Addendum to BSAL verification report

Warkworth Continuation 2014

Prepared for Warkworth Mining Limited | 5 June 2014

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Addendum to BSAL verification report

Final

Report J14013RP2 | Prepared for Warkworth Mining Limited | 5 June 2014

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Date	05 June 2014	Date	05 June 2014

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Table of Contents

Appendices

Tables

Figures

1 Introduction

The Warkworth Continuation 2014 (the proposal) seeks to extend mining beyond the current limits of approval to ensure it remains economically viable and coal is extracted in the most economic manner as required under clause 15 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*.

The mining extension area is approximately 698ha (referred to herein as proposal area) and is located in a mining lease 20m below ground level, but will require a mining lease from the surface to 20m below surface level. This mining lease is yet to be approved.

Under the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP) , an application for a state significant mining or petroleum development must be accompanied by:

a) a gateway certificate; or

b) a site verification certificate (SVC) that certifies that the land on which the proposed development is to be carried out is not on biophysical strategic agricultural land.

The Mining SEPP sets out the requirements for supporting documentation which must accompany an SVC application and requires the supporting documentation to be prepared in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (the Interim protocol).

Warkworth Mining Limited made a SVC application to the NSW Department of Planning and Environment (DP&E) for the area requiring a mining lease from the surface to 20m below the ground. The SVC application was accompanied by a Biophysical Strategic Agricultural Land (BSAL) verification report (Appendix A) which was based on a desktop study using previous soil surveys of the area.

In accordance with the assessment procedures, the DPE requested the NSW Office of Environment and Heritage (OEH) to review the SVC application and provide a recommendation for their consideration. In their review, the OEH required additional information to complete their assessment of the SVC application against the Interim protocol.

Notwithstanding the additional information that was required by OEH, it was acknowledged that the data provided in the BSAL verification report was consistent with OEH knowledge and data of the area. That is, no BSAL has been mapped in the locality and soils units known to be in the area are of low fertility.

The purpose of this report is to provide additional information requested by OEH so that they can complete their assessment of the SVC application against the Interim protocol and the current publically available procedure.

This report includes:

- an introduction (this section);
- the methodology used in conducting this survey;
- a description of how this survey addressed the Interim protocol compliance issues;
- the results and discussion of this survey; and
- conclusions.

2 Method

This section describes the additional soil survey fieldwork and laboratory analysis that was done to address the additional matters raised by OEH.

2.1 Soil descriptions and sampling

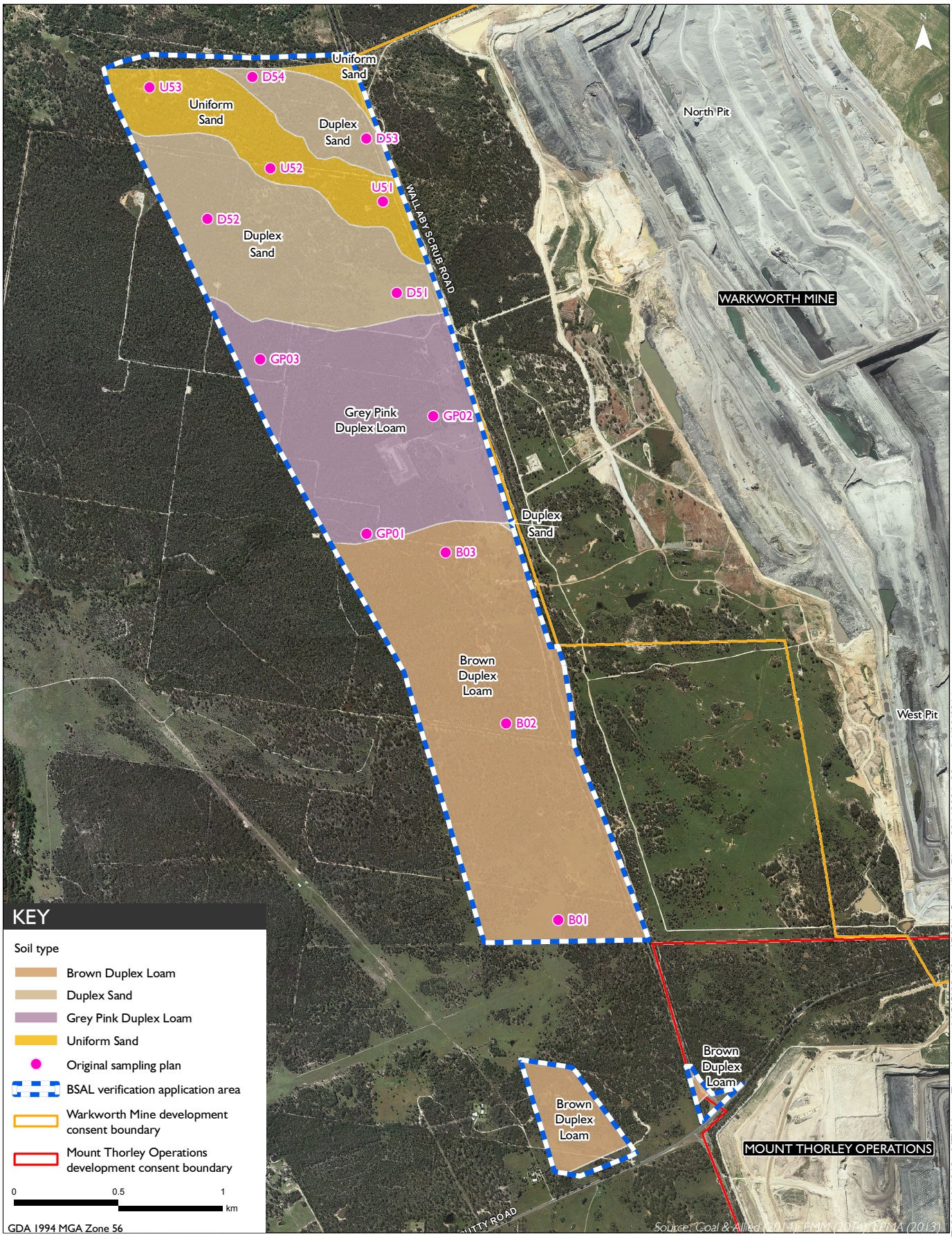
The Interim protocol requires a minimum of three detailed soil description sites be surveyed for each soil type. A detailed test site is defined as soil profile inspection site that is described in sufficient detail to allow all major physical and chemical soil features of relevance to BSAL to be clearly identified. The description must include site data, ie the soil description, and samples for laboratory analysis, ie soil sample analysis.

A survey plan for detailed soil descriptions was prepared based on existing mapping of soil units. The survey plan and existing mapping units are shown on Figure 2.1. As per the Interim protocol, the survey plan was based on three detailed sites for each soil type on the existing mapping. Tasks completed at each detailed soil description site were:

- prepare 1m deep trenches;
- record detailed soil descriptions using the Soil and Land Information System (SALIS) data card and BSAL data card; and
- collect soil samples at: 0, 0-50mm, 50-150mm, 150-300mm, 300-600mm and 600-1,000mm below ground level (bgl):
    - surface samples (0 mm bgl) were collected as a bulk sample from 12 sub-samples collected in a 10m radius around the trench; and
    - 250g soil samples were collected from each depth.

Check and exclusion sites were not included in the survey plan as it was considered that the existing soil mapping was satisfactory as it was previously accepted by DP&E. Where the existing mapping was in conflict with the field observations, additional check sites were undertaken which comprised holes dug to 0.5m and assessments that included brief soil profile descriptions, soil characteristic observations and vegetation observations. No laboratory analysis of samples was done on check sites.

The OEH requested BSAL mapping at 1:25,000 in its interim assessment. Under the Interim protocol this scale of mapping is required for developments which are considered to pose a high risk to agriculture, eg an open cut mine located on alluvial soils that are very likely to be BSAL. It is considered that the proposal poses a low risk to agriculture because the area being assessed is not on alluvial soils, is heavily wooded, not used for agriculture and has several physical and chemical criteria that would prevent it from being classified as BSAL. Therefore, the sampling density in the survey plan was for one sample per 50ha which is approximately 1:50,000 mapping. OEH confirmed via email that they agreed with the survey plan for 1:50,000 mapping.



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Original sampling plan
Warkworth Mine continuation
BSAL verification
Figure 2.1

2.2 Soil sample analysis

Soil samples from detailed test sites were packed into eskies with chain of custody certificates and sent to a NATA laboratory for analysis.

Soil samples were analysed using appropriate test procedures, eg National Test Code, for:

- soil pH (1:5 soil:water or 1:5 soil: CaCl2);
- salinity (EC 1:5 and ECe 1:5); and
- exchangeable cations and cation exchange capacity (for deriving exchangeable sodium percentage and the Ca:Mg ratio).

Laboratory analysis results were entered into the SALIS laboratory data template.

3 Interim protocol requirements

The OEH assessment of the SVC desktop based application required additional information to be provided to enable a thorough assessment against the Interim protocol. Table 3.1 summarises the additional information requested by OEH and how the supplementary soil survey has addressed the information request.

Table 3.1 Resolution of information requests

Information request	Resolution of information request
Maps	
Map of assessment area showing BSAL (at 1:25,000) and exclusion zones marked according to their BSAL limitation. Spatial dataset (boundary of BSAL areas) supplied in GIS format as per the Interim protocol.	BSAL was mapped at 1:50,000 in accordance with the Interim protocol. See section 3.1 for further details. A hard copy map has been provided in Figure 4.2 A spatial dataset of soil type polygons, BSAL polygons and soil sampling points have been provided.
Metadata for spatial datasets have been provided as per the Interim protocol	A spatial dataset of soil type polygons, BSAL polygons and soil sampling points have been provided.
Lodgement of site and laboratory data	
All site observations lodged on BSAL soil data cards and all required field attributes completed correctly for each observation type as per the Interim protocol, ie check, exclusion and detailed.	Soil data cards have been supplied in a physical form. Laboratory data has been supplied digitally in the specified SALIS format.
All laboratory data supplied in the SALIS lab data template, appropriate test procedures, eg National Test Code, identified and all relevant test results completed as per the *Interim protocol*.	Laboratory data has been supplied digitally in the specified SALIS format.
Site assessment	
Sampling density is as specified in the *Interim protocol*.	Sampling density within the project footprint was mapped at 1:50,000 in accordance with the Interim protocol. See section 3.1 for further details.
Observation sites (check, detailed and exclusion sites) are relatively evenly distributed across the study area	Within the approximately 698 ha proposal area 15 detailed sites and four check sites were investigated.
Each soil type identified has at least three detailed sites	Each soil unit has a minimum of three detailed sites recorded.
All relevant data has been collected and provided for detailed sites as per the *Interim protocol*.	Within the approximately 698 ha proposal area 15 detailed sites and four check sites were investigated. A hard copy map has been provided in Figure 4.2 A spatial dataset of soil type polygons, BSAL polygons and soil sampling points have been provided. BSAL was mapped at 1:50,000 in accordance with the Interim protocol. See section 3.1 for further details. Soil data cards have been supplied in a physical form. Laboratory data has been supplied digitally in the specified SALIS format.
Description of detailed sites is accompanied by a photograph of the site and of the soil profile being described.	Photographs of each site and soil profile have been provided in a digital format.
Adequate numbers of check sites used to: i) allocate a site to a soil type and soil map unit; and ii) confirm existing mapping	Detailed sites were used to verify the existing soil polygons. Check sites were only used where the detailed sites returned a soil type not in line with the existing mapping.

3.1 Map scale

A mapping scale of 1:50,000 was determined as addressing the appropriate level of risk of the proposal. The reasoning and acceptance of this mapping scale is detailed in Section 2.1.

The field survey of 15 detailed sites and four check sites covered the approximately 698ha proposal area at an intensity of one site per 36.74ha. According to the *Guidelines for surveying soil and land resources* (McKensie et al 2008), a 1:50,000 sampling intensity ranges between on one site per 20ha to 100ha. The sampling intensity for this survey is at the more intense end of this range and is therefore deemed acceptable given the level of risk to agriculture associated with this proposal.

4 Results and discussion

A field survey of 15 detailed sites and four check sites was undertaken from 26 May 2014 to 28 May 2014 covering the four soil units identified in the existing mapping. The survey confirmed the presence of the four soil units identified in the proposal area. Soil units were renamed in line with the Australian soil classification (Isbell 1996) as described in Table 4.1. Figure 4.1 shows the survey locations and the resultant soil mapping from this recent survey.

Table 4.1 Renamed soil units

Original soil units names	New soil units names
Uniform sand	Arenic rudosol
Duplex sand	Yellow sodosol
Grey pink duplex loam	Grey sodosol
Brown duplex loam	Brown kurosol

The type of observations made at each survey site are listed in Table 4.2.

Table 4.2 Site units

Detailed sites	Check sites
US1	DSC1
US2	DSC2
US3	DSC3
DS1	DSC4
DS2	
DS3	
DS4	
DS5	
GP01	
GP02	
GP03	
B01	
B02	
B03	
B04	

4.1 Polygons

The survey confirmed the presence and spatial extent of six of the seven soil polygons identified in the original survey. The northern most Duplex sand (Yellow sodosol) polygon identified in Figure 2.1 was found to be incorrect and through the use of two detailed and four check sites, the polygon was found to be Arenic rudosol (Uniform sand). This soil unit is consistent with the soil units to its immediate north and south.

The correction was made in line with the Interim protocol which states that a soil polygon has to be greater than 70 per cent of a single soil type. Only a small area on the eastern side of the polygon, along

the access track, is composed of the Yellow sodosol (Duplex sand). The incorrect polygon was corrected and merged with the surrounding Arenic rudosol (Uniform sand) polygons as shown in Figure 4.1.

4.2 Soil units

The four soil units identified in existing soil mapping where found to be consistent with those identified during the survey.

The soil unit descriptions from the existing soil mapping, shown in Appendix C, were found to have a strong correlation with the field survey results. The field survey results are attached in Appendix D in the form of BSAL soil data cards.

4.3 Laboratory data

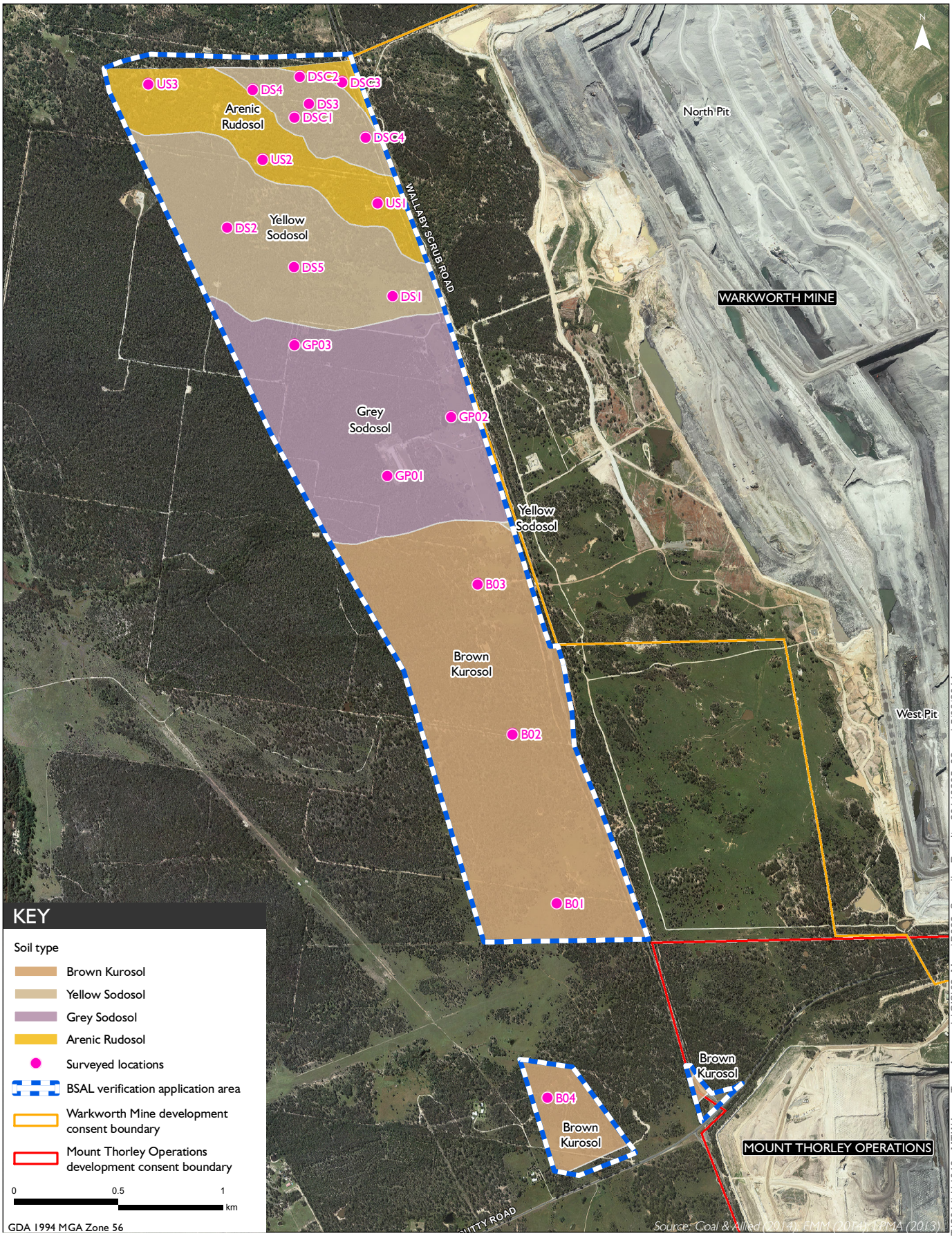
The laboratory analysis further confirms the existing descriptions of the four soils units identified by existing mapping. All four soil units consistently demonstrate low soil fertility with the Arenic rudosol demonstrating particularly low levels. The Yellow sodosol, Grey sodosol and Brown Kurosol demonstrated exchangeable sodium percentages that were sodic to strongly sodic. Strongly acidic surface soils that were below ideal plant growth levels (pH 5.5) were noted in all four soil units.

The BSAL assessment failed the four soil units on low fertility. This assessment is consistent with the low soil fertility apparent in the laboratory results.

4.4 BSAL determination

The BSAL verification report at Appendix A, found that there were was no BSAL within the proposal area based on the four soil units in existing soil mapping.

This survey has not identified any significant changes in the presence or quality of soil units found within the proposal area. The change in extent of soil units will have no bearing on the BSAL verification assessment report findings (Appendix A). Figure 4.2 shows the resulting BSAL mapping for the proposal area based on the detailed soil description from the sampling locations shown on Figure 2.1.



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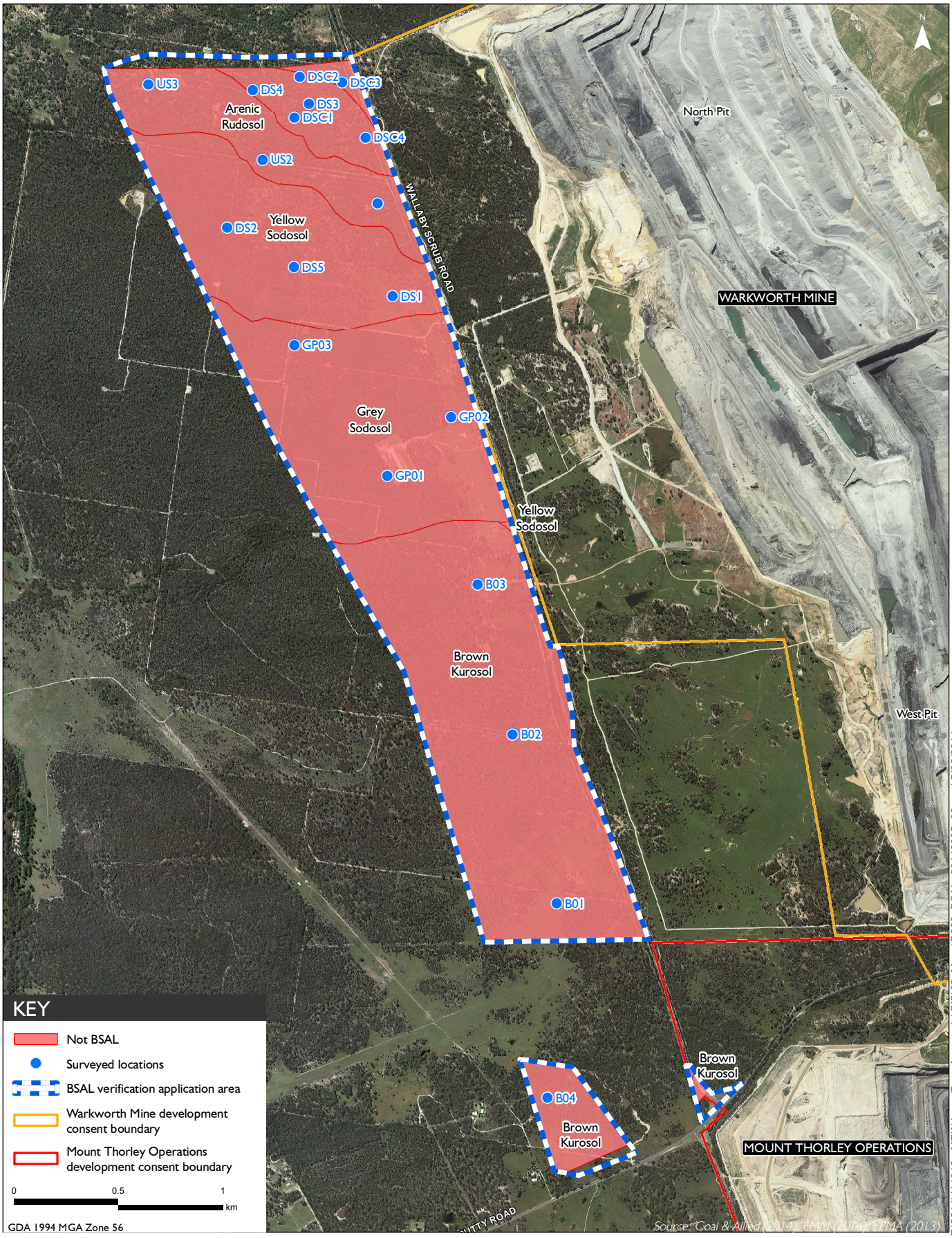
Sampling results
Warkworth Mine continuation
BSAL verification
Figure 4.1



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BSAL map
Warkworth Mine continuation
BSAL verification
Figure 4.2

5 Conclusions

The soil survey descriptions used for the BSAL verification report were found to accurately describe the soil units within the proposal area. An incorrectly identified polygon was recognised and corrected by this survey. There was no influence on the findings of the BSAL verification report by this error.

