- | <1.00 | ---- | | |
| **EK059: Nitrite plus Nitrate as N (NOx)** | | | | | | | | |
| **Nitrite + Nitrate as N (Sol.)** | ---- | 0.1 | mg/kg | ---- | **4.5** | ---- | | |
| **EK061: Total Kjeldahl Nitrogen (TKN)** | | | | | | | | |
| **Total Kjeldahl Nitrogen as N** | ---- | 20 | mg/kg | ---- | **1580** | ---- | | |
| **EK062: Total Nitrogen as N (TKN + NOx)** | | | | | | | | |
| **^ Total Nitrogen as N** | ---- | 20 | mg/kg | ---- | **1580** | ---- | | |
| **EK067: Total Phosphorus as P** | | | | | | | | |
| **Total Phosphorus as P** | ---- | 20 | mg/kg | ---- | **199** | ---- | | |
| **EP004: Organic Matter** | | | | | | | | |
| **Organic Matter** | ---- | 0.5 | % | ---- | **2.3** | ---- | | |

# Attachment D

Test pit logs from Slater (1986)

Appendix 1. Morphological and Analytical Data for Selected Soil Profiles.

---

| | |
|---|---|
| Soil Profile Class: | Teviot (Profile 1) |
| Great Soil Group: | Grey clay |
| Principal Profile Form: | Ug 5.14 |
| Parent Material: | Highly weathered feldspathic sandstone of Juandah Coal Measures (Jurassic). |
| Topography: | Upper slope of undulating landscape, westerly aspect, 2.5% slope. |
| Location: | SG55-12. Roma. GM9011. Austinvale area. Near Theiss Core hole C258 on track leading from "A" road to trial excavation; 870 m west of trial excavation. Site 1. |
| Vegetation: | Cleared. Previously open forest of brigalow (*Acacia harpophylla*) and bauhinia (*Lysiphyllum carronii*) with occasional bottle tree (*Brachychiton rupestre*) and shrub understorey of wilga (*Geijera parviflora*) and false sandalwood (*Eremophila mitchellii*). Sucker regrowth of brigalow has occurred. |
| Land Use: | Currently low intensity agistment grazing, but to be prepared for summer cropping. |
| Profile Morphology: | Surface: moderately self mulching with thin (5 mm) fragile surface crust. |
| m | |
| A11 0 - 0.06 | Brownish black (10YR3/1); light-medium clay, (fine sandy); strong 2-5 mm granular; dry, moderately weak; few small subangular siliceous pebbles. Clear to - |
| A12 0.06 - 0.20 | Brownish black (10YR3/1); light medium clay; moderate 10-20 mm angular blocky; dry, moderately strong; very few fine calcareous nodules. Clear to - |

Appendix 1 (cont.)

| | |
|---|---|
| B21K 0.20 - 0.40 | Yellowish grey (2.5Y4/1); medium clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common medium calcareous nodules; few fine soft calcareous segregations. Gradual to - |
| B22 0.40 - 0.75 | Yellowish grey (2.54 4/1); medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to - |
| B23 0.75 - 1.0 | Dark greyish yellow (2.54 4/2); medium clay; moderate 20 - 50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to - |
| B24 1.0 - 1.3 | Dull yellow orange (1oYR6/3); medium clay; moderate 20-50 mm lenticular breaking to moderate 20-50 mm angular blocky; dry, very firm; very few fine marganiferous veins. Gradual to - |
| C 1.3+ | Dull yellow orange (10YR6/4); sandy clay loam; massive; dry, moderately weak. Highly weathered feldspathic sandstone. |

Laboratory Data

| Depth(m) | 0-0.1 | 0.1-0.2 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|---|
| pH | 7.8 | 8.5 | 8.3 | 7.9 | 8.0 | 7.6 |
| Electrical conductivity (mS $cm^{-1}$) | 0.13 | 0.22 | 0.44 | 0.82 | 0.89 | 0.79 |
| Chloride (%) | 0.0015 | 0.002 | 0.038 | 0.165 | 0.183 | 0.100 |
| Particle size distribution (%) | | | | | | |
| Coarse sand (2.0-0.2mm) | 18 | | 12 | 12 | 10 | 10 |
| Fine sand (0.2-0.02mm) | 31 | | 28 | 29 | 28 | 26 |
| Silt (0.02-0.002mm) | 10 | | 21 | 18 | 16 | 16 |
| Clay (< 0.002mm) | 39 | | 40 | 41 | 51 | 50 |
| Cation exchange capacity (meq $100g^{-1}$) | 29 | | 31 | 34 | 37 | 36 |
| Gravimetric moisture % | | | | | | |
| Air dry | 5.4 | | 5.8 | 7.0 | 7.6 | 6.8 |
| 0.1 bar | 32 | | 35 | 38 | 41 | 40 |
| 15 bar | 17 | | 18 | 20 | 23 | 22 |
| Organic carbon (%) | 1.22 | | 0.80 | 0.66 | 0.67 | 0.30 |
| Nitrate nitrogen (µg $g^{-1}$) | 7.0 | | 8.8 | 8.4 | 4.6 | 3.0 |
| Extractable phosphorus (µg $g^{-1}$) | | | | | | |
| BSES | 22 | | 13 | 9 | 14 | 10 |
| Bicarbonate | 12 | | 4 | 3 | 4 | 3 |
| Sulphate sulphur (µg $g^{-1}$) | 8.0 | | 8.5 | 5.5 | 5.0 | 4.0 |
| DTPA-Extractable micronutrients: | | | | | | |
| Iron (µg $g^{-1}$) | 9 | | 8 | 10 | 7 | 16 |
| Manganese (µg $g^{-1}$) | 6 | | 2 | 2 | 3 | 4 |
| Copper (µg $g^{-1}$) | 0.8 | | 0.5 | 0.5 | 0.5 | 0.3 |
| Zinc (µg $g^{-1}$) | 0.4 | | 0.3 | 0.3 | 0.5 | 0.3 |
| Cations: | | | | | | |
| Calcium (meq. $100g^{-1}$) | 31 | | 45 | 33 | 33 | 23 |

Laboratory Data (cont.)

| Depth(m) | 0-0.1 | 0.1-0.2 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|---|
| Cations (cont.): | | | | | | |
| Magnesium (meq. $100g^{-1}$) | 6.3 | | 7.5 | 7.9 | 7.8 | 7.4 |
| Sodium (meq. $100g^{-1}$) | 2.1 | | 5.4 | 7.9 | 8.9 | 9.9 |
| Potassium (meq. $100g^{-1}$) | 0.83 | | 0.44 | 0.28 | 0.24 | 0.15 |
| Mineralogy*: | | | | | | |
| Major minerals | KQ | | KQ | KQ | | K |
| Minor minerals | | | | MI | | QM |
| Trace minerals | | | | | | |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

| | |
|---|---|
| Soil Profile Class: | Teviot (Profile 2) |
| Great Soil Group: | Grey clay |
| Principal Profile Form: | Ug 5.14 |
| Parent Material: | Weathered feldspathic sandstone (Juandah Coal Measures) |
| Topography: | Mid-slope, undulating landscape, slope 2%, WSW aspect. |
| Location: | SG55-12. Roma. GM8912. Near Austinvale area. Theiss chip hole site R348. 500 m north of gate on track leading to trial excavation. Site 2. |
| Vegetation: | Cleared, with brigalow sucker regrowth. Previously brigalow open forest with shrub understorey of Wilga. |
| Land Use: | Previously cropped (canary, grain sorghum) |
| Profile Morphology: | Surface: Moderately self mulching, cracking, with thin fragile, laminar surface crust. A few subrounded silicified wood cobbles are present on surface. |
| A11 0-0.03 | Brownish black (10YR3/1); light medium clay; moderate 2-5 mm granular; dry, moderately weak. Clear to - |
| A12 0.03 - 0.12 | Black (10YR 2/1); light medium clay; moderate 10-20 mm angular blocky; dry, moderately firm; few fine calcareous nodules. Clear to - |
| B21K 0.12 - 0.45 | Brownish grey (10YR4/1); light medium clay; moderate 20 - 50 mm lenticular breaking to moderate 10 - 20 mm angular blocky; dry moderately strong; common medium calcareous nodules. Gradual to - |

| | |
|---|---|
| B22K 0.45 - 0.75 | Greyish yellow brown (10YR4/2); light medium clay; moderate 20-50 mm lenticular; dry very firm; common medium calcareous nodules. Gradual to - |
| B23 0.75 - 1.0 | Dull yellow orange (10YR6/4); light medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few fine calcareous nodules. Clear to - |
| C 1.0 + | Highly weathered friable feldspathic sandstone. |

Laboratory Data

| Depth (m) | 0 - 0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 |
|---|---|---|---|---|
| pH | 7.9 | 8.9 | 8.9 | 8.6 |
| Electrical conductivity ($mS\ cm^{-1}$) | 0.20 | 0.50 | 0.80 | 0.83 |
| Chloride (%) | 0.0145 | 0.053 | 0.094 | 0.114 |
| Particle size distribution(%): | | | | |
| Coarse sand (2.0-0.2 mm) | 18 | 10 | 11 | 16 |
| Fine sand (0.2-0.02 mm) | 32 | 33 | 31 | 35 |
| Silt (0.02-0.002 mm) | 11 | 16 | 14 | 11 |
| Clay (< 0.002 mm) | 40 | 40 | 42 | 38 |
| Cation exchange capacity ($meq\ 100g^{-1}$) | 35 | 36 | 36 | 29 |
| Gravimetric moisture %: | | | | |
| Air dry | 6.7 | 6.8 | 6.9 | 5.8 |
| 0.1 bar | 32.4 | 35.5 | 38.5 | 34.9 |
| 15 bar | 17.8 | 19.5 | 22.5 | 19.8 |
| Organic carbon (%) | 1.08 | 0.53 | 0.41 | 0.24 |
| Nitrate nitrogen ($\mu g\ g^{-1}$) | 9.6 | 2.0 | 1.4 | 0.8 |
| Extractable phosphorus ($\mu g\ g^{-1}$): | | | | |
| BSES | 12 | 8 | 8 | 5 |
| Bicarbonate | 6 | 2 | 2 | 2 |
| Sulphate sulphur ($\mu g\ g^{-1}$) | 6.5 | 27.0 | 59.5 | 50.5 |
| DTPA-Extractable micronutrients: | | | | |
| Iron ($\mu g\ g^{-1}$) | 15 | 8 | 6 | 4 |
| Manganese ($\mu g\ g^{-1}$) | 5 | 7 | 8 | 1 |
| Copper ($\mu g\ g^{-1}$) | 0.9 | 1.1 | 0.9 | 0.5 |
| Zinc ($\mu g\ g^{-1}$) | 1.6 | 0.9 | 1.3 | 0.7 |

Laboratory Data (cont.)

| Depth (m) | 0 - 0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 |
|---|---|---|---|---|
| Cations: | | | | |
| Calcium (meq. $100g^{-1}$) | 19.5 | 84 | 69 | 21 |
| Magnesium (meq. $100g^{-1}$) | 6.1 | 11.3 | 11.0 | 9.8 |
| Sodium (meq. $100g^{-1}$) | 2.69 | 7.60 | 10.43 | 11.83 |
| Potassium (meq. $100g^{-1}$) | 0.54 | 0.38 | 0.34 | 0.31 |
| Mineralogy*: | | | | |
| Major | KQ | KQ | KQM | K |
| Minor | | | | Q |
| Trace | I | | | M |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Rolleston

Great Soil Group: Black earth - brown clay

Principal Profile Form: Ug 5.15

Parent Material: Weathered siltstone (Juandah Coal Measures)

Topography: Lower midslope; 1% slope, ENE aspect.

Location: SG 55-12 Roma. GM 8910 Austinvale area. Theiss chip hole R 330. 530 m west of Coolanna homestead. Site 3.

Vegetation: Cleared for cultivation. Previously open forest of brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*).

Land Use: Annual cropping (currently grain sorghum).

Profile Morphology:

Surface: Moderately self mulching, cracking.

| | m | |
|---|---|---|
| Ap1 | 0 - 0.05 | Brownish black (7.5YR3/2); medium heavy clay; strong 2-5 mm granular; dry, moderately weak. Clear to - |
| Ap2 | 0.05 - 0.20 | Brownish black (7.5YR3/1); heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| B21 | 0.20 - 0.40 | Brownish black (10YR3/1); heavy clay; moderate 20-50 mm lenticular; dry, moderately strong; very few fine calcareous nodules. Gradual to - |
| B22K | 0.40 - 0.75 | Brown (7.5YR4/4); heavy clay; moderate 20-50 mm lenticular; dry, very strong; common medium calcareous nodules. Gradual to - |
| B23n | 0.75 - 1.0 | Bright brown (7.5YR5/5); heavy clay; moderate 20-50 mm breaking to moderate 10-20 mm lenticular; dry, very strong; few medium calcareous nodules; common district mangans; few fine manganiferous veins. Gradual to - |

B24 1.0 - 1.5+ Orange (7.5YR6/6); heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, very strong; few fine manganiferous veins.

Weathered siltstone is encountered at 2.6 m.

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| pH | 8.3 | 8.6 | 9.1 | 8.9 | 8.6 | 5.8 |
| Electrical conductivity ($mS\ cm^{-1}$) | 0.12 | 0.19 | 0.28 | 0.89 | 0.83 | 0.58 |
| Chloride (%) | 0.003 | 0.004 | 0.011 | 0.055 | 0.063 | 0.061 |
| Particle size distribution(%): | | | | | | |
| Coarse sand (2.0-0.2 mm) | 5 | 3 | 4 | 3 | | 2 |
| Fine sand (0.2-0.02 mm) | 22 | 24 | 21 | 19 | | 15 |
| Silt (0.02-0.002 mm) | 11 | 10 | 11 | 14 | | 21 |
| Clay (< 0.002 mm) | 61 | 61 | 62 | 62 | | 60 |
| Cation exchange capacity ($meq\ 100g^{-1}$) | 40 | 38 | 39 | 39 | | 38 |
| Gravimetric moisture %: | | | | | | |
| Air dry | 7.0 | 6.9 | 8.1 | 7.8 | | 6.4 |
| 0.1 bar | 36 | 38 | 40 | 42 | | 38 |
| 15 bar | 19 | 20 | 20 | 21 | | 20 |
| Organic carbon (%) | 1.50 | 0.91 | 0.78 | 0.47 | | 0.39 |
| Nitrate nitrogen ($\mu g\ g^{-1}$) | 13.6 | 4.8 | 3.2 | 2.6 | | 4.9 |
| Extractable phosphorus ($\mu g\ g^{-1}$): | | | | | | |
| BSES | 38 | 28 | 18 | 14 | | 10 |
| Bicarbonate | 24 | 8 | 3 | 3 | | 2 |
| Sulphate sulphur ($\mu g\ g^{-1}$) | 16 | 18 | 81 | 86 | | 80 |
| DTPA-Extractable micronutrients: | | | | | | |
| Iron ($\mu g\ g^{-1}$) | 11 | 10 | 10 | 8 | | 10 |
| Manganese ($\mu g\ g^{-1}$) | 6 | 6 | 6 | 7 | | 9 |
| Copper ($\mu g\ g^{-1}$) | 2.4 | 2.0 | 2.2 | 2.0 | | 2.2 |
| Zinc ($\mu g\ g^{-1}$) | 1.1 | 1.3 | 0.6 | 0.6 | | 1.6 |
| Cations: | | | | | | |
| Calcium ($meq.\ 100g^{-1}$) | 40 | 38 | 39 | 39 | | 38 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| Cations (cont.) | | | | | | |
| Magnesium (meq. $100g^{-1}$) | 5.3 | 5.8 | 11.0 | 11.4 | | 10.1 |
| Sodium (meq. $100g^{-1}$) | 1.1 | 2.1 | 7.6 | 8.9 | | 10.3 |
| Potassium (meq. $100g^{-1}$) | 1.06 | 0.47 | 0.61 | 0.43 | | 0.36 |
| Mineralogy*: | | | | | | |
| Major | K | K | K | K | | K |
| Minor | Q | Q | Q | Q | | Q |
| Trace | I | | M | | | MI |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Downfall

Great Soil Group: Grey clay

Principal Profile Form: Ug 5.24

Parent Material: Weathered mudstone (Juandah Coal Measures)

Topography: Upper midslope; patch of normal gilgai along contour; 1% slope W aspect.

Location: SG. 55-12. Roma. GM 8705. Woleebee area. Adjacent to Jackson Road, 2.2 km east of Woleebee Creek bridge. Across road from Theiss core hole C 505. Site 4.

Vegetation: Open forest of belah (*Casuarina cristata*) with shrub understorey of wilga (*Geijera parviflora*). Limited clearing has occurred.

Land Use: Beef cattle grazing; cultivation nearby.

Profile Morphology: Surface: Gilgai - moderate; normal; 50% small depressions; vertical interval 0.4 m horizontal interval 4 m. Moderately self mulching.

Depression profile:

| | m | |
|---|---|---|
| A11 | 0 - 0.03 | Greyish yellow brown (10YR4/2); medium clay; moderate 2-5 mm granular; dry, moderately weak; few medium calcareous nodules. Clear to - |
| A12 | 0.03 - 0.15 | Greyish yellow brown (10YR4/2); medium heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| B21 | 0.15 - 0.40 | Greyish yellow brown (10YR4/2); medium heavy clay; moderate 20-50 mm lenticular; dry, moderately strong, few medium carbonate nodules. Gradual to - |
| B22K | 0.40 - 1.0 | Dull yellowish brown (10YR5/3); medium heavy clay; moderate 20-50 mm lenticular; dry, |

| | | |
|---|---|---|
| B22K (cont.) | | moderately strong; common medium calcareous nodules; common medium soft calcareous segregations. Gradual to - |
| B23 | 1.0 - 1.5+ | Dull yellow orange (10YR6/4); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry moderately strong; few fine manganiferous veins. |
| | | Mudstone is encountered at 1.9 m. |

Mound Profile:

| | m | |
|---|---|---|
| A11 | 0 - 0.05 | Greyish brown (7.5YR4/2); medium heavy clay; strong 2.5 mm granular; dry moderately weak; common medium calcareous nodules. Clear to - |
| A12 | 0.05 - 0.15 | Greyish yellowish brown (10YR4/2); medium heavy clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| B21K | 0.15 - 0.50 | Dull yellowish brown (10YR4/3); medium heavy clay; moderate 20-50 mm lenticular; dry, moderately strong; common medium calcareous nodules. Gradual to - |
| B22 | 0.50 - 1.0 | Dull yellowish brown (10YR5/3); medium heavy clay, moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules. Gradual to - |
| B23 | 1.0 - 1.5 | Dull yellow orange (10YR6/3); medium heavy clay; moderate 20-50 mm prismatic; dry, moderately strong. |

Laboratory Data (Depression profile)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|
| pH | 7.8 | 8.2 | 8.7 | 8.6 | 8.4 |
| Electrical conductivity (mS $cm^{-1}$) | 0.19 | 0.20 | 0.24 | 0.48 | 0.98 |
| Chloride (%) | 0.0035 | 0.005 | 0.008 | 0.045 | 0.093 |
| Particle size distribution(%): | | | | | |
| Coarse sand (2.0-0.2 mm) | 16 | 17 | 15 | 16 | 16 |
| Fine sand (0.2-0.02 mm) | 25 | 25 | 23 | 24 | 22 |
| Silt (0.02-0.002 mm) | 12 | 11 | 10 | 11 | 11 |
| Clay (< 0.002 mm) | 48 | 49 | 51 | 50 | 50 |
| Cation exchange capacity (meq. $100g^{-1}$) | 32 | 34 | 35 | 36 | 33 |
| Gravimetric moisture %: | | | | | |
| Air dry | 5.4 | 4.8 | 6.6 | 7.0 | 6.8 |
| 0.1 bar | 36 | 38 | 39 | 37 | 37 |
| 15 bar | 18 | 19 | 19 | 18 | 18 |
| Organic carbon (%) | 3.68 | 1.44 | 0.64 | 0.38 | 0.38 |
| Nitrate nitrogen (µg $g^{-1}$) | 12.0 | 10.4 | 6.4 | 2.6 | 3.8 |
| Extractable phosphorus (µg $g^{-1}$): | | | | | |
| BSES | 120 | 42 | 10 | 14 | 14 |
| Bicarbonate | 58 | 17 | 3 | 2 | 2 |
| Sulphate sulphur (µg $g^{-1}$) | 17.5 | 11.0 | 20.0 | 90.0 | 115 |
| DTPA-Extractable micronutrients: | | | | | |
| Iron (µg $g^{-1}$) | 15 | 13 | 10 | 10 | 11 |
| Manganese (µg $g^{-1}$) | 8 | 5 | 4 | 3 | 3 |
| Copper (µg $g^{-1}$) | 0.7 | 0.7 | 0.6 | 0.4 | 0.5 |
| Zinc (µg $g^{-1}$) | 1.4 | 0.7 | 0.4 | 0.2 | 0.3 |
| Cations: | | | | | |
| Calcium (meq. $100g^{-1}$) | 26.9 | 43.4 | 46.7 | 28.3 | 25.2 |

Laboratory Data (Depression profile)(cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|
| Cations (cont.) | | | | | |
| Magnesium (meq. 100 $g^{-1}$) | 4.03 | 3.43 | 3.95 | 4.22 | 4.22 |
| Sodium (meq. 100$g^{-1}$) | 0.73 | 1.60 | 3.10 | 6.27 | 8.38 |
| Potassium (meq. 100$g^{-1}$) | 1.90 | 1.08 | 0.63 | 0.33 | 0.28 |
| Mineralogy*: | | | | | |
| Major | KQ | | KQ | | K |
| Minor | | | | | Q |
| Trace | I | | | | MI |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Laboratory Data (Mound profile)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 |
|---|---|---|---|
| pH | 7.3 | 8.3 | 8.6 |
| Electrical conductivity (mS $cm^{-1}$) | 0.15 | 0.17 | 0.39 |
| Chloride (%) | 0.003 | 0.002 | 0.022 |
| Organic carbon (%) | 2.57 | 1.20 | 0.35 |
| Nitrate nitrogen (µg $g^{-1}$) | 12.0 | 9.6 | 3.6 |
| Extractable phosphorus (µg $g^{-1}$): | | | |
| BSES | 29 | 15 | 15 |
| Bicarbonate | 16 | 4 | 3 |
| Sulphate sulphur (µg $g^{-1}$) | 6.5 | 8.5 | 50 |
| DTPA-Extractable micronutrients: | | | |
| Iron (µg $g^{-1}$) | 9 | 8 | 7 |
| Manganese (µg $g^{-1}$) | 4 | 2 | 2 |
| Copper (µg $g^{-1}$) | 0.4 | 0.3 | 0.3 |
| Zinc (µg $g^{-1}$) | 0.7 | 0.4 | 0.2 |
| Cations: | | | |
| Calcium (meq. $100g^{-1}$) | 34.2 | 46.1 | 35.2 |
| Magnesium (meq. $100g^{-1}$) | 3.56 | 4.58 | 4.85 |
| Sodium (meq. $100g^{-1}$) | 0.60 | 2.09 | 5.03 |
| Potassium (meq. $100g^{-1}$) | 1.16 | 0.58 | 0.34 |

Soil Profile Class: Coolanna

Great Soil Group: Brown clay

Principal Profile Form: Ug 5.15

Parent Material: Weathered siltstone (Juandah Coal Measures)

Topography: Midslope; 1% slope; NNE aspect.

Location: SG 55-12 Roma. GM 9112. Austinvale area. 50 m south of Theiss chip hole R 344. 700 m NNE of trial excavation. Site 5.

Vegetation: Cleared. Previously woodland of brigalow.

Land Use: Cropping. Currently fallow.

Profile Morphology: Surface: moderately self-mulching, cracking, with thin fragile crust.

| | m | |
|---|---|---|
| A11 | 0 - 0.05 | Brownish black (7.5YR3/2); medium clay; strong 2-5 mm granular; dry, moderately weak; few medium ferruginous nodules; few small sub-rounded siliceous pebbles. Clear to - |
| A12 | 0.05 - 0.12 | Brownish black (10YR3/2); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| A13 | 0.12 - 0.20 | Greyish brown (7.5YR4/2); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| B21K | 0.20 - 0.40 | Brown (7.5YR4/3); medium heavy clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common medium calcareous nodules. Gradual to - |
| B22 | 0.40 - 0.75 | Dull reddish brown (5YR5/4); medium heavy clay; moderate 20-50 mm lenticular breaking to moderate 10-20 mm angular blocky; few medium calcareous nodules. Gradual to - |

| | | |
|---|---|---|
| B23 | 0.75 - 1.35 | Bright reddish brown (5YR5/6); medium heavy clay; moderate 20-50 mm lenticular; dry moderately strong; few medium gypseous crystals. Gradual to - |
| B24 | 1.35 - 1.50 | Bright reddish brown (5YR5/8); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; few medium gypseous crystals. |

Weathered siltstone is encountered at 2.1 m.

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| pH | 8.3 | 8.9 | 9.0 | 8.2 | 5.0 | 5.7 |
| Electrical conductivity (mS $cm^{-1}$) | 0.15 | 0.23 | 0.39 | 0.75 | 0.82 | 0.81 |
| Chloride (%) | 0.0095 | 0.012 | 0.025 | 0.121 | 0.100 | 0.071 |
| Particle size distribution (%): | | | | | | |
| Coarse sand (2.0-0.2mm) | 8 | 7 | 8 | 8 | | 9 |
| Fine sand (0.2-0.02mm) | 29 | 23 | 27 | 24 | | 25 |
| Silt (0.02-0.002mm) | 16 | 16 | 10 | 16 | | 15 |
| Clay (< 0.002mm) | 48 | 52 | 54 | 51 | | 51 |
| Cation exchange capacity (meq. $100g^{-1}$) | 34 | 33 | 32 | 35 | | 34 |
| Gravimetric moisture %: | | | | | | |
| Air dry | 7.2 | 7.1 | 6.9 | 7.4 | | 7.6 |
| 0.1 bar | 37 | 38 | 39 | 39 | | 38 |
| 15 bar | 18 | 19 | 20 | 20 | | 20 |
| Organic carbon (%) | 1.44 | 0.70 | 0.45 | 0.31 | | 0.24 |
| Nitrate nitrogen (µg $g^{-1}$) | 13.2 | 3.2 | 1.9 | 2.0 | | 4.0 |
| Extractable phosphorus (µg $g^{-1}$): | | | | | | |
| BSES | 39 | 13 | 14 | 15 | | 15 |
| Bicarbonate | 6 | 3 | 3 | 3 | | 3 |
| Sulphate sulphur (µg $g^{-1}$) | 13.0 | 28.0 | 83.0 | 145.0 | | 290.0 |
| DTPA-Extractable micronutrients: | | | | | | |
| Iron (µg $g^{-1}$) | 16 | 10 | 9 | 12 | | 17 |
| Manganese (µg $g^{-1}$) | 5 | 4 | 4 | 3 | | 2 |
| Copper (µg $g^{-1}$) | 0.8 | 0.7 | 0.6 | 0.6 | | 0.6 |
| Zinc (µg $g^{-1}$) | 2.0 | 1.0 | 0.9 | 0.9 | | 0.9 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| Cations: | | | | | | |
| Calcium (meq. $100g^{-1}$) | 30 | 63 | 29.8 | 14.8 | | 11.2 |
| Magnesium (meq. $100g^{-1}$) | 7.62 | 13.0 | 13.0 | 11.5 | | 11.0 |
| Sodium (meq. $100g^{-1}$) | 1.93 | 3.9 | 6.0 | 7.4 | | 8.8 |
| Potassium (meq. $100g^{-1}$) | 0.51 | 0.31 | 0.28 | 0.28 | | 0.31 |
| Mineralogy*: | | | | | | |
| Major | K | K | K | K | | KQ |
| Minor | Q | Q | Q | Q | | M |
| Trace | | | | | | I |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Cheshire

Great Soil Group: No suitable group.

Principal Profile Form: Uf 6.31

Parent Material: Feldspathic sandstone or fine sandy siltstone (Juandah Coal Measures)

Topography: Near crest in undulating landscape; 2% slope; N aspect.

Location: SG 55-12 Roma. GM 9011 Austinvale area. 50 m west of Theiss chip hole R 352. 700 m NNE of trial excavation. Site 6.

Vegetation: Cleared apart from isolated shade trees. Previously open forest of brigalow (*Acacia harpophylla*), bumbil (*Capparis mitchellii*), bauhinia (*Lysiphyllum carronii*), bottle tree (*Brachychiton rupestre*) with associated softwood species and wilga (*Geijera parviflora*).

Land Use: Previously cultivated; currently cattle grazing.

Profile morphology: Surface: moderately self mulching, common surface strew of silicified wood 1 mm to 0.25 m.

| | m | |
|---|---|---|
| A11 | 0 - 0.05 | Brownish black (10YR3/2); light clay; moderate 2-5 mm granular; dry, moderately weak, few medium ferruginous nodules; common medium subangular siliceous pebbles. Clear to - |
| A12 | 0.05 - 0.20 | Brownish black (10YR3/2); light medium clay; moderate 5-10 mm angular blocky; dry, moderately firm. Clear to - |
| B21 | 0.20-0.40 | Dull yellowish brown (10YR4/3); medium clay; moderate 10-20 mm lenticular breaking to moderate 10-20 mm angular blocky; dry, moderately strong; common fine to medium calcareous nodules. Gradual to - |

| | | |
|---|---|---|
| B22 | 0.40 - 0.75 | Dull yellowish brown (10YR5/4); medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few fine carbonate nodules. Gradual to - |
| B23 | 0.75 - 1.30 | Yellowish brown (10YR5/6); medium clay; moderate 20-50 mm lenticular; dry, moderately strong. Gradual to - |
| C | 130+ | Bright yellowish brown (10YR6/6); weathered fine sandy siltstone. |

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|
| pH | 7.6 | 8.9 | 9.1 | 8.9 | 8.9 |
| Electrical conductivity ($mS\ cm^{-1}$) | 0.17 | 0.27 | 0.57 | 0.58 | 0.55 |
| Chloride (%) | 0.005 | 0.011 | 0.061 | 0.067 | 0.066 |
| Particle size distribution(%): | | | | | |
| Coarse sand (2.0-0.2 mm) | 11 | 10 | 11 | | 15 |
| Fine sand (0.02-0.002 mm) | 38 | 30 | 27 | | 31 |
| Silt (0.02-0.002 mm) | 16 | 16 | 14 | | 11 |
| Clay (< 0.002 mm) | 37 | 35 | 48 | | 45 |
| Cation exchange capacity ($meq.\ 100g^{-1}$) | 30 | 34 | 33 | | 32 |
| Gravimetric moisture %: | | | | | |
| Air dry | 7.4 | 7.6 | 7.8 | | 7.5 |
| 0.1 bar | 32 | 35 | 36 | | 33 |
| 15 bar | 17 | 20 | 20 | | 19 |
| Organic carbon (%) | 1.22 | 0.67 | 0.40 | | 0.16 |
| Nitrate nitrogen ($\mu g\ g^{-1}$) | 25.6 | 19.4 | 8.0 | | 1.0 |
| Extractable phosphorus ($\mu g\ g^{-1}$): | | | | | |
| BSES | 25 | 11 | 7 | | 9 |
| Bicarbonate | 10 | 2 | 2 | | 1 |
| Sulphate sulphur ($\mu g\ g^{-1}$) | 10 | 9 | 13 | | 5.5 |
| DTPA-Extractable micronutrients: | | | | | |
| Iron ($\mu g\ g^{-1}$) | 10 | 9 | 5 | | 6 |
| Manganese ($\mu g\ g^{-1}$) | 6 | 3 | 2 | | 1 |
| Copper ($\mu g\ g^{-1}$) | 0.6 | 0.5 | 0.3 | | 0.2 |
| Zinc ($\mu g\ g^{-1}$) | 1.4 | 0.8 | 0.6 | | 0.6 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 |
|---|---|---|---|---|---|
| Cations: | | | | | |
| Calcium (meq. $100g^{-1}$) | 27.6 | 85 | 90 | | 26.5 |
| Magnesium (meq. $100g^{-1}$) | 7.7 | 13.3 | 15 | | 13 |
| Sodium (meq. $100g^{-1}$) | 2.17 | 5.13 | 10.17 | | 12.17 |
| Potassium (meq. $100g^{-1}$) | 0.44 | 0.27 | 0.27 | | 0.23 |
| Mineralogy*: | | | | | |
| Major | K | | KQM | | KQ |
| Minor | | | | | |
| Trace | MI | | I | | M |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Austinvale

Great Soil Group: No suitable group

Principal Profile Form: Uf 6.31

Parent Material: Fine sandy siltstone (Juandah Coal Measures)

Topography: Midslope; 2% slope; N aspect.

Location: SG 55-12. Roma GM 9011. Austinvale area. 50 m south west of Theiss chip hole R 350. Site 7.

Vegetation: Cleared. Previously brigalow open forest. Regrowth of bitterbark (*Alstonia constricta*).

Land Use: Previously cultivated, currently cattle grazing.

Profile morphology: Surface: moderately hardsetting, some sheet erosion.

| | (m) | |
|---|---|---|
| A11 | 0 - 0.05 | Brown (7.5YR4/4); medium clay; weak 5-10 mm angular blocky; dry, moderately firm. Clear to - |
| A12 | 0.05 - 0.10 | Dull reddish brown (5YR4/4); medium clay; moderate 10-20 mm angular blocky; dry, moderately firm. Clear to - |
| B21 | 0.10 - 0.20 | Reddish brown (5YR4/6); medium clay; moderate 20-50 mm angular blocky; dry, very firm. Gradual to - |
| B22 | 0.20 - 0.40 | Bright brown (7.5YR5/6); medium heavy clay; moderate 20-50 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, moderately strong; few fine calcareous nodules. Gradual to - |
| B23 | 0.40 - 0.54 | Yellowish brown (10YR5/7); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry moderately strong; few medium soft calcareous segregations. Clear to - |

C 0.54+ Slightly weathered yellowish brown (10YR5/8) fine sandy siltstone.

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 |
|---|---|---|---|
| pH | 7.4 | 8.1 | 8.5 |
| Electrical conductivity (mS $cm^{-1}$) | 0.07 | 0.07 | 0.09 |
| Chloride (%) | 0.003 | 0.001 | 0.001 |
| Particle size distribution (%): | | | |
| Coarse sand (2.0-0.2 mm) | 8 | 6 | 8 |
| Fine sand (0.2-0.02 mm) | 27 | 23 | 36 |
| Silt (0.02-0.002 mm) | 16 | 16 | 21 |
| Clay (< 0.002 mm) | 51 | 55 | 38 |
| Cation exchange capacity (meq. $100g^{-1}$) | 34 | 34 | 28 |
| Gravimetric moisture percentage: | | | |
| Air dry | 7.6 | 6.8 | 4.1 |
| 0.1 bar | 35 | 38 | 31 |
| 15 bar | 19 | 20 | 16 |
| Organic carbon (%) | 0.72 | 0.53 | 0.30 |
| Nitrate nitrogen (µg $g^{-1}$) | 6.4 | 0.2 | 0.4 |
| Extractable phosphorus (µg $g^{-1}$): | | | |
| BSES | 9 | 46 | 95 |
| Bicarbonate | 4 | 2 | 2 |
| Sulphate sulphur (µg $g^{-1}$) | | | |
| DTPA-Extractable micronutrients: | | | |
| Iron (µg $g^{-1}$) | 10 | 5 | 5 |
| Manganese (µg $g^{-1}$) | 4 | 3 | 2 |
| Copper (µg $g^{-1}$) | 1.0 | 0.8 | 1.0 |
| Zinc (µg $g^{-1}$) | 4 | 3 | 0.5 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 |
|---|---|---|---|
| Cations: | | | |
| Calcium (meq. $100g^{-1}$) | 19.5 | 23 | 45 |
| Magnesium (meq. $100g^{-1}$) | 7.75 | 7.67 | 6.91 |
| Sodium (meq. $100g^{-1}$) | 0.74 | 0.60 | 0.54 |
| Potassium (meq. $100g^{-1}$) | 0.36 | 0.29 | 0.26 |
| Mineralogy*: | | | |
| Major | K | K | K |
| Minor | Q | Q | Q |
| Trace | M | M | I |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Beechley

Great Soil Group: Grey clay

Principal Profile Form: Ug 5.14

Parent Material: Feldspathic sandstone (Juandah Coal Measures)

Topography: Near crest, undulating landscape; slope 2.5%; NNE aspect.

Location: S 44-12 Roma. GM 8509. Woleebee area. 200 m north of Theiss chip hole R 473. Site 8.

Vegetation: Cleared. Nearby vegetation is brigalow open forest with associated softwood species.

Land Use: Grazing. Cultivated for grain sorghum nearby.

Profile Morphology: Surface: Stone cover - abundant subrounded siliceous large pebbles, cobbles and stones.

| | m | |
|---|---|---|
| A11 | 0 - 0.04 | Black (10YR2/1); light medium clay; moderate 2-5 mm granular; dry, very weak; abundant subrounded siliceous pebbles and cobbles. Clear to - |
| A12 | 0.04 - 0.15 | Brownish black (10YR3/1); light medium clay; moderate 5-10 mm angular blocky; dry, moderately firm; common medium and large subrounded siliceous pebbles. Clear to - |
| B21 | 0.15 - 0.45 | Brownish grey (10YR4/1); light medium clay; moderate 20-50 mm lenticular; dry, moderately strong; few medium calcareous nodules; few medium subrounded siliceous pebbles. Gradual to - |
| B22 | 0.45 - 0.75 | Greyish yellow brown (10YR4/2); medium clay; moderate 20-50 mm lenticular; dry moderately strong. Gradual to - |

| | | |
|---|---|---|
| B23 | 0.75 - 0.90 | Dull yellowish brown (10YR5/3); medium clay; moderate 20-50 mm lenticular; dry, moderately strong. Clear to - |
| C | 0.90+ | Weathered feldspathic sandstone. |

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8 0.9 |
|---|---|---|---|---|
| pH | 7.2 | 8.3 | 8.5 | 7.1 |
| Electrical conductivity ($mS\ cm^{-1}$) | 0.05 | 0.11 | 0.67 | 0.75 |
| Chloride (%) | 0.001 | 0.003 | 0.035 | 0.092 |
| Particle size distribution (%): | | | | |
| Coarse sand (2.0-0.2 mm) | 13 | | | |
| Fine sand (0.2-0.02 mm) | 28 | | | |
| Silt (0.02-0.002 mm) | 18 | | | |
| Clay (< 0.002 mm) | 42 | | | |
| Cation exchange capacity ($meq.\ 100g^{-1}$) | 33 | | | |
| Gravimetric moisture percentage: | | | | |
| Air dry | 6.9 | | | |
| 0.1 bar | 32 | | | |
| 15 bar | 18 | | | |
| Organic carbon (%) | 1.97 | | | |
| Nitrate nitrogen ($\mu g\ g^{-1}$) | 3.8 | | | |
| Extractable phosphorus ($\mu g\ g^{-1}$): | | | | |
| BSES | 29 | | | |
| Bicarbonate | 12 | | | |
| Sulphate sulphur ($\mu g\ g^{-1}$) | 2.5 | | | |
| DTPA-Extractable micronutrients: | | | | |
| Iron ($\mu g\ g^{-1}$) | 9 | | | |
| Manganese ($\mu g\ g^{-1}$) | 6 | | | |
| Copper ($\mu g\ g^{-1}$) | 0.8 | | | |
| Zinc ($\mu g\ g^{-1}$) | 1.1 | | | |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 |
|---|---|---|---|---|
| Cations: | | | | |
| Calcium (meq. $100g^{-1}$) | 14.83 | | | |
| Magnesium (meq. $100g^{-1}$) | 1.89 | | | |
| Sodium (meq. $100g^{-1}$) | 0.05 | | | |
| Potassium (meq. $100g^{-1}$) | 0.83 | | | |
| Mineralogy*: | | | | |
| Major | KQ | | | |

* K = kaolinite, Q = quartz.

Soil Profile Class: Salisbury Park

Great Soil Group: Lithosol

Principal Profile Form: Uc 1.21

Parent Material: Outcrop of Springbok sandstone

Topography: Crest of low hill, slope 2% W aspect.

Location: SG 55-12 Roma. GM 8807. Woleebee area.
50 m south of Theiss core hole C 670. Site 10.

Vegetation: Woodland of silver-leaved ironbark (*Eucalyptus melanophloia*) with some brigalow (*Acacia harpophylla*).

Land Use: Rough grazing.