This survey therefore confirms and supports the original determination that there is no BSAL located within the proposal area.

6 References

EMM 2014, BSAL *Site verification certificate report*.

GSS Environmental 2010, *Warkworth mine extension: Soil survey and land resource assessment report*.

Isbell RF 1996, *The Australian soil classification*, CSIRO Publishing, Collingwood.

Office of Environment and Heritage 2013, *Interim Protocol for site verification and mapping of biophysical strategic agricultural land New South Wales*, New South Wales Government.

McKensie NJ, Grundy MJ, Webster R & Ringrose-Voase 2008, *Guidelines for surveying soil and land resources*, second edition, CSIRO Publishing, Collingwood.

Appendix A

BSAL verification report

BSAL Site Verification Certificate Report

Warkworth Continuation 2014

Prepared for Rio Tinto Coal Australia | 8 May 2014

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BSAL Site Verification Certificate Report

Final

Report J14013RP1 | Prepared for Rio Tinto Coal Australia | 8 May 2014

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Date	8 May2014	Date	8 May2014

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FINAL	8/05/2014	Ross Aitken-Smith	Dr Tim Rohde

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Table of Contents

Appendices

Tables

Tables

Figures

1 Introduction

1.1 Legislative context

In 2012, the NSW government introduced the *Strategic Regional Land Use Policy* to balance land use outcomes between agriculture and mining projects. Under this policy, the NSW Strategic Regional Land Use Plans (SRLUPs) for the Upper Hunter were developed and identified strategic agricultural lands, which comprise biophysical strategic agricultural land (BSAL) and Critical Industry Clusters (CIC). Land identified as being highly suitable for agriculture is known as BSAL while CICs are regional concentrations of highly productive industries, namely equine and viticulture, which are related to each other, contribute to the identity of that region and provide significant employment opportunities.

Clause 50A of the *Environmental Planning and Assessment Regulation 2000* requires that a development application for mining development on certain identified land (including land shown on the Strategic Agricultural Land Map) must be accompanied by:

- a gateway certificate, or
- a site verification certificate that certifies that the land on which the proposed development is to be carried out is not biophysical strategic agricultural land.

Clause 17A of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries*) *2007* (the Mining SEPP) defines mining development as:

> 1(a) development specified in clause 5 (Mining) of Schedule 1 to State Environmental Planning Policy (State and Regional Development) 2011, but only if:
>
> (i) a mining lease under the *Mining Act 1992* is required to be issued to enable the development to be carried out because:
>
> (A) the development is proposed to be carried out outside the mining area of an existing mining lease.

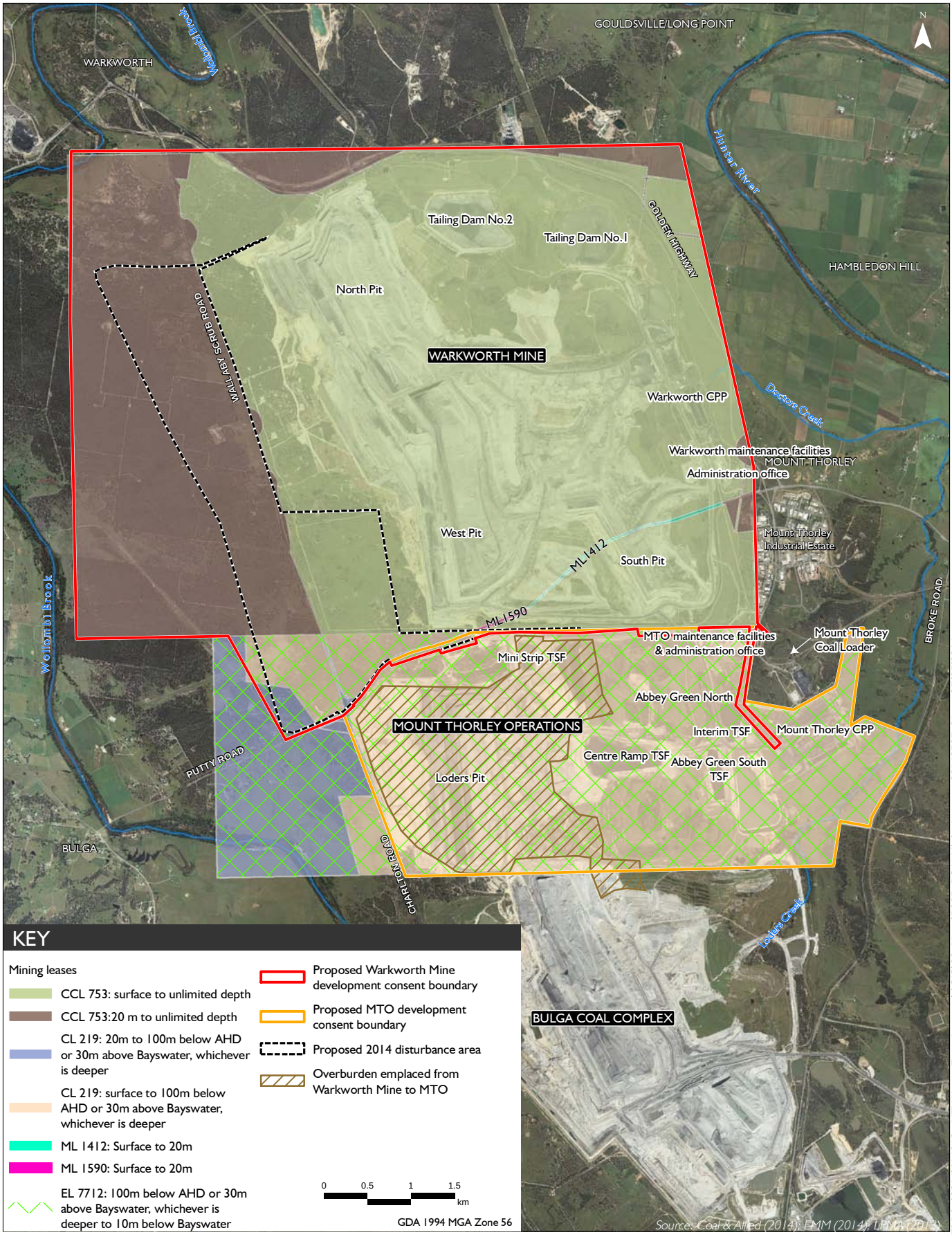
Further to this, under the S*tate Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013* (the 2013 Mining SEPP amendment), where a mining lease is required, State Significant Development (SSD) that is wholly or partially on either BSAL or an area mapped as CIC, must be considered through the Gateway process unless additional verification can prove otherwise. The assessment of the potential impacts of a proposal on agricultural land and water resources (including CICs) must be undertaken before a development application is lodged.

In light of the above, Warkworth Continuation 2014 constitutes a mining development, as defined in the Mining SEPP. The footprint of the proposal is located within a mining lease 20m below ground level (bgl), however requires a mining lease from the surface to 20m bgl. The majority of the footprint contains endangered ecological communities (EECs).

Although there are no lands mapped as BSAL within the footprint of disturbance, and the majority of the footprint contains EECs, the proponent still requires either a gateway certificate or a BSAL site verification certificate prior to lodging a development application because a surface mining lease is required.

1.2 Project context

The majority of the Warkworth Continuation 2014 (the proposal) area is withinCCL753, with the southern part within CL219 (which is a Mount Thorley Operations mining tenement) (Figure 1.1). Within the proposed mining area, CCL753 and the section of CL219 are subsurface mining leases granted in 1981. These mining leases do not include the surface to 20m depth. Mining Lease Applications 352 and 353 cover the surface to 20m depth required for the proposal, however these are yet to be approved. For the purposes of this report, these areas are known as the BSAL verification application area. The BSAL verification application area is approximately 667.5ha and shown in Figure 1.2.



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Mining leases
Warkworth Mine continuation
BSAL verification report
Figure 1.1

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BSAL verification application area

Warkworth Mine continuation
BSAL verification report
Figure 1.2

1.3 Purpose

This report has been prepared in accordance with the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013) with the purpose of obtaining a site verification certificate for the BSAL verification application area to enable lodgement of a development application.

The BSAL verification application area is outside areas mapped as BSAL in the SRLRP. However, due to the regional scale of the mapping, where a proposal potentially triggers the Gateway process the proponent is required to undertake further evaluation to confirm that the proposal will not impact BSAL. Where BSAL is not identified, a site verification certificate is required that certifies that the land where the proposal is to be carried out is not BSAL.

The NSW Government has undertaken mapping for the 2013 Mining SEPP amendment to identify BSAL and the equine and viticulture CICs at a regional scale. The proposal is outside the 2km barrier nominated by the SRLUP Guidelines for CICs and hence further assessment is not required.

1.3.1 Statement of qualification

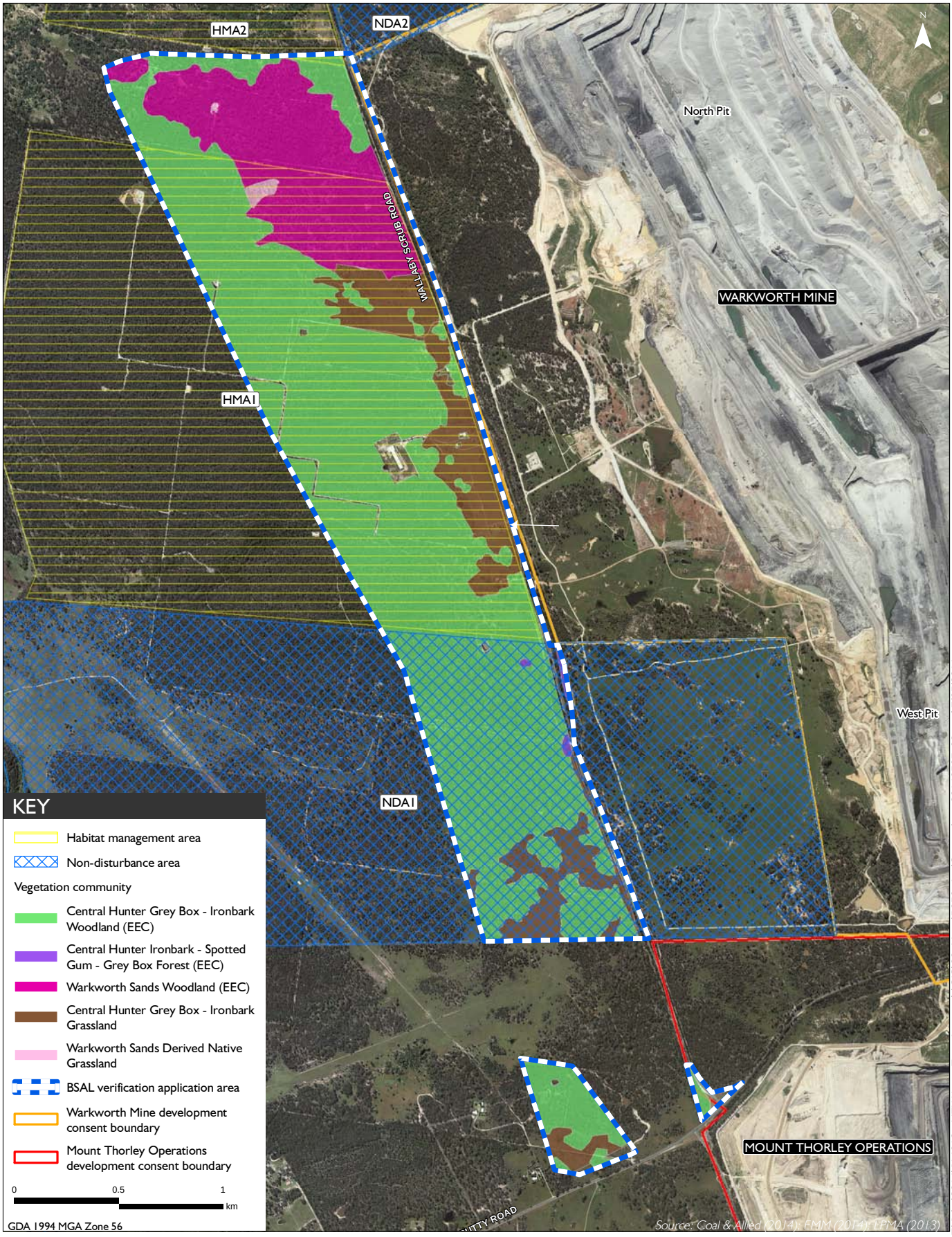
This report has been prepared with the oversight of Dr. Timothy Rohde a certified professional soil scientist. Dr. Rohde's qualifications and accreditations are presented in Appendix A.

1.4 Biophysical constraints to agriculture

Several existing biophysical constraints are present at the BSAL verification application area, which prevent it from meeting the criteria for BSAL (Figure 1.3). The constraints include the predominant presence of EEC woodland with little to no grassland or pasture.

The existing land use is also constrained by the presence of the Green Offsets, protected under the existing development consent for Warkworth Mine (DA 300-9-2002i). The Green Offsets comprise a habitat management area (HMA) and a non-disturbance area (NDA). The woodland areas contain EECs listed under the NSW Threatened Species Conservation Act 1995.

Currently no agriculture occurs at the BSAL verification application area. It should be noted that the HMA and NDA will be relocated as part of Warkworth Continuation 2014.



Constraints for agriculture

Warkworth Mine continuation

BSAL verification report

Figure 1.3

1.4.1 Habitat management areas

The existing HMA comprises the majority of the BSAL verification application area (Figure 1.3). The HMA limits all agricultural activity. The HMA was established upon granting of the current development consent in 2003. As part of the development consent and the prescribed management regime, no agricultural activity can currently occur within the HMA.

1.4.2 Non disturbance area

Similarly, the NDA within the BSAL verification application area (Figure 1.3) was also established upon granting of the current development consent in 2003. As part of the development consent and the prescribed management regime, no agricultural activity can currently occur within the NDA.

1.4.3 Endangered ecological communities

The majority of the BSAL verification application area has been identified as the Central Hunter Grey Box - Ironbark Woodland EEC (Figure 1.3). A smaller portion in the north of the site has been mapped as Warkworth Sands Woodland EEC. Within the BSAL verification application area, the Central Hunter Grey Box – Ironbark Woodland EEC is associated with Duplex Sand, Grey Pink Duplex Loam, Brown Duplex Loam and Uniform Sand soil units and the Warkworth Sands Woodland EEC is associated with the Uniform Sand soil unit. Both EECs have been excluded from agricultural activities for an extended period of time. The listing protects the EECs from everything except "routine agricultural management activity". Accordingly, there are no real prospects of the site ever being classified as BSAL.

1.5 Risk to agriculture

The potential impacts to agricultural resources are considered low given the presence of EEC woodland where no agricultural land use exists.

A risk assessment was undertaken in accordance with:

- the Guideline for Agricultural Impact Statements at the Exploration Stage (DTIRIS, 2012) which is based on the probability of occurrence and the consequence of the impact, as described in the Land Use Conflict Risk Assessment Guide (NSW DPI 2011)
- Appendix 3 of the Interim Protocol for site verification and mapping of biophysical strategic agricultural land.

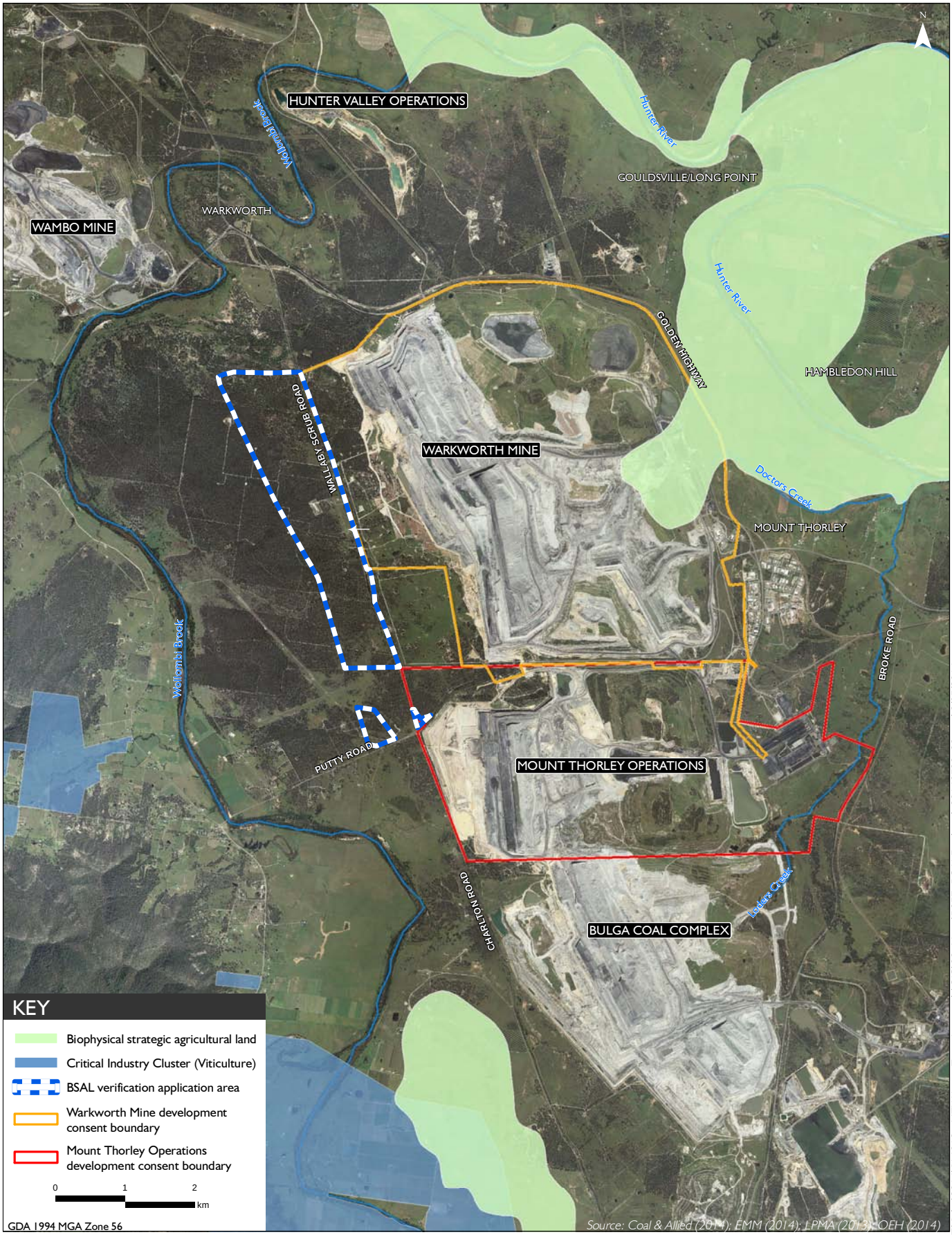
Based on the risk matrix contained within the Guideline for Agricultural Impact Statements at the Exploration Stage, a risk ranking of A5 ‘low risk’ of agricultural impact was determined.

The A5 risk ranking is based on a consequence of ‘very minor damage and minor impact to agricultural resources or industries’ with a likelihood of the consequence being an ‘almost certain’ probability. Due to the absence of agricultural activity and predominance of EEC woodland this risk ranking is appropriate as ‘no measurable or identifiable impact on an agricultural resource or industry’ can be identified.

2 Regional verification of biophysical strategic agricultural land

The regional BSAL trigger map is presented in Figure 2.1 and indicates no BSAL in the vicinity of the proposal. The nearest BSAL is approximately 4 km to the east. Due to the regional scale of the SRLUP mapping, the proponent is required to undertake further evaluation to confirm that BSAL will not be impacted. Where BSAL is not identified, a site verification certificate is required that certifies that the land, where the proposal is to be carried out, is not BSAL.

The nearest CIC is approximately 5 km to the south, outside the 2 km barrier nominated by the SRLUP Guidelines for CICs and hence further CIC assessment is not required.