Profile Morphology: Surface: hardsetting.

| | m | |
|---|---|---|
| A11 | 0 - 0.04 | Dull yellowish brown (10YR5/3); coarse loamy sand; massive; dry, moderately weak; abundant subangular medium to large siliceous pebbles. Clear to - |
| A12 | 0.04 - 0.10 | Dull yellow orange (10YR6/4); coarse sand; massive; dry moderately weak; abundant subangular medium siliceous pebbles and sandstone fragments. Clear to - |
| C | 0.10+ | Quartzose sandstone and gravel. |

Laboratory Data

| Depth (m) | 0-0.1 |
|---|---|
| pH | 6.7 |
| Electrical conductivity (mS $cm^{-1}$) | 0.02 |
| Chloride (%) | 0.001 |
| Particle size distribution (%): | |
| Coarse sand (2.0-0.2 mm) | 68 |
| Fine sand (0.2-0.02 mm) | 18 |
| Silt (0.02-0.002 mm) | 5 |
| Clay (< 0.002 mm) | 7 |
| Cation exchange capacity (meq. $100g^{-1}$) | 6.4 |
| Gravimetric moisture percentage: | |
| Air dry | 2.1 |
| 0.1 bar | 16 |
| 15 bar | 7 |
| Organic carbon (%) | 0.45 |
| Nitrate nitrogen (µg $g^{-1}$) | 1.0 |
| Extractable phosphorus (µg $g^{-1}$): | |
| BSES | 14 |
| Bicarbonate | 7 |
| Sulphate sulphur (µg $g^{-1}$) | 2.0 |
| DTPA-extractable micronutrients: | |
| Iron (µg $g^{-1}$) | 19 |
| Manganese (µg $g^{-1}$) | 5 |
| Copper (µg $g^{-1}$) | 0.3 |
| Zinc (µg $g^{-1}$) | 0.5 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 |
|---|---|
| Cations: | |
| Calcium (meq. $100g^{-1}$) | 3.18 |
| Magnesium (meq. $100g^{-1}$) | 1.02 |
| Sodium (meg. $100g^{-1}$) | 0.23 |
| Potassium (meq. $100g^{-1}$) | 0.27 |
| Mineralogy*: | |
| Major | Q |
| Trace | K |

* K = kaolinite, Q = quartz.

Soil Profile Class: Retro

Great Soil Group: Solodized solonetz

Principal Profile Form: Dy 2.43

Parent Material: Feldspathic sandstone (Springbok sandstone) with colluvial influence.

Topography: Lower slope, marginal to drainage floor of Woleebee Creek. 2% slope, west aspect.

Location: SG 55-12 Roma GM 8705. Near Theiss chip hole R 652. Woleebee area. Site 9.

Vegetation: Open forest of brigalow *(Acacia harpophylla)*, poplar box *(Eucalyptus populnea)*, belah *(Casuarina cristata)* with shrub understorey of false sandalwood *(Eremophila mitchellii)* and bull-oak *(Casuarina leuhmarinii)*.

Land Use: Road reserve. Partially cleared for grazing nearby.

Profile Morphology: Surface: hardsetting.

| | m | |
|---|---|---|
| A1 | 0 - 0.11 | Brownish grey (10YR4/1); sandy clay loam; massive; dry, moderately firm. Clear to - |
| A2cb | 0.11 - 0.13 | Conspicuously bleached; dull yellow orange (10YR7/2D); fine sandy clay loam; dry, moderately firm; few rounded medium siliceous pebbles. Clear to - |
| B21t | 0.13 - 0.25 | Dark greyish yellow (2.5Y4/2); medium clay; moderate 50-100 mm collumnar breaking to moderate 50-100 mm angular blocky; dry, very strong. Gradual to - |
| B22tk | | Dark greyish yellow (2.5Y4/2); medium clay; moderate 50-100 mm prismatic breaking to moderate 20-50 mm angular blocky; dry, very strong; common fine calcareous nodules; few |

| | | |
|---|---|---|
| B23t | 0.45 - 0.85 | Greyish yellow (2.5Y6/2); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry moderately strong; few fine carbonate nodules. Gradual to - |
| C | 0.85+ | Friable weathered sandstone. |

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 |
|---|---|---|---|
| pH | 7.1 | 8.3 | 8.9 |
| Electrical conductivity (mS $cm^{-1}$) | 0.03 | 0.18 | 0.42 |
| Chloride (%) | 0.001 | 0.005 | 0.040 |
| Particle size distribution (%): | | | |
| Coarse sand (2.0-0.2 mm) | 14 | 3 | 2 |
| Fine sand (0.2-0.02 mm) | 42 | 36 | 36 |
| Silt (0.02-0.002 mm | 16 | 14 | 16 |
| Clay (< 0.002 mm) | 28 | 49 | 47 |
| Cation exchange capacity (meq. $100g^{-1}$) | 17 | 33 | 31 |
| Gravimetric moisture percentage: | | | |
| Air dry | 2.7 | 6.5 | 6.7 |
| 0.1 bar | 22 | 39 | 39 |
| 15 bar | 11 | 26 | 25 |
| Organic carbon (%) | 0.73 | 0.60 | 0.52 |
| Nitrate nitrogen (µg $g^{-1}$) | 1.0 | 3.4 | 2.2 |
| Extractable phosphorus (µg $g^{-1}$): | | | |
| BSES | 21 | 6 | 5 |
| Bicarbonate | 12 | 3 | 3 |
| Sulphate sulphur (µg $g^{-1}$) | 3.0 | 5.5 | 48 |
| DTPA-Extractable micronutrients: | | | |
| Iron (µg $g^{-1}$) | 10 | 10 | 10 |
| Manganese (µg $g^{-1}$) | 11 | 7 | 4 |
| Copper (µg $g^{-1}$) | 0.6 | 0.7 | 0.4 |
| Zinc (µg $g^{-1}$) | 0.6 | 0.4 | 0.2 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 |
|---|---|---|---|
| Cations: | | | |
| Calcium (meq. $100g^{-1}$) | 6.6 | 12.31 | 87.31 |
| Magnesium (meq. $100g^{-1}$) | 11 | 7 | 4 |
| Sodium (meq. $100g^{-1}$) | 0.08 | 2.25 | 5.71 |
| Potassium (meq. $100g^{-1}$) | 0.33 | 0.08 | 0.09 |
| Mineralogy*: | | | |
| Major | KQ | | KQ |
| Minor | | | |
| Trace | | | IM |

* I = illite, K = kaolinite, M = montmorillorite, Q = quartz.

Soil Profile Class: Woleebee

Great Soil Group: Solodized solonetz

Principal Profile Form: Dd 1.43

Parent Material: Quaternary alluvium

Topography: Flat alluvial plant associated with Woleebee Creek.

Location: SG 55-12 Roma. GM 8505. Woleebee area. Adjacent to road leading to Cambrai homestead. Theiss core hole C 506. Site 11.

Vegetation: Woodland of poplar box (*Eucalyptus populnea*) with understorey of false sandalwood (*Eremophila mitchellii*) and mimosa (*Acacia farnesiana*). Ground cover includes kangaroo grass (*Themeda australis*), barbed-wire grass (*Cymbopogon refractus*), spear grass (*Heteropogon contortus*), buffel grass (*Cenchrus ciliaris*).

Land Use: Cattle grazing on native pasture.

Profile Morphology: Surface: hardsetting.

| | m | |
|---|---|---|
| A1 | 0 - 0.09 | Greyish yellow brown (10YR4/2); silt loam; massive or weak 5-10 mm subangular blocky; dry, moderately weak. Clear to - |
| A2cb | 0.09 - 0.10 | Conspicuously bleached; light grey (10YR7/1D); silt loam; massive; dry, moderately weak. Abrupt to - |
| B21t | 0.10 - 0.35 | Brownish black (10YR3/1); medium clay; moderate 50-100 mm collumnar, breaking to moderate 20-50 mm angular blocky; dry, moderately strong; few fine calcareous nodules. Gradual to - |
| B22tk | 0.35 - 0.60 | Brownish black (10YR3/2); medium clay, fine sandy; moderate 20-50 mm angular blocky; dry, moderately strong; common fine calcareous |

B22tk 0.35 - 0.60 (cont.) nodules; common medium soft calcareous segregations. Gradual to -

D 0.60+ Greyish yellow brown (10YR4/2); fine sandy clay loam; weak 5-10 mm angular blocky; dry, moderately firm.

Laboratory Data

| Depth (m) | 0-0.1 | 0.1-0.2 | 0.2-0.3 | 0.4-0.5 |
|---|---|---|---|---|
| pH | 7.6 | 7.5 | 8.3 | 8.8 |
| Electrical conductivity (mS $cm^{-1}$) | 0.19 | 0.39 | 0.46 | 0.63 |
| Chloride (%) | 0.018 | 0.045 | 0.055 | 0.093 |
| Particle size distribution (%): | | | | |
| Coarse sand (2.0-0.2 mm) | 13 | 12 | 14 | 15 |
| Fine sand (0.2-0.02 mm) | 48 | 28 | 28 | 34 |
| Silt (0.02-0.002 mm) | 22 | 18 | 16 | 16 |
| Clay (< 0.002 mm) | 18 | 42 | 38 | 36 |
| Cation exchange capacity (meq. $100g^{-1}$) | 14 | 31 | 28 | 26 |
| Moisture percentage: | | | | |
| Air dry | 2.1 | 5.6 | 5.3 | 4.9 |
| 0.1 bar | 25.2 | 37.1 | 36.6 | 32.9 |
| 15 bar | 14.8 | 24.3 | 22.0 | 22.2 |
| Organic carbon (%) | 1.38 | 0.97 | 0.59 | 0.26 |
| Nitrate nitrogen (µg $g^{-1}$) | 10.6 | 3.6 | 3.0 | 1.2 |
| Extractable phosphorus (µg $g^{-1}$): | | | | |
| BSES | 83 | 16 | 30 | 37 |
| Bicarbonate | 49 | 5 | 5 | 6 |
| Sulphate sulphur (µg $g^{-1}$) | 17.5 | 16.5 | 15.0 | 21.5 |
| DTPA-Extractable micronutrients: | | | | |
| Iron (µg $g^{-1}$) | 17 | 23 | 8 | 7 |
| Manganese (µg $g^{-1}$) | 21 | 3 | 2 | 1 |
| Copper (µg $g^{-1}$) | 0.3 | 0.4 | 0.3 | 0.3 |
| Zinc (µg $g^{-1}$) | 0.7 | 0.3 | 0.2 | 0.3 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.1-0.2 | 0.2-0.3 | 0.4-0.5 |
|---|---|---|---|---|
| Cations: | 21% | 23% | 27% | |
| Calcium (meq. $100g^{-1}$) | 9.72 | 16.31 | 14.31 | 14.12 |
| Magnesium (meq. $100g^{-1}$) | 2.06 | 5.39 | 4.53 | 3.32 |
| Sodium (meq. $100g^{-1}$) | 2.74 | 6.68 | 7.27 | 6.94 |
| Potassium (meq. $100g^{-1}$) | 0.89 | 0.55 | 0.48 | 0.34 |
| Mineralogy: | | | | |
| Major | KQ | KQ | KQ | KQ |
| Minor | | | | |
| Trace | I | | IM | IM |

* I = illite, K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Juandah

Great Soil Group: Black earth

Principal Profile Form: Ug 5.16

Parent Material: Quaternary argillaceous alluvium.

Topography: Depression (relict channel) in drainage floor of Woleebee Creek. 0% slope.

Location: SG 55-12 GM8707. Woleebee area. 320 m west of Theiss chip hole R 657. Site 12.

Vegetation: Grassland with scattered coolibah (*Eucalyptus microtheca*) and poplar box (*Eucalyptus populnea*).

Land Use: Cattle grazing on native pasture.

Profile Morphology:

| | m | |
|---|---|---|
| A11 | 0 - 0.05 | Surface: moderately self mulching. Brownish black (10YR3/1); with few fine distinct orange root mottles; heavy clay; strong 5-10 mm angular blocky; dry, moderately strong. Clear to - |
| A12 | 0.05 - 0.10 | Black (2.5Y2/1); heavy clay; strong 10-20 mm angular blocky; dry, moderately strong. Clear to - |
| B21 | 0.10 - 0.50 | Brownish black (2.5Y3/1); heavy clay; moderate 20-50 mm lenticular; dry, moderately strong. Gradual to - |
| B22 | 0.50 - 1.30 | Greyish yellow brown (10YR4/2); heavy clay; medium 20-50 mm lenticular; dry, very strong. Gradual to - |
| B23 | 1.30 - 1.50 | Greyish yellow brown (10YR5/2); heavy clay; moderate 20-50 mm prismatic; dry, very strong. |

Laboratory Data

| Depth (m) | 0-0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| pH | 7.0 | 7.6 | 8.2 | 8.2 | 8.3 | 8.2 |
| Electrical conductivity (mS $cm^{-1}$) | 0.07 | 0.06 | 0.08 | 0.16 | 0.29 | 0.31 |
| Chloride (%) | 0.004 | 0.006 | 0.018 | 0.039 | 0.069 | 0.095 |
| Particle size distribution(%): | | | | | | |
| Coarse sand (2.0-0.2mm) | 4 | | 3 | | | |
| Fine sand (0.2-0.02mm) | 15 | | 14 | | | |
| Silt (0.02-0.002mm) | 30 | | 20 | | | |
| Clay (< 0.002 mm) | 53 | | 65 | | | |
| Cation exchange capacity (meq. $100g^{-1}$) | 39 | | 44 | | | |
| Gravimetric moisture percentage: | | | | | | |
| Air dry | 7.2 | | 8.4 | | | |
| 0.1 bar | 41 | | 48 | | | |
| 15 bar | 24 | | 26 | | | |
| Organic carbon (%) | 1.01 | | 0.53 | | | |
| Nitrate nitrogen (µg $g^{-1}$) | 4.2 | | 2.4 | | | |
| Extractable phosphorus (µg $g^{-1}$): | | | | | | |
| BSES | 34 | | 10 | | | |
| Bicarbonate | 35 | | 8 | | | |
| Sulphate sulphur (µg $g^{-1}$) | 16.0 | | 22 | | | |
| DTPA-Extractable micronutrients: | | | | | | |
| Iron (µg $g^{-1}$) | 85 | | 29 | | | |
| Manganese (µg $g^{-1}$) | 11 | | 6 | | | |
| Copper (µg $g^{-1}$) | 1.4 | | 0.8 | | | |
| Zinc (µg $g^{-1}$) | 0.7 | | 0.6 | | | |

Laboratory Data (cont.)

| Depth (m) | 0 -0.1 | 0.2-0.3 | 0.5-0.6 | 0.8-0.9 | 1.1-1.2 | 1.4-1.5 |
|---|---|---|---|---|---|---|
| Cations: | | | | | | |
| Calcium (meq. $100g^{-1}$) | 17.83 | | 25.91 | | | |
| Magnesium (meq. $100g^{-1}$) | 6.11 | | 3.84 | | | |
| Sodium (meq. $100g^{-1}$) | 2.43 | | 2.61 | | | |
| Potassium (meq $100g^{-1}$) | 1.39 | | 0.78 | | | |
| Mineralogy*: | | | | | | |
| Major | K | | K | | | |
| Minor | | | M | | | |
| Trace | Q | | Q | | | |

* K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Cambrai

Great Soil Group: Alluvial

Principal Profile Form: Gn 3.92

Parent Material: Quaternary alluvium deposited by Woleebee and Wandoan Creeks.

Topography: Creek levee 0.5% slope westwards towards Wandoan Creek.

Location: SG 55-12 Roma GM 8607. Woleebee area. 50 m west of Theiss core hole C 539. Site 13.

Vegetation: Cleared. Nearby vegetation is open forest of poplar box *(Eucalyptus populnea)*, rusty gum *(Angophora costata)* & Queensland blue gum *(Eucalyptus tereticorins)*.

Land Use: Cropping, currently forage sorghum.

Profile Morphology: Surface: firm.

| | m | |
|---|---|---|
| A11 | 0 - 0.20 | Brownish grey (10YR4/1); loam, weak 10-20 mm angular blocky; dry, moderately weak. Gradual to - |
| A12 | 0.20 - 0.38 | Dark grayish yellow (2.5Y4/2); sandy clay loam; moderate 10-20 mm angular blocky; dry moderately weak. Gradual to - |
| B1 | 0.38 - 0.60 | Greyish yellow brown (10YR4/2); clay loam; fine sandy; moderate 10-20 mm angular blocky; dry moderately firm. Gradual to - |
| B2 | 0.60 - 1.0 | Brown (10YR4/3); loamy sand; massive; dry, moderately firm; few small rounded siliceous pebbles. Gradual to - |
| B3 | 1.0 - 1.5 | Dull yellowish brown (10YR5/4); clayey sand; massive; dry, moderately firm. |

Laboratory Data

| Depth (m) | 0-0.1 | 0.5-0.6 |
|---|---|---|
| pH | 6.4 | 7.3 |
| Electrical conductivity (mS $cm^{-1}$) | 0.04 | 0.06 |
| Chloride (%) | 0.0005 | 0.001 |
| Particle size distribution (%): | | |
| Coarse sand (2.0-0.2 mm) | 13 | 10 |
| Fine sand (0.2-0.02 mm) | 38 | 34 |
| Silt (0.02-0.002 mm) | 25 | 24 |
| Clay (<0.002 mm) | 23 | 32 |
| Cation exchange capacity (meq. $100g^{-1}$) | 16 | 23 |
| Gravimetric moisture percentage: | | |
| Air dry | 2.6 | 3.9 |
| 0.1 bar | 22.3 | 29.7 |
| 15 bar | 11.7 | 18.2 |
| Organic carbon (%) | 0.78 | 0.43 |
| Nitrate nitrogen (µg $g^{-1}$) | 4.6 | 2.8 |
| Extractable phosphorus (µg $g^{-1}$): | | |
| BSES | 54 | 17 |
| Bicarbonate | 35 | 10 |
| Sulphate sulphur (µg $g^{-1}$) | 3.5 | 4.0 |
| DTPA-extractable micronutrients: | | |
| Iron (µg $g^{-1}$) | 22 | 9 |
| Manganese (µg $g^{-1}$) | 11 | 2 |
| Copper (µg $g^{-1}$) | 0.3 | 0.5 |
| Zinc (µg $g^{-1}$) | 0.6 | 0.3 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 | 0.5-0.6 |
|---|---|---|
| Cations: | | |
| Calcium (meq. $100g^{-1}$) | 7.03 | 15.51 |
| Magnesium (meq. $100g^{-1}$) | 2.23 | 3.92 |
| Sodium (meq. $100g^{-1}$) | 0.04 | 0.29 |
| Potassium (meq. $100g^{-1}$) | 0.90 | 0.75 |
| Mineralogy*: | | |
| Major | QK | QK |
| Trace | | M |

* K = kaolinite, M = montmorillonite, Q = quartz.

Soil Profile Class: Elsbar

Great Soil Group: Earthy sand

Principal Profile Form: Uc 5.22

Parent Material: Alluvium

Topography: Slight rise within alluvial plain between creeks.

Location: SG 55-12 Roma. GM 8606. Woleebee area. Thiess chip hole R 994. Site 14. 500 m east of Cambrai homestead.

Vegetation: Partially cleared. Clumps of rough-barked apple (*Angophora floribunda*) occur.

Profile Morphology: Surface: loose.

| | m | |
|---|---|---|
| A1 | 0 - 0.30 | Brownish black (2.5Y3/2); sand; single grain; dry, loose. Gradual to - |
| A2 | 0.30 - 0.65 | Dull yellowish brown (10YR4/3); sand; massive; dry, very weak. Diffuse to - |
| B2 | 0.65 - 1.50 | Brown (10YR4/4); sand; dry, moderately weak; few small rounded quartz pebbles. |

Laboratory Data

| Depth (m) | 0-0.1 |
|---|---|
| pH | 6.6 |
| Electrical conductivity (mS $cm^{-1}$) | 0.02 |
| Chloride (%) | 0.0005 |
| Particle size distribution (%): | |
| Coarse sand (2.0-0.2 mm) | 78 |
| Fine sand (0.2-0.02 mm) | 14 |
| Silt (0.02-0.002 mm) | 4 |
| Clay (< 0.002 mm) | 5 |
| Cation exchange capacity (meq. $100g^{-1}$) | 5 |
| Moisture percentage: | |
| Air dry | 0.5 |
| 0.1 bar | 8 |
| 15 bar | 3 |
| Organic carbon (%) | 0.38 |
| Nitrate nitrogen (µg $g^{-1}$) | 6.4 |
| Extractable phosphorus (µg $g^{-1}$): | |
| BSES | 35 |
| Bicarbonate | 24 |
| Sulphate sulphur (µg $g^{-1}$) | 2.5 |
| DTPA-Extractable micronutrients: | |
| Iron (µg $g^{-1}$) | 15 |
| Manganese (µg $g^{-1}$) | 12 |
| Copper (µg $g^{-1}$) | 0.3 |
| Zinc (µg $g^{-1}$) | 0.9 |
| Cations: | |
| Calcium (meq. $100g^{-1}$) | 2.87 |

Laboratory Data (cont.)

| Depth (m) | 0-0.1 |
|---|---|
| Cations (cont.) | |
| Magnesium (meq. $100g^{-1}$) | 0.66 |
| Sodium (meq. $100g^{-1}$) | 0.06 |
| Potassium (meq. $100g^{-1}$) | 0.62 |
| Mineralogy*: | |
| Major | Q |
| Trace | K |

* K = kaolinite, Q = quartz.

# Attachment E

Land suitability criteria

# Attachment E – Land suitability criteria

**Table E-1: Suitability criteria for rainfed broadacre cropping**

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Water availability | PAWC >150 mm | PAWC 125-150 mm | PAWC 100-125 mm | PAWC 75-100 mm | PAWC <75 mm |
| Nutrient deficiency | Bicarbonate P >10 ppm | Bicarbonate P 5-10 ppm and Exchangeable K >0.3 meq. % | Bicarbonate P 5-10 ppm and Exchangeable K ≤0.3 meq. % or pH <5 60-90 cm below surface or pH >9 60-90 cm below surface | Bicarbonate P <10 ppm and Exchangeable K ≤0.3 meq. %, and Exchangeable Ca <3 meq.%, or pH <5 30-60 cm below surface, or pH >9 30-60 cm below surface | pH <5 within 30 cm of surface or pH >9 within 30 cm of surface |
| Soil physical factors | Cracking clays with very fine self-mulch (peds <2 mm), or Rigid soils with a loose, soft or firm surface when dry | Cracking clays with fine self-mulch (peds 2-10 mm) | Cracking clays with coarse self-mulch (peds 10-20 mm) or Rigid soils with a hard setting surface when dry | Cracking clays with coarse peds at the surface (≥20 mm) | |
| Soil workability | Friable cracking clays (indicated by very fine self-mulch), or Rigid soils with a loose, soft or firm surface when dry | Firm cracking clays (indicated by fine self-mulch) or Rigid soils with a hard setting surface when dry | Stiff cracking clays (indicated by coarse self-mulch with peds>10 mm, crusting or hard setting surface) | | |
| Salinity | Rootzone EC <0.15 mS/cm or Rootzone Cl <300 ppm | Rootzone EC 0.15 -0.3 mS/cm or Rootzone Cl 300-600 ppm | Rootzone EC 0.3-0.9 mS/cm or Rootzone Cl 600-900 ppm | Rootzone EC 0.9-1.2 mS/cm, or Rootzone Cl 900-1,500 ppm | Rootzone EC >1.2 mS/cm or Rootzone Cl ≥1,500 ppm |
| Rockiness | <10% coarse surface gravel (>6 cm diameter) and rock outcrop | 10-20% coarse surface gravel and rock outcrop | 20-50% surface cobble (6-20 cm diameter) and rock outcrop | 50-90% surface cobble and rock outcrop, or | >90% surface cobble and rock outcrop, or |

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | | | | 20-50% stone and boulders (>20 cm diameter) | >50% stone and boulders and rock outcrop |
| Microrelief | No melonholes (semi-circular depressions <30 cm deep and usually surrounded by mounds) | Melonholes 30-60 cm deep cover <20% surface area or Melonholes >60 cm deep cover <10% surface area | Melonholes 30-60 cm deep cover 20-50% of surface area or Melonholes >60 cm deep cover 10-20% surface area | Melonholes 60-100 cm deep cover 50% surface area | Melonholes at least 100 cm deep cover 50% surface area |
| Wetness | Undulating terrain or elevated plains | Low-lying level plains with melonholes covering <25% surface area, or Rigid soils with sodic subsoil (ESP 6-14) within 60 cm of the surface, or Non-sodic rigid soils with coarse pale grey and yellow mottles within 75 cm of the surface | Low-lying level plains with melonholes covering 25-50% surface area, or Rigid soils with strongly sodic subsoil (ESP≥15) within 60 cm of the surface, or Non-sodic rigid soils with coarse pale grey and yellow mottles within 50 cm of the surface | Seasonal swamps and lowlying run-on areas | Permanent swamps and lakes |
| Topography | No gully dissection | Occasional deep gullies impede cultivation slightly | Many deep gullies reduce arable area by <33% or require major changes to cultivation practices | Many deep gullies make the arable areas too small to cultivate | Abundant deep gullies prevent any practical cultivation |
| Water erosion | Slopes <0.5% on cracking clays without melonholes, or Slopes <1% on melonhole clays, or Slopes <1% on nonsodic rigid soils, or Slopes <0.5% on sodic rigid soils | Slopes 0.5-1% on cracking clays without melonholes or Slopes 1-3% on melonhole clays, or Slopes 1-2% on non-sodic rigid soils, or Slopes 0.5-1% on sodic rigid soils | Slopes 1-3% on cracking clays without melonholes or Slopes 2-4% on non-sodic rigid soils or Slopes 1-2% on sodic rigid soils | Slopes 3-5% on all cracking clays or Slopes 4-6% on non-sodic rigid soils or Slopes 2-3% on sodic rigid soils | Slopes >5% on all cracking clays or Slopes >6% on nonsodic rigid soils or Slopes >3% on sodic rigid soils |

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Flooding | No flooding | Rare flooding (only during abnormal 1 in 50 to 100 year events) | Infrequent flooding (inundation occurs <half the times that stream flow increases) | Occasional flooding (inundation occurs ≥half the times that stream flow increases) | Regular flooding (inundation occurs whenever stream flow increases) |

**Table E-2: Suitability criteria for beef cattle grazing**

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Water availability | PAWC >125 mm | PAWC 100-125 mm | PAWC 75-100 mm | PAWC 50-75 mm | PAWC ≤50 mm |
| Nutrient deficiency | Brigalow, gidgee, blackwood or softwood scrub soils and former scrub soils with Bicarbonate P >10 ppm | Eucalypt vegetation and downs with Bicarbonate P >10 ppm | Other soils with Bicarbonate P 5-10 ppm except Sands and loams at least 75 cm deep or overlying rock at shallow depth | Sands and loams at least 75 cm deep or overlying rock at shallow depth, with Bicarbonate P 5-10 ppm, or Bicarbonate P ≤4 ppm | |
| Soil physical factors | Cracking clays with very fine self-mulch (peds <2 mm), or Rigid soils with a loose, soft or firm surface when dry | Cracking clays with fine self-mulch (peds 2-10 mm), or Rigid soils with a hard setting surface when dry | Cracking clays with coarse peds (peds ≥10 mm) or crust on the surface | | |
| Salinity | Rootzone EC < 0.15 mS/cm or Rootzone Cl <300 ppm | Rootzone EC 0.15-0.3 mS/cm or Rootzone Cl 300-600 ppm | Rootzone EC 0.3-0.9 mS/cm or Rootzone Cl 600-900 ppm | Rootzone EC 0.9-1.2 mS/cm or Rootzone Cl 900-1500 ppm | Rootzone EC >1.2 mS/cm or Rootzone Cl ≥1500 ppm |
| Rockiness | <20% coarse surface gravel (>6 cm diam.) and rock outcrop | 20-50% coarse surface gravel and rock outcrop | 50-90% surface cobble and rock outcrop | >90% surface cobble and rock outcrop | Rock outcrop and surface coarse fragments cover total area |
| Microrelief | Melonholes cover <20% surface area (semi-circular depressions at | Shallow melonholes (30-60 cm deep) cover 20-50% | Deep melonholes (>60 cm deep) cover 20-50% of | | |

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | least 30 cm deep and usually surrounded by mounds) | surface area | surface area | | |
| pH (1:5) | 5.6-6.6 | 6.6-8.0<br>5.0-5.6 | 8.0-9.0<br>4.5-5.0 | 9.0-10.0<br>4.0-4.5 | >10.0<br>< 4.0 |
| ESP (10 cm)% Exchangable Sodium Percentage | <5.0 | 5-10 | 10-15 | 15-30 | >30 |
| Wetness | Undulating terrain or elevated plains | Low-lying level plains ,<br>or<br>Rigid soils with strongly sodic subsoil (ESP≥15) within 60 cm of the surface,<br>or<br>Non-sodic rigid soils with coarse pale grey and yellow mottles within 50 cm of the surface | Shallow seasonal and permanent swamps | | Permanent lakes and deep swamps |
| Topography | | | | Many deep gullies make cultivation for sowing pastures impractical,<br>or<br>Slopes >15% make cultivation along contours impractical | Strongly dissected terrain over ≥75% of the area preventing adequate herd management |
| Water erosion | Slopes <1% on sodic rigid soils<br>or<br>Slopes <3% on all other soils | Slopes 1-3% on sodic rigid soils<br>or<br>Slopes 3-6% on cracking clays,<br>or<br>Slopes 3-12% on non-sodic rigid soils | Slopes 3-6% on sodic rigid soils<br>or<br>Slopes 6-9% on cracking clays,<br>or<br>Slopes 12-20% on nonsodic rigid soils | Slopes 6-12% on sodic rigid soils<br>or<br>Slopes 9-15% on cracking clays<br>or<br>Slopes 20-45% on non-sodic rigid soils | Slopes >45% |

| Limitation | Land suitability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Flooding | No flooding | Periodic flooding (from once in 50 years to whenever stream flow increases) | | | |
| Vegetation regrowth (management limitation) | Softwood, brigalow, gidgee<br>or<br>blackwood scrub without melonholes ,<br>or<br>Queensland bluegrass grasslands,<br>or<br>Mountain coolabah, bloodwood and ironbark open woodlands | Brigalow, gidgee or blackwood scrub with melonholes,<br>or<br>Box and ironbark woodlands without wattle understorey,<br>or<br>Coolabah woodlands on flooded country | | Eucalypt woodlands with wattle understorey<br>or<br>Broad-leaved teatree woodlands | |

**Table E-3: Suitability assessment for dry land cropping**

| | Cheshire | Kinnoul | Downfall | Teviot | Rolleston | Juandah | Woleebee | Retro |
|---|---|---|---|---|---|---|---|---|
| Water availability | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 |
| Nutrient deficiency | 3 | 3 | 4 | 3 | 4 | 2 | 3 | 2 |
| soil physical factors | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| workability | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| salinity | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 |
| rockiness | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| wetness | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 |
| topography | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Water erosion | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 |
| Flooding | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 |
| Land suitability class | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 |

**Table E-4: Suitability assessment for beef cattle grazing**

| | Cheshire | Kinnoul | Downfall | Teviot | Rolleston | Juandah | Woleebee | Retro |
|---|---|---|---|---|---|---|---|---|
| Water availability | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| Nutrient deficiency | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| soil physical factors | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| salinity | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| rockiness | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| micro relief | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| pH | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| ESP | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

| | Cheshire | Kinnoul | Downfall | Teviot | Rolleston | Juandah | Woleebee | Retro |
|---|---|---|---|---|---|---|---|---|
| wetness | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| topography | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Water erosion | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Flooding | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| vegetation regrowth | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Land suitability class** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** |

# Attachment F

Soil chemical property ratings

# Attachment F – Soil chemical property ratings

## Table F-1: Ratings used for interpretation of soil analyses

| | Ratings | | | | |
|---|---|---|---|---|---|
| **Soil test (units)** | **Very low** | **Low** | **Medium** | **High** | **Very high** |
| Total nitrogen (mg/kg) | <500 | 500 – 1500 | 1500 – 2500 | 2500 – 5000 | >5,000 |
| Total phosphorus (mg/kg) | <50 | 50 – 200 | 200 – 500 | 500 – 1000 | >1,000 |
| Extractable potassium (meq%) | <0.1 | 0.1 – 0.2 | 0.2 – 0.5 | 0.05 – 1.0 | >1.0 |
| $SO_4$ (mg/kg) | — | <4 | 4 – 10 | >10 | — |
| Cl- (mg/kg) | <100 | 100 – 300 | 300 – 600 | 600 – 2,000 | >2,000 |
| Cu (mg/kg) | <0.1 | 0.1 – 0.3 | 0.3 – 5 | 5 – 15 | >15 |
| Mn (mg/kg) | <1 | 1 – 2 | 2 – 50 | 50 – 500 | >500 |
| Zn (mg/kg) pH >7 | <0.3 | 0.3 – 0.8 | 0.8 – 5 | 5 – 15 | >15 |
| Zn (mg/kg) pH <7 | <0.2 | 0.2 – 0.5 | 0.5 – 5 | 5 – 15 | >15 |
| Total organic carbon (%) | <0.5 | 0.5 – 1.6 | 1.5 – 2.5 | 2.5 – 5.0 | >5.0 |

(after Biggs, Coutts and Harris 1999)

Note: For total nitrogen, total phosphorus, extractable potassium and total organic matter, low values represent a nutrient deficiency, and medium to high values are preferential. For other parameters in the above table, high to very high values represent levels at which plant toxicities may occur, and low to medium values are preferential. Very low values may result in deficiencies in some plants

## Table F-2: Ratings used for interpretation of pH

| **Rating** | **pH** |
|---|---|
| Extremely acid | <4.5 |
| Very strongly acid | 4.5-5.0 |
| Strongly acid | 5.1-5.5 |
| Medium acid | 5.6-6.0 |
| Slightly acid | 6.1-6.5 |
| Neutral | 6.6-7.3 |
| Mildly alkaline | 7.4-7.8 |
| Moderately alkaline | 7.9-8.4 |
| Strongly alkaline | 8.5-9.0 |
| Very strongly alkaline | >9.0 |

(after Biggs, Coutts and Harris, 1999)

**Table F-3: Ratings for interpretation of electrical conductivity (EC)**

| Salinity rating | Root zone salinity (EC µS/cm) | | | |
|---|---|---|---|---|
| | 10-20% clay | 20-40% clay | 40-60% clay | 60-80% clay |
| Very low | <50 | <80 | <120 | <180 |
| Low | 100 | 165 | 250 | 370 |
| Medium | 250 | 400 | 580 | 850 |
| High | 450 | 670 | 1,000 | 1,500 |
| Very high | 700 | 1,050 | 1,580 | 2,400 |
| Extreme | >700 | >1050 | >1580 | >2400 |

(after Biggs, Coutts and Harris, 1999)

# Attachment G

Overburden laboratory results

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB0805676** | Page | : 1 of 5 |
| Client | : **PARSONS BRINCKERHOFF AUST P/L** | Laboratory | : Environmental Division Brisbane |
| Contact | : MR JOSEF MAJOR | Contact | : Tim Kilmister |
| Address | : GPO BOX 2907<br>BRISBANE QLD, AUSTRALIA 4000 | Address | : 32 Shand Street Stafford QLD Australia 4053 |
| E-mail | : jmajor@pb.com.au | E-mail | : Services.Brisbane@alsenviro.com |
| Telephone | : +61 38546222 | Telephone | : +61-7-3243 7222 |
| Facsimile | : +61 07 38314223 | Facsimile | : +61-7-3243 7218 |
| Project | : 2133006C | QC Level | : NEPM 1999 Schedule B(3) and ALS QCS3 requirement |
| Order number | : 3247 | | |
| C-O-C number | : 202272-202273 | Date Samples Received | : 01-MAY-2008 |
| Sampler | : XSTRATA | Issue Date | : 20-MAY-2008 |
| Site | : WANDOAN | | |
| | | No. of samples received | : 15 |
| Quote number | : EN/008/08 | No. of samples analysed | : 15 |

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

## *Signatories*

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Inorganics |
| Kim McCabe | Senior Inorganic Chemist | Stafford Minerals |
| Matthew Goodwin | Senior Analyst | Inorganics |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ANC Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong.**
- **EG005T (Total Metals): Poor matrix spike recovery on EB0805676-001 (L6673/352602) due to sample matrix interferences.**

## Analytical Results

Sub-Matrix: **ROCK**

| Compound | CAS Number | LOR | Unit | Client sample ID: L6673/352602<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-001 | L6673/352622<br>30-APR-2008 15:00<br>EB0805676-002 | L6673/352632<br>30-APR-2008 15:00<br>EB0805676-003 | L6673/352607<br>30-APR-2008 15:00<br>EB0805676-004 | L6673/352620<br>30-APR-2008 15:00<br>EB0805676-005 |
|---|---|---|---|---|---|---|---|---|
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **9.2** | **10.0** | **10.4** | **9.7** | **8.0** |
| **EA009: Nett Acid Production Potential** | | | | | | | | |
| **^ Net Acid Production Potential** | ---- | 0.5 | kg H2SO4/t | **-14.6** | **-5.1** | **-12.3** | **-6.0** | **-4.1** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **1080** | **495** | **390** | **1020** | **396** |
| **EA011: Net Acid Generation** | | | | | | | | |
| **pH (OX)** | ---- | 0.1 | pH Unit | **8.3** | **6.8** | **7.6** | **5.5** | **3.7** |
| **NAG (pH 4.5)** | ---- | 0.1 | kg H2SO4/t | <0.1 | <0.1 | <0.1 | <0.1 | **11.7** |
| **NAG (pH 7.0)** | ---- | 0.1 | kg H2SO4/t | <0.1 | **0.2** | <0.1 | **4.5** | **42.0** |
| **EA013: Acid Neutralising Capacity** | | | | | | | | |
| **ANC as H2SO4** | ---- | 0.5 | kg H2SO4 equ | **15.6** | **6.0** | **13.2** | **7.2** | **8.4** |
| **Fizz Rating** | ---- | 0 | Fizz Unit | **0** | **0** | **0** | **0** | **0** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103°C)** | ---- | 1.0 | % | **10.2** | **7.8** | **6.7** | **11.5** | **10.3** |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | **15.6** | **3.2** | **11.2** | **4.5** | **2.8** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | **10.5** | **0.9** | **1.1** | **5.4** | **1.8** |
| **^ Exchangeable Potassium** | ---- | 0.10 | meq/100g | **0.58** | **0.68** | **0.70** | **0.92** | **0.79** |
| **^ Exchangeable Sodium** | ---- | 0.10 | meq/100g | **8.02** | **12.0** | **11.3** | **10.7** | **12.7** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | **34.6** | **16.8** | **24.3** | **21.5** | **18.1** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | **23.2** | **71.2** | **46.6** | **49.9** | **69.9** |
| **ED042T: Total Sulphur by LECO** | | | | | | | | |
| **Sulfur - Total as S (LECO)** | ---- | 0.01 | % | **0.03** | **0.03** | **0.03** | **0.04** | **0.14** |
| **EG005T: Total Metals by ICP-AES** | | | | | | | | |
| **Arsenic** | 7440-38-2 | 5 | mg/kg | <5 | <5 | <5 | <5 | <5 |
| **Cadmium** | 7440-43-9 | 1 | mg/kg | <1 | <1 | <1 | <1 | <1 |
| **Chromium** | 7440-47-3 | 2 | mg/kg | **10** | **5** | **9** | **6** | <2 |
| **Copper** | 7440-50-8 | 5 | mg/kg | **32** | **45** | **42** | **30** | **45** |
| **Lead** | 7439-92-1 | 5 | mg/kg | **18** | **17** | **24** | **19** | **26** |
| **Nickel** | 7440-02-0 | 2 | mg/kg | **12** | **3** | **6** | **7** | **2** |
| **Zinc** | 7440-66-6 | 5 | mg/kg | **81** | **22** | **101** | **124** | **5** |