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Regional BSAL trigger map
Warkworth Mine continuation
BSAL verification report
Figure 2.1

3 Local verification of biophysical strategic agricultural land

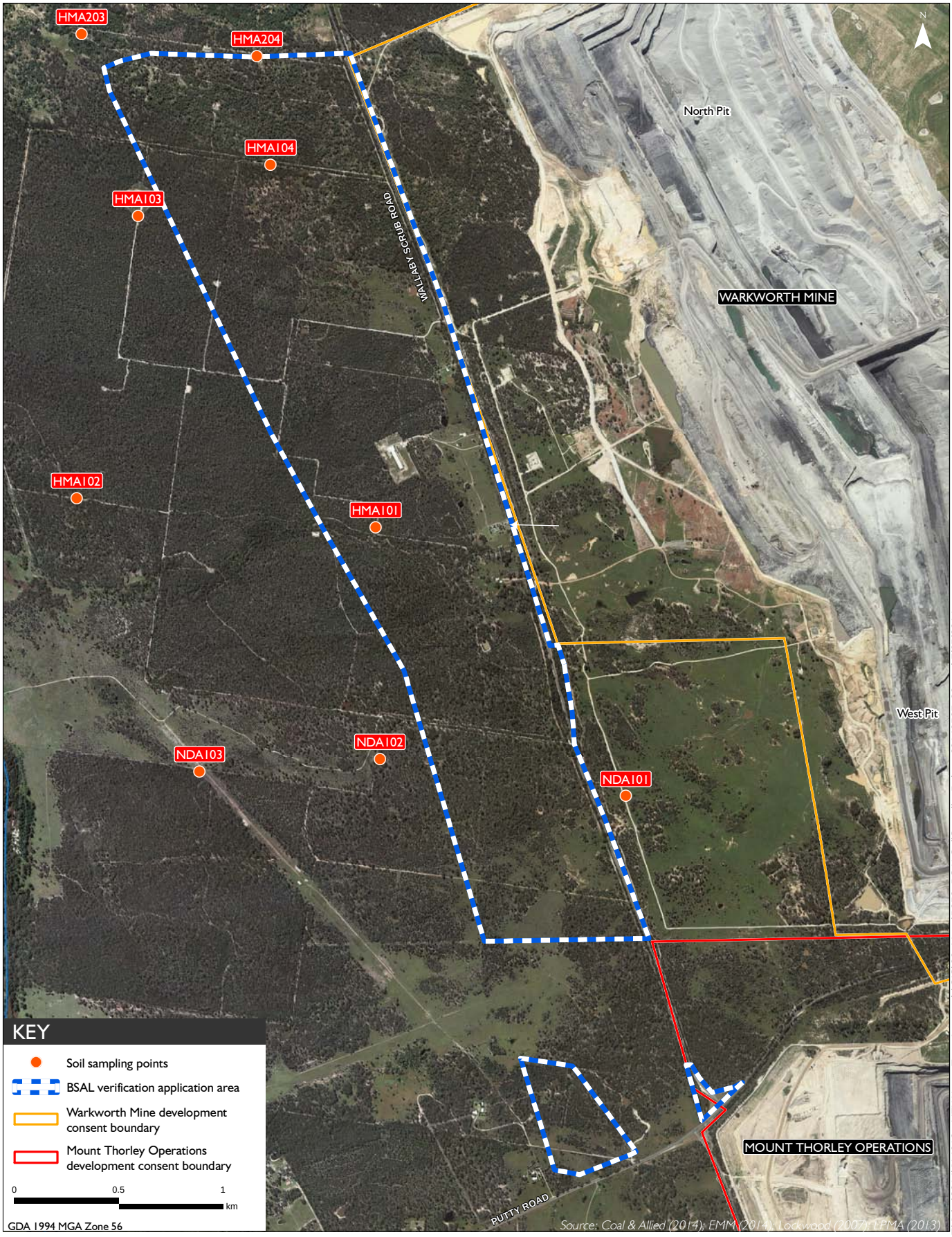
3.1 Method

The BSAL verification has been completed by desktop assessment using the following studies:

- Lockwood PV (2007) *Warkworth Sands soil survey: Soil sampling and analysis within the Green Offsets and Archerfield*; and
- GSS Environmental (2010) *Warkworth mine extension: Soil survey and land resource assessment*.

The GSS Environmental (GSSE) soil survey and resource assessment was a desktop study, with limited test-pitting done outside the BSAL verification application area. The soil survey and resource assessment drew upon a number of regional scale (1:250,000) and local scale (<1:100,000) soil surveys that incorporated part or all of the proposed activity area. GSSE produced a local scale map (<1:100,000) showing the spatial distribution of soil. Soils were described using an adaption of the Northcote (1971) key. The relevant aspect of the GSSE soil survey to the assessment area has been reproduced in Figure 3.1.

The BSAL verification assessment follows the key steps described in the *Interim Protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013).



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Soil sampling points
Warkworth Mine continuation
BSAL verification report
Figure 3.1

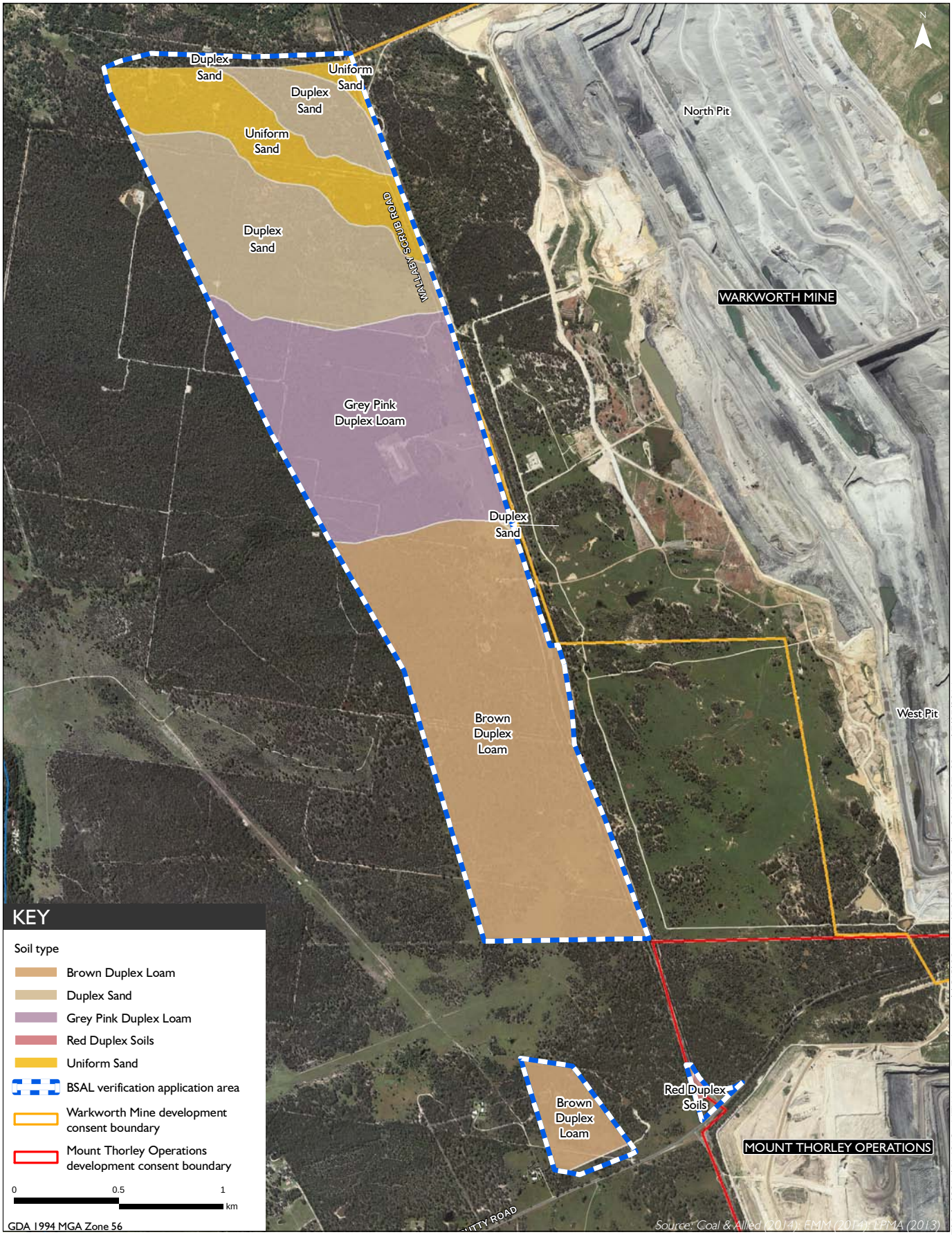
3.1.1 Scale of biophysical strategic agricultural land verification assessment

The BSAL verification requires a soil survey scale of at least 1:100,000 correlating to a low level of risk. The risk ranking for the BSAL verification application area is described in Section 1.5 of this report.

The *Interim Protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013) in Appendix 3 describes a minimum sample density of one sample site per 25 to 400 hectares (ha) for BSAL assessment of low risk activities.

The BSAL verification of the BSAL verification application area has been done using soil descriptions and laboratory analysis reported in the Lockwood (2007) study. The relevant laboratory sample locations and soil descriptions from Lockwood (2007) are presented in Figure 3.1 and Figure 3.2 respectively. The soil descriptions and laboratory sample locations are relevant because they either fall inside or very close to the BSAL verification application area.

The BSAL verification application area is approximately 667.5 ha. The BSAL verification utilises six sample locations correlating to approximately one sample per 100 ha. The BSAL verification results described in Section 3.2 are therefore relevant for a low risk activity and satisfy guidance described in Appendix 3 of OEH (2013). It should also be noted that the site descriptions and laboratory sample locations used in this BSAL verification are evenly distributed across the BSAL verification application area, with at least one description and one set of laboratory data available for each soil unit described by GSSE (2010) and presented in Figure 3.2 .



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Soil units
Warkworth Mine continuation
BSAL verification report
Figure 3.2

3.1.2 Soil descriptions

Both GSSE (2010) and Lockwood (2007) have used different conventions for the naming of each soil unit. A comparison between the two naming conventions that shows how soil units align is provided in Table 3.1.

Table 3.1 Soil unit classification comparison

GSSE (2010)	Lockwood (2007)
Brown duplex loam	Sodosols (brown and yellow)
Red duplex loam	Sodosols (red)
Duplex sand	Shallow Warkworth sands (Sodosols)
Grey-pink duplex loam	Sodosols (grey)
Uniform sand	Deep Warkworth sands (Tenosols)

The Lockwood (2007) soil descriptions of the soil profile relevant to this BSAL verification assessment is provided as Appendix B.

3.1.3 Laboratory analysis

Laboratory analysis for the six soil units listed in Table 3.2 were completed by Lockwood (2007). The laboratory analysis is included as Appendix C.

Table 3.2 Lockwood (2007) soil sample number and soil unit

Lockwood (2007) soil sample number[1]	Soil unit[2]
HMA204	Duplex sand
HMA104	Uniform sand
HMA103	Grey-pink duplex loam
HMA101	Grey-pink duplex loam
NDA102	Brown duplex loam
NDA101	Brown duplex loam

Notes: 1.Refer to Figure 3.1.

2. Refer to Figure 3.2 and Table 3.1

3.2 Results

Table 3.3 tabulates the results of the BSAL verification assessment. The BSAL verification assessment has been undertaken using the following resources:

- flow chart for site assessment of BSAL presented at Figure 2 in the *Interim Protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013);
- soil profile descriptions;
- soil profile laboratory analysis;
- water availability from the NSW Office of Water (NOW); and

- relative fertility assessment from the Appendix 2 of the *Interim Protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013).

Table 3.3 BSAL assessment for BSAL verification application area

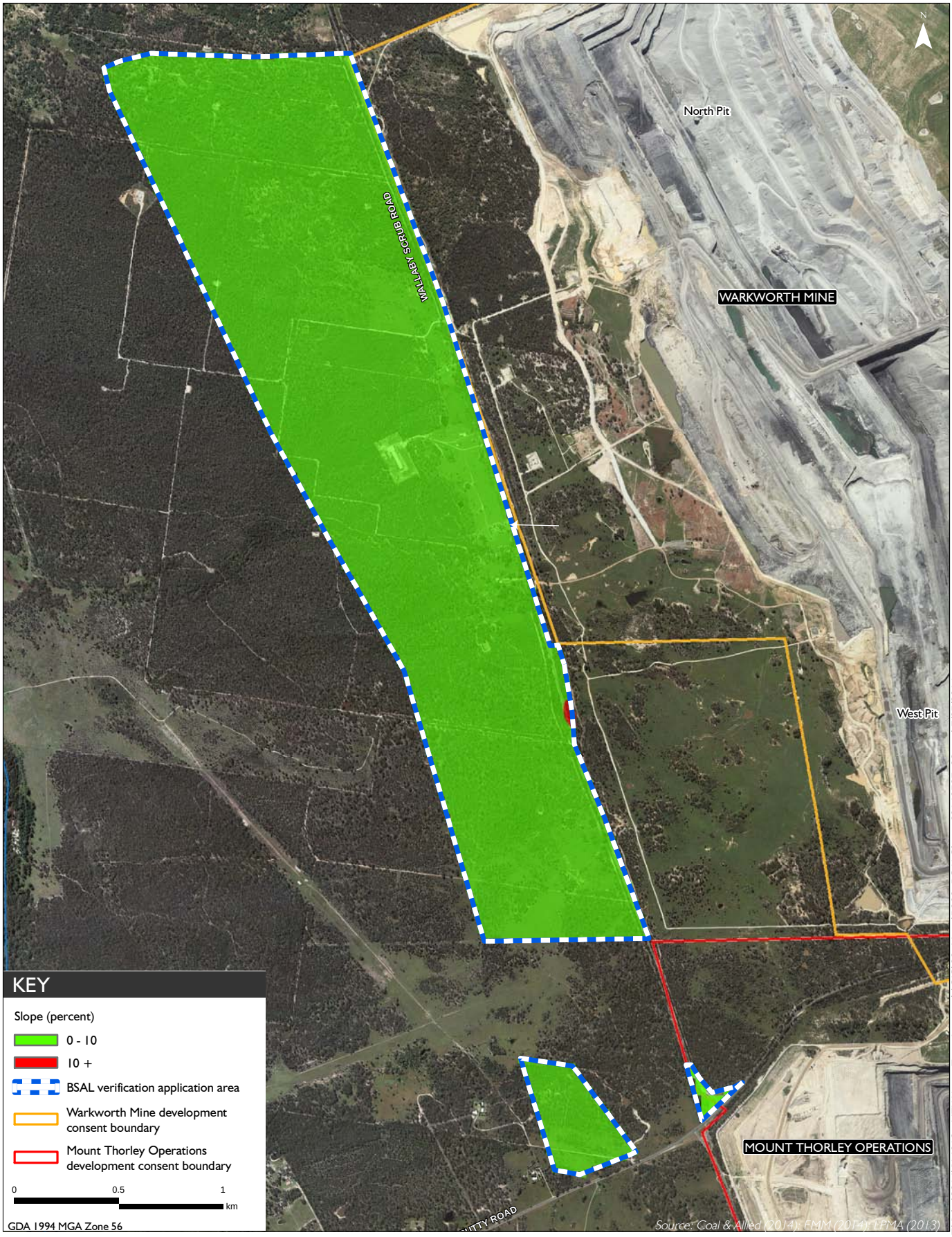
Criteria	Duplex sand (HMA204)	Uniform sand (HMA104)	Grey-pink duplex loam (HMA103)	Grey-pink duplex loam (HMA101)	Brown duplex loam (NDA102)	Brown duplex loam (NDA101)
Access to "reliable water supply" (only 1 "YES" is required to proceed)						
Within the area mapped using BOM data as having 350mm and above rainfall 9 out of 10 years?	Yes	Yes	Yes	Yes	Yes	Yes
Overlying a groundwater source declared by NOW as highly productive groundwater?	-	-	-	-	-	-
Within the area mapped by NOW as being within 150m of a highly reliable surface water supply?	-	-	-	-	-	-
Onsite verification can show access to a reliable water supply by localised groundwater conditions or alternate access to a highly reliable surface water supply via an easement	-	-	-	-	-	-
Soils and landscape verification (requires a "YES" to proceed to the next step)						
Is the slope ≤ 10% (refer to Figure 3.3)	Yes	Yes	Yes	Yes	Yes	Yes
Is there <30% rock outcrop?	Yes	Yes	Yes	Yes	Yes	Yes
Does ≤20% of area have unattached rock fragments >60mm diameter?	Yes	Yes	Yes	Yes	Yes	Yes
Does ≤50% of area have gilgais >500mm deep?	Yes	Yes	Yes	Yes	Yes	Yes
Soils and landscape verification (only 1 "YES" is required to proceed)						
Is slope between 5% and 10%? And does soil have moderately high or high fertility?	No	No	No	No	No	No
Is slope <5%? And are there some rock outcrops? And does soil have moderately high or high fertility?						
Is slope <5%? And Are there nil rock outcrops? And does soil have moderate fertility?						
Soils and landscape verification (requires a "YES" to proceed to the next step)						

Table 3.3 BSAL assessment for BSAL verification application area

Criteria	Duplex sand (HMA204)	Uniform sand (HMA104)	Grey-pink duplex loam (HMA103)	Grey-pink duplex loam (HMA101)	Brown duplex loam (NDA102)	Brown duplex loam (NDA101)
Is effective rooting depth to a physical barrier ≥750mm?						
Is soil drainage better than poor?						
Is pH within the upper 600mm pH_{water} 5–8.9 or ph_{CaCl} 4.5–8.1?						
Is salinity within the upper 600mm (ECe) 4dS/m or chloride <800mg/kg when gypsum is present?						
Is effective rooting depth to a chemical barrier ≥75mm?						
Minimum area						
Does the biophysical resource have a contiguous area of ≥20ha?						
BSAL						
Is the Soil Management Unit (SMU) deemed to be BSAL						

Notes: *1. Source: Interim protocol for site verification and mapping of biophysical strategic agricultural land (OEH 2013).*

2. YES indicates that the source information does not provide a clear no decision and therefore a yes is applied.*



EMM
EMGA Mitchell McLennan

COAL & ALLIED
Managed by Rio Tinto Coal Australia

Slope
Warkworth Mine continuation
BSAL verification report
Figure 3.3

3.3 Assessment outcomes

The BSAL verification assessment is completed by exclusion. That is, once a soil has failed on one criterion it can no longer be categorised as BSAL.

The BSAL verification assessment has shown that all soil units have failed the BSAL verification assessment on the basis of having fertility less than 'moderately high'.

No soil units within the BSAL verification application area are classified as BSAL.

It should also be noted that:

- The Uniform sand/Tenosol (HMA104) would have also likely failed on the basis of rooting depth. That is the soil profile descriptions (Appendix D) indicate that the soil profile is less than 750mm.

- The Duplex soils/Sodosols (HMA204, HMA103, HMA101, NDA101 and NDA102) would have likely failed on the basis of poor drainage. That is the soil profile descriptions (from GSSE 2010) indicate the presences of gleying and mottling (refer to Table 2 of the *Interim Protocol for site verification and mapping of biophysical strategic agricultural land* (OEH 2013)).

4 Conclusion

The Warkworth Continuation 2014 constitutes a mining development, as defined in the Mining SEPP. The footprint of the proposal is located within a mining lease 20 m below ground level (bgl) and requires a mining lease from the surface to 20 m bgl. The majority of the footprint contains EECs.

Although there are no lands mapped as BSAL within the footprint of disturbance, and the majority of the footprint contains EECs, the proponent is still required to obtain either a gateway certificate or a BSAL site verification certificate, because a surface mining lease is required. These requirements precede lodgement of a development application.

BSAL verification has been undertaken in accordance with the Interim protocol for site verification and mapping of biophysical strategic agricultural land (OEH 2013).

The BSAL verification has found the proposal to have a low risk of agricultural impact due to the absence of agricultural resources within the footprint. The verification has found that all soil units have failed the BSAL verification assessment on the basis of having fertility less than moderately high. No soil units within the BSAL verification application area are classified as BSAL.

It should also be noted that:

- The Uniform sand/Tenosol (HMA104) would have also likely failed on the basis of rooting depth.
- The Duplex soils/Sodosols (HMA204, HMA103, HMA101, NDA101 and NDA102) would have likely failed on the basis of poor drainage.

This report has shown that the nearest CIC is approximately 5km to the south, outside the 2km barrier nominated by the SRLUP Guidelines for CICs and no further assessment is required.

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GSS Environmental (2010) Warkworth mine extension: Soil survey and land resource assessment report

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http://www.resources.nsw.gov.au/environment/pgf/Glines/agricultural-impact-statements

Appendix A

Statement of qualification

Curriculum vitae

Timothy Rohde

Associate Environmental Scientist

Timothy is a Senior Environmental Scientist with 11 years environmental consulting experience in Australia and Indonesia. His work encompasses mining engineering, geotechnical engineering, unsaturated soil mechanics, soil science and geochemistry. Since 2004, he has specialised in mining waste characterisation including waste rock dumps, tailings storage facilities and heap leach piles. Timothy also specialises in closure and rehabilitation having managed projects related to closure cost estimation and technical aspects related to closure of waste rock dumps, tailings storage facilities and heap leach piles.

Timothy is uniquely placed not only understanding geochemistry of these structures but also design and closure to limit / mitigate environmental issues that these mine domains can produce.

Education and Professional Qualifications

- PhD (Mining Engineering), University of Queensland, (UQ), 2009
- Post Graduate Diploma (Mined Land Rehabilitation), (UQ), 2004
- Bachelor of Environmental Science (Natural Resource Science), (UQ), 2002
- Chartered Professional Soil Scientist (CPSS), Stage 2

Previous Positions and Appointments

- Senior Scientist – Mining, Sinclair Knight Merz, 2011-2012
- Senior Scientist – Mining, Environmental Earth Sciences, 2010-2011
- Senior Scientist – Mining, AECOM, 2008-2010
- Associate Lecturer / Research Fellow, The University of Queensland, 2007-2008
- Consultant to UniQuest, The University of Queensland, 2002-2007

Professional Affiliations

- Australian Society of Soil Science
- International Union of Soil Science
- Central Queensland Mine Rehabilitation Group
- MAusIMM

Publications

- Chapman P.J., Willimas, D.J., and Rohde, T.K. (2009) *Unsaturated Behaviour of Tailings during Deposition and Desiccation Cycles with Reference to Closure Design.* Proceedings of the 4th Asia-Pacific Conference on Unsaturated Soils, Newcastle, Australia, 23-25 November 2009. Publisher Unknown.
- Chapman P.J., Willimas, D.J., Rohde, T.K., and Ennor S.J. (2009). *Acid Drainage Management and Closure Design of a Sulfidic Tailings Storage Facility in a Dry Climate.* Proceedings of the 8th International Conference on Acid Rock Drainage, Skellefteå, Sweden, 23-26 June 2009. Publisher Unknown.
- Rohde, T.K. (2012). *Strategic Cropping Land: Implications for Approval – Applications to Closure.* Proceedings of 1st International Conference on Life of Mining, Brisbane, Australia, 10-12 July 2012, The AUSIMM. Draft Submission.

Curriculum vitae

Timothy Rohde

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- Rohde, T.K. and Williams, D.J. (2011). *Store and Release Cover Performance at Cadia Hill Gold Mine. NSW Australia.* Proceedings of 6th International Conference on Mine Closure, Alberta, Canada, 18-21 September 2011, Australian Geomechanics Centre. In Press.