## Analytical Results

Sub-Matrix: **ROCK**

| Compound | CAS Number | LOR | Unit | Client sample ID: L6673/352628<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-006 | Client sample ID: R9066/255227<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-007 | Client sample ID: R9066/255226<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-008 | Client sample ID: R9066/255224<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-009 | Client sample ID: R9066/255228<br>Client sampling date / time: 30-APR-2008 15:00<br>EB0805676-010 |
|---|---|---|---|---|---|---|---|---|
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **10.0** | **9.7** | **9.7** | **9.9** | **10.0** |
| **EA009: Nett Acid Production Potential** | | | | | | | | |
| **^ Net Acid Production Potential** | ---- | 0.5 | kg H2SO4/t | **-10.4** | **-9.1** | **-7.2** | **-10.4** | **-12.2** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **391** | **720** | **608** | **763** | **574** |
| **EA011: Net Acid Generation** | | | | | | | | |
| **pH (OX)** | ---- | 0.1 | pH Unit | **5.2** | **3.8** | **4.3** | **8.3** | **6.0** |
| **NAG (pH 4.5)** | ---- | 0.1 | kg H2SO4/t | <0.1 | **10.4** | **2.0** | <0.1 | <0.1 |
| **NAG (pH 7.0)** | ---- | 0.1 | kg H2SO4/t | **6.5** | **50.4** | **62.2** | <0.1 | **1.5** |
| **EA013: Acid Neutralising Capacity** | | | | | | | | |
| **ANC as H2SO4** | ---- | 0.5 | kg H2SO4 equ | **11.6** | **11.9** | **9.1** | **10.7** | **13.5** |
| **Fizz Rating** | ---- | 0 | Fizz Unit | **0** | **0** | **0** | **0** | **0** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103°C)** | ---- | 1.0 | % | **9.9** | **8.9** | **8.2** | **6.8** | **6.5** |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | **4.2** | **11.4** | **6.7** | **15.5** | **4.6** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | **1.6** | **1.4** | **2.2** | **8.9** | **1.0** |
| **^ Exchangeable Potassium** | ---- | 0.10 | meq/100g | **0.99** | **0.46** | **0.73** | **0.50** | **0.66** |
| **^ Exchangeable Sodium** | ---- | 0.10 | meq/100g | **15.0** | **8.82** | **13.1** | **9.81** | **10.8** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | **21.7** | **22.0** | **22.8** | **34.6** | **17.0** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | **69.0** | **40.0** | **57.6** | **28.3** | **63.7** |
| **ED042T: Total Sulphur by LECO** | | | | | | | | |
| **Sulfur - Total as S (LECO)** | ---- | 0.01 | % | **0.04** | **0.09** | **0.06** | **0.01** | **0.04** |
| **EG005T: Total Metals by ICP-AES** | | | | | | | | |
| **Arsenic** | 7440-38-2 | 5 | mg/kg | <5 | <5 | <5 | <5 | <5 |
| **Cadmium** | 7440-43-9 | 1 | mg/kg | <1 | <1 | <1 | <1 | <1 |
| **Chromium** | 7440-47-3 | 2 | mg/kg | **6** | **4** | **5** | **7** | **8** |
| **Copper** | 7440-50-8 | 5 | mg/kg | **28** | **32** | **28** | **12** | **30** |
| **Lead** | 7439-92-1 | 5 | mg/kg | **13** | **15** | **19** | **8** | **18** |
| **Nickel** | 7440-02-0 | 2 | mg/kg | **4** | **9** | **3** | **9** | **8** |
| **Zinc** | 7440-66-6 | 5 | mg/kg | **17** | **93** | **58** | **65** | **100** |

## Analytical Results

Sub-Matrix: **ROCK**

| Compound | CAS Number | LOR | Unit | Client sample ID: R9066/255232 | R9066/255233 | C7073/364999 | C7073/365000 | C6773/352124 |
|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time: 30-APR-2008 15:00 | 30-APR-2008 15:00 | 30-APR-2008 15:00 | 30-APR-2008 15:00 | 30-APR-2008 15:00 |
| | | | | EB0805676-011 | EB0805676-012 | EB0805676-013 | EB0805676-014 | EB0805676-015 |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **10.3** | **10.4** | **10.3** | **10.4** | **10.4** |
| **EA009: Nett Acid Production Potential** | | | | | | | | |
| **^ Net Acid Production Potential** | ---- | 0.5 | kg H2SO4/t | **-18.3** | **-11.0** | **-48.8** | **-9.5** | **-6.0** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **673** | **443** | **531** | **361** | **280** |
| **EA011: Net Acid Generation** | | | | | | | | |
| **pH (OX)** | ---- | 0.1 | pH Unit | **8.5** | **8.4** | **8.1** | **6.8** | **6.2** |
| **NAG (pH 4.5)** | ---- | 0.1 | kg H2SO4/t | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **NAG (pH 7.0)** | ---- | 0.1 | kg H2SO4/t | <0.1 | <0.1 | <0.1 | **0.6** | **2.0** |
| **EA013: Acid Neutralising Capacity** | | | | | | | | |
| **ANC as H2SO4** | ---- | 0.5 | kg H2SO4 equ | **19.6** | **12.5** | **50.0** | **10.4** | **7.0** |
| **Fizz Rating** | ---- | 0 | Fizz Unit | **2** | **0** | **2** | **0** | **0** |
| **EA055: Moisture Content** | | | | | | | | |
| **^ Moisture Content (dried @ 103°C)** | ---- | 1.0 | % | **7.8** | **8.7** | **10.2** | **6.9** | **5.8** |
| **ED007: Exchangeable Cations** | | | | | | | | |
| **^ Exchangeable Calcium** | ---- | 0.1 | meq/100g | **15.9** | **9.2** | **22.3** | **5.0** | **3.5** |
| **^ Exchangeable Magnesium** | ---- | 0.1 | meq/100g | **0.9** | **0.9** | **3.4** | **1.0** | **0.8** |
| **^ Exchangeable Potassium** | ---- | 0.10 | meq/100g | **0.76** | **0.92** | **0.57** | **0.85** | **0.97** |
| **^ Exchangeable Sodium** | ---- | 0.10 | meq/100g | **17.1** | **24.0** | **16.1** | **15.6** | **10.5** |
| **^ Cation Exchange Capacity** | ---- | 0.1 | meq/100g | **34.6** | **35.0** | **42.4** | **22.5** | **15.7** |
| **^ Exchangeable Sodium Percent** | ---- | 0.1 | % | **49.4** | **68.7** | **38.1** | **69.4** | **66.9** |
| **ED042T: Total Sulphur by LECO** | | | | | | | | |
| **Sulfur - Total as S (LECO)** | ---- | 0.01 | % | **0.04** | **0.05** | **0.04** | **0.03** | **0.03** |
| **EG005T: Total Metals by ICP-AES** | | | | | | | | |
| **Arsenic** | 7440-38-2 | 5 | mg/kg | <5 | <5 | **6** | <5 | <5 |
| **Cadmium** | 7440-43-9 | 1 | mg/kg | <1 | <1 | <1 | <1 | <1 |
| **Chromium** | 7440-47-3 | 2 | mg/kg | **8** | **6** | **5** | **8** | **9** |
| **Copper** | 7440-50-8 | 5 | mg/kg | **34** | **32** | **45** | **31** | **35** |
| **Lead** | 7439-92-1 | 5 | mg/kg | **14** | **11** | **11** | **12** | **18** |
| **Nickel** | 7440-02-0 | 2 | mg/kg | **10** | **8** | **6** | **12** | **8** |
| **Zinc** | 7440-66-6 | 5 | mg/kg | **83** | **68** | **68** | **113** | **133** |

# Attachment H

Overburden logs from previous assessments

Appendix 4(a) Analytical data for overburden samples

Laboratory Data

| Location | Austinvale R 330 | | | |
|---|---|---|---|---|
| Depth (m) | 3-5 Highly weathered siltstone | 5-10 Weathered siltstone | 15-20 Slightly weathered siltstone | 20-29 Fresh siltstone |
| Description | | | | |
| pH | 6.1 | 9.0 | 9.5 | 9.6 |
| Electrical conductivity mS $cm^{-1}$ | 0.66 | 0.58 | 0.59 | 0.47 |
| Chloride % | 0.099 | 0.064 | 0.060 | 0.044 |
| Particle size distribution %: | | | | |
| Coarse sand | 2 | 10 | 12 | 13 |
| Fine sand | 17 | 22 | 34 | 29 |
| Silt | 24 | 34 | 20 | 25 |
| Clay | 56 | 38 | 35 | 36 |
| Cation exchange capacity meq $100g^{-1}$ | 34.8 | 26.1 | 26.2 | 25.4 |
| Moisture percentage: | | | | |
| Air dry | 6.2 | 5.6 | 4.1 | 3.5 |
| 0.1 bar | 31.8 | 31.5 | 28.2 | 25.8 |
| 15 bar | 21.0 | 19.3 | 17.4 | 16.8 |
| Organic carbon % | 0.29 | 0.42 | 0.38 | 1.07 |
| Nitrate nitrogen mg $kg^{-1}$ | 4.8 | 5.0 | 1.1 | 0.4 |
| Extractable phosphorus mg $kg^{-1}$: | | | | |
| BSES | 30 | 320 | 350 | 400 |
| Bicarbonate | 3 | 1 | 2 | 2 |
| Sulphate sulphur mg $kg^{-1}$ | 49.0 | 87.5 | 45.0 | 60.0 |
| DTPA Extractable micronutrients: | | | | |
| Iron mg $kg^{-1}$ | 41 | 9 | 16 | 24 |
| Manganese mg $kg^{-1}$ | 2 | 2 | 4 | 3 |
| Copper mg $kg^{-1}$ | 2.8 | 2.3 | 2.0 | 1.2 |
| Zinc mg $kg^{-1}$ | 1.9 | 1.4 | 1.5 | 5.7 |

Laboratory Data (cont.)

| Depth (m) | 3-5 Highly weathered siltstone | 5-10 Weathered siltstone | 15-20 Slightly weathered siltstone | 20-29 Fresh silts |
|---|---|---|---|---|
| Cations: | | | | |
| Calcium meq. $100g^{-1}$ | 8.2 | 10.6 | 12.6 | 18.9 |
| Magnesium meq. $100g^{-1}$ | 6.8 | 10.0 | 8.6 | 4.6 |
| Sodium meq. $100g^{-1}$ | 10.1 | 9.6 | 6.8 | 7.1 |
| Potassium meq. $100g^{-1}$ | 0.36 | 0.36 | 0.32 | 0.36 |
| Mineralogy: | | | | |
| Major | K | KQ | KQ | K |
| Minor | IMVC | I | I | QI |
| Trace | | VM | M | M |

Laboratory Data

| Location | Austinvale C 149 | Frank Creek R 307 | Mud Creek F 1592 | Austinvale C 355(costein |
|---|---|---|---|---|
| Depth(m) | 8-9 | 20-21 | 58-59 | 3-5 |
| Description | Weathered sandstone | Fresh sandstone | Fresh sandstone | Weathered siltstone |
| pH | 6.2 | 10.0 | 10.1 | 9.3 |
| Electrical conductivity mS $cm^{-1}$ | 0.65 | 0.49 | 0.61 | 0.32 |
| Chloride % | 0.096 | 0.020 | 0.005 | 0.038 |
| Particle size distribution %: | | | | |
| Coarse sand | 20 | 22 | 20 | |
| Fine sand | 49 | 32 | 41 | |
| Silt | 5 | 22 | 5 | |
| Clay | 27 | 25 | 32 | |
| Cation exchange capacity meq.$100g^{-1}$ | 24.3 | 24.8 | 28.5 | |
| Moisture percentage: | | | | |
| Air dry | 7.1 | 6.2 | 6.8 | |
| 1/3 bar | 26.4 | 45.6 | 44.8 | |
| 15 bar | 16 | 37 | 38 | |
| Organic carbon % | 0.18 | 0.45 | 0.24 | 0.12 |
| Nitrate nitrogen mg $kg^{-1}$ | 0.4 | 0.4 | 0.2 | 0.8 |
| Extractable phosphorus mg $kg^{-1}$: | | | | |
| BSES | 560 | 580 | 620 | 380 |
| Bicarbonate | 31 | 3 | 3 | 2 |
| Sulphate sulphur mg $kg^{-1}$ | 2.5 | 60.0 | 4.5 | 4.0 |
| DTPA Extractable micronutrients: | | | | |
| Iron mg $kg^{-1}$ | 12 | 12 | 13 | 24 |
| Manganese mg $kg^{-1}$ | 6 | 3 | 2 | 3 |
| Copper mg $kg^{-1}$ | 0.7 | 2.0 | 0.5 | 1.2 |
| Zinc mg $kg^{-1}$ | 2.3 | 3.3 | 2.7 | 5.7 |

Laboratory Data (cont.)

| Depth(m) | Austinvale C 149 8-9 | Frank Creek R 307 20-21 | Mud Creek F 1592 58-59 | Austinvale C 355(cost in 3-5 |
|---|---|---|---|---|
| Description | Weathered sandstone | Fresh sandstone | Fresh sandstone | Weathered siltsonte |
| Cations: | | | | |
| Calcium meq. $100g^{-1}$ | 19.8 | 29.9 | 22.6 | 7.8 |
| Magnesium meq. $100g^{-1}$ | 6.3 | 2.5 | 2.3 | 7.4 |
| Sodium meq. $100g^{-1}$ | 11.1 | 17.4 | 24.6 | 6.1 |
| Potassium meq. $100g^{-1}$ | 0.26 | 0.46 | 0.46 | 0.26 |
| Mineralogy: | | | | |
| Major | K | K | K | |
| Minor | M | Q | | |
| Trace | I | | M | |

Appendix 4(b) Electrical conductivity and pH values for overburden samples.

| Location | Depth (m) | Lithology | pH(1:5 substrate/ water) | E.C. (1:5) mS $cm^{-1}$ |
|---|---|---|---|---|
| Frank Creek R 307 | 0-1 | Soil | 8.41 | 0.48 |
| | 1-2 | Sandstone - highly weathered | 8.73 | 0.56 |
| | 2-3 | " | 8.66 | 0.65 |
| | 3-4 | " | 9.58 | 0.68 |
| | 4-5 | " | 9.66 | 0.41 |
| | 5-6 | " | 9.65 | 0.40 |
| | 6-7 | " | 9.63 | 0.39 |
| | 7-8 | " | 9.65 | 0.40 |
| | 8-9 | Sandstone - weathered | 9.55 | 0.46 |
| | 9-10 | " | 9.60 | 0.45 |
| | 10-11 | Siltstone - weathered | 8.95 | 1.15 |
| | 11-12 | " | 9.01 | 0.97 |
| | 12-13 | " | 8.81 | 0.93 |
| | 13-14 | Sandstone - weathered | 9.12 | 0.74 |
| | 14-15 | " | 9.31 | 0.76 |
| | 15-16 | " | 9.48 | 0.78 |
| | 16-17 | " | 9.37 | 0.79 |
| | 17-18 | Sandstone - fresh | 9.70 | 0.74 |
| | 18-19 | " | 9.73 | 0.74 |
| | 19-20 | " | 9.77 | 0.74 |
| | 20-21 | " | 9.94 | 0.73 |
| | 22-22 | " | 9.81 | 0.74 |
| | 22-23 | " | 9.91 | 0.74 |
| | 23-24 | " | 9.90 | 0.74 |
| | 24-25 | " | 9.89 | 0.74 |
| | 25-26 | " | 9.86 | 0.74 |
| | 26-27 | " | 9.94 | 0.73 |

| Location | Depth (m) | Lithology | pH(1:5 substrate/water) | E.C. (1:5 mS $cm^{-1}$ |
|---|---|---|---|---|
| | 27-28 | Sandstone - fresh | 9.93 | 0.73 |
| Anchor Bar R 303 | 0-1 | Soil | 9.05 | 0.55 |
| | 1-2 | Sandstone - weathered | 9.03 | 0.52 |
| | 2-3 | " | 9.28 | 0.49 |
| | 3-4 | " | 9.26 | 0.51 |
| | 4-5 | " | 9.15 | 0.51 |
| | 5-6 | " | 9.11 | 0.52 |
| | 6-7 | " | 9.11 | 0.51 |
| | 7-8 | " | 8.96 | 0.53 |
| | 8-9 | Mudstone | 9.09 | 0.57 |
| | 9-10 | Claystone | 8.89 | 0.63 |
| | 10-11 | Mudstone | 9.12 | 0.57 |
| | 11-12 | Mudstone | 9.18 | 0.55 |
| | 12-13 | Mudstone | 9.10 | 0.58 |
| | 13-14 | Sandstone | 9.18 | 0.58 |
| | 14-15 | Claystone | 8.85 | 0.61 |
| | 15-16 | Sandstone - fresh | 9.22 | 0.76 |
| | 16-17 | Siltstone | 6.25 | 1.36 |
| | 17-18 | Coal & shale | 6.21 | 1.37 |
| Mud Creek F 1592 | 14.2 | Sandstone | 9.63 | 0.788 |
| | 19.3 | Siltstone | 9.08 | 0.862 |
| | 28 | Siltstone | 8.39 | 0.913 |
| | 31.3 | Siltstone | 9.70 | 0.727 |
| | 49 | Sandstone | 9.76 | 0.607 |
| | 53.2 | Siltstone | 9.37 | 0.578 |
| | 58.2 | Sandstone | 10.05 | 0.737 |
| | 62.4 | " | 9.82 | 0.794 |
| | 73 | " | 9.91 | 0.667 |
| | 76.9 | " | 9.80 | 0.796 |

## IM COAL DIVISION. WANDOAN COAL PROJECT. CLAYSTONE SEAM SLAKE TESTING. RESULTS AND COMMENTS.

### DRILL HOLE C 5004 (11/03/92)

| Depth | Lithology | Location w.r.t. Coal Seam | Estimated Slake Grade | Remarks | Sample Number |
|---|---|---|---|---|---|
| 15.15 | Lt-Cs Dk Brown | Top of A1 | 1 | No Reaction | 644772 |
| 15.88 and 15.92 | Speckled Cm-Bu-Br ?Tuffaceous? | Within top of A1 | 4.5 | Discrete lumps don't break down. Moderate gel aprons to small powder piles: mild colloidal cloud | 644773 |
| 16.12 | Wh spckd Br Cs | Ditto | 2 | No lump reaction.Slt swell to powder | 644775 |
| 16.81 | Ditto | Middle A1 | 2 | Ditto | 644774 |
| 18.37 | Ditto | Parting-A1/A2 | 2 | Ditto | 644776 |
| 18.92 | 1cm dk gy Cs | Top of A2 | 5 | Some lumps crack - no further reaction Other lumps go to shapeless pile with slt gel apron.No colloidal cloud | Nil Sa |
| 22.03 | 17cm dk gy Cs ptg | Bot of A3 | 5 | Brkdn to shapeless low profile gel rich pile with remnant sharp lumps: slt colloidal cloud | Nil Sa |
| 22.9 | Med gy unif Cs | Top of 24cm Co Sm under A4 | 4.5 | Moderate physical brkdn to lumps:mild gel apron to powder spots.Clear water | Nil Sa |
| 23.23 | Ditto | Under latter sm by 3cm | 4.5 | Ditto | 644783 |
| | | RECORED LENGTH | | | |
| 22.68 | Off white-lt gy clayey siist | 2cm under coal sm | 5 | 2-4mm lumps brk up but stay in-situ with sub rounded edges.Powder gives extensive thin colloidal gel.Water quite cloudy. | 644784 |
| 23.02 | Med dk gy uniform Cs | 1 to 2cm above small coal seam | 6 | Lumps brk down to low profile coll gel and remnant particle piles.Widespread thin gel apron:sltly cloudy water. | 644785 |
| 23.37 | Med gy uniform silty Cs | 3 cm below small coal seam. | 5.5 | Thin gel apron to flattish rounded break down piles some remnant lumps mid pile: mildly cloudy water. | 644786 |
| 24.05 | Ditto | 4 cm above coal sm | 5 | Lump brk up to rndd facsimile shapes: Thin gel apron to powder:slt coll eld | 644787 |
| 24.31 | Ditto | 2 cm below coal sm | 5 | Ditto | 644788 |
| 24.38 | Pale cm-buff Cs | 5 cm above thick coal seam | 3 | Initial split apart to lumps w sub-rndd edges: thin colldl gel to pdr spots: slt colldl cloud | 644789 |
| 25.1 | Unif dk gy Cs | Between coal seams | 6 | Lumps mostly broken to shapeless piles Thicker gel apron:Cloudy water. | 644790 |
| 25.48 | Ditto | Interbdd w small coal seams | 5.5 | Ditto but less cloudy water. | 644791 |
| 25.72 | Ditto | Ditto | 5.5 | Shapeless piles w remnant lump frags: Thin gel apron from pdr w remnant non clay grains:mildly cloudy water. | 644792 |
| 25.94 | Bu cm br. wh specked crumbly claystone | Ditto | 5 | Brkdn to remnant rndd lump piles.Thin gel aprons from pwdr:slt colloidal cloud | 644793 |
| 26.14 | Dk br-black carbonaceous wh spckd Cs | Interbedded in thicker coal sm | 2 | No lump brkdn:slt swell to powder: no colloidal cloud. | Nil Sa |
| 26.31 | Ditto | 2cm below 30cm coal seam. | 4 | No lump brkdn. slt colloidal gel? Slightly cloudy water. | Nil Sa |