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- Williams, D.J. & Rohde, T.K. (2007). *Saturation required for continuum flow through different mine waste materials*. Proceedings of 10th Australia New Zealand Conference on Geomechanics, Brisbane, Australia, 21-24 October 2007, II, 280-285.

- Williams, D.J. & Rohde, T.K. (2007). *Strategies for reducing seepage from surface waste rock piles during operation and post-closure.* Proceedings of 2nd International Seminar on Mine Closure, Santiago, Chile, 16-19 October 2007, I, 521-532.

- Williams, D.J. & Rohde, T.K. (2008). *Rainfall infiltration into and seepage from waste rock piles – A review.* Proceedings of 1st International Seminar on Rock Dumps, Stockpiles and Heap Pads, Perth, Australia, 5-6 March 2008. Australian Geomechanics Centre.

- Williams, D.J. & Rohde, T.K. (2008). *Waste rock dump rainfall infiltration and base seepage at Cadia.* Proceedings of 6th Australian Workshop on Acid and Metalliferous Drainage, Burnie, Australia, 15-17 April 2008. Australian Centre for Minerals Extension Research.

- Williams, D.J., and Rohde, T.K. (2008). *Field Measurements of Mine Rock Dump Rainfall Infiltration and Base Seepage.* Geotechnical News, 26(1), 52-57.

- Williams, D.J., Rohde, T.K., Stolberg, D.J. & Pope, G. (2006). *Alternative design and instrumentation of covers over potentially acid forming mine wastes.* Proceedings of 5th International Congress on Environmental Geotechnics, Cardiff, UK, 26-30 June 2006, II, 1007-1014.

Curriculum vitae


Timothy Rohde

Representative Experience

Geochemistry Studies

- Mt Boppy, (NSW) 2011. Timothy completed a geochemistry baseline study of the Mt Boppy mine area to determine the potential for future acid mine drainage upon recommencing mining at the site. The study included a desktop review of site core logs and Total S assays to determine the likely geology units that may produce acid mine drainage. The desktop review was verified by limited sampling of the pit wall surface sulfides and the tailings storage facility. The project outcomes included a waste rock sulfur model and a waste rock management plan to limit future risk of acid mine drainage.

- Granny Deeps Project, (WA) 2010. Timothy has undertaken a geochemistry prefeasibility study for the proposed project. Project scope included development of a geochemistry block model for the proposed open pit accounting for environmental mitigation of acid rock drainage.

- Queen Bee Historical Mine, (NSW) 2010. Timothy completed a closure study for the site, satisfying the following general principles:

    - Geochemistry: This included understanding the geochemistry of waste rock and its ability to generate acid and metalliferous drainage;

    - Water Management: This included both surface water management of clean water entering clean water diversions and dirty water temporarily stored in evaporation ponds prior to removal by evaporation; and

    - Cover Design and Sediment Management: This included an understanding of the physical and chemical characteristics as well as an infiltration water balance to ensure that percolation into the underlying reactive waste rock was limited.

- Wetar Island, (Indonesia) 2008 – 2011. Timothy developed a waste rock dump design for environmental mitigation in escarped and difficult terrain. Timothy was also responsible for identifying environmental mitigation strategies and final closure and rehabilitation of the proposed heap leach pile to be constructed in sequential lifts over a 10 year period. The project is based in Indonesia, all environmental design has been approved under local laws and regulations.

- Mt Goldsworthy, (WA) 2009. Timothy undertook a review of all historical geochemistry data at the mine site to reassess potential acidity loads released to the environment (ARD). Based on the review and knowledge of local geology Timothy completed a conceptual design of a pit pump back system to return contaminated seepage to the open pit lake. Pit water quality was modelled over several years using PHREEQC.

- Stuart Oil Shale, (QLD) 2008 – 2010. Timothy has completed an assessment of the acid forming potential of waste rock and processed shale from an oil shale project near Gladstone. The assessment included kinetic column testing and leachate analysis. Timothy also designed the final covers trials for placed spent shale material (please refer to publication list).

Curriculum vitae


Timothy Rohde

- Olympic Dam, (SA) 2008. Timothy in collaboration with HLA completed static and kinetic testing program. Geochemical modelling (PHREEQC) was used to enhance prediction capability and assess natural attenuation mechanisms known to exist in the underlying limestone and calcareous clays.

- Telfer, (WA) 2009. Timothy identified opportunities and constraints on the use of saline mine water derived from the Telfer underground operations and addressed the key issues associated with its use on the surrounding landscape. Timothy completed a desktop review of the likely soil classification and boundaries across the mine area and undertook simple geochemical modelling (PHREEQC) to assess the likely mechanisms affecting fate and transport of surface salt resulting from evaporation of applied dust suppression water.

Mine Site Compliance and Closure

Timothy has experience in mine site compliance and closure having completed compliance and closure designs for waste rock dumps, tailings storage facilities and surface water management and release.

Recent projects include:

- Broken Head Quarry (NSW) 2012 in progress. Timothy is currently preparing a detailed closure strategy, landform model and ± 30% closure cost estimate investigating the option of returning the quarry area into a rural residential development.

- Channar (WA) 2012, in progress. Channar is scheduled to cease approximately in the mid 2020's. To satisfy the requirements of Channar Mining Joint Venture Agreement the site is required the development of a closure plan and Cost Estimate to a ±20% level of accuracy. Timothy's role on the project was as Landform Design Manager. In this role Timothy lead a team of 6 people as well as completing technical works related to geochemistry and soil science. Timothy was also responsible for developing the work packet for Mining One Consulting and management of the sub-consultants and technically reviewing their work.

- Stanwell Power Assets (QLD) 2011. Timothy was part of a multi-disciplinary team working on a decommissioning plan, order-of-magnitude cost estimate and rehabilitation plan for a number of power generation assets owned and operated by Stanwell Power throughout Queensland. Timothy was responsible for delineating potential site contamination and closure and rehabilitation strategies. Strategies include developing bills of quantities as foundation assumptions towards the cost estimation study.

- QAL, (QLD) 2011. To comply with Rio Tinto's Closure Standard, QAL was updating an existing closure plan prepared in 2003. The closure plan included the refinery, associated red mud dam areas and the wharf and storage facility located on South Trees Island connected to the mainland by a causeway bridge. Timothy was the Project Manager on the project and coordinated a team of 12 people, including cost estimator, engineers and scientists. Timothy was also responsible for preparing the final deliverables (Knowledge base review, Closure strategy, Closure management plan and Closure cost estimate).

- Tanami Gold, (NT) 2011. Timothy authored the Notice of Intent (NOI) for the Central Tanami Project (former Groundrush, Newmont Asia Pacific). The purpose of the NOI is to provide the NT government with sufficient detail to determine whether the project will be reviewed by either the EIS / PER process.

Curriculum vitae


Timothy Rohde

- Crocodile Gold, (NT) 2009. Timothy has undertaken Mine Management Plans and Water Management Plans for five operations prior to start-up to gain regulatory approval. Compliance reporting included developing a site water balance and a conceptual land irrigation area.

- Ranger Uranium Mine, (NT) 2008. Investigated compliance issues for RUM arising from deluge and cyclone events that resulted in pit inundation and lost production.

- Wetar Mine, Wetar (Indonesia) 2008 and 2010. Timothy has investigated the unsaturated soil mechanics behind the operational water balance for a copper heap leach pad and completed engineered closure designs. The 2010 study included conceptual design of a waste rock dump built within a coastal valley. Design considered potential environmental impacts and strategies to mitigate these potential effects.

- Newcrest Mine, (NSW) 2005 to 2008. Timothy has successfully designed an alternative closure plan resulting in management of acid rock drainage, reduced earthworks and increased visual amenity by designing the final closure plan in sympathy to the surrounding landscape.

- Century-Zinifex Mine, (QLD) 2007. Contribution to waste rock dump closure planning.

- Cosmos Nickel Mine, (WA) 2006 to 2008. Contributed to the ongoing compliant closure plan for a potentially contaminating tailings storage facility.

Timothy has prepared Mine Closure and Rehabilitation Plans including probabilistic closure cost estimation.

Recent experience includes:

- Mt Keith Nickel Operation, (WA) 2010

- Leinster Nickel Operation, (WA) 2010

- Kambalda Nickel Concentrator, (WA) 2010

- Kalgoorlie Nickel Smelter, (WA) 2010

- Kwinana Nickel Refinery, (WA) 2010

- Muja South, (WA) 2010

- Dawson Coal Mine (QLD) 2010

- Wetar Mine, Wetar (Indonesia) 2009

Curriculum vitae


Timothy Rohde

Material Management

Timothy has undertaken compaction trials (and testing of hydraulic conductivity) for a number of clients to assess the compaction performance of overburden, including rocky spoil, clayey overburden and Vertosols. These studies have involved private enterprise projects, some being highly sensitive from a political or environmental perspective.

Recent projects include:

- Century-Zinifex Mine, (QLD) 2007
- Ensham Coal Mine, (QLD) 2007
- Newcrest Mine, (NSW) 2005 to 2006

The main objective of these studies has been to assess the relative efficiency of haul truck and scrapper compaction of trafficked waste rock surfaces to assess the viability of non-inclusion of compacted clay restrictive seals as part of final closure design.

Landform and Closure Design

- Blair Athol, (QLD) 2012. Timothy was engaged by Rio Tinto Coal Australia to undertake a literature review of all relevant documentation related to landform design and closure for the Blair Athol mine. Based on the review of soil chemistry and spoil geochemistry Tim developed a field validation program to assess stockpile suitability for closure and to assess the performance of existing rehabilitated areas against a hybrid set of closure criteria that Tim developed from the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland. Based on the available literature and site validation program Tim assessed simple slopes and all of catchments for erosion potential and rates using MINErosion 3.1 and 4.1. Based on the study Blair Athol mine was able to refine their landform scheduling model and adjust their closure cost estimation accordingly.

Timothy has developed and constructed world-class demonstrations of instrumented waste rock dumps and tailings storage facilities. Instrumentation has included:

- Full weather stations to record rainfall, temperature, humidity, wind speed and direction, actual evaporation, and solar radiation;
- Lysimeters to measure base seepage and trafficked surface infiltration; and
- Temperature sensors and gas sampling tubes to assess oxygen levels and oxidation.

Recent projects include:

- Mt Keith Nickel Operation, (Conceptual Only) (WA), 2010
- Leinster Nickel Operation, (Conceptual Only) (WA), 2010

Curriculum vitae


Timothy Rohde

- Kambalda Nickel Concentrator, (Conceptual Only) (WA), 2010
- Kalgoorlie Nickel Smelter, (Conceptual Only) (WA) 2010
- Kwinana Nickel Refinery, (WA) 2010
- Toms Gully, (Conceptual Only) (NT) 2009
- Millennium Coal Mine, (QLD) 2009 to 2010
- North Point and Princess Louise, (Conceptual Only) (NT) 2009
- Cosmos Mine, (WA) 2006 to 2008
- Newcrest Mine, (NSW) 2003 to 2008
- Olympic Dam, (Conceptual Only) (SA) 2008

Cover Design

Timothy has developed and constructed world-class demonstrations of cover design trials at a number of mine sites throughout Australia. He has evaluated the “store/release” cover system as the preferred approach in semi-arid conditions, such as those that exist over much of Australia. Timothy has developed as an alternative, a thick mono-layer of overburden design. He has designed and installed real-time monitoring systems using time domain reflectometry to measure volumetric water content, thermocouple sensors to measure soil suction, and lysimeters to measure percolation rates at the cover/waste interface and the waste/foundation interface. Timotyh is an experienced modeller and routinely uses HYDRUS-2D and Vadose/w.

Recent projects include:

- Century Mine (QLD) 2012
- Iluka Mineral Sands (Vadose/w) (SA) 2012
- Brukunga Legacy Site (Vadose/w) (SA) 2012
- Mt Keith Nickel Operation, (Conceptual Only) (WA) 2010
- Leinster Nickel Operation, (Conceptual Only) (WA) 2010
- Kambalda Nickel Concentrator, (Conceptual Only) (WA) 2010
- Kalgoorlie Nickel Smelter, (Conceptual Only), (WA) 2010
- Francis Creek, (NT) 2009

Curriculum vitae


Timothy Rohde

- Toms Gully, (Conceptual Only) (NT) 2009
- Millennium Coal Mine, (QLD) 2009 to 2010
- North Point and Princess Louise, (Conceptual Only) (NT) 2009
- Newcrest Mine, (NSW) 2003 to 2008
- Stuart Shale Oil, (QLD) 2005
- Kidston Mine, (QLD) 2003

Mining Co-disposal

Timothy has been involved in the development of co-disposal techniques. He developed co-disposal to allow better use of available storage volume, better grading and limit oxygen ingress. Key findings from Timothy's work have included improved grading by co-disposal limits oxygen ingress via the base rubble zone and coarse-grained angle of repose layers. In addition, co-disposal results in an increased water holding capacity. This means that the mixture will remain saturated to a greater degree than relatively free-drained coarse waste rock, reducing the availability of oxygen and potential oxidation of any sulfides present, thus further reducing the potential for Acid Mine Drainage.

Recent projects include:

- Kestrel Coal Mine, (QLD) 2009
- Fortescue, (WA) 2008

Soil Assessment and Land Suitability

- Moolarben Coal (NSW) 2012. Preparation of s Strategic Agricultural Assessment including the assessment of biophysical strategic agricultural land (BSAL). The assessment was completed by desktop by analysis of a previously completed soil survey of the mine lease.
- Saraji East (QLD) 2012. Preparation of a Protection Order for submission to the DERM for confirmed strategic cropping. The soil survey and protection order were used to reconfigure the mine operation, allowing mining to proceed, while protecting some of the states prime agricultural land.
- Collingwood and Taroom (QLD) 2012. The project involved a soil survey to describe and map soils using the Australian Soil Classification and Northcote Key to a depth of 1 m. The project is heavily centred on strategic cropping land due to its proximity to the central protection area. Timothy's involvement in the project is project direction and management and mentoring of junior staff members that have been progressively trained throughout 2011.
- Peak Downs Expansion (QLD) 2011. The study included a desktop assessment and field survey. The field survey includes describing soil using the Australian Soils Classification and Northcote Key to a depth of 1 m. Reporting

Curriculum vitae


Timothy Rohde

includes management of soil units and preservation for rehabilitation of the mine site post closure. Project also includes project management and development and training of junior staff.

- New Acland (QLD) 2011. Development of a Topsoil Stripping and Management Plan. The Topsoil Stripping and Management Plan objectives includes: Devise and maintain a topsoil balance that achieves rehabilitation objectives during the life of the mine; Ensure effective topsoil removal techniques are employed to maximise volumes of suitable topsoil and minimise wastage; and Maintain topsoil viability during stripping, spreading and stockpiling, through best practice techniques and effective stockpile design and treatment. Project also includes project management and development and training of junior staff.

- Wards Well (QLD) 2011. The study included a desktop assessment and field survey. The field survey includes describing soil using the Australian Soils Classification and Northcote Key to a depth of 1 m. Reporting includes management of soil units and preservation for rehabilitation of the mine site post closure. Project also includes project management and development and training of junior staff.

- Arrow Energy (QLD) 2011. The study included a desktop assessment and field survey. The field survey included describing soil using the Australian Soils Classification and Northcote Key to a depth of 1 m. Reporting includes management of soil units during construction of the pipeline.

- Xstrata (QLD) (2010). Timothy completed baseline studies for geology, soil and landscape and closure and rehabilitation for the Rolleston West Expansion EIS. Studies included gap analysis of existing data from the operational Rolleston Mine, advice to site geology staff on chip sampling from the exploration program and reporting of geochemistry, soil characteristics and landform design for the proposed expansion. Studies accounted for future possible expansion, without sterilising future resources.

- Ipswich City Council (QLD) 2010. This Soils of Ipswich Field Guide was developed to assist in identifying soils at risk of erosion, so appropriate erosion and sediment control measures could be implemented. Activities to which this applies included:

    - Building and maintaining roads and services;
    - Infrastructure (e.g. stormwater, potable water, sewers etc.);
    - Construction works (e.g. building, installation of minor infrastructure in parks etc) and landscaping;
    - Designing, approving and monitoring development activities; and
    - Any other activities that require the excavation and/or trenching of soils.

- The ultimate aim was to assist in preventing the erosion and transport of sediment to infrastructure (e.g. roadways, stormwater systems etc)

- Linc Energy (QLD) 2008. The study included a desktop assessment and field survey. Field soil survey locations were selected to include sites representative of the main soil types occurring within the study area. The Queensland Universal Soil Loss Equation (USLE) K-factor data was used to identify soils that are susceptible to erosion.

Curriculum vitae


Timothy Rohde

Acid Sulfate Soil Management

Timothy has developed environmental management plans for control and management of acid sulfate soils, water quality, and sediment and erosion control for coastal land developments.

Recent projects include:

- Gloucester to Hexham Pipeline, (NSW) 2010
- Black Swamp, (QLD) 2009 and 2010
- Curtis Island LNG, (QLD) 2010
- Brisbane Eastern Busway, (QLD) 2009
- Darling Walk, (NSW) 2008

Mine Water Management

Timothy has been involved in the development of site water balances using GoldSim at the following mine site:

- Burton Coal Mine, (QLD) 2010

In addition Timothy has developed Final Void Management Plans for:

- Werris Creek Coal Mine, (NSW) 2010

Appendix B

Lockwood (2007) soil profile descriptions

Sodosols and related soils (depth to clay <0.5 m)

Profile: **NDA101 (core)**
Location: 56H 316758E 6388536N
ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 50	Dark yellowish brown (10YR 4/4)	—	Silty loam	Weak polyhedral (10 mm)	—	Firm	Clear
A2	50 – 150	Dark yellowish brown (10YR 4/5)	—	Silty loam	Massive	—	Firm	Abrupt
B21	150 – 400	Yellowish brown (7.5YR 5/8)	—	Medium heavy clay	Strong prismatic	—	Strong	Gradual
B22	400 - 900	Yellowish brown (10YR 5/6)	—	Medium heavy clay	Strong angular blocky	—	Strong	Gradual
B3	900 – 1000+	Yellow (10YR 7/6)	—	Silty clay	Moderate angular blocky	Weathered sandstone	Strong	

Profile no: **NDA102 (core)**
Location: 56H 315584E 6388715N
ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 20	Dark yellowish brown (10YR 4/4)	—	Silty loam	Massive	—	Firm	Abrupt
A2	20 – 120	Yellowish brown (10YR 5/4)	—	Silty loam	Massive	—	Firm	Sharp
B21	120 – 450	Strong brown (7.5YR 4/6)	Few fine distinct dark	Heavy clay	Strong polyhedral	—	Strong	Gradual
B22	450 – 700	Yellowish brown (10YR 5/6)	—	Heavy clay	Moderate polyhedral	—	Strong	Gradual
B3	700 – 900+	Brownish yellow (10YR 6/6)	—	Medium clay	Moderate polyhedral	Weathered sandstone	Strong	

Profile no: **NDA103 (core)**

Location: 56H 314715E 6388649N

ASC: Yellow Dermosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 30	Dark yellowish brown (10YR 4/4)	—	Sandy clay loam	Massive	—	Very firm	Abrupt
A2	30 – 100	Brown (10YR 4/3)	—	Sandy clay loam	Massive	—	Very firm	Sharp
B2	100 – 400	Brownish yellow (10YR 6/6)	Many medium distinct pale	Light clay	Strong prismatic	—	Strong	Gradual
B3	400 – 500+	Yellowish brown (10YR 5/6)	Many medium distinct brown	Light clay	Moderate blocky	—	Strong	

Profile no: **HMA101 (core)**

Location: 56H 315562E 6389819N

ASC: Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 50	Brown (10YR 4/3)	—	Light sandy loam	Massive	—	Weak	Clear
A2	50 – 300	Light grey (10YR 7/2)	—	Light sandy loam	Massive	Common subangular quartz (10 – 20 mm)	Weak	Sharp
B2	300 – 500+	Light brownish grey (10YR 6/2)	—	Medium clay	Moderate blocky	—	Strong	

Profile no: **HMA103 (core)**

Location: 56H 314429E 6391309N

ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 75	Dark yellowish brown (10YR 4/4)	—	Loamy sand	Weak subangular blocky (10 – 20 mm)	—	Very weak	Clear
A2	75 – 300	Yellowish brown (10YR 5/4)	—	Clayey sand	Massive	—	Very weak	Sharp
B2	300 – 1000+	Yellowish brown (10YR 5/8)	Common medium distinct pale	Medium clay	Strong angular blocky	—	Very firm	

Profile no: **HMA202 (core)**

Location: 56H,314236,6392647

ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 50	Dark yellowish brown (10YR 3/4)	—	Sandy clay loam	Weak subangular blocky (10 – 20 mm)	—	Firm	Clear
A2	50 – 150	Brown (10YR 4/3)	—	Sandy clay loam	Massive	—	Firm	Sharp
B21	150 – 1100	Dark yellowish brown (10YR 4/6)	Common medium distinct yellowish brown	Heavy clay	Strong angular blocky	—	Strong	Diffuse
B22	1100 – 1400+	Yellowish brown (10YR 5/4)	Common medium distinct yellowish brown and dark	Medium clay	Strong angular blocky	—	Strong	

Profile no: **HMA206 (pit)**

Location: 56H 314229E 6392661N

ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 150	10YR 3/3 (dark brown)	—	Clay loam	Weak subangular blocky (20 – 30 mm)	—	Very firm	Clear
A2	150 - 300	10YR 5/3 (brown)	—	Clay loam	Massive	—	Strong	Sharp
B2	300 – 1200	10YR 5/3 (brown)	—	Heavy clay	Strong prismatic (25 – 50 mm) breaking to strong polyhedral (10 mm)	—	Very strong	Gradual
B3	1200 – 1400+	10YR 5/4 (yellowish brown)	Common coarse prominent brownish yellow (10YR 6/8) and few medium prominent light grey (10YR 7/1)	Medium clay	Strong prismatic (30 – 40 mm)	—	Strong	

Profile no: **NDA201 (core)**

Location: 56H 315407E 6392711N

ASC: Brown Chromosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 150	Brown (7.5YR 4/4)	—	Clay loam	Moderate granular (5-10 mm)	—	Strong	Abrupt
B2	150 – 700	Strong brown (7.5YR 4/6)	Few medium prominent pale and dark	Medium clay	Strong angular blocky	—	Strong	Gradual
C	700 – 1000+	—	—	—	—	Weathered sandstone	Strong	

Profile no: **NDA202 (core)**

Location: 56H 316047E 6393025N

ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 120	Dark yellowish brown (10YR 4/4)	Common fine distinct brown	Clay loam	Weak subangular blocky (10 – 20 mm)	—	Firm	Sharp
B21	120 - 600	Yellowish brown (10YR 5/4)	Common medium distinct pale and few fine prominent red	Medium heavy clay	Strong angular blocky	—	Strong	Diffuse
B22	600 – 1400+	Light grey (2.5Y 7/2)	Common fine prominent yellow-brown	Medium heavy clay	Strong angular blocky	—	Strong	

Profile no: **HMA301 (core)**

Location: 56H 317636E 6393737N

ASC: Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 25	Dark yellowish brown (10YR 4/4)	—	Sandy clay loam	Weak subangular blocky (20 mm)	—	Firm	Clear
A2	25 - 100	Yellowish brown (10YR 5/4)	—	Sandy clay loam	Massive	Common subrounded quartz (10 – 15 mm)	Firm	Sharp
B21	100 - 1100	Pale brown (10YR 6/3)	Common very coarse distinct dark and few fine distinct yellow	Medium heavy clay	Strong prismatic	—	Strong	Diffuse
B22	1100 – 1300+	Ligt grey (10YR 7/2)	Many medium prominent yellow	Medium heavy clay	Strong prismatic	—	Strong	

Note: sand in cracks in B2 horizons.

Profile no: **HMA302 (core)**

Location: 56H 315929E 6394554N

ASC: Yellow Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 40	Dark brown (10YR 3/3)	—	Sandy loam	Weak subangular blocky (20 – 30 mm)	—	Firm	Clear
A2	40 – 200	Yellowish brown (10YR 5/4)	—	Clayey sand	Massive	—	Weak	Sharp
B2	200 – 900+	Light yellowish brown (10YR 6/4)	Many coarse distinct strong brown and few fine distinct dark reddish brown	Medium clay	Strong prismatic	—	Strong	

Profile no: **ARCH02 (core)**

Location: 56H 317137E 6400647N

ASC: Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 -50	Dark yellowish brown (10YR 3/4)	—	Loam	Moderate subangular blocky (10 - 20 mm)	—	Firm	Clear
A2	50 – 120	Dark yellowish brown (10YR 4/6)	—	Sandy clay loam	Weak subangular blocky	—	Firm	Sharp
B2	120 – 1500+	Yellowish brown (10YR 5/6)	Common medium distinct dark and pale brown	Medium clay	Strong prismatic	—	Strong	

Profile no: **ARCH09 (pit)**

Location: 56H 316418E 6402391N

ASC: Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 100	Dark brown (7.5YR 3/2)	—	Clayey sand	Weak subangular blocky (10-20 mm)	—	Moderate	Clear
A2	100 - 200	Pinkish grey (7.5YR 6/2)	—	Loamy sand	Massive	—	Weak	Sharp
B2	200 - 1300	Light brown (7.5YR 6/3)	Many very coarse prominent strong brown (7.5YR 5/8)	Medium clay	Strong columnar (120 – 200 mm)	—	Strong	Diffuse
C	1300 – 1500+	Light grey (7.5YR 7/1)	Many very coarse prominent strong brown (7.5YR 5/6)	Sandy clay loam	Massive	—	Strong	

Profile no: **ARCH11 (pit)**

Location: 56H 316939E 6402995N

ASC: Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 200	7.5YR 4/4 (brown)	—	Loamy sand	Weak subangular blocky (10 – 20 mm)	—	Weak	Gradual
C	200 - 550	7.5YR 6/4 (light brown)	—	Loamy sand	Massive	—	Weak	Sharp
2B2	550 - 1000	7.5YR 6/3 (light brown)	Many very coarse distinct reddish yellow (7.5YR 6/8)	Medium heavy clay	Strong columnar (150 – 250 mm)	—	Strong	Diffuse
2C	1000 – 1600+	7.5YR 5/6 (strong brown)	Many very coarse distinct light brown (7.5YR 6/3)	Sandy clay loam	Massive	—	Strong	

Arenic Rudosols overlying buried soils (depth to clay 0.5 – 2 m)

Profile no: **HMA102 (core)**

Location: 56H 314135E 6389965N

ASC: Arenic Rudosol/Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 -50	Dark brown (7.5YR 3/3)	—	Sand	Single grain	—	Loose	Abrupt
C1	50 -300	Yellowish red (5YR 5/6)	—	Sand	Single grain	—	Loose	Gradual
C2	300 – 700	Pink (5YR 7/3)	—	Sand	Single grain	—	Loose	Sharp
2B2b	700 – 1300+	Brown (10YR 5/3)	—	Medium clay	Strong blocky	—	Strong	

Profile no: **HMA104 (core)**

Location: 56H 315056E 6391557N

ASC: Arenic Rudosol/Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 100	Dark yellowish brown (10YR 4/4)	—	Loamy sand	Weak subangular blocky (10 – 20 mm)	—	Very weak	Gradual
C1	100 – 250	Very pale brown (10YR 7/3)	—	Sand	Single grain	—	Loose	Gradual
C2	250 – 500	Light grey (10YR 7/2)	—	Sand	Single grain	—	Loose	Sharp
2B2b	500 – 900+	Light brownish grey (10YR 6/2)	Common medium prominent orange	Medium heavy clay	Strong angular blocky	—	Strong	

Profile no: **HMA203 (core)**

Location: 56H 314159E 6392184N

ASC: Arenic Rudosol/Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 150	Dark yellowish brown (10YR 4/4)	—	Loamy sand	Massive to weak subangular blocky (10 - 20 mm)	—	Very weak	Diffuse
C	150 – 800	Very pale brown (10YR 7/3)	—	Sand	Single grain	—	Loose	Clear
2B2	800+	Very pale brown (10YR 7/3)	Few fine prominent strong brown	Medium clay		—		

Profile no: **HMA303 (core)**

Location: 56H 316544E 6393408N

ASC: Arenic Rudosol/Brown Kurosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 15	Brown (7.5YR 4/4)	—	Loamy sand	Weak platy (15 mm)	—	Weak	Clear
C	15 - 600	Light brown (7.5YR 6/4)	—	Sand	Single grain	—	Very weak	Sharp
2B2b	600 - 850	Strong brown (7.5YR 5/8)	Many medium prominent pale and light grey	Medium clay	Strong prismatic	—	Very firm	Gradual
2C	850+					Weathered sandstone		

Profile no: **ARCH01 (core)**

Location: 56H 317071E 6401148N

ASC: Arenic Rudosol/Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 120	Dark brown (10YR 3/3)	—	Loamy sand	Weak subangular blocky (10 – 30 mm)	—	Weak	Gradual
C	120 - 550	Yellowish brown (10YR 5/4)	—	Sand	Single grain	—	Weak	Abrupt
2B2b	550 – 1050+	Light brownish grey (10YR 6/2)	Many coarse prominent strong brown	Light medium clay (with some coarse sand)	Strong angular blocky	—	Very firm	

Profile no: **ARCH05 (core)**

Location: 56H 316569E 6402275N

ASC: Arenic Rudoaol/Brown Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 200	Dark reddish brown (5YR 3/4)	—	Loamy sand	Weak subangular blocky (10 – 20 mm)	—	Very weak	Diffuse
C	200 - 600	Reddish brown (5YR 5/3)	—	Sand	Single grain	—	Loose	Abrupt
2B2b	600 – 650+	Yellowish brown (10YR 5/6)	Many medium distinct pale	Medium clay	Strong prismatic	—	Strong	

Profile no: **ARCH07**

Location: 56H 316933E 6403003N

ASC: Arenic Rudosol/Grey Sodosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 50	Dark brown (7.5YR 3/4)	—	Loamy sand	Single grain to massive	—	Very weak	Clear
C1	50 - 350	Brown (7.5YR 4/4)	—	Loamy sand	Single grain to massive	—	Very weak	Clear
C2	350 - 650	Brown (7.5YR 5/4)	—	Loamy sand	Single grain to massive	Few subangular quartz (10 – 15 mm)	Very weak	Abrupt
2B2b	650 – 1000+	Light grey (10YR 7/2)	Many medium prominent yellowish brown	Medium clay	Strong prismatic	—	Strong	

Profile no: **ARCH10 (pit)**

Location: 56H 317448E 6402100N

ASC: Arenic Rudosol/Grey Dermosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 200	7.5YR 3/3 (dark brown)	—	Sand	Massive to weak subangular blocky	—	Very weak	Diffuse
C	200 - 1300	7.5YR 6/2 (pinkish grey)	Very few medium prominent strong brown	Sand	Single grain	—	Loose	Clear
2Ab	1300 - 1600	7.5YR 7/2 (pinkish grey)	Many very coarse prominent yellowish red (5YR 5/6)	Sandy clay loam	Massive	—	Strong	Gradual
2B2b	1600 – 1700+	7.5YR 7/2 (pinkish grey)	Many very coarse prominent reddish yellow (5YR 6/8)	Clay loam, sandy	Moderate angular blocky (20 – 40 mm)	—	Strong	

Arenic Rudosols and Orthic Tenosols (depth to clay >2 m)

Profile no: **HMA201 (core)**
Location: 56H 314809E 6392453N
ASC: Arenic Rudosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A11	0 - 50	Dark yellowish brown (10YR 4/4)	—	Loamy sand	Weak subangular blocky (10 – 20 mm)	—	Very weak	Clear
A12	50 - 300	Yellowish brown (10YR 5/4)	—	Sand	Single grain	—	Loose	Diffuse
C	300 – 1300+	Very pale brown (10YR 7/3)	—	Sand	Single grain	—	Loose	

Profile no: **HMA204 (core)**
Location: 56H 314993E 6392074N
ASC: Arenic Rudosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 25	Yellowish brown (10YR 5/6)	—	Sand	Single grain	—	Loose	Clear
C	25 – 1500+	Brownish yellow (10YR 6/6)	—	Sand	Single grain	—	Loose	

Profile no: **HMA205 (pit + sand auger)**
Location: 56H 314800E 6392456N
ASC: Bleached-Orthic Tenosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 100	7.5YR 4/3 (brown)	—	Sand	Single grain	—	Loose	Gradual
A2e	100 – 2500	7.5YR 7/4 (pink)	—	Sand	Single grain	Very few subrounded ferromanganiferous concretions (10 – 20 mm)	Loose	Gradual
B21	2500 – 5500	7.5YR 5/8 (strong brown)	Many coarse prominent light grey (10YR 7/1)	Clayey sand	Massive	—	Very weak	Diffuse
B22	5500 – 6000+	2.5YR 4/8 (red brown)	—	Clayey sand	Massive	—	Very weak	

Profile no: **HMA304 (core)**
Location: 56H 316987E 6393415N
ASC: Arenic Rudosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 – 60	Dark yellowish brown (10YR 4/4)	—	Loamy sand	Single grain	—	Loose	Clear
C	60 – 1300+	Pale brown (10YR 6/3)	—	Loamy sand	Single grain	—	Loose	

Profile no: **ARCH04 (core)**

Location: 56H 317462E 6402102N

ASC: Brown-Orthic Tenosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A1	0 - 400	Dark yellowish brown (10YR 3/4)	—	Sand	Single grain	—	Loose	Diffuse
A2	400 - 900	Brown (10YR 5/3)	—	Sand	Single grain	—	Loose	Clear
B2w	900 – 1400+	Yellowish brown (10YR 5/6)	Common fine prominent strong brown	Sand	Single grain	—	Loose	

Profile no: **ARCH06**

Location: 56H 316857E 6402778N

ASC: Arenic Rudosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
A11	0 - 30	Brown (7.5YR 4/3)	—	Loamy sand	Weak platy (15 mm)	—	Very weak	Clear
A12	30 - 500	Brown (7.5YR 4/3)	—	Sand	Single grain	—	Loose	Diffuse
C?	500 – 1500+	Strong brown (7.5YR 4/6)	—	Sand	Single grain	—	Loose	

Black Dermosols

Profile no: **ARCH03 (core)**

Location: 56H 317698E 6400659N

ASC: Black Dermosol (?)

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
Ap	0 - 100	Very dark brown (10YR 2/2)	—	Light clay	Disturbed fragments (recently cultivated)	—	Very firm	Clear
B2?	100 – 1400+	Very dark brown (10YR 2/2)	—	Light clay	Strong angular blocky	—	Strong	

Profile no: **ARCH08 (core)**

Location: 56H 317045E 6403575N

ASC: Black Dermosol

Horizon	Depth (mm)	Colour (moist)	Mottles	Field texture	Structure	Coarse fragments, segregations	Consistence (dry)	Boundary
Ap	0 - 100	Very dark brown (7.5YR 2/3)	—	Light clay	Weak blocky (30 – 50 mm)	—	Very firm	Clear
B21	100 - 700	Very dark brown (7.5YR 2/2)	—	Light clay	Strong polyhedral (10 – 20 mm)	—	Very firm	Gradual
B22	700 – 1500+	Dark brown (7.5YR 3/3)	—	Light clay	Strong polyhedral (20 – 30 mm)	—	Very firm	

Appendix C

Lockwood (2007) laboratory analysis

Sodosols and related soils: soil chemical and physical analyses.

Site	Depth m	pHw	Bray P mg/kg	Carbon %	Ex Al $cmol_c/kg$	Ex Ca $cmol_c/kg$	Ex Mg $cmol_c/kg$	Ex Na $cmol_c/kg$	Ex K $cmol_c/kg$	ECEC $cmol_c/kg$	ECe dS/m	ESP %	Emerson class	Loveday & Pyle
NDA101	0 - 0.1	5.5	4.9	2.15	0.0	8.0	4.8	0.7	1.2	14.7	0.87	5.0	5	2.0
NDA101	0.1 - 0.2	6.3	1.1	0.80	0.0	5.0	5.0	1.0	0.5	11.5	0.46	8.7	3b	6.0
NDA101	0.2 - 0.5	5.9	1.3		0.0	9.5	12.9	3.8	0.6	26.7	1.32	14.3	1	14.0
NDA101	0.5 - 1.0	6.4	1.0		0.0	8.5	14.3	7.1	0.5	30.3	2.47	23.5	2	13.5
NDA102	0 - 0.1	5.9	2.7	2.00	0.0	3.2	6.3	1.0	1.0	11.4	1.03	8.4	3b	5.5
NDA102	0.1 - 0.2	6.0	0.6	0.77	0.0	1.0	7.0	1.9	0.3	10.2	0.83	18.6	3b	8.0
NDA102	0.2 - 0.5	6.0	0.5		0.0	2.4	30.5	9.2	0.6	42.7	3.61	21.5	1	15.0
NDA102	0.5 - 1.0	6.8	1.9		0.0	1.9	26.0	8.9	0.6	37.3	3.71	23.8	1	15.0
NDA103	0 - 0.1	5.8	1.3	1.17	0.0	3.0	7.8	1.2	0.7	12.8	0.80	9.5	3b	6.5
NDA103	0.1 - 0.2	6.0	0.8	1.09	0.0	2.8	9.4	2.0	0.5	14.6	0.99	13.4	2	11.0
NDA103	0.2 - 0.5	6.1	0.6		0.0	1.4	14.9	5.6	0.3	22.2	2.62	25.2	2	13.0
NDA103	0.5 - 1.0	6.6	0.4		0.0	1.1	17.8	8.9	0.4	28.2	1.17	31.5	2	14.0
NDA201	0 - 0.1	6.0	1.9	2.40	0.0	16.3	3.8	0.2	2.5	22.8	0.87	0.9	3b	5.5
NDA201	0.1 - 0.2	6.3	1.1	1.93	0.0	17.7	3.5	0.1	2.0	23.3	0.65	0.5	3a	6.5
NDA201	0.2 - 0.5	7.2	2.5		0.0	29.8	4.5	0.2	1.6	36.1	1.12	0.5	6	0.0
NDA201	0.5 - 1.0	8.3	0.8		0.0	28.6	5.8	0.1	0.9	35.4	0.67	0.4	5	0.0
NDA202	0 - 0.1	6.0	1.1	1.72	0.0	5.9	6.3	0.7	1.0	13.9	0.55	5.0	3b	2.5
NDA202	0.1 - 0.2	7.2	0.6	1.01	0.0	8.5	12.3	2.4	0.9	24.1	0.79	10.0	2	13.0
NDA202	0.2 - 0.5	7.5	1.2		0.0	8.6	13.6	4.3	0.8	27.3	1.63	15.9	2	10.5
NDA202	0.5 - 1.0	8.9	0.7		0.0	9.8	18.6	9.8	0.9	39.1	1.42	25.1	3b	6.0
NDA202	1.0 - 1.4	8.2	0.4		0.0	5.6	20.3	12.2	0.9	39.1	1.45	31.3	1	15.0
HMA101	0 - 0.1	5.8	1.9	1.49	0.0	1.9	1.2	0.1	0.4	3.7	0.24	3.9	5	2.5
HMA101	0.1 - 0.2	6.2	1.8	1.86	0.0	0.9	1.2	0.2	0.2	2.6	0.25	6.7	5	2.5
HMA101	0.2 - 0.5	6.7	4.1		0.0	0.2	10.4	4.9	0.6	16.0	2.43	30.4	2	12.5

Sodosols and related soils: soil chemical and physical analyses (continued)

Site	Depth m	pHw	Bray P mg/kg	Carbon %	Ex Al $cmol_c/kg$	Ex Ca $cmol_c/kg$	Ex Mg $cmol_c/kg$	Ex Na $cmol_c/kg$	Ex K $cmol_c/kg$	ECEC $cmol_c/kg$	ECe dS/m	ESP %	Emerson class	Loveday & Pyle
HMA103	0 - 0.1	5.8	1.7	2.22	0.0	4.2	2.3	0.4	0.4	7.3	2.05	6.1	5	2.0
HMA103	0.1 - 0.2	5.8	1.3	0.66	0.0	0.9	0.8	0.2	0.1	2.1	0.77	9.1	5	1.0
HMA103	0.2 - 0.5	6.2	2.8		0.0	0.2	6.6	3.3	0.2	10.1	1.89	32.1	1	15.5
HMA103	0.5 - 0.9	6.9	0.2		0.0	0.0	13.1	7.9	0.3	21.4	1.44	37.0	1	15.5
HMA202	0 - 0.1	5.4	1.3	3.14	0.0	5.4	3.9	0.8	1.1	11.2	1.19	7.4	5	0.0
HMA202	0.1 - 0.2	5.9	0.8	0.84	0.0	2.5	2.9	1.0	0.6	7.0	0.85	14.7	3b	4.0
HMA202	0.2 - 0.5	6.0	0.4		0.0	8.1	16.8	9.8	1.8	36.5	2.38	26.8	2	13.0
HMA202	0.5 - 1.0	5.9	0.3		0.0	6.1	16.4	12.9	1.5	37.0	3.35	34.9	1	15.5
HMA202	1.0 - 1.4	6.1	0.2		0.0	3.3	9.7	8.7	0.9	22.6	3.93	38.6	1	15.5
HMA301	0 - 0.1	5.3	1.7	2.90	0.0	2.9	5.9	0.7	0.8	10.4	0.56	6.9	3b	4.0
HMA301	0.1 - 0.2	5.8	0.6	0.61	0.0	1.2	15.0	2.2	0.7	19.1	1.06	11.3	3b	7.0
HMA301	0.2 - 0.5	6.8	1.4		0.0	0.9	20.1	5.6	0.5	27.1	2.51	20.6	2	10.5
HMA301	0.5 - 1.0	8.0	2.0		0.0	0.4	19.6	7.3	0.5	28.0	3.58	26.3	1	14.5
HMA301	1.0 - 1.3	8.6	1.5		0.0	0.1	20.1	8.4	0.8	29.5	4.44	28.6	1	15.5
HMA302	0 - 0.1	6.0	11.3	0.67	0.0	3.6	1.9	0.1	1.0	6.5	0.32	1.1	7	5.0
HMA302	0.1 - 0.2	6.0	7.7	2.07	0.0	1.9	1.2	0.1	0.7	3.9	0.42	1.8	5	3.5
HMA302	0.2 - 0.5	6.3	7.2		0.0	1.1	13.9	4.4	1.0	20.5	1.77	21.7	1	13.5
HMA302	0.5 - 0.8	5.7	1.0		0.0	0.3	12.5	6.7	0.3	19.8	3.80	34.0	1	15.0
ARCH02	0 - 0.1	5.8	2.6	0.55	0.0	3.9	4.1	0.7	1.6	10.2	0.81	6.8	3b	5.5
ARCH02	0.1 - 0.2	6.1	1.1	1.75	0.0	3.4	6.4	1.2	1.0	12.0	0.72	9.7	3b	8.0
ARCH02	0.2 - 0.5	7.2	0.5		0.0	4.5	21.3	7.2	0.8	33.8	3.55	21.4	3b	7.0
ARCH02	0.5 - 1.0	8.9	0.4		0.0	3.5	20.8	12.5	0.9	37.7	7.38	33.1	1	14.5
ARCH02	1.0 - 1.4	9.1	0.5		0.0	13.5	22.5	11.9	0.6	48.5	8.26	24.6	1	15.0

Shallow Warkworth Sands (Arenic Rudosols/Sodosols): soil chemical and physical analyses.