DRILL HOLE C 5001(13/03/92)

| | | | | | |
|---|---|---|---|---|---|
| 19.62 | Dk gy Cs w carbcs lam laminations | 2cm above bl carb claystone | 2 | No reaction except slt powder swell | Nil Sa |
| 19.76 | Black uniform claystone | 14 cm above A1 | 1 | No reaction. | 644809 |
| 20.06 | Wh clay spckd buff clyst | 10cm Clayst bed overlying A1 | 3 | Brkdown and split apart to lumpsorigl shape holds slt swell to powder. | 644810 |
| 20.25 | Med- dk gy-br wh speckd carb Cs | Cs bed in top of A1 A1 | 1 | No reaction | 644811 |
| 20.86 | Ditto but drkr br | Cs bnd in top 1/3rd A1 → | 1 | Ditto | 644812 |
| 22.44 | VF wh cl specked pale buff-br finely carbncs fragmented Cs | Cs band in A1 base As | 3 | As for 20.06m. above. | Nil |
| 22.58 | Hd lt br-gy carb bndd wh spckd cs | Cs ptg bnd betwn A1 and A2 sms | 2 | As 19.62m but mild brk up to lumps. | Nil |
| 23.12 | Dk bl-br-gy carb claystone | Cs beds in mid A2 High carb lam nos | 2 | Little or no lump brkdn:slt pdr swell | 644813 |
| 23.21 | Ditto | Ditto | 2 | Ditto | 644815 |
| 23.41 | Pale br-gy wh spckd v hd cs w vf carbncs wisps | Cs bnd in bot 1/3rd A A2 | 2 | Modest thin gel cloud to powder Smaller lumps brkdn: no coll cld | 644817 |
| 23.72 | Ditto but browner | Thin Cs ptg band betwn A2 and A3. | 2 | Ditto | 644818 |
| 25.66 | Uniformn dk gy-br carbncs Cs | 10cm ptg betwn A3 and A4. | 2 | Only slt swell to powder. | 644819 |
| 26.28 | Med gy Cs | Cs 8cm below A4. | 1 | No reaction | 644820 |
| 26.55 | Pale gy silty Cs | Sst/Cs bed top 4cm under coaly Cs I/B below A4. | 4.5 | Rounding to lumpsmodest thin gel apron: mildly cloudy water. | 644821 |
| 26.96 | Med gy Cs | Cs 5cm above Co band in IR Cs/Co ptg betwn A4 & B1 | 4.5 | Ditto | 644822 |
| 27.19 | Br gy Ca-Cs | Cs bed in Cs/Co I/B in A4-B1 ptg | 2.5 | Powder swells: no lump brkdn | 644823 |
| 27.23 | Ditto | Ditto | 2 | Powder swells silty: no lump brkdown. | 644823 |
| 27.37 | Wh specked crn buff Cs | Cs band 6cm above B1. | 3 | Minor gel cloud: lumps split apart but stay sharpno cldl cloud. | 644824 |
| 28.21 | Med gy uniformn Cs | Cs band in bot 1/3 of B1. | 3 | Ditto | 644825 |
| 29.03 | Cs-tuffaceous? Med br. soapy | Top 1/3 of B2. | 5.5 | Brkdn to shapeless pile w remnant sharp lump fragsgel apron:moderately cloudy. | 644826 |
| 30.73 | Med-dk br gy unif -ormn claystone. | B2-B3 Cs ptg | 3 | No lump brkdn:minor gel cloudslt swell to powder. | 644827 |
| 31.6 | Uniformn med gy claystone. | Silty Cs ptg in bot 1/3 B3 | 6.5 | V cloudy colloidal cloud:widespread gel apron:shapeless pile. | 644828 |
| 31.83 | Ditto | Cs 2cm below B3 | 6.5 | Ditto | 644829 |
| 33.18 | Ditto | Silty Cs bnd just above C1 sm. | 5 | Brkdn to shapeless piles w remnant sharp fragsgel apron: mildly cloudy | 644830 |
| 33.63 | Ditto | 6cm under C1. | 5.5 | Shapeless rounded pilesgel apron. | 644831 |
| 37.32 | Ditto | 3/4cm above C2. | 5.5 | Ditto | 644832 |
| 37.81 | Ditto | Cs bnd in bot 1/3 C2. | 5 | Ditto but less lump breakdown. | 644833 |
| 39.53 | Br Cs | Top 1/4 C3 | 3 | Mild lump breakdown: no gel. | 644834 |
| 39.77 | Pale br Cs | Top 1/3rd C3. | 4.5 | Lump brkdown: slight cloud: modest gel. | 644835 |
| 40.32 | Pale br Cs band Ditt | In bot 1/3rd C3. | 5 | No larger lump brkdn: smaller lumps brkdn to shapeless pilesModerate gel apron: slt to mod cloudiness. | 644836 |

DRILL HOLE C 5016(24/03/92)

| | | | | | |
|---|---|---|---|---|---|
| 12.32 | Vfg ss mud weath. | | 5 | Remnant lumps in sand pilesmod gel: slight colloidal cloud to water. | 644501 |
| 14.78 | Uniform gy Cs | | 4.5 | Lumps crack apart:moderate gel layer. slight colloidal cloud. | 644502 |
| 13.79 | White soapy Cs | | 4 | Rapid brkdown to shapeless piles with remnant lumps:Slight gel apron, no cloud | 644503 |
| 16.38 | Medl gy Cs | 4cm above A1 sm. | 5 | Larger lumps remain intact;v small frags have gel apron;powder has gel apron:No colloidal cloud to water. | |
| 16.7 | Ditto | Parting~Co sms | 4.5 | Ditto but less reactive | 644505 |
| 17.27 | Br-gy carb Cs | Between Coal sms | 2 | V slight swell to powder:unreactive | 644506 |
| 17.58 | Brownish gy Cs | 3 cm below Co sm | 4.5 | Small lumps do not break down;powder swells and some goes to gel. | 644507 |
| 18.12 | Cm-or wxy tuffaceous-eous lithology. | 5cm above thick coal seam. | 6 | V rapid brkdn to shapeless pile w remnant lumps;mid colloidal cloud | 644508 |
| 18.5 | V finely wn spckd Cs w tuffs lk. | 1.5cm bnd | 4.5 | V little frag brkdn;slt gel apron to small frags and powder. | 644509 |
| 19.02 | Pale to med gy 5 cm CS bnd | Lies in thick coal seam. | 5 | Little frag brkd;Powder goes to gel Slight colloidal cloud in water. | 644510 |
| 20.14 | Brownish gy Cs band 1 | 3cm under A sm. | 5.5 | Slow fragment brkdn, powder slowly to gel;Slt colloidal cloud to water | 644511 |
| 21 | Brn carbonaceous and br-gy Cs | | 4.5 | Minor frag brkdn;powder spots go to swell puffs rather than gel;slt cloud | 644512 |
| 21.26 to 21.28 | Gy & br-gy Cs | 5cm under thick coal seam. | 6 | Rounding to frags/lumps then these break down to granular shapeless piles with gel apron and cloudy water. | 644513 |
| 22.5 | Pale gy unif Cs cracked wet surf suggests swelling clays. | | 5.5 | Rapid brkdn of half the frags to shape-less rndd piles of flaky curved grains. Moderate gel apron;slt colloidal cloud. | 644514 |
| 29.55 & 29.62 | Top- gy Cs, bot-br carb Cs | 11cm and 4cm above Co sm | 5.5 | Gy Cs—to shapeless pile w remnant frags;medium gel apron;slt colloidal Br Cs—no reaction. | 644515 |
| 29.87 | Med gy Cs | In ptg 3cm above next coal seam. | 5.5 | As 29.55m above. | 644516 |
| 30.54 | Pale gy silty Cs. | 4cm below Co sm. | 5.5 | Rapid brkdn to flat swollen pile;gel | 644517 |
| 31.43 | Pale gy hd britt-le (CC?) Cs. | 3cm above Co sm | 6 | As 30.54m above, but even more rapid brkdn to flat pile and wider, rapid spread gel apron.Mild colldl cld. All in less than 3 mins. | 644518 |
| 31.93 | Cs. | 4.5cm band in top end of Co sm. | Test aborted | | 644519 |
| 32.06 | Finely wn sptd med br wxy Cs Tuffaceous? | In top 1/2 of Coal sm. | 6 | Rapid brkdn of smaller frags to shape-less piles w remnant core frags in many cases.Lge frags w surface swelli-ng puffs and rounding edges;spume of fgag to shapeless pile in 5 mins. Colloidally cloudy water. | 644520 |
| 32.7 | Thin hd br-gy-bl Cs band. | Bottom zone of C2 sm. | 5 | No fragment brkdn but swelling and gel apron to gy powdered matl;no reaction with darker material. | 644521 |
| 33.09 | Vfg clyy ss | 3cm under C2 sm. | 6 | Rapid brkdn to swollen piles, powder swelling w gel aprons to powder spots; slt colldl cloud. | 644522 |
| 35.18 (crrctd) | Hd (calcareous?) mud, tiny slow bubbles w HCl) brittle Cs. | 4 cm above C3. | 6 | As for 33.09m but bigger gel aprons— v slt colldl cloud. | 644523 |
| 35.39 (crrctd) | Tuffcs lkg pale br-gy Cs. | 15cm under C3 top | 5.5 | Rapid collapse to flattish rndd pile w remnant small swollen frags;Small gel layer spread;no colloidal cloud. | 644524 |
| 35.87 | Cm-br col tuff. | C3 tuff. | 6 | Rapid initial break up but more remnant frags than usual gy Cs;flat gellified exterior rim exterior rim to brkdn piles w modest gel apron;Mild coll cld. | 644525 |
| 36.25 | Dark brown clst. | 2cm under C3 bot | 5 | Brkdn to smth flat pile of powder and crushed rock;Small gel-swell to sepa-rate powder spots.No colldl cloud. | 644526 |
| 36.32 | Gy sdy soapy Cs | 10 cm under C3 base. | 6 | Rapid brkdn.Main pile in gel swell colloidal cloud. | 644527 |

CSR Coal Laboratory
149 Kerry Road,
ARCHERFIELD

Report No. 182
Subject : Environmental Test Samples
Reference : RFA 2906, M. Evans.

| Lab. No. | Field No. | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|
| 6169 | R4004 1 | 0 | 5.75 | 9.9 | 0.780 |
| 6170 | 2 | 0 | 4.54 | 5.9 | 0.527 |
| 6171 | 3 | 0 | 4.00 | 5.6 | 0.502 |
| 6172 | 4 | 0 | 4.13 | 5.5 | 0.528 |
| 6173 | 5 | 0 | 3.45 | 5.9 | 0.543 |
| 6174 | 6 | 0 | 3.07 | 7.3 | 0.419 |
| 6175 | 7 | 0 | 2.83 | 9.4 | 0.541 |
| 6176 | 8 | 0 | 2.83 | 9.4 | 0.568 |
| 6177 | 9 | 0 | 2.33 | 9.7 | 0.493 |
| 6178 | 10 | 0 | 2.84 | 9.3 | 0.555 |
| 6179 | 11 | 0 | 3.03 | 8.4 | 0.598 |
| 6180 | 12 | 1 | 2.15 | 9.7 | 0.558 |
| 6181 | 13 | 1 | 2.24 | 9.6 | 0.587 |
| 6182 | 14 | 2 | 2.38 | 9.6 | 0.558 |
| 6183 | 15 | 1 | 2.44 | 9.5 | 0.542 |
| 6184 | 16 | 1 | 2.18 | 9.8 | 0.574 |
| 6185 | 17 | 3 | 2.09 | 9.7 | 0.548 |
| 6186 | 18 | 2 | 2.33 | 9.6 | 0.560 |
| 6187 | 19 | 2 | 2.45 | 9.5 | 0.541 |
| 6188 | 20 | 2 | 2.85 | 9.2 | 0.505 |
| 6197 | 29 | 0 | 3.27 | 10.1 | 0.606 |
| 6198 | 30 | 1 | 6.06 | 8.7 | 0.434 |
| 6199 | 31 | 0 | 3.66 | 9.9 | 0.658 |
| 6200 | 32 | 0 | 2.61 | 9.8 | 0.449 |
| 6201 | 33 | 0 | 3.68 | 10.2 | 0.709 |
| 6202 | 34 | 0 | 3.07 | 10.1 | 0.625 |
| 6203 | 35 | 1 | 3.42 | 10.2 | 0.645 |
| 6204 | 36 | 0 | 6.30 | 9.2 | 0.578 |
| 6205 | 37 | 0 | 5.83 | 9.5 | 0.693 |
| 6206 | 38 | 0 | 3.98 | 9.7 | 0.518 |
| 6207 | 39 | 0 | 3.00 | 10.2 | 0.693 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6208 | R4004 | 40 | 0 | 3.50 | 10.1 | 0.698 |
| 6209 | | 41 | 0 | 4.21 | 10.2 | 0.700 |
| 6210 | | 42 | 1 | 3.35 | 10.3 | 0.729 |
| 6211 | | 43 | 0 | 2.98 | 10.2 | 0.658 |
| 6212 | R4007 | 1 | 0 | 4.34 | 7.2 | 0.902 |
| 6213 | | 2 | 0 | 4.44 | 5.3 | 0.637 |
| 6214 | | 3 | 0 | 3.59 | 5.1 | 0.564 |
| 6215 | | 4 | 0 | 2.55 | 5.9 | 0.474 |
| 6216 | | 5 | 0 | 2.32 | 6.9 | 0.425 |
| 6217 | | 6 | 0 | 2.70 | 7.3 | 0.480 |
| 6218 | | 7 | 0 | 2.37 | 9.9 | 0.480 |
| 6219 | | 8 | 0 | 2.56 | 9.7 | 0.511 |
| 6220 | | 9 | 0 | 2.20 | 9.6 | 0.488 |
| 6221 | | 10 | 0 | 1.84 | 10.1 | 0.451 |
| 6222 | | 11 | 0 | 2.10 | 10.0 | 0.543 |
| 6223 | | 12 | 0 | 2.26 | 10.2 | 0.545 |
| 6224 | | 13 | 0 | 2.53 | 10.1 | 0.555 |
| 6225 | | 14 | 0 | 3.47 | 9.9 | 0.623 |
| 6227 | | 16 | 0 | 3.98 | 9.8 | 0.619 |
| 6228 | | 17 | 1 | 3.68 | 10.0 | 0.673 |
| 6231 | | 20 | 1 | 4.09 | 9.5 | 0.478 |
| 6232 | | 21 | 0 | 3.38 | 9.8 | 0.466 |
| 6233 | | 22 | 2 | 2.85 | 10.1 | 0.517 |
| 6234 | | 23 | 0 | 2.80 | 10.1 | 0.541 |
| 6235 | | 24 | 2 | 2.74 | 10.0 | 0.489 |
| 6236 | R4009 | 1 | 0 | 8.00 | 8.5 | 0.900 |
| 6237 | | 2 | 0 | 3.50 | 7.1 | 0.628 |
| 6238 | | 3 | 0 | 6.38 | 8.4 | 0.582 |
| 6239 | | 4 | 0 | 7.24 | 9.3 | 0.597 |
| 6240 | | 5 | 0 | 7.54 | 9.5 | 0.622 |
| 6241 | | 6 | 0 | 6.92 | 9.6 | 0.627 |
| 6242 | | 7/8 | 0 | 7.20 | 9.6 | 0.660 |
| 6244 | | 9 | 0 | 7.43 | 9.6 | 0.696 |
| 6245 | | 10 | 0 | 7.34 | 9.4 | 0.708 |
| 6246 | | 11 | 0 | 7.34 | 9.4 | 0.724 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6247 | R4009 | 12 | 0 | 6.61 | 9.7 | 0.674 |
| 6248 | | 13 | 0 | 6.27 | 9.7 | 0.648 |
| 6249 | | 14 | 0 | 6.47 | 9.6 | 0.662 |
| 6250 | | 15 | 0 | 6.38 | 9.6 | 0.673 |
| 6251 | R4010 | 1 | 0 | 5.04 | 6.4 | 0.560 |
| 6252 | | 2 | 0 | 4.64 | 5.5 | 0.658 |
| 6253 | | 3 | 0 | 4.19 | 5.7 | 0.579 |
| 6254 | | 4 | 0 | 2.94 | 6.0 | 0.462 |
| 6255 | | 5 | 0 | 3.22 | 7.1 | 0.516 |
| 6256 | | 6 | 0 | 3.31 | 7.3 | 0.534 |
| 6257 | | 7 | 1 | 2.32 | 9.6 | 0.483 |
| 6258 | | 8 | 0 | 2.54 | 9.6 | 0.466 |
| 6259 | | 9 | 0 | 2.73 | 8.4 | 0.992 |
| 6260 | | 10 | 0 | 2.73 | 9.5 | 0.638 |
| 6261 | | 11 | 0 | 2.42 | 9.6 | 0.532 |
| 6262 | | 12 | 1 | 2.41 | 9.3 | 0.445 |
| 6263 | | 13 | 2 | 2.54 | 9.6 | 0.522 |
| 6264 | | 14 | 0 | 2.10 | 9.6 | 0.416 |
| 6265 | | 15 | 0 | 2.10 | 9.5 | 0.396 |
| 6266 | | 16 | 0 | 3.37 | 9.4 | 0.462 |
| 6267 | | 17 | 3 | 2.59 | 9.5 | 0.529 |
| 6268 | | 18 | 2 | 2.07 | 9.7 | 0.483 |
| 6269 | R4015 | 1 | 0 | 6.94 | 8.7 | 0.831 |
| 6270 | | 2 | 0 | 11.36 | 7.9 | 0.717 |
| 6271 | | 3 | 0 | 9.32 | 9.0 | 0.632 |
| 6272 | | 4 | 0 | 4.20 | 6.9 | 0.430 |
| 6273 | | 5 | 0 | 2.67 | 9.7 | 0.368 |
| 6274 | | 6 | 0 | 3.35 | 9.4 | 0.476 |
| 6275 | | 7 | 0 | 2.32 | 9.7 | 0.408 |
| 6276 | | 8 | 0 | 2.70 | 9.1 | 0.482 |
| 6277 | | 9 | 1 | 5.75 | 7.6 | 0.516 |