Site	Depth m	pHw	Bray P mg/kg	Carbon %	Ex Al $cmol_c/kg$	Ex Ca $cmol_c/kg$	Ex Mg $cmol_c/kg$	Ex Na $cmol_c/kg$	Ex K $cmol_c/kg$	ECEC $cmol_c/kg$	ECe dS/m	ESP %	Emerson class	Loveday & Pyle
HMA102	0 - 0.1	7.5	4.8	0.23	0.0	1.6	0.2	0.0	0.1	2.0	0.17	1.4		
HMA102	0.1 - 0.2	6.9	1.2	0.10	0.0	0.6	0.1	0.0	0.1	0.8	0.12	2.6		
HMA102	0.2 - 0.5	6.7	25.9		0.0	0.6	0.2	0.1	0.1	0.9	0.32	10.9		
HMA102	0.5 - 0.8	6.3	13.5		0.0	0.5	0.7	0.2	0.1	1.5	0.86	14.9		
HMA104	0 - 0.1	5.1	2.6	3.66	0.0	1.7	1.6	0.2	0.7	4.2	1.65	4.8		
HMA104	0.1 - 0.2	5.2	1.4	0.90	0.0	0.3	0.7	0.1	0.4	1.5	0.64	9.1	5	0.0
HMA104	0.2 - 0.5	5.9	11.1		0.0	0.1	0.5	0.0	0.2	0.8	0.20	5.4		
HMA104	0.5 - 1.0	5.5	2.9		1.6	0.0	11.7	1.6	1.3	16.2	0.43	9.9	3a	6.0
HMA203	0 - 0.1	5.8	1.4	0.42	0.0	0.8	0.4	0.1	0.2	1.4	0.36	4.7	5	1.5
HMA203	0.1 - 0.2	5.6	0.8	0.12	0.0	0.1	0.2	0.1	0.2	0.6	0.30	12.3	5	1.5
HMA203	0.2 - 0.5	6.0	18.3		0.0	0.3	0.2	0.0	0.2	0.8	0.25	6.4		
HMA203	0.5 - 0.7	6.1	13.0		0.0	0.5	0.2	0.0	0.1	0.8	0.21	6.2		
HMA303	0 - 0.1	5.9	1.4	0.61	0.0	1.3	0.6	0.1	0.2	2.2	0.22	2.7	5	1.5
HMA303	0.1 - 0.2	5.4	1.3	0.51	0.0	0.1	0.4	0.1	0.1	0.8	0.32	11.0	3a	4.5
HMA303	0.2 - 0.5	5.9	3.0		0.0	0.2	0.4	0.0	0.1	0.8	0.12	6.0	3b	5.0
HMA303	0.5 - 0.8	5.2	0.8		0.8	0.3	7.0	1.7	0.7	10.5	0.65	16.6	5	1.5
ARCH01	0 - 0.1	5.2	3.9	0.18	0.0	1.9	1.1	0.4	0.3	3.7	1.59	11.2		
ARCH01	0.1 - 0.2	5.5	1.1	1.04	0.0	0.5	0.6	0.2	0.2	1.6	0.61	14.6	3b	3.5
ARCH01	0.2 - 0.5	6.0	1.7		0.0	0.4	0.5	0.1	0.1	1.2	0.23	8.8	3b	4.0
ARCH01	0.5 - 1.0	5.6	0.9		0.0	0.5	13.1	5.5	0.3	19.4	2.94	28.5	1	15.0
ARCH05	0 - 0.1	4.9	2.8	0.40	0.0	0.9	0.5	0.1	0.2	1.7	0.83	6.7	5	1.0
ARCH05	0.1 - 0.2	5.1	1.3	0.79	0.0	0.3	0.4	0.1	0.1	0.9	0.50	11.7	3a	4.5
ARCH05	0.2 - 0.5	5.9	1.2		0.0	0.2	0.3	0.1	0.1	0.8	0.19	11.4	3a	5.0
ARCH07	0 - 0.1	5.2	2.2	0.37	0.0	1.6	0.5	0.0	0.4	2.5	0.41	1.8	3a	4.5
ARCH07	0.1 - 0.2	5.6	0.7	0.33	0.0	1.3	0.6	0.0	0.3	2.2	0.32	0.7	3a	4.5
ARCH07	0.2 - 0.5	5.9	2.3		0.0	1.9	0.7	0.0	0.3	2.9	0.47	1.3	1	5.0
ARCH07	0.5 - 1.0	7.3	1.2		0.0	1.7	8.6	3.4	0.3	13.9	1.25	24.2	1	15.5

Deep Warkworth Sands (Arenic Rudosols and Orthic Tenosols): soil chemical and physical analyses.

Site	Depth m	pHw	Bray P mg/kg	Carbon %	Ex Al $cmol_c/kg$	Ex Ca $cmol_c/kg$	Ex Mg $cmol_c/kg$	Ex Na $cmol_c/kg$	Ex K $cmol_c/kg$	ECEC $cmol_c/kg$	ECe dS/m	ESP %	Emerson class	Loveday & Pyle
HMA201	0 – 0.1	4.7	3.3	0.70	0.0	1.3	0.5	0.1	0.2	2.1	1.33	4.4		
HMA201	0.1 – 0.2	4.8	3.5	0.32	0.0	0.7	0.2	0.0	0.2	1.2	0.78	1.8		
HMA201	0.2 – 0.5	5.4	7.3		0.0	0.2	0.1	0.0	0.1	0.5	0.21	3.3		
HMA201	0.5 – 1.0	5.7	1.6		0.0	0.3	0.2	0.0	0.1	0.6	0.13	0.0		
HMA204	0 – 0.1	5.5	1.7	0.18	0.0	0.6	0.2	0.0	0.1	1.0	0.18	3.8		
HMA204	0.1 – 0.2	5.3	1.2	0.18	0.0	0.3	0.2	0.0	0.1	0.7	0.23	1.9		
HMA204	0.2 – 0.5	5.5	4.8		0.0	0.3	0.3	0.0	0.1	0.7	0.31	6.8		
HMA304	0 – 0.1	5.2	1.8	0.20	0.0	0.6	0.4	0.1	0.1	1.2	0.31	4.3		
HMA304	0.1 – 0.2	5.0	1.1	0.64	0.0	0.1	0.1	0.0	0.1	0.3	0.27	12.6		
HMA304	0.2 – 0.5	5.4	4.9		0.0	0.0	0.0	0.0	0.1	0.2	0.17	16.3		
HMA304	0.5 – 0.8	5.8	4.7		0.0	0.2	0.1	0.0	0.1	0.4	0.13	3.0		
ARCH04	0 – 0.1	6.4	1.9	1.84	0.0	2.8	1.2	0.1	0.6	4.7	0.86	1.9		
ARCH04	0.1 – 0.2	6.5	1.6	0.95	0.0	1.6	0.6	0.0	0.4	2.6	0.36	1.0		
ARCH04	0.2 – 0.5	6.4	2.4		0.0	1.3	0.5	0.0	0.4	2.3	0.50	1.8		
ARCH04	0.5 – 1.0	6.2	2.6		0.0	0.5	0.3	0.0	0.3	1.1	0.38	2.6		
ARCH04	1.0 – 1.4	6.0	3.5		0.0	0.3	0.4	0.1	0.1	0.9	0.39	10.2		
ARCH06	0 – 0.1	6.1	1.2	0.34	0.0	1.8	0.6	0.0	0.3	2.8	0.25	1.4		
ARCH06	0.1 – 0.2	6.0	3.1	0.57	0.0	0.9	0.5	0.1	0.2	1.6	0.21	4.6		
ARCH06	0.2 – 0.5	5.9	2.1		0.0	0.6	0.3	0.0	0.2	1.1	0.25	2.5		
ARCH06	0.5 – 1.0	6.2	2.3		0.0	0.4	0.4	0.0	0.2	1.0	0.21	4.1		
ARCH06	1.0 – 1.5	6.4	2.5		0.0	0.4	0.3	0.0	0.2	1.0	0.13	3.9		

Black Dermosols: soil chemical and physical analyses.

Site	Depth m	pHw	Bray P mg/kg	Carbon %	Ex Al $cmol_c/kg$	Ex Ca $cmol_c/kg$	Ex Mg $cmol_c/kg$	Ex Na $cmol_c/kg$	Ex K $cmol_c/kg$	ECEC $cmol_c/kg$	ECe dS/m	ESP %	Emerson class	Loveday & Pyle
ARCH03	0 - 0.1	6.2	85.1	1.07	0.0	18.7	11.0	0.4	3.2	33.4	2.12	1.3	3b	4.0
ARCH03	0.1 - 0.2	6.3	70.5	1.89	0.0	20.6	12.1	0.5	1.9	35.2	1.91	1.5	3b	5.0
ARCH03	0.2 - 0.5	7.5	23.9		0.0	29.4	15.6	1.2	0.6	46.8	0.77	2.7	3b	5.5
ARCH03	0.5 - 1.0	7.7	30.9		0.0	28.3	15.9	2.2	0.5	46.8	2.01	4.6	3b	5.5
ARCH03	1.0 - 1.3	8.1	27.6		0.0	30.1	16.8	1.8	0.6	49.3	0.82	3.7	3b	5.0
ARCH08	0 - 0.1	6.7	83.6	2.32	0.0	20.2	10.4	0.6	4.9	36.2	1.28	1.6	3b	4.5
ARCH08	0.1 - 0.2	7.0	58.6	1.71	0.0	20.8	10.3	0.6	3.3	35.1	0.63	1.8	3b	5.5
ARCH08	0.2 - 0.5	7.6	23.7		0.0	27.5	13.0	0.7	3.1	44.3	0.70	1.6	3b	4.0
ARCH08	0.5 - 1.0	7.9	30.4		0.0	22.8	11.9	0.6	0.9	36.2	0.72	1.6	3b	4.0
ARCH08	1.0 - 1.5	8.1	30.3		0.0	22.4	12.1	0.7	0.6	35.9	0.82	1.8	3b	5.0

Appendix 5 Soil particle size distribution

Site	Depth m	Coarse sand %	Fine sand %	Silt %	Clay %	Total %
Sodosols and related soils						
NDA103	0 - 0.1	26.0	44.7	9.0	20.3	100.0
NDA103	0.1 - 0.2	24.7	41.6	8.8	24.2	99.2
NDA103	0.2 - 0.5	19.7	38.2	8.3	33.4	99.6
NDA103	0.5 - 1.0	13.2	39.7	8.8	37.5	99.2
NDA202	0 - 0.1	26.5	36.7	16.0	22.0	101.3
NDA202	0.1 - 0.2	16.3	26.1	15.9	40.4	98.7
NDA202	0.2 - 0.5	19.7	26.9	14.1	38.1	98.8
NDA202	0.5 - 1.0	11.6	18.8	17.1	50.8	98.4
NDA202	1.0 - 1.4	6.7	10.8	20.6	60.1	98.1
HMA202	0 - 0.1	20.1	28.8	26.4	27.0	102.4
HMA202	0.1 - 0.2	25.4	33.3	25.0	16.4	100.1
HMA202	0.2 - 0.5	2.1	21.0	16.5	59.4	99.0
HMA202	0.5 - 1.0	2.7	26.7	17.0	52.8	99.2
HMA202	1.0 - 1.4	4.9	42.5	15.3	37.0	99.7
Arenic Rudosols/Sodosols						
HMA104	0 – 0.1	56.1	27.7	7.7	8.3	99.8
HMA104	0.1 – 0.2	61.5	28.1	5.5	4.6	99.7
HMA104	0.2 – 0.5	61.3	32.8	3.3	3.2	100.5
HMA104	0.5 – 1.0	28.7	11.8	1.6	56.3	98.4
HMA303	0 – 0.1	51.3	38.7	5.5	5.5	101.0
HMA303	0.1 – 0.2	51.3	39.8	4.7	4.1	99.9
HMA303	0.2 – 0.5	45.8	42.9	6.4	4.2	99.2
HMA303	0.5 – 0.8	27.1	23.8	4.8	42.9	98.5
ARCH05	0 – 0.1	71.5	17.8	6.6	5.2	101.0
ARCH05	0.1 – 0.2	75.5	15.4	5.9	3.2	100.0
ARCH05	0.2 – 0.5	72.3	17.6	7.0	3.4	100.3
ARCH07	0 – 0.1	58.7	26.7	8.3	7.5	101.2
ARCH07	0.1 – 0.2	65.6	24.2	6.6	4.0	100.5
ARCH07	0.2 – 0.5	62.3	24.9	7.2	5.2	99.6
ARCH07	0.5 – 1.0	51.5	16.7	5.1	25.5	98.8
Arenic Rudosols and Orthic Tenosols						
HMA201	0 - 0.1	59.3	31.3	5.6	3.9	100.1
HMA201	0.1 - 0.2	62.5	30.2	4.5	2.3	99.6
HMA201	0.2 - 0.5	58.9	32.5	6.0	2.6	99.9
HMA201	0.5 - 1.0	52.5	35.7	9.3	2.1	99.7
ARCH04	0 - 0.1	82.1	11.0	3.7	3.6	100.3
ARCH04	0.1 - 0.2	76.6	14.9	4.9	3.3	99.8
ARCH04	0.2 - 0.5	69.2	17.3	9.8	3.5	99.8
ARCH04	0.5 - 1.0	74.6	16.3	6.6	1.9	99.4
ARCH04	1.0 - 1.4	69.4	16.2	11.2	2.6	99.5

Appendix D

Soil descriptions

Brown Duplex Loam

Description: This soil unit is characterised by an abrupt texture change between the dark brown silty/ loam surface soil and the clayey brown sandy clay loam and yellowish brown medium heavy clay subsurface layers (duplex soil) (**Table 5**). This soil unit is identified in the Australian Soil Classification as a Sodosol and has also in the past been referred to in Great Soil Group terminology as Solonetz, Solodised-Solonetz and Solodic soils.

Location: This soil unit is the dominant soil in the Warkworth Mine study area (40.8 per cent cover) and is associated with undulating hillslopes, particularly mid-low sloping land and creek flats. This common soil unit was profiled during the Wollombi Brook investigation, refer **Appendix 4, Plate 1** and **Plate 2**.

Management: The surface 0.10m of topsoil is suitable for stripping and reuse as a topdressing material in rehabilitation works. Some topsoil profiles exhibited high sodicity values, however, soil aggregate stability was reasonable due to significant soil organic carbon content. In addition this topsoil's loamy soil texture is desirable for rehabilitation works.

The subsoil is unsuitable for rehabilitation works as it is highly sodic and dispersive.

The topsoil requires standard erosion and sediment control measures if disturbed. Given the soil's sodicity range, additional measures for stockpiling the soil and its reuse during rehabilitation works is recommended. These measures include stockpiling the soil where it is not exposed to wet conditions after stripping as this will limit dispersion and erosion, and the use of soil ameliorants such as gypsum and biosolids to improve aggregate cohesion (refer **Section 4**).

Table 5 – Brown Duplex Loam Profile

Layer #	Depth (m)	Description	
		Field	Laboratory
1	0.00 - 0.02	Dark (yellowish) brown (10 YR 4/4) silty loam to loam exhibiting weak peds of 10 millimetres (mm) or massive pedality. Boundary abrupt.	Moderately acidic with an average pH of 6.0 (range 5.4 - 6.3, n = 5) and non-saline with low Electrical Conductivity (ECe) of less than 1dS/m 9 (range 0.46 – 1.19dS/m, n = 5).
2	0.02 - 0.12	Dark yellowish brown (10 YR 5/4) silty loam with massive pedality. Boundary sharp.	Moderately sodic with an average Exchangeable Sodium Percentage (ESP) of 12%, (range 5 - 18.9, n = 5) with generally stable soil aggregates as indicated by Emerson Aggregate Test (EAT) classifications of 3-5.
3	0.12 - 0.45	Brown (7.5 YR 5/8 - 7.5 YR 4/6) heavy clay with a strong structure (polyhedral to prismatic). Boundary gradual.	Moderately acidic with an average pH of 6.0 (range 5.8 - 6.7, n = 12) and non-saline with average low ECe of less than 2dS/m (range 0.34 - 4.24, n = 12; note >4dS/m was an exception).
4	0.45 - 0.70	Yellowish brown (10 YR 5/6) heavy clay with strong structure (polyhedral to angular blocky peds). Boundary gradual.	Highly sodic with an average ESP of 27% (range 14.3 - 37.1; n = 5) and low aggregate stability with EAT classes of 1 and 2 (n = 10).
5	0.70 - 2.00	Yellowish (10 YR 6/6) medium clay to silty clay with moderate structure (polyhedral to angular blocky peds).	

n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).

Duplex Sand

Description: This soil unit is characterised by an abrupt texture change between the sandy surface soil and the medium-heavy clayey subsurface soil (duplex soil). Subsurface soils may be greyish, brownish or yellowish in colour (**Table 7**).

Location: This soil unit is the third most dominant soil in the Warkworth Mine study area (16.5 per cent cover) and is associated with the Uniform Sands in the northern part of the study area.

Management: The top 0.30m of topsoil is suitable to marginally suitable for stripping and reuse as topdressing in rehabilitation works. The top 0.05m of this soil is of suitable nature and the subsequent 0.25m is of marginal nature due to its single grain structure. It is recommended that the full 0.30m of topsoil be utilised, however, additional measures to treat the 0.05-0.30m fraction are recommended. These measures are discussed below.

The subsoil is not recommended for reuse in rehabilitation activities due to the limiting factors of texture, high sodicity and dispersion. Sodicity in the topsoil was observed to increase in a minority of soil profiles which contained clayey sand textures. As sodicity is related to exchangeable cations and soil clay content, these few outliers with small clay contents do not impact overall stripping depth recommendations.

The topsoil requires standard erosion and sediment control measures if disturbed and given its textural structure additional measures are recommended. Suitable measures include storing the soil where it is not exposed to wet conditions after stripping as this will limit dispersion and erosion, and the use of soil ameliorants (e.g. gypsum and biosolids) to improve aggregate cohesion (refer **Section 4**).

This soil unit is closely related to the uniform soil unit (**Table 9**) which supports the endangered Warkworth Sands vegetation community. This soil may contain a viable seed-bank for this community and utilisation of all sandy topsoil to aid restoration efforts in alternative Green Offset zones is feasible. Stripping depth may be in places as deep as 1m for this purpose.

Table 7 – Duplex Sand Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.00 - 0.05	Dark yellowish brown (105 YR 4/4) loamy sand with weak subangular structure and very weak consistence. Boundary gradual.	Moderately acidic with an average pH of 6.0 (range 5.8 - 7.5, n = 5) and non-saline with low ECe of less than 1dS/m (range 0.17 - 2.05dS/m, n = 5). Sodicity was low with average ESP of 6.15% (range 2.3 - 12.3, n = 5) and moderate to high aggregate stability with EAT class measurements of 5. The higher ESP was a class 3b.
2	0.05 - 0.30	Pale brown (10 YR 7/3) sand with single grain structure and loose consistence. Boundary abrupt.	
3	0.30 - 0.50+	Light brownish grey to brown (10 YR 6/2 - 10 YR 5/3) medium heavy clay with strong blocky structure and strong consistence.	Slightly acidic with an average pH of 6.3 (range 5.5 - 7.6, n = 13) and non-saline with low ECe of less than 1dS/m (range 0.16 - 1.86dS/m, n = 12). Highly sodic however with an ESP range of 10-50% (n = 3) and low-moderate aggregate stability with EAT classifications of 1 and 2 (n = 12).
n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).			

Grey-Pink Duplex Loam

Description: This soil unit is characterised by an abrupt texture change between the grey-brown sandy-loam surface soil and the underlying grey-pinkish clayey subsurface soil (**Table 8**). This soil unit is also identified in the Australian Soil Classification as a Sodosol. A distinguishing feature of this duplex unit is the grey clayey subsurface horizon. Grey colours occur in the landscape as seasonal saturation of the soil profile mobilises insitu-pigment bearing minerals (iron oxides) which are subsequently lost to free draining waters.

Location: This soil unit occurs mainly in and around Wallaby Scrub Road sloping towards Wollombi Brook. This soil unit generally occurs in the landscape on the lower-slopes and is a minor soil unit covering 10.2 per cent of the study area. Grey layers also occur higher up the hill-slope (termed gley) where impermeable or poorly draining horizons result in a localised saturated environment which favours mobilisation and loss of pigment bearing minerals.

This soil unit was profiled the during the Wollombi Brook investigation, refer **Appendix 4, Plate 3** and **Plate 4**.

Management: The surface 0.30m of this soil is suitable for stripping and reuse as topdressing in rehabilitation. The subsoil is not recommended for reuse in rehabilitation due to the limiting factors of textural structure and likely high sodicity and dispersion issues.

The topsoil soil requires standard erosion and sediment control measures if disturbed. Caution during stripping is advised as mixing of the quality topsoil with the subsoil will negatively impact on rehabilitation works.

Table 8 – Grey-Pink Duplex Loam Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.0 - 0.05	Brown (10 YR 4/3) sandy loam with massive structure and weak consistence. Boundary clear.	Moderately acidic with a pH of 6.0 and non-saline with low ECe of less than 0.5dS/m (n = 1). Non sodic with ESP of 5% and high aggregate stability with an EAT classification of 5 (n = 1).
2	0.05 - 0.30	Light grey to pinkish-grey (10 YR 7/2 - 7.5YR 6/2) sandy loam with weak (20 - 30mm block peds) to massive pedality and weak consistence. Boundary abrupt.	
3	0.30 - 0.50+	Light brownish - grey to pinkish-grey (10 YR 6/2 - 7.5YR 6/2) medium clay with moderate structure (blocky, angular peds) and strong consistence.	Slightly acidic with an average pH of 6.3 (range 5.9 - 6.7, n = 2) and non-saline with low ECe of less than 2dS/m (range 1.11 - 2.43dS/m, n = 2). A high sodic value was recorded (ESP of 30%) combined with a low-moderate aggregate stability with EAT classifications of 1 and 2 (n = 2).

n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).

Uniform Sand

Description: This soil unit is characterised by predominately yellowish-brown sand throughout the soil profile for a minimum of two metres (**Table 9**).

Location: This minor soil unit (6.9 per cent of the study area) occurs in the northern part of the study area, predominately to the north-western boundary. This deep sand is associated with the Warkworth Sands vegetation community. It has developed from aeolian deposition of sand particles and its location reflects recent and past wind direction (McKensie et al., 2008). It is termed a continental dune. This soil unit is identified in the Australian Soil Classification as a Tenosol as it exhibits weak pedological development.

This soil unit was profiled during the Wollombi Brook investigation, refer **Appendix 4, Plate 5** and **Plate 6**.

Management: This soil is not suitable for stripping and reuse as topdressing in mine rehabilitation works due to its single grain sandy structure.

This soil supports the endangered Warkworth Sands vegetation community and as such the stripping and reuse of this soil to support restoration/recreation works in alternative Green Offset zones is feasible. Recommended stripping depth is 1-2m. This soil does not present any sodic, erodibility or acidity issues that would prevent its re-use in this context, either in its removal, transport or storage. Due to its single grain texture, preventing wind erosion during storage is recommended. This soil is strongly acidic which is appropriate for this specific vegetation community. Generally strong soil acidity is not considered optimal for mine rehabilitation works.

Table 9 – Uniform Sand Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.00 - 0.05	Grey or Brown sand (7.5 YR 5/1 - 7.5 YR 4/2) sand. Single grained with loose consistence. Boundary diffuse to gradual.	Strongly acidic with a pH of 4.7 - 5.3 throughout the profile (n = 2) and non-saline with low average ECe of less than 1.5dS/m (range 0.13 - 10.23, n = 2).
2	0.05 - 2.00	Pink-greyish or light brown (7.5 YR 6/2 - 7.5 YR 6/4) sand. Single grained with loose consistence.	Non sodic with ESP of <3% (range 1.8 - 6.8, n = 2).
n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).			

Appendix B

Laboratory data

CERTIFICATE OF ANALYSIS

Work Order	: **ES1411884**	Page	: 1 of 18
Client	: **EMGA MITCHELL MCLENNAN**	Laboratory	: Environmental Division Sydney
Contact	: MR TIMOTHY ROHDE	Contact	: Client Services
Address	: 1/4 87 WICKHAM TERRACE SPRING HILL QLD 4000	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: trohde@emgamm.com	E-mail	: sydney@alsglobal.com
Telephone	: 07 3839 1800	Telephone	: +61-2-8784 8555
Facsimile	: 07 3839 1866	Facsimile	: +61-2-8784 8500
Project	: WARKWORTH	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 29-MAY-2014
Sampler	: NC	Issue Date	: 03-JUN-2014
Site	: ----		
		No. of samples received	: 78
Quote number	: BN/482/14	No. of samples analysed	: 78

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

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*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Di-An Dao		Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney 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 performed, 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 insufficient 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	B02, 0-30MM	B02, 30-100MM	B02, 150-300MM	B02, 300-500MM	B02, 500-800MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-001	ES1411884-002	ES1411884-003	ES1411884-004	ES1411884-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.6	5.2	4.6	4.5	4.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	91	31	194	278	364
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	9.0	7.0	13.2	14.0	10.7
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	10.8	2.1	2.0	1.8	1.2
Exchangeable Magnesium	----	0.1	meq/100g	7.1	3.2	7.6	8.2	5.8
Exchangeable Potassium	----	0.1	meq/100g	1.0	0.4	0.4	0.3	0.2
Exchangeable Sodium	----	0.1	meq/100g	0.2	0.3	1.3	1.7	1.3
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	0.1
Cation Exchange Capacity	----	0.1	meq/100g	19.1	6.0	11.3	12.1	8.5
Exchangeable Sodium Percent	----	0.1	%	1.3	4.6	9.0	10.4	11.1
Calcium/Magnesium Ratio	----	0.1	-	1.5	0.6	0.3	0.2	0.2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	B02, 800-1000MM	B01, 10-50MM	B01, 50-100MM	B01, 150-260MM	B01, 300-550MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-006	ES1411884-007	ES1411884-008	ES1411884-009	ES1411884-010
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.8	5.6	5.2	4.7	5.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	310	16	15	119	345
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	11.6	13.0	15.2	22.1	15.7
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.5	2.2	1.9	2.3	1.4
Exchangeable Magnesium	----	0.1	meq/100g	3.1	5.1	5.2	12.2	9.2
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.5	0.6	0.4	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.9	0.8	0.5	2.5	2.5
Exchangeable Aluminium	----	0.1	meq/100g	0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	4.7	8.7	8.2	17.4	13.4
Exchangeable Sodium Percent	----	0.1	%	12.7	7.4	5.3	10.6	12.6
Calcium/Magnesium Ratio	----	0.1	-	0.2	0.4	0.4	0.2	0.2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	B01, 550-800MM	B04, 0-50MM	B04, 50-110MM	B04, 150-260MM	B04, 260-470MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-011	ES1411884-012	ES1411884-013	ES1411884-014	ES1411884-015
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.5	5.5	6.0	6.0	4.8
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	490	36	40	94	427
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	15.2	4.5	5.6	4.3	17.4
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.1	4.8	4.4	2.4	1.5
Exchangeable Magnesium	----	0.1	meq/100g	7.6	1.6	1.7	1.4	4.8
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.7	0.6	0.5	1.3
Exchangeable Sodium	----	0.1	meq/100g	2.5	<0.1	<0.1	<0.1	1.5
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	11.4	7.2	6.8	4.5	9.2
Exchangeable Sodium Percent	----	0.1	%	14.0	1.1	1.2	2.0	11.6
Calcium/Magnesium Ratio	----	0.1	-	0.1	3.0	2.6	1.7	0.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	B04, 470-700MM	B04, 700-1000MM	B03, 0-50MM	B03, 50-150MM	B03, 150-240MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-016	ES1411884-017	ES1411884-018	ES1411884-019	ES1411884-020
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.9	5.0	5.3	5.0	5.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	587	30	64	67	87
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	14.6	10.9	12.2	10.3	10.9
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	1.0	0.5	2.0	2.2	2.1
Exchangeable Magnesium	----	0.1	meq/100g	3.8	1.8	2.0	3.0	3.0
Exchangeable Potassium	----	0.1	meq/100g	0.8	0.2	0.5	0.3	0.2
Exchangeable Sodium	----	0.1	meq/100g	1.6	0.8	0.2	0.7	0.7
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	7.2	3.3	4.8	6.3	6.0
Exchangeable Sodium Percent	----	0.1	%	14.4	15.5	4.2	8.4	9.3
Calcium/Magnesium Ratio	----	0.1	-	0.3	0.3	1.0	0.7	0.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	B03, 300-470MM	B03, 600-730MM	B03, 730-1000MM	DS5, 0-50MM	DS5, 100-200MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-021	ES1411884-022	ES1411884-023	ES1411884-024	ES1411884-025
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.0	5.2	5.2	5.3	5.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	335	662	700	9	16
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.5	12.6	13.7	4.4	3.0
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.3	0.3	0.3	0.8	0.9
Exchangeable Magnesium	----	0.1	meq/100g	1.2	1.5	1.6	1.1	0.7
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.2	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.8	1.1	0.8	0.2	0.2
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.4	2.9	2.8	2.2	1.8
Exchangeable Sodium Percent	----	0.1	%	18.2	19.2	17.2	6.0	7.9
Calcium/Magnesium Ratio	----	0.1	-	0.2	0.2	0.2	0.7	1.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	DS5, 200-300MM	DS5, 300-550MM	DS5, 600-900MM	DS3, 0-50MM	DS3, 50-150MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-026	ES1411884-027	ES1411884-028	ES1411884-029	ES1411884-030
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.9	7.0	7.5	4.2	3.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	73	229	476	12	5
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	13.4	14.1	10.0	3.4	4.4
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	2.3	1.0	0.5	0.4	0.2
Exchangeable Magnesium	----	0.1	meq/100g	7.3	3.7	3.0	0.2	<0.1
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	0.2	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	1.7	1.3	1.2	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	11.6	6.2	4.9	0.7	0.3
Exchangeable Sodium Percent	----	0.1	%	10.7	13.9	15.3	2.1	4.5
Calcium/Magnesium Ratio	----	0.1	-	0.3	0.3	0.2	2.0	2.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	DS3, 180-300MM	DS3, 300-600MM	DS3, 600-1000MM	DS4, 0-50MM	DS4, 50-150MM
			Client sampling date / time	28-MAY-2014 15:00	28-MAY-2014 15:00	28-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-031	ES1411884-032	ES1411884-033	ES1411884-034	ES1411884-035
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	3.8	4.0	4.6	3.8	4.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	3	3	2	10	8
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	3.6	3.5	3.9	1.8	3.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	0.2	0.8	0.2
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.1	<0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	<0.1	<0.1	0.3	1.0	0.3
Exchangeable Sodium Percent	----	0.1	%	12.1	15.3	4.2	1.1	2.5
Calcium/Magnesium Ratio	----	0.1	-	1.0	1.0	2.0	8.0	2.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	DS4, 150-300MM	DS4, 600-1000MM	DS4, 350-600MM	US1, 0-50MM	US1, 50-110MM
			Client sampling date / time	26-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-036	ES1411884-037	ES1411884-038	ES1411884-039	ES1411884-040
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	3.9	4.1	3.9	4.0	4.1
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	11	4	5	6	8
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	3.9	3.6	3.8	2.6	2.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.1	0.2
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	0.2	<0.1	0.1	0.2	0.3
Exchangeable Sodium Percent	----	0.1	%	4.9	10.5	9.8	5.9	10.1
Calcium/Magnesium Ratio	----	0.1	-	1.0	1.0	1.0	----	2.0
Calcium/Magnesium Ratio	----	0.1	-	----	----	----	2.5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	US1, 150-300MM	US1, 300-600MM	US1, 600-1000MM	DS1, 0-50MM	DS1, 50-130MM
			Client sampling date / time	26-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-041	ES1411884-042	ES1411884-043	ES1411884-044	ES1411884-045
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.0	4.1	4.5	5.3	5.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	5	4	2	28	21
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	2.6	2.9	3.5	18.4	14.8
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	2.2	1.4	0.6
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	2.4	1.5	1.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.4	0.2	0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.2	0.3	0.3
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	<0.1	0.2	5.2	3.4	2.3
Exchangeable Sodium Percent	----	0.1	%	8.5	<0.1	4.1	6.8	10.1
Calcium/Magnesium Ratio	----	0.1	-	1.0	1.0	0.9	0.9	0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	DS1, 150-300MM	DS1, 300-460MM	DS1, 600-1000MM	US3, 0-50MM	US3, 50-130MM
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-046	ES1411884-047	ES1411884-048	ES1411884-049	ES1411884-050
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.2	5.9	7.0	4.4	4.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	30	277	618	6	4
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	12.4	12.8	12.2	3.5	3.2
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.4	0.2	<0.1	0.2	0.1
Exchangeable Magnesium	----	0.1	meq/100g	1.3	1.4	1.6	0.1	<0.1
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.4	0.7	1.0	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.2	2.3	2.8	0.4	0.2
Exchangeable Sodium Percent	----	0.1	%	11.7	16.7	18.7	2.6	5.2
Calcium/Magnesium Ratio	----	0.1	-	0.3	0.1	<0.1	2.0	1.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	US3, 150-300MM	US3, 300-600MM	US3, 600-1000MM	GP1, 0-50MM	GP1, 50-150MM
			Client sampling date / time	26-MAY-2014 15:00	26-MAY-2014 15:00	26-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-051	ES1411884-052	ES1411884-053	ES1411884-054	ES1411884-055
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.0**	**4.4**	**4.4**	**4.1**	**4.6**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3**	**2**	**3**	**16**	**24**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	**4.3**	**4.8**	**5.3**	**4.2**	**5.6**
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	**0.3**	**0.4**	**0.2**	**0.2**	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	<0.1	**0.5**	**0.5**
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	**0.2**	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	**0.5**	**0.5**	**0.2**	**0.9**	**0.7**
Exchangeable Sodium Percent	----	0.1	%	**2.5**	**2.7**	**5.0**	**6.3**	**9.6**
Calcium/Magnesium Ratio	----	0.1	-	**3.0**	**4.0**	**2.0**	**0.4**	**0.2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	GP1, 190-300MM	GP1, 300-600MM	GP1, 750-1000MM	GP03, 0-50MM	GP03, 50-150MM
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-056	ES1411884-057	ES1411884-058	ES1411884-059	ES1411884-060
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.5	6.3	6.7	4.0	4.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	187	639	485	18	12
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	15.0	14.7	8.2	5.0	5.3
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.3	<0.1
Exchangeable Magnesium	----	0.1	meq/100g	1.7	1.2	2.2	1.2	1.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	0.2	0.2
Exchangeable Sodium	----	0.1	meq/100g	0.4	0.6	0.8	0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	2.2	1.9	3.1	1.8	1.5
Exchangeable Sodium Percent	----	0.1	%	13.4	17.6	15.0	5.0	5.3
Calcium/Magnesium Ratio	----	0.1	-	<0.1	<0.1	<0.1	0.2	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	GP03, 150-300MM	GP03, 300-500MM	GP03, 500-940MM	GP02, 0-50MM	GP02, 50-140MM
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-061	ES1411884-062	ES1411884-063	ES1411884-064	ES1411884-065
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.8	7.0	8.0	5.6	5.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	205	378	558	17	10
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	14.0	15.9	16.2	18.1	12.6
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	1.9	1.0
Exchangeable Magnesium	----	0.1	meq/100g	8.1	6.1	10.9	1.6	1.0
Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.4	0.4	0.3
Exchangeable Sodium	----	0.1	meq/100g	1.2	1.0	1.9	0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	9.6	7.2	13.2	4.1	2.4
Exchangeable Sodium Percent	----	0.1	%	9.7	9.9	10.4	2.9	3.5
Calcium/Magnesium Ratio	----	0.1	-	<0.1	<0.1	<0.1	1.2	1.0

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	GP02, 150-300MM	GP02, 320-600MM	GP02, 600-1000MM	DS2, 0-50MM	DS2, 60-140MM
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-066	ES1411884-067	ES1411884-068	ES1411884-069	ES1411884-070
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.2	5.6	6.2	4.4	4.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	10	49	207	129	55
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	10.4	13.0	12.2	4.2	4.4
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.4	0.1	<0.1	3.3	1.0
Exchangeable Magnesium	----	0.1	meq/100g	0.7	1.4	1.9	1.7	1.4
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.1	0.3	0.2
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	0.6	0.1	0.2
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	1.4	2.0	2.6	5.4	2.8
Exchangeable Sodium Percent	----	0.1	%	4.3	9.4	13.8	1.8	5.2
Calcium/Magnesium Ratio	----	0.1	-	0.6	<0.1	<0.1	1.9	0.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	DS2, 150-300MM	DS2, 300-600MM	DS2, 600-900MM	US2, 0-50MM	US2, 50-150MM
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00
Compound	CAS Number	LOR	Unit	ES1411884-071	ES1411884-072	ES1411884-073	ES1411884-074	ES1411884-075
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.8	7.2	7.9	3.9	3.4
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	323	442	357	23	18
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	9.8	11.4	10.8	7.0	4.0
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	0.4	0.4	0.2	0.7	0.3
Exchangeable Magnesium	----	0.1	meq/100g	2.5	2.2	1.7	0.4	0.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.8	0.8	0.6	<0.1	<0.1
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	3.8	3.5	2.6	1.2	0.6
Exchangeable Sodium Percent	----	0.1	%	13.3	14.8	15.2	1.7	2.0
Calcium/Magnesium Ratio	----	0.1	-	0.2	0.2	0.1	1.8	1.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	US2, 150-300M	US2, 300-450MM	US2, 600-1000MM	-----	-----
			Client sampling date / time	27-MAY-2014 15:00	27-MAY-2014 15:00	27-MAY-2014 15:00	----	----
Compound	CAS Number	LOR	Unit	ES1411884-076	ES1411884-077	ES1411884-078	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	3.4	3.5	3.8	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	11	9	4	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	2.5	3.3	3.2	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
Exchangeable Magnesium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	----	----
Cation Exchange Capacity	----	0.1	meq/100g	0.2	0.2	<0.1	----	----
Exchangeable Sodium Percent	----	0.1	%	<0.1	<0.1	<0.1	----	----
Calcium/Magnesium Ratio	----	0.1	-	1.0	1.0	1.0	----	----

Appendix C

Soil descriptions

Brown Kurosol

Brown Duplex Loam

Description: This soil unit is characterised by an abrupt texture change between the dark brown silty/ loam surface soil and the clayey brown sandy clay loam and yellowish brown medium heavy clay subsurface layers (duplex soil) (**Table 5**). This soil unit is identified in the Australian Soil Classification as a Sodosol and has also in the past been referred to in Great Soil Group terminology as Solonetz, Solodised-Solonetz and Solodic soils.

Location: This soil unit is the dominant soil in the Warkworth Mine study area (40.8 per cent cover) and is associated with undulating hillslopes, particularly mid-low sloping land and creek flats. This common soil unit was profiled during the Wollombi Brook investigation, refer **Appendix 4, Plate 1** and **Plate 2**.

Management: The surface 0.10m of topsoil is suitable for stripping and reuse as a topdressing material in rehabilitation works. Some topsoil profiles exhibited high sodicity values, however, soil aggregate stability was reasonable due to significant soil organic carbon content. In addition this topsoil's loamy soil texture is desirable for rehabilitation works.

The subsoil is unsuitable for rehabilitation works as it is highly sodic and dispersive.

The topsoil requires standard erosion and sediment control measures if disturbed. Given the soil's sodicity range, additional measures for stockpiling the soil and its reuse during rehabilitation works is recommended. These measures include stockpiling the soil where it is not exposed to wet conditions after stripping as this will limit dispersion and erosion, and the use of soil ameliorants such as gypsum and biosolids to improve aggregate cohesion (refer **Section 4**).

Table 5 – Brown Duplex Loam Profile

Layer #	Depth (m)	Description	
		Field	Laboratory
1	0.00 - 0.02	Dark (yellowish) brown (10 YR 4/4) silty loam to loam exhibiting weak peds of 10 millimetres (mm) or massive pedality. Boundary abrupt.	Moderately acidic with an average pH of 6.0 (range 5.4 - 6.3, n = 5) and non-saline with low Electrical Conductivity (ECe) of less than 1dS/m 9 (range 0.46 – 1.19dS/m, n = 5).
2	0.02 - 0.12	Dark yellowish brown (10 YR 5/4) silty loam with massive pedality. Boundary sharp.	Moderately sodic with an average Exchangeable Sodium Percentage (ESP) of 12%, (range 5 - 18.9, n = 5) with generally stable soil aggregates as indicated by Emerson Aggregate Test (EAT) classifications of 3-5.
3	0.12 - 0.45	Brown (7.5 YR 5/8 - 7.5 YR 4/6) heavy clay with a strong structure (polyhedral to prismatic). Boundary gradual.	Moderately acidic with an average pH of 6.0 (range 5.8 - 6.7, n = 12) and non-saline with average low ECe of less than 2dS/m (range 0.34 - 4.24, n = 12; note >4dS/m was an exception).
4	0.45 - 0.70	Yellowish brown (10 YR 5/6) heavy clay with strong structure (polyhedral to angular blocky peds). Boundary gradual.	Highly sodic with an average ESP of 27% (range 14.3 - 37.1; n = 5) and low aggregate stability with EAT classes of 1 and 2 (n = 10).
5	0.70 - 2.00	Yellowish (10 YR 6/6) medium clay to silty clay with moderate structure (polyhedral to angular blocky peds).	

n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).

Yellow Sodosol

Duplex Sand

Description: This soil unit is characterised by an abrupt texture change between the sandy surface soil and the medium-heavy clayey subsurface soil (duplex soil). Subsurface soils may be greyish, brownish or yellowish in colour (**Table 7**).

Location: This soil unit is the third most dominant soil in the Warkworth Mine study area (16.5 per cent cover) and is associated with the Uniform Sands in the northern part of the study area.

Management: The top 0.30m of topsoil is suitable to marginally suitable for stripping and reuse as topdressing in rehabilitation works. The top 0.05m of this soil is of suitable nature and the subsequent 0.25m is of marginal nature due to its single grain structure. It is recommended that the full 0.30m of topsoil be utilised, however, additional measures to treat the 0.05-0.30m fraction are recommended. These measures are discussed below.

The subsoil is not recommended for reuse in rehabilitation activities due to the limiting factors of texture, high sodicity and dispersion. Sodicity in the topsoil was observed to increase in a minority of soil profiles which contained clayey sand textures. As sodicity is related to exchangeable cations and soil clay content, these few outliers with small clay contents do not impact overall stripping depth recommendations.

The topsoil requires standard erosion and sediment control measures if disturbed and given its textural structure additional measures are recommended. Suitable measures include storing the soil where it is not exposed to wet conditions after stripping as this will limit dispersion and erosion, and the use of soil ameliorants (e.g. gypsum and biosolids) to improve aggregate cohesion (refer **Section 4**).

This soil unit is closely related to the uniform soil unit (**Table 9**) which supports the endangered Warkworth Sands vegetation community. This soil may contain a viable seed-bank for this community and utilisation of all sandy topsoil to aid restoration efforts in alternative Green Offset zones is feasible. Stripping depth may be in places as deep as 1m for this purpose.

Table 7 – Duplex Sand Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.00 - 0.05	Dark yellowish brown (10 YR 4/4) loamy sand with weak subangular structure and very weak consistence. Boundary gradual.	Moderately acidic with an average pH of 6.0 (range 5.8 - 7.5, n = 5) and non-saline with low ECe of less than 1dS/m (range 0.17 - 2.05dS/m, n = 5). Sodicity was low with average ESP of 6.15% (range 2.3 - 12.3, n = 5) and moderate to high aggregate stability with EAT class measurements of 5. The higher ESP was a class 3b.
2	0.05 - 0.30	Pale brown (10 YR 7/3) sand with single grain structure and loose consistence. Boundary abrupt.	
3	0.30 - 0.50+	Light brownish grey to brown (10 YR 6/2 - 10 YR 5/3) medium heavy clay with strong blocky structure and strong consistence.	Slightly acidic with an average pH of 6.3 (range 5.5 - 7.6, n = 13) and non-saline with low ECe of less than 1dS/m (range 0.16 - 1.86dS/m, n = 12). Highly sodic however with an ESP range of 10-50% (n = 3) and low-moderate aggregate stability with EAT classifications of 1 and 2 (n = 12).

n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).