| Lab. No. | Field No. | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|
| 6293 | R4022 1 | 0 | 3.58 | 9.2 | 0.733 |
| 6294 | 2 | 0 | 2.72 | 9.4 | 0.578 |
| 6295 | 3 | 0 | 3.04 | 8.4 | 0.516 |
| 6296 | 4 | 0 | 3.87 | 9.8 | 0.579 |
| 6297 | 5/6 | 0 | 5.14 | 9.6 | 0.852 |
| 6299 | 7 | 0 | 8.75 | 9.0 | 1.034 |
| 6300 | 8 | 0 | 8.05 | 9.0 | 1.033 |
| 6301 | 9 | 0 | 6.34 | 8.2 | 1.510 |
| 6302 | 10 | 0 | 4.29 | 8.7 | 0.947 |
| 6303 | 11/12 | 0 | 2.98 | 8.5 | 0.744 |
| 6305 | 13 | 0 | 4.47 | 9.1 | 0.935 |
| 6306 | 14 | 1 | 3.87 | 9.5 | 0.824 |
| 6307 | 15 | 0 | 3.25 | 9.6 | 0.765 |
| 6308 | 16 | 0 | 3.02 | 9.7 | 0.752 |
| 6309 | 17 | 0 | 2.43 | 9.7 | 0.686 |
| 6310 | 18 | 1 | 2.75 | 9.6 | 0.726 |
| 6311 | 19 | 0 | 2.45 | 9.8 | 0.766 |
| 6312 | 20 | 0 | 2.71 | 9.7 | 0.787 |
| 6313 | 21 | 0 | 2.44 | 9.7 | 0.759 |
| 6314 | 22 | 0 | 2.44 | 9.5 | 0.741 |
| 6315 | 23 | 0 | 2.11 | 9.8 | 0.636 |
| 6316 | 24 | 1 | 2.15 | 9.5 | 0.717 |
| 6317 | 25 | 0 | 2.15 | 9.8 | 0.691 |
| 6318 | 26 | 0 | 1.68 | 9.9 | 0.671 |
| 6319 | 27 | 0 | 2.01 | 9.9 | 0.705 |
| 6320 | 28 | 0 | 1.98 | 9.9 | 0.722 |
| 6321 | 29 | 0 | 2.56 | 9.9 | 0.727 |
| 6322 | 30 | 0 | 2.62 | 9.9 | 0.764 |
| 6323 | 31 | 0 | 2.10 | 10.0 | 0.632 |
| 6324 | 32 | 1 | 1.82 | 10.1 | 0.589 |
| 6325 | 33 | 0 | 2.74 | 10.1 | 0.657 |
| 6326 | 34 | 1 | 2.52 | 10.1 | 0.628 |
| 6327 | 35 | 0 | 3.91 | 9.6 | 0.710 |
| 6328 | 36 | 1 | 3.83 | 9.6 | 0.596 |
| 6329 | 37 | 0 | 3.19 | 9.9 | 0.635 |
| 6330 | 38 | 0 | 2.92 | 9.7 | 0.567 |
| 6331 | 39 | 0 | 3.05 | 9.7 | 0.553 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6332 | R4022 | 40 | 0 | 4.04 | 9.6 | 0.625 |
| 6333 | | 41 | 0 | 6.12 | 8.7 | 0.475 |
| 6334 | | 42 | 1 | 6.97 | 8.4 | 0.410 |
| 6335 | | 43 | 0 | 3.45 | 9.7 | 0.646 |
| 6336 | | 44 | 0 | 2.79 | 9.6 | 0.534 |
| 6337 | | 45 | 0 | 2.61 | 9.6 | 0.489 |
| 6338 | | 46 | 0 | 6.79 | 9.2 | 0.710 |
| 6339 | | 47 | 0 | 6.13 | 8.7 | 0.515 |
| 6340 | | 48 | 0 | 7.46 | 8.2 | 0.319 |
| 6341 | | 49 | 1 | 3.34 | 9.4 | 0.789 |
| 6342 | | 50 | 1 | 5.14 | 9.2 | 0.636 |
| 6343 | | 51 | 0 | 4.60 | 9.3 | 0.674 |
| 6344 | | 52 | 0 | 5.67 | 9.0 | 0.570 |
| 6345 | | 53 | 2 | 6.46 | 9.8 | 0.913 |
| 6346 | | 54 | 0 | 4.49 | 10.2 | 0.760 |
| 6347 | R4023 | 1 | 0 | 3.67 | 8.7 | 0.632 |
| 6348 | | 2 | 0 | 3.08 | 6.4 | 0.342 |
| 6349 | | 3 | 0 | 2.44 | 8.3 | 0.429 |
| 6350 | | 4 | 0 | 1.98 | 8.4 | 0.352 |
| 6351 | | 5 | 0 | 2.41 | 8.7 | 0.437 |
| 6352 | | 6 | 0 | 2.22 | 9.7 | 0.696 |
| 6353 | | 7 | 0 | 1.57 | 10.1 | 0.532 |
| 6354 | | 8 | 0 | 2.27 | 10.0 | 0.603 |
| 6355 | | 9 | 0 | 3.85 | 9.7 | 0.752 |
| 6356 | | 10 | 0 | 5.88 | 9.2 | 0.906 |
| 6357 | | 11 | 0 | 6.42 | 9.4 | 0.970 |
| 6358 | | 12 | 0 | 6.31 | 9.4 | 0.877 |
| 6359 | | 13 | 0 | 7.73 | 8.1 | 1.198 |
| 6360 | | 14 | 0 | 7.44 | 9.6 | 0.997 |
| 6361 | | 15 | 2 | 6.71 | 9.2 | 0.842 |
| 6362 | | 16 | 1 | 6.04 | 9.2 | 0.816 |
| 6363 | | 17 | 1 | 3.62 | 9.5 | 0.660 |
| 6364 | | 18 | 2 | 3.79 | 9.7 | 0.722 |
| 6365 | | 19 | 0 | 3.22 | 9.7 | 0.687 |
| 6366 | | 20 | 1 | 2.55 | 9.9 | 0.660 |
| 6367 | | 21 | 1 | 2.43 | 10.0 | 0.660 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6368 | R4023 | 22 | 1 | 2.07 | 10.2 | 0.637 |
| 6369 | | 23 | 1 | 2.24 | 10.1 | 0.722 |
| 6370 | | 24 | 0 | 2.04 | 9.8 | 0.716 |
| 6371 | | 25 | 2 | 3.37 | 10.1 | 0.805 |
| 6372 | | 26 | 3 | 4.05 | 10.2 | 0.784 |
| 6373 | | 27 | 0 | 4.96 | 10.0 | 0.822 |
| 6374 | | 28 | 3 | 4.81 | 10.0 | 0.822 |
| 6375 | | 29 | 0 | 3.25 | 9.9 | 0.700 |
| 6376 | | 30 | 1 | 2.22 | 9.9 | 0.808 |
| 6377 | | 31 | 1 | 2.14 | 10.3 | 0.575 |
| 6378 | | 32 | 1 | 1.80 | 10.2 | 0.710 |
| 6379 | | 33 | 1 | 1.71 | 10.3 | 0.638 |
| 6380 | | 34 | 0 | 2.30 | 10.1 | 0.682 |
| 6381 | | 35 | 1 | 3.53 | 9.9 | 0.771 |
| 6382 | | 36 | 3 | 3.09 | 10.2 | 0.748 |
| 6383 | | 37 | 0 | 3.94 | 10.0 | 0.751 |
| 6385 | | 39 | 1 | 2.77 | 9.5 | 0.592 |
| 6386 | R4024 | 1 | 0 | 2.96 | 9.7 | 0.337 |
| 6387 | | 2 | 0 | 4.82 | 9.6 | 0.857 |
| 6388 | | 3 | 0 | 2.69 | 10.0 | 0.610 |
| 6389 | | 4 | 0 | 6.42 | 9.3 | 0.958 |
| 6390 | | 5 | 0 | 6.68 | 9.3 | 0.958 |
| 6391 | | 6 | 0 | 6.87 | 8.6 | 0.770 |
| 6392 | | 7 | 0 | 6.99 | 9.8 | 0.907 |
| 6393 | | 8 | 0 | 7.51 | 9.6 | 0.980 |
| 6394 | | 9 | 0 | 8.31 | 9.5 | 1.198 |
| 6395 | | 10 | 0 | 6.77 | 8.6 | 1.249 |
| 6396 | | 11 | 0 | 4.76 | 8.7 | 0.898 |
| 6397 | | 12 | 1 | 4.22 | 9.7 | 0.897 |
| 6398 | | 13 | 2 | 3.97 | 9.5 | 0.775 |
| 6399 | | 14 | 2 | 3.81 | 9.8 | 0.810 |
| 6400 | | 15 | 1 | 3.11 | 9.9 | 0.796 |
| 6401 | | 16 | 1 | 3.16 | 9.9 | 0.705 |
| 6402 | | 17 | 0 | 2.73 | 10.0 | 0.716 |
| 6403 | | 18 | 1 | 2.62 | 9.7 | 0.650 |
| 6404 | | 19 | 0 | 1.65 | 10.3 | 0.628 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6405 | R4024 | 20 | 0 | 2.45 | 10.2 | 0.792 |
| 6406 | | 21 | 0 | 2.51 | 10.2 | 0.778 |
| 6407 | | 22 | 0 | 2.52 | 9.8 | 0.732 |
| 6408 | | 23 | 0 | 2.45 | 10.0 | 0.775 |
| 6409 | | 24 | 1 | 2.29 | 10.2 | 0.728 |
| 6410 | | 25 | 1 | 2.55 | 9.6 | 0.754 |
| 6411 | | 26 | 1 | 2.18 | 10.1 | 0.740 |
| 6412 | | 27 | 1 | 2.23 | 9.9 | 0.705 |
| 6413 | | 28 | 1 | 2.38 | 10.2 | 0.720 |
| 6414 | | 29 | 0 | 1.55 | 10.5 | 0.598 |
| 6415 | | 30 | 2 | 2.75 | 10.0 | 0.680 |
| 6416 | | 31 | 0 | 3.53 | 10.0 | 0.760 |
| 6417 | | 32 | 0 | 3.21 | 9.7 | 0.690 |
| 6418 | | 33 | 1 | 3.56 | 9.9 | 0.640 |
| 6419 | | 34 | 0 | 3.01 | 10.0 | 0.610 |
| 6420 | | 35 | 0 | 2.31 | 9.9 | 0.515 |
| 6421 | | 36 | 0 | 3.46 | 9.7 | 0.528 |
| 6422 | R4026 | 1 | 0 | 4.69 | 8.8 | 0.945 |
| 6423 | | 2 | 0 | 4.48 | 6.6 | 0.938 |
| 6424 | | 3 | 0 | 3.71 | 5.0 | 0.828 |
| 6425 | | 4 | 0 | 2.87 | 5.0 | 0.812 |
| 6426 | | 5 | 0 | 2.00 | 9.4 | 0.700 |
| 6427 | | 6 | 0 | 0.98 | 8.7 | 0.706 |
| 6428 | | 7 | 0 | 2.52 | 8.4 | 0.732 |
| 6429 | | 8 | 0 | 2.44 | 9.7 | 0.719 |
| 6430 | | 9 | 3 | 1.50 | 10.0 | 0.520 |
| 6431 | | 10 | 2 | 1.29 | 10.2 | 0.520 |
| 6432 | | 11 | 1 | 1.20 | 10.2 | 0.500 |
| 6433 | | 12 | 1 | 2.29 | 10.1 | 0.660 |
| 6434 | | 13 | 0 | 1.70 | 10.0 | 0.630 |
| 6435 | | 14 | 1 | 1.41 | 10.1 | 0.660 |
| 6436 | | 15 | 1 | 1.59 | 10.1 | 0.643 |
| 6437 | | 16 | 1 | 2.02 | 9.9 | 0.684 |
| 6438 | | 17 | 0 | 1.71 | 10.0 | 0.600 |
| 6439 | | 18 | 1 | 2.07 | 10.1 | 0.659 |
| 6440 | | 19 | 0 | 2.18 | 9.9 | 0.716 |
| 6441 | | 20 | 1 | 2.82 | 9.6 | 0.677 |
| 6442 | | 21 | 0 | 3.31 | 9.5 | 0.677 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6446 | R4035 | 1 | 0 | 5.77 | 8.0 | 0.943 |
| 6447 | | 2 | 0 | 4.61 | 5.4 | 0.740 |
| 6448 | | 3 | 0 | 4.33 | 5.4 | 0.565 |
| 6449 | | 4 | 0 | 4.16 | 9.5 | 0.635 |
| 6450 | | 5 | 0 | 4.34 | 9.9 | 0.606 |
| 6451 | | 6 | 0 | 4.28 | 9.3 | 0.666 |
| 6452 | | 7 | 0 | 4.50 | 9.5 | 0.649 |
| 6453 | | 8 | 0 | 4.42 | 9.7 | 0.690 |
| 6454 | | 9 | 0 | 4.30 | 9.9 | 0.665 |
| 6455 | | 10 | 0 | 4.06 | 10.1 | 0.626 |
| 6456 | | 11 | 0 | 4.17 | 10.1 | 0.603 |
| 6457 | | 12 | 1 | 4.44 | 10.3 | 0.660 |
| 6458 | | 13 | 0 | 4.62 | 10.2 | 0.660 |
| 6459 | | 14 | 0 | 4.78 | 10.4 | 0.672 |
| 6460 | | 15 | 0 | 3.86 | 10.5 | 0.623 |
| 6461 | | 16 | 0 | 3.46 | 10.4 | 0.702 |
| 6462 | | 17 | 2 | 3.56 | 10.4 | 0.640 |
| 6463 | | 18 | 0 | 2.82 | 10.5 | 0.612 |
| 6464 | | 19 | 0 | 1.92 | 10.7 | 0.523 |
| 6465 | | 20 | 0 | 2.42 | 10.6 | 0.652 |
| 6466 | | 21 | 0 | 2.90 | 10.5 | 0.635 |
| 6467 | | 22 | 0 | 2.72 | 10.7 | 0.618 |
| 6468 | | 23 | 0 | 2.94 | 10.6 | 0.533 |
| 6469 | | 24 | 0 | 1.49 | 10.8 | 0.490 |
| 6470 | | 25 | 0 | 2.61 | 10.7 | 0.632 |
| 6471 | | 26 | 0 | 2.30 | 10.7 | 0.600 |
| 6472 | | 27 | 0 | 2.52 | 10.6 | 0.630 |
| 6473 | | 28 | 0 | 2.65 | 10.7 | 0.595 |
| 6474 | | 29 | 0 | 2.97 | 10.4 | 0.630 |
| 6475 | | 30 | 0 | 2.79 | 9.5 | 0.561 |
| 6476 | R3036 | 1 | 0 | 4.13 | 9.0 | 0.738 |
| 6477 | | 2 | 0 | 3.35 | 9.3 | 0.699 |
| 6478 | | 3 | 0 | 3.40 | 9.2 | 0.621 |
| 6479 | | 4 | 0 | 5.37 | 6.2 | 1.006 |
| 6480 | | 5 | 0 | 3.61 | 7.0 | 0.680 |
| 6481 | | 6 | 0 | 3.06 | 8.3 | 0.680 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6482 | R3036 | 7 | 0 | 3.81 | 9.4 | 0.635 |
| 6483 | | 8 | 0 | 3.82 | 9.5 | 0.563 |
| 6484 | | 9 | 0 | 3.59 | 9.1 | 0.578 |
| 6485 | | 10 | 0 | 2.76 | 9.1 | 0.652 |
| 6486 | | 11 | 0 | 3.23 | 9.6 | 0.628 |
| 7487 | | 12 | 0 | 4.77 | 9.3 | 0.613 |
| 6488 | | 13 | 1 | 6.17 | 8.6 | 0.620 |
| 6489 | | 14 | 1 | 8.86 | 9.0 | 0.696 |
| 6490 | | 15 | 0 | 7.46 | 7.8 | 0.460 |
| 6491 | | 16 | 2 | 7.29 | 8.1 | 0.524 |
| 6492A | | 17 | 1 | 5.86 | 9.1 | 0.597 |
| 6492B | | 18 | 1 | 7.43 | 10.0 | 0.981 |
| 6493 | | 19 | 1 | 4.67 | 10.3 | 0.724 |
| 6494 | | 20 | 0 | 5.19 | 10.2 | 0.770 |
| 6495 | | 21 | 1 | 4.02 | 10.3 | 0.670 |
| 6496 | | 22 | 1 | 4.51 | 10.4 | 0.646 |
| 6497 | | 23 | 1 | 4.24 | 10.3 | 0.606 |
| 6498 | | 24 | 1 | 4.36 | 10.3 | 0.655 |
| 6499 | | 25 | 0 | 4.00 | 10.2 | 0.570 |
| 6500 | | 26 | 0 | 3.86 | 10.3 | 0.622 |
| 6501 | | 27 | 0 | 4.33 | 10.3 | 0.622 |
| 6502 | | 28 | 0 | 5.02 | 9.7 | 0.510 |
| 6503 | | 29 | 0 | 5.75 | 9.2 | 0.405 |
| 6504 | | 30 | 0 | 6.70 | 8.8 | 0.346 |
| 6505 | | 31 | 0 | 4.29 | 10.2 | 0.552 |
| 6506 | | 32 | 0 | 3.91 | 10.2 | 0.765 |
| 6507 | | 33 | 0 | 9.90 | 9.9 | 0.952 |
| 6508 | | 34 | 0 | 3.40 | 9.9 | 0.480 |
| 6509 | | 35 | 0 | 3.07 | 10.0 | 0.[illegible]52 |
| 6510 | | 36 | 0 | 3.25 | 10.0 | 0.618 |
| 6511 | | 37 | 0 | 3.28 | 10.2 | 0.692 |
| 6512 | | 38 | 0 | 4.90 | 9.2 | 0.404 |
| 6513 | | 39 | 0 | 2.64 | 10.1 | 0.591 |
| 6514 | | 40 | 0 | 3.09 | 10.1 | 0.722 |
| 6515 | | 41 | 0 | 3.79 | 10.3 | 0.735 |
| 6516 | | 42 | 0 | 3.82 | 10.3 | 0.680 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6517 | R4039 | 1 | 0 | 3.70 | 8.7 | 0.730 |
| 6518 | | 2 | 0 | 3.08 | 5.7 | 0.435 |
| 6519 | | 3 | 1 | 3.13 | 8.6 | 0.510 |
| 6520 | | 4 | 0 | 2.22 | 9.4 | 0.542 |
| 6521 | | 5 | 0 | 3.51 | 9.3 | 0.594 |
| 6522 | | 6 | 0 | 3.57 | 9.3 | 0.599 |
| 6523 | | 7 | 1 | 4.07 | 9.3 | 0.594 |
| 6524 | | 8 | 0 | 4.12 | 9.9 | 0.553 |
| 6525 | | 9 | 0 | 4.90 | 9.7 | 0.584 |
| 6526 | | 10 | 0 | 6.56 | 9.3 | 0.575 |
| 6527 | | 11 | 0 | 6.48 | 9.7 | 0.609 |
| 6528 | | 12 | 0 | 6.67 | 9.8 | 0.555 |
| 6529 | | 13 | 0 | 4.96 | 10.0 | 0.675 |
| 6530 | | 14 | 1 | 5.42 | 9.7 | 0.700 |
| 6531 | | 15 | 1 | 4.29 | 9.9 | 0.657 |
| 6532 | | 16 | 1 | 5.14 | 9.8 | 0.698 |
| 6533 | | 17 | 1 | 5.61 | 10.0 | 0.768 |
| 6534 | | 18 | 1 | 4.92 | 9.9 | 0.750 |
| 6535 | | 19 | 0 | 5.36 | 9.3 | 0.605 |
| 6536 | | 20 | 1 | 5.42 | 10.0 | 0.716 |
| 6537 | | 21 | 1 | 6.12 | 10.1 | 0.702 |
| 6538 | | 22 | 1 | 5.96 | 10.1 | 0.779 |
| 6539 | | 23 | 0 | 6.33 | 9.3 | 0.489 |
| 6540 | | 24 | 2 | 5.21 | 10.0 | 0.684 |
| 6541 | | 25 | 0 | 4.49 | 9.8 | 0.583 |
| 6542 | | 26 | 1 | 5.83 | 9.1 | 0.453 |
| 6543 | | 27 | 1 | 3.01 | 10.0 | 0.520 |
| 6544 | | 28 | 2 | 3.78 | 10.2 | 0.700 |
| 6545 | | 29 | 3 | 4.00 | 10.2 | 0.644 |
| 6546 | | 30 | 2 | 4.14 | 10.2 | 0.676 |
| 6547 | | 31 | 1 | 4.17 | 10.2 | 0.725 |
| 6548 | | 32 | 1 | 3.54 | 10.3 | 0.633 |
| 6549 | | 33 | 1 | 3.80 | 10.4 | 0.670 |
| 6550 | | 34 | 0 | 3.72 | 10.4 | 0.650 |
| 6551 | | 35 | 2 | 3.82 | 10.4 | 0.612 |

| Lab. No. | Field No. | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|
| STD No. 1 | A1 | | 11.53 | | |
| | A2 | | 6.77 | | |
| | A3 | | 6.42 | | |
| | A4 | | 3.43 | | |
| | A5 | | 5.82 | | |
| | A6 | | 4.69 | | |
| | A7 | | 1.54 | | |
| STD No.2 | A1 | | 11.32 | | |
| | A2 | | 6.91 | | |
| | A3 | | 6.62 | | |
| | A4 | | 3.75 | | |
| | A5 | | 6.04 | | |
| | A6 | | 4.68 | | |
| | A7 | | 1.79 | | |
| STD No. 3 | cover samples | 6293 - 6301 | | | |
| | | 6347 - 6360 | | | |
| | | 6400 - 6551 | | | |
| STD No. 2 | cover samples | 6169 - 6277 | | | |
| | | 6302 - 6346 | | | |
| | | 6361 - 6399 | | | |

For any numbers which are missing there were no corresponding samples.

J Davis

JVR. Davis

CSR Coal Laboratory
149 Kerry Road,
ARCHERFIELD

Report No. 182 Continued
Subject : Environmental Test Samples
Reference : RFA 2906, M. Evans.

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6949 | R4012 | 1 | 0 | 5.22 | 9.1 | 0.603 |
| 6950 | | 2 | 0 | 2.79 | 9.6 | 0.523 |
| 6951 | | 3 | 0 | 3.74 | 9.3 | 0.562 |
| 6952 | | 4 | 0 | 3.91 | 9.4 | 0.581 |
| 6953 | | 5 | 1 | 3.17 | 9.8 | 0.487 |
| 6954 | | 6 | 0 | 2.97 | 9.8 | 0.487 |
| 6955 | | 7 | 1 | 3.07 | 9.8 | 0.483 |
| 6956 | | 8 | 1 | 1.86 | 9.7 | 0.392 |
| 6957 | | 9 | 0 | 3.32 | 9.8 | 0.500 |
| 6958 | | 10/11 | 1 | 4.05 | 9.4 | 0.480 |
| 6962 | | 14 | 1 | 4.11 | 9.4 | 0.676 |
| 6963 | | 15 | 1 | 3.05 | 9.7 | 0.678 |
| 6964 | | 16 | 0 | 3.04 | 9.7 | 0.622 |
| 6971 | | 23 | 1 | 6.34 | 9.1 | 0.420 |
| 6972 | | 24 | 1 | 3.18 | 10.0 | 0.594 |
| 6973 | | 25/26 | 0 | 4.16 | 9.9 | 0.614 |
| 6975 | | 27 | 0 | 5.56 | 10.2 | 0.823 |
| 6976 | | 28 | 0 | 6.65 | 10.1 | 0.860 |
| 6977 | | 29 | 0 | 6.82 | 10.3 | 0.795 |
| 6978 | | 30 | 0 | 5.58 | 10.0 | 0.658 |
| 6979 | R4013 | 1 | 0 | 6.80 | 9.0 | 0.469 |
| 6980 | | 2 | 1 | 3.86 | 9.7 | 0.337 |
| 6981 | | 3 | 0 | 4.07 | 9.6 | 0.359 |
| 6982 | | 4 | 0 | 3.27 | 9.6 | 0.323 |
| 6983 | | 5 | 0 | 2.95 | 9.8 | 0.311 |
| 6984 | | 6 | 0 | 3.54 | 9.8 | 0.304 |
| 6985 | | 7 | 0 | 3.28 | 9.6 | 0.346 |
| 6986 | | 8 | 0 | 4.08 | 9.5 | 0.369 |
| 6987 | | 9 | 0 | 3.28 | 9.0 | 0.298 |
| 6988 | | 10 | 0 | 3.80 | 9.1 | 0.402 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 6989 | R4013 | 11 | 0 | 3.83 | 9.2 | 0.442 |
| 6990 | | 12 | 0 | 3.69 | 9.1 | 0.442 |
| 6991 | | 13 | 0 | 4.15 | 8.0 | 0.400 |
| 6992 | | 14 | 0 | 3.99 | 8.7 | 0.510 |
| 6993 | | 15 | 0 | 3.73 | 8.4 | 0.443 |
| 6994 | | 16 | 1 | 3.61 | 8.6 | 0.417 |
| 6995 | | 17 | 3 | 3.16 | 9.3 | 0.434 |
| 6996 | | 18 | 3 | 4.38 | 9.3 | 0.468 |
| 6999 | | 21 | 0 | 3.85 | 9.7 | 0.631 |
| 7000 | | 22 | 0 | 4.30 | 9.9 | 0.722 |
| 7001 | | 23 | 0 | 5.85 | 10.0 | 0.834 |
| 7002 | | 24 | 0 | 3.98 | 9.8 | 0.657 |
| 7004 | | 26 | 0 | 2.89 | 9.7 | 0.634 |
| 7005 | | 27 | 0 | 2.96 | 9.8 | 0.596 |
| 7006 | | 28 | 0 | 2.94 | 9.8 | 0.586 |
| 7007 | | 29 | 0 | 3.09 | 9.8 | 0.620 |
| 7008 | | 30 | 0 | 3.71 | 9.7 | 0.677 |
| 7009 | | 31 | 0 | 8.17 | 10.0 | 1.138 |
| 7010 | | 32 | 1 | 3.74 | 9.9 | .722 |
| 7011 | | 33 | 1 | 3.87 | 9.9 | .655 |
| 7013 | | 35 | 1 | 5.14 | 9.4 | 0.650 |
| 7015 | | 37 | 0 | 3.32 | 9.7 | 0.627 |
| 7017 | | 39 | 1 | 5.39 | 10.0 | 0.782 |
| 7018 | | 40 | 0 | 5.30 | 10.0 | 0.732 |
| 7019 | R4011 | 1 | 0 | 4.40 | 9.7 | 0.755 |
| 7020 | | 2 | 0 | 3.76 | 4.6 | 0.558 |
| 7021 | | 3 | 0 | 3.95 | 4.7 | 0.417 |
| 7022 | | 4 | 0 | 3.45 | 5.1 | 0.455 |
| 7023 | | 5 | 0 | 2.95 | 10.0 | 0.508 |
| 7024 | | 6 | 0 | 3.43 | 9.7 | 0.617 |
| 7025 | | 7 | 0 | 3.30 | 9.3 | 0.718 |
| 7026 | | 8 | 3 | 3.66 | 9.5 | 0.698 |
| 7027 | | 9 | 0 | 7.13 | 9.5 | 0.837 |
| 7028 | | 10 | 0 | 4.33 | 9.4 | 0.736 |
| 7029 | | 11 | 1 | 8.02 | 9.2 | 0.852 |
| 7030 | | 12 | 0 | 7.01 | 9.4 | 0.789 |

| Lab. No. | Field No. | | S.T. | ADM | PH | EC |
|---|---|---|---|---|---|---|
| 7031 | R4011 | 13 | 2 | 5.27 | 10.1 | 0.772 |
| 7032 | | 14 | 3 | 5.34 | 10.2 | 0.785 |
| 7033 | | 15 | 1 | 4.91 | 10.1 | 0.734 |
| 7034 | | 16 | 1 | 5.85 | 10.0 | 0.822 |
| 7035 | | 17 | 2 | 5.98 | 10.1 | 0.843 |
| 7036 | | 18 | 1 | 3.49 | 10.0 | 0.654 |
| 7037 | | 19.. | 1 | 2.95 | 9.9 | 0.554 |
| 7038 | | 20 | 2 | 2.32 | 10.0 | 0.579 |
| STD | | A1 | | 12.37 | | |
| | | A2 | | 6.82 | | |
| | | A3 | | 6.61 | | |
| | | A4 | | 3.69 | | |
| | | A5 | | 6.11 | | |
| | | A6 | | 4.89 | | |
| | | A7 | | 1.85 | | |

J.Davis.
JR Davis

RFA 2915 WANDOAN OVERBURDEN REPORT 194

| LAB NO | HOLENO | DEPTH | ADM | pH | EC | Mg | Na | Ca |
|---|---|---|---|---|---|---|---|---|
| 7312c | 4053 | 1-3 | 5.05 | 7.9 | .584 | 1.1 | 136 | 3.0 |
| 7314c | | 3-5 | 3.64 | 7.0 | .652 | 2.5 | 165 | 3.5 |
| 7316c | | 5-7 | 3.89 | 8.7 | .672 | 5.0 | 155 | 3.3 |
| 7318c | | 7-9 | 2.21 | 9.2 | .645 | 4.6 | 142 | 3.5 |
| 7319c | | 9-10 | 2.15 | 9.3 | .630 | 5.4 | 142 | 5.2 |
| 7330c | | 19-21 | 3.24 | 9.8 | .645 | 6.3 | 268 | 2.6 |
| 7332c | | 21-23 | 3.83 | 9.4 | .637 | 6.7 | 296 | 2.2 |
| 7334c | | 23-25 | 3.94 | 9.7 | .756 | 5.7 | 236 | 2.4 |
| 7336c | | 25-27 | 3.45 | 9.6 | .742 | 6.0 | 356 | 2.8 |
| 7338c | | 27-29 | 3.71 | 9.0 | .623 | 2.5 | 304 | 2.0 |
| 7347c | 4056 | 1-3 | 6.19 | 8.5 | .686 | 4.2 | 224 | 7.0 |
| 7349c | | 3-5 | 3.62 | 5.9 | .489 | 6.4 | 210 | 1.7 |
| 7351c | | 5-7 | 3.37 | 5.3 | .512 | 3.8 | 192 | 0.9 |
| 7353c | | 7-9 | 3.02 | 8.7 | .639 | 1.8 | 190 | 2.2 |
| 7355c | | 9-11 | 2.91 | 9.7 | .659 | 0.9 | 176 | 1.7 |
| 7357c | | 11-13 | 3.20 | 9.8 | .676 | 2.0 | 200 | 3.5 |
| 7359c | | 13-15 | 3.22 | 9.4 | .722 | 7.3 | 296 | 4.4 |
| 7361c | | 15-17 | 2.71 | 9.1 | .720 | 2.9 | 280 | 2.6 |
| 7363c | | 17-19 | 2.75 | 8.4 | .656 | 2.5 | 268 | 1.3 |
| 7365c | | 19-21 | 2.09 | 9.5 | .684 | 1.1 | 244 | 1.3 |
| 7367c | | 21-23 | 2.80 | 9.4 | .716 | 1.8 | 286 | 0.4 |
| 7369c | | 23-25 | 3.59 | 8.6 | .684 | 0.4 | 272 | 0.4 |
| 7371c | | 25-27 | 2.78 | 9.6 | .587 | 2.5 | 238 | 1.7 |
| 7373c | | 27-29 | 1.94 | 9.6 | .606 | 3.2 | 252 | 1.7 |
| 7375c | | 29-31 | 4.05 | 8.8 | .667 | 3.8 | 290 | 2.8 |
| 7377c | | 31-33 | 2.55 | 9.8 | .663 | 6.2 | 256 | 2.6 |
| 7379c | | 33-35 | 2.89 | 10.1 | .693 | 6.3 | 296 | 2.0 |
| 7381c | | 35-37 | 3.19 | 10.2 | .677 | 5.7 | 290 | 1.7 |
| 7383c | | 37-39 | 2.62 | 10.0 | .659 | 5.7 | 248 | 2.5 |
| 7385c | | 39-41 | 2.74 | 9.9 | .659 | 5.6 | 264 | 2.2 |
| 7387c | | 41-43 | 1.90 | 10.0 | .597 | 3.8 | 210 | 3.0 |
| 7389c | | 43-45 | 1.67 | 10.0 | .566 | 3.1 | 200 | 3.0 |
| 7391c | | 45-47 | 2.10 | 9.9 | .619 | 5.0 | 228 | 2.5 |
| 7393c | | 47-49 | 1.62 | 10.0 | .551 | 3.5 | 200 | 3.6 |
| 7395c | | 49-50 | 2.73 | 9.6 | .429 | 4.8 | 171 | 5.0 |
| 7397c | 4057 | 1-3 | 4.54 | 8.7 | .376 | 3.2 | 80 | 7.2 |
| 7399c | | 3-5 | 2.50 | 8.2 | .178 | 0.6 | 41 | 1.3 |
| 7401c | | 5-7 | 2.19 | 7.7 | .176 | 0.8 | 45 | 1.3 |
| 7403c | | 7-9 | 2.46 | 7.4 | .295 | 1.3 | 74 | 2.3 |
| 7405c | | 9-11 | 3.03 | 8.3 | .438 | 1.4 | 108 | 2.8 |
| 7407c | | 11-13 | 2.61 | 8.8 | .419 | 1.5 | 102 | 2.1 |
| 7409c | | 13-15 | 2.28 | 9.2 | .361 | 2.1 | 92 | 3.5 |

| LAB NO | HOLENO | DEPTH | ADM | pH | EC | Mg | Na | Ca |
|---|---|---|---|---|---|---|---|---|
| 7411c | 4059 | 1-2 | 3.01 | 8.7 | .563 | 1.1 | 143 | 2.6 |
| 7413c | | 2-4 | 2.75 | 6.3 | .571 | 0.3 | 127 | 0.5 |
| 7415c | | 4-6 | 2.94 | 8.8 | .598 | 0.8 | 163 | 1.5 |
| 7417c | | 6-8 | 4.29 | 6.2 | .672 | 8.4 | 234 | 14.4 |
| 7418.5c | | 8-9 | 5.26 | 5.5 | .687 | 2.6 | 258 | 2.8 |
| 7430c | | 19-21 | 3.31 | 9.8 | .612 | 0.6 | 183 | 1.3 |
| 7432c | | 21-23 | 4.19 | 10.0 | .799 | 4.8 | 360 | 3.5 |
| 7434c | | 23-25 | 2.87 | 10.2 | .698 | 4.1 | 284 | 2.7 |
| 7436c | | 25-27 | 2.68 | 10.2 | .676 | 6.9 | 330 | 2.5 |
| 7438c | | 27-29 | 2.37 | 10.2 | .632 | 4.2 | 268 | 3.0 |
| 7440c | | 29-31 | 2.78 | 10.2 | .638 | 4.3 | 288 | 2.6 |
| 7442c | | 31-33 | 3.02 | 10.1 | .654 | 8.4 | 336 | 2.8 |
| 7444c | | 33-35 | 2.65 | 10.2 | .655 | 6.6 | 300 | 2.4 |
| 7446c | 4060 | 1-2 | 3.43 | 9.7 | .393 | 8.0 | 185 | 5.1 |
| 7448c | | 2-4 | 4.46 | 97 | .466 | 3.6 | 165 | 4.4 |
| 7450c | | 4-6 | 6.32 | 9.4 | .602 | 4.6 | 340 | 5.4 |
| 7452c | | 6-8 | 6.08 | 9.7 | .600 | 4.0 | 99 | 5.0 |
| 7454c | | 8-10 | 6.11 | 9.8 | .626 | 2.6 | 330 | 4.4 |
| 7456c | | 10-12 | 6.92 | 9.1 | .766 | 4.3 | 376 | 4.4 |
| 7458c | | 12-14 | 5.86 | 7.9 | .759 | 8.6 | 300 | 4.6 |
| 7459.5c | | 14-15 | 3.62 | 9.4 | .618 | 4.4 | 236 | 2.7 |
| 7462.5c | | 17-18 | 3.41 | 10.1 | .651 | 7.3 | 260 | 3.3 |
| 7464c | | 18-20 | 2.36 | 10.3 | .578 | 4.0 | 194 | 4.6 |
| 7466c | | 20-22 | 3.20 | 10.4 | .609 | 6.9 | 240 | 3.7 |
| 7468c | | 22-24 | 3.46 | 10.2 | .619 | 7.2 | 296 | 2.8 |
| 7470c | | 24-26 | 2.99 | 10.2 | .581 | 8.0 | 312 | 3.5 |
| 7472c | | 26-28 | 3.04 | 10.2 | .574 | 7.5 | 324 | 2.8 |
| 7474c | | 28-30 | 3.22 | 10.2 | .576 | 6.3 | 308 | 3.0 |
| 7476c | | 30-32 | 2.92 | 10.2 | .572 | 7.2 | 290 | 3.5 |
| 7478c | | 32-34 | 2.73 | 10.3 | .570 | 7.6 | 312 | 3.0 |
| 7480c | | 34-36 | 3.11 | 9.8 | .550 | 3.3 | 262 | 3.0 |
| 7482c | | 36-38 | 2.31 | 9.9 | .515 | 1.9 | 200 | 3.3 |
| 7484c | | 38-40 | 1.47 | 10.2 | .473 | 1.5 | 181 | 2.2 |
| 7486c | | 40-41 | 2.60 | 9.4 | .724 | 4.2 | 193 | 12.8 |
| 7488c | 4066 | 1-3 | 4.14 | 8.7 | .810 | 3.6 | 204 | 12.1 |
| 7490c | | 3-5 | 4.14 | 7.4 | .534 | 4.2 | 204 | 4.0 |
| 7492c | | 5-7 | 5.29 | 9.6 | .629 | 8.0 | 210 | 2.5 |
| 7494c | | 7-9 | 4.51 | 10.0 | .641 | 8.1 | 276 | 3.6 |
| 7496c | | 9-11 | 2.90 | 10.0 | .639 | 2.9 | 208 | 3.8 |
| 7498c | | 11-13 | 2.48 | 10.1 | .636 | 3.5 | 214 | 3.6 |
| 7500c | | 13-15 | 2.28 | 10.1 | .621 | 2.9 | 234 | 3.2 |
| 7502c | | 15-17 | 1.97 | 10.3 | .600 | 2.1 | 200 | 3.2 |
| 7503.5c | | 17-18 | 1.92 | 10.4 | .602 | 2.4 | 208 | 3.7 |
| 7507c | 4068 | 1-2 | 5.67 | 9.4 | .473 | 3.3 | 191 | 9.3 |
| 7509c | | 2-4 | 7.12 | 9.5 | .436 | 0.3 | 116 | 5.7 |
| 7511c | | 4-6 | 6.44 | 9.6 | .404 | 1.1 | 119 | 6.0 |

| LAB NO | HOLENO | DEPTH | ADM | pH | EC | Mg | Na | Ca |
|---|---|---|---|---|---|---|---|---|
| 7514c | 4053 | 36-38 | 2.50 | 10.1 | .547 | 1.5 | 232 | 1.9 |
| 7516c | | 38-40 | 2.25 | 10.2 | .549 | 2.6 | 268 | 2.3 |
| 7518c | | 40-42 | 2.90 | 10.3 | .611 | 4.3 | 280 | 2.9 |
| 7519c | | 43-45 | 3.86 | 10.4 | .663 | 4.1 | 348 | 0.8 |
| 7521c | | 45-47 | 4.85 | 10.5 | .684 | 3.6 | 348 | 0.4 |
| 7523c | | 47-49 | 5.20 | 10.5 | .658 | 3.2 | 450 | 0.2 |
| 7524.5c | | 49-50 | 4.71 | 10.5 | .687 | 3.2 | 492 | 2.6 |
| 7527c | 4059 | 36-38 | 3.18 | 10.4 | .621 | 5.0 | 350 | 2.2 |
| 7529c | | 38-40 | 2.95 | 10.4 | .613 | 5.8 | 354 | 2.4 |
| 7531c | | 40-42 | 3.17 | 10.5 | .613 | 5.6 | 334 | 2.7 |
| 7533c | | 42-44 | 3.32 | 10.5 | .623 | 5.8 | 344 | 2.0 |
| 7535c | | 44-46 | 4.09 | 10.3 | .669 | 7.6 | 486 | 2.5 |

| STANDARDS | | |
|---|---|---|
| | A1 | 12.02 |
| | A2 | 7.42 |
| | A3 | 7.11 |
| | A4 | 4.52 |
| | A5 | 5.86 |
| | A7 | 2.20 |
| | BL | 17.92 |

CSR MATERIALS LABORATORY

REPORT 195

RFA 2916 WANDOAN OVERBURDEN

| LAB NO | HOLE NO | DEPTH | ADM | pH | EC | Mg | Na | Ca |
|---|---|---|---|---|---|---|---|---|
| 7559 | 4075 | 1-2 | 4.27 | 8.7 | 0.591 | 1.6 | 149 | 2.1 |
| 7560 | | 3-4 | 4.31 | 5.8 | 0.434 | 2.5 | 149 | 1.0 |
| 7561 | | 5-6 | 4.37 | 7.7 | 0.510 | 3.1 | 165 | 1.5 |
| 7562 | | 7-8 | 4.24 | 9.8 | 0.577 | 1.2 | 151 | 0.9 |
| 7563 | | 9-10 | 3.53 | 8.5 | 0.776 | 2.2 | 196 | 0.9 |
| 7564 | | 11-12 | 2.92 | 9.1 | 0.495 | 1.0 | 134 | 0.6 |
| 7565 | | 13-14 | 2.89 | 9.8 | 0.542 | 0.5 | 143 | 0.4 |
| 7566 | | 15 | 4.88 | 10.4 | 0.594 | 2.6 | 200 | 3.0 |
| 7567 | 4076 | 1-2 | 3.41 | 8.7 | 0.527 | 0.9 | 148 | 2.3 |
| 7568 | | 3-4 | 2.34 | 9.3 | 0.442 | 1.3 | 148 | 2.4 |
| 7569 | | 5-6 | 2.55 | 10.2 | 0.418 | 1.8 | 134 | 2.0 |
| 7570 | | 7-8 | 3.48 | 8.9 | 0.570 | 1.0 | 149 | 0.6 |
| 7571 | | 9-10 | 2.26 | 9.9 | 0.574 | 0.5 | 145 | 0.7 |
| 7572 | | 11-12 | 2.63 | 9.85 | 0.502 | 2.1 | 168 | 2.0 |
| 7573 | | 13-14 | 3.21 | 10.4 | 0.563 | 1.8 | 184 | 2.8 |
| 7574 | | 15-16 | 2.74 | 10.5 | 0.516 | 1.7 | 178 | 2.6 |
| 7575 | | 17-18 | 3.00 | 10.4 | 0.531 | 1.7 | 189 | 2.8 |
| 7576 | | 19-20 | 2.53 | 10.25 | 0.514 | 1.6 | 184 | 2.4 |
| 7577 | | 21-22 | 1.75 | 9.9 | 0.432 | 0.8 | 142 | 0.6 |
| 7578 | | 23 | 2.93 | 9.5 | 0.381 | 0.5 | 132 | 0.4 |

| STANDARDS | | |
|---|---|---|
| | A1 | 11.38 |
| | A2 | 6.93 |
| | A3 | 6.32 |
| | A4 | 3.86 |
| | BL | 25.71 |