Grey Sodosol

Grey-Pink Duplex Loam

Description: This soil unit is characterised by an abrupt texture change between the grey-brown sandy-loam surface soil and the underlying grey-pinkish clayey subsurface soil (**Table 8**). This soil unit is also identified in the Australian Soil Classification as a Sodosol. A distinguishing feature of this duplex unit is the grey clayey subsurface horizon. Grey colours occur in the landscape as seasonal saturation of the soil profile mobilises insitu-pigment bearing minerals (iron oxides) which are subsequently lost to free draining waters.

Location: This soil unit occurs mainly in and around Wallaby Scrub Road sloping towards Wollombi Brook. This soil unit generally occurs in the landscape on the lower-slopes and is a minor soil unit covering 10.2 per cent of the study area. Grey layers also occur higher up the hill-slope (termed gley) where impermeable or poorly draining horizons result in a localised saturated environment which favours mobilisation and loss of pigment bearing minerals.

This soil unit was profiled the during the Wollombi Brook investigation, refer **Appendix 4, Plate 3** and **Plate 4**.

Management: The surface 0.30m of this soil is suitable for stripping and reuse as topdressing in rehabilitation. The subsoil is not recommended for reuse in rehabilitation due to the limiting factors of textural structure and likely high sodicity and dispersion issues.

The topsoil soil requires standard erosion and sediment control measures if disturbed. Caution during stripping is advised as mixing of the quality topsoil with the subsoil will negatively impact on rehabilitation works.

Table 8 – Grey-Pink Duplex Loam Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.0 - 0.05	Brown (10 YR 4/3) sandy loam with massive structure and weak consistence. Boundary clear.	Moderately acidic with a pH of 6.0 and non-saline with low ECe of less than 0.5dS/m (n = 1). Non sodic with ESP of 5% and high aggregate stability with an EAT classification of 5 (n = 1).
2	0.05 - 0.30	Light grey to pinkish-grey (10 YR 7/2 - 7.5YR 6/2) sandy loam with weak (20 - 30mm block peds) to massive pedality and weak consistence. Boundary abrupt.	
3	0.30 - 0.50+	Light brownish - grey to pinkish-grey (10 YR 6/2 - 7.5YR 6/2) medium clay with moderate structure (blocky, angular peds) and strong consistence.	Slightly acidic with an average pH of 6.3 (range 5.9 - 6.7, n = 2) and non-saline with low ECe of less than 2dS/m (range 1.11 - 2.43dS/m, n = 2). A high sodic value was recorded (ESP of 30%) combined with a low-moderate aggregate stability with EAT classifications of 1 and 2 (n = 2).

n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).

Arenic Rudosol

Uniform Sand

Description: This soil unit is characterised by predominately yellowish-brown sand throughout the soil profile for a minimum of two metres (**Table 9**).

Location: This minor soil unit (6.9 per cent of the study area) occurs in the northern part of the study area, predominately to the north-western boundary. This deep sand is associated with the Warkworth Sands vegetation community. It has developed from aeolian deposition of sand particles and its location reflects recent and past wind direction (McKensie et al., 2008). It is termed a continental dune. This soil unit is identified in the Australian Soil Classification as a Tenosol as it exhibits weak pedological development.

This soil unit was profiled during the Wollombi Brook investigation, refer **Appendix 4, Plate 5** and **Plate 6**.

Management: This soil is not suitable for stripping and reuse as topdressing in mine rehabilitation works due to its single grain sandy structure.

This soil supports the endangered Warkworth Sands vegetation community and as such the stripping and reuse of this soil to support restoration/recreation works in alternative Green Offset zones is feasible. Recommended stripping depth is 1-2m. This soil does not present any sodic, erodibility or acidity issues that would prevent its re-use in this context, either in its removal, transport or storage. Due to its single grain texture, preventing wind erosion during storage is recommended. This soil is strongly acidic which is appropriate for this specific vegetation community. Generally strong soil acidity is not considered optimal for mine rehabilitation works.

Table 9 – Uniform Sand Profile

Layer	Depth	Description	
#	(m)	Field	Laboratory
1	0.00 - 0.05	Grey or Brown sand (7.5 YR 5/1 - 7.5 YR 4/2) sand. Single grained with loose consistence. Boundary diffuse to gradual.	Strongly acidic with a pH of 4.7 - 5.3 throughout the profile (n = 2) and non-saline with low average ECe of less than 1.5dS/m (range 0.13 - 10.23, n = 2).
2	0.05 - 2.00	Pink-greyish or light brown (7.5 YR 6/2 - 7.5 YR 6/4) sand. Single grained with loose consistence.	Non sodic with ESP of <3% (range 1.8 - 6.8, n = 2).
n = number of replicate soil profile sites, actual data replicates often larger as vertical sampling per layer varied (e.g. layer 2 may have been sampled at 0.05 and 0.10m at some soil profile sites).			

Appendix D

BSAL soil data cards

SURVEY TITLE: WARKWORTH

SITE LOCATION: B.O.I

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

SOIL TYPE

A.S.C.: O KU; SO AB; GG FD; SG AZ

FAMILY: B E L O W

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub (3), mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

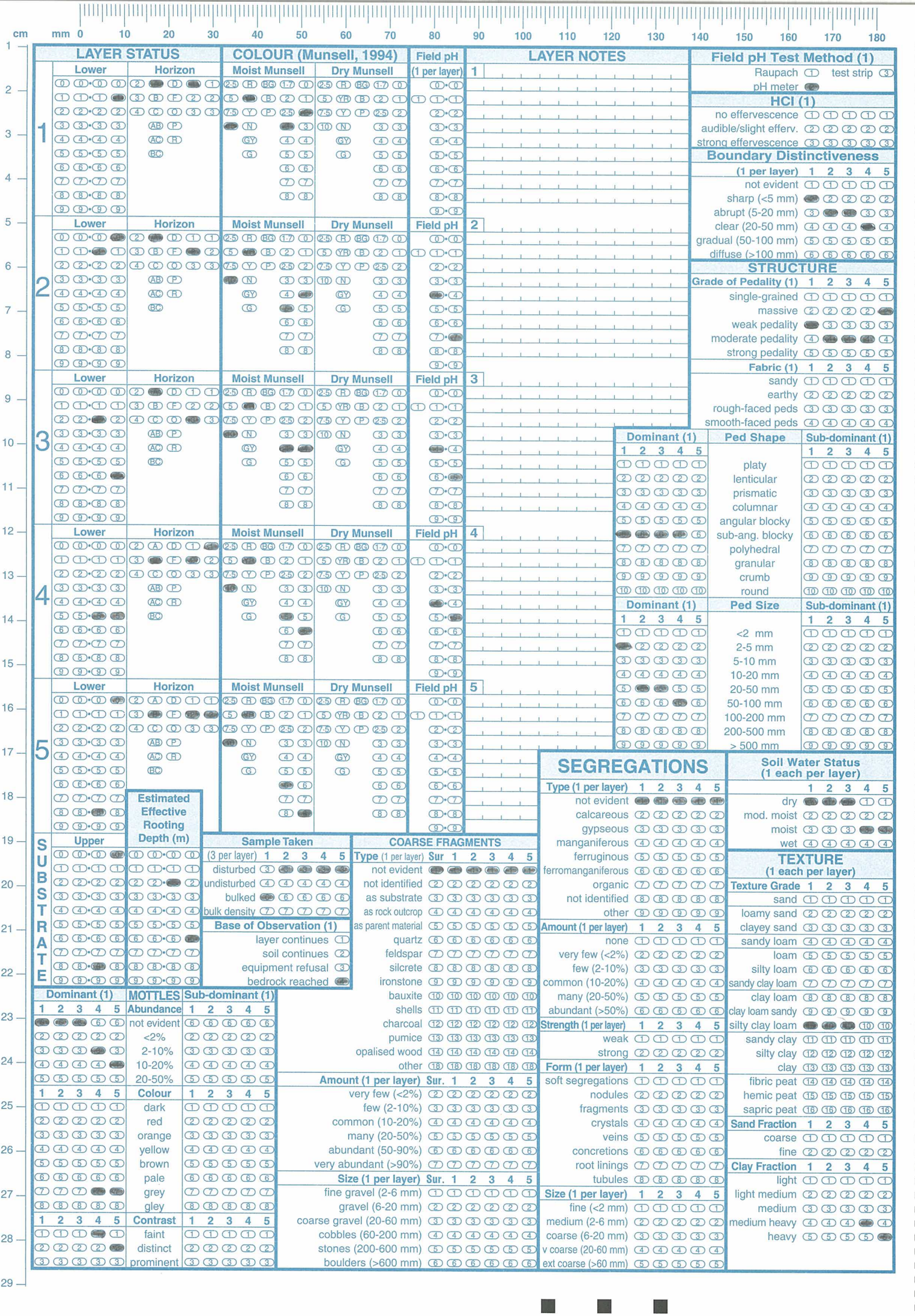
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm	(6)	(6)
hardset (7)		
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4054


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
MOTTLES
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: NARKNORTH

SITE LOCATION: BO2

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site, Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed (2), exclusion (3)

SOIL TYPE

A.S.C.: O Ku; SO AB; GG FD; SG AZ

FAMILY: B E L O W

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub (3), mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning (2), maximal, minimal (4)

Aspect (1): N, NW, NE, E, SW, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

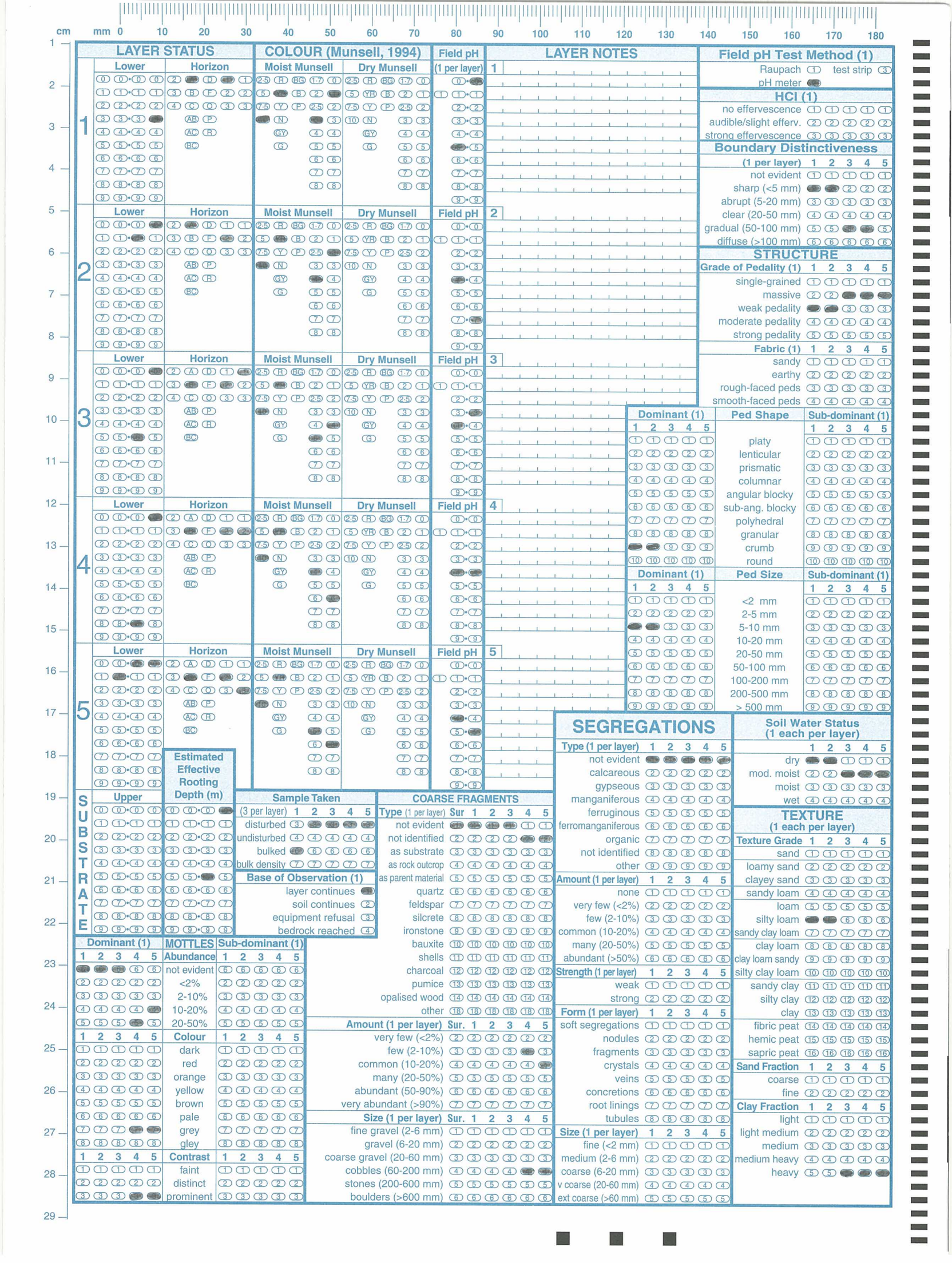
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm (6)	(6)	(6)
hardset		
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4055


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Upper
SUBSTRATE
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
Dominant (1)
MOTTLES
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Field pH Test Method (1)
Raupach test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Dominant (1)
Ped Size
Sub-dominant (1)
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy

SURVEY TITLE: WARKWORTH

SITE LOCATION: B03

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

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- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

SOIL TYPE

A.S.C.

O: Kle

SO: AB

GG: FD

SG: Az

FAMILY: BEGOW

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub (3), mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope (6), simple slope (7), lower slope, open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SW, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

Photo file name/s:

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

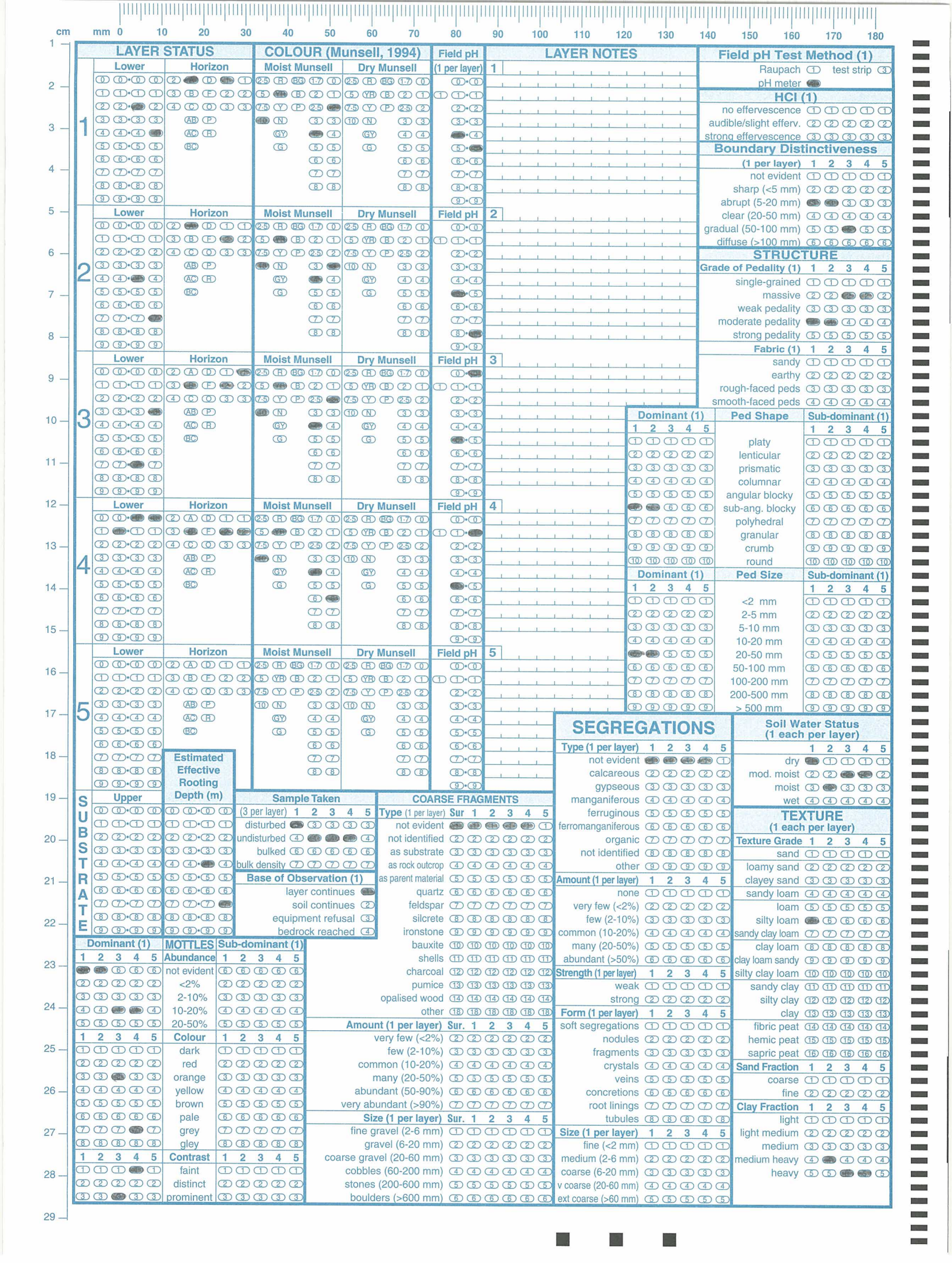
Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm (6)		
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Please do not mark this space.

4056


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Dominant (1)
Ped Size
Sub-dominant (1)
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
1 2 3 4 5
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
MOTTLES
Dominant (1)
Abundance
Sub-dominant (1)
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: BO4

PROFILE MAP DETAILS

Profile No.	Map Sheet No.	Eastings	Northings
0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
1 1 1	1 1 1 1 1 1	1 1 1 1 1 1	1 1 1 1 1 1
2 2 2	2 2 2 2 2 2	2 2 2 2 2 2	2 2 2 2 2 2
3 3 3	3 3 3 3 3 3	3 3 3 3 3 3	3 3 3 3 3 3
4 4 4	4 4 4 4 4 4	4 4 4 4 4 4	4 4 4 4 4 4
5 5 5	5 5 5 5 5 5	5 5 5 5 5 5	5 5 5 5 5 5
6 6 6	6 6 6 6 6 6	6 6 6 6 6 6	6 6 6 6 6 6
7 7 7	7 7 7 7 7 7	7 7 7 7 7 7	7 7 7 7 7 7
8 8 8	8 8 8 8 8 8	8 8 8 8 8 8	8 8 8 8 8 8
9 9 9	9 9 9 9 9 9	9 9 9 9 9 9	9 9 9 9 9 9

SURVEY DETAILS

Described By	Profile Date	Photo Taken (1)	No. of Layers
0 0 0 0	0 Jan Jul 0 0	profile 1	
1 1 1	1 1 Feb Aug 1	site 2	0
2 2 2	2 2 Mar Sep 2 2	both profile & site 3	1
3 3 3 3	3 3 Apr Oct 3 3	**Nature of Exposure (2)**	2
4 4 4 4	4 May Nov 4 4	auger 1	3
5 5 5 5	5 Jun Dec 5 5	pit 2	4
6 6 6 6	6 6 6	batter 3	
7 7 7 7	7 7 7	gully 4	
8 8 8 8	8 8 8	core sample 5	
9 9 9 9	9 9 9	other 6	

Potential BSAL? (1): yes 1 no 2

Site type (1): checked 1, detailed 2, exclusion 3

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: KU

SO: AB

GG: FD

SG: AZ

FAMILY: B E L O W

C:

G.S.G.

A

B B B

C C

D D

E E E

G G G

H H H

K K K

L L

N M

P P P

R R

S S S

T Z

W

X

Y

affinity with

VEGETATION

Vegetation Community (1)

unknown 1, rainforest 2, wet sclerophyll forest 3, dry sclerophyll forest 4, woodland grass u'storey 5, woodland shrub u'storey 6, tall shrubland 7, low shrubland 8, heath 9, grassland/herbland 10, swamp complex 11, littoral complex 12, no vegetation 13

Growth Forms (4)

tree 1, tree mallee 2, shrub 3, mallee shrub 4, heath shrub 5, chenopod shrub 6, hummock grass 7, tussock grass 8, sod grass 9, sedge 10, rush 11, forb 12, fern/cycad 13, moss 14, lichen 15, liverwort 16, vine 17

LAND USE (1)

national/state parks 1, timber/scrub/unused 2, logged native forest 3, hardwood plantation 4, softwood plantation 5, volun./native pasture 6, improved pasture 7, cropping 8, orchard/vineyard 9, vegetables/flowers 10, urban 11, industrial 12, quarry/mining 13, other 14

LANDFORM ELEMENT (1)

alcove 43	cone 3	footslope 21	ox-bow 57	sink hole/doline 52
backplain 31	crater 51	foredune 12	pan/playa 56	stream channel 46
bank 25	cut face 28	gully 42	pediment 22	streambed 45
bar 6	cut-over surface 39	hillcrest 1	pit 60	summit surface 2
beach 26	dam 16	hillslope 2	plain 30	swale 47
beach ridge 7	drainage depression 41	lagoon 54	prior stream 9	swamp 58
bench 19	dune 11	lake 55	rock flat 34	talus 23
berm 29	embankment 14	landslide 20	rock platform 35	tidal creek 48
blow-out 59	estuary 44	levee 8	scald 36	tidal flat 37
channel bench 33	fan 27	lunette 13	scarp 18	tor 4
cirque 50	fill top 40	maar 53	scree 24	trench 49
cliff 5	flood-out 32	mound 15	scroll 10	valley flat 38

LITHOLOGY

Substrate (3)

not identified 1	limestone 23	coarse-basic 45
unconsolidated 2	tuff 24	fine-acidic 46
gravel 3	breccia 25	fine-intermediate 47
sand 4	greywacke 26	fine-basic 48
silt 5	arkose 27	serpentine 49
clay 6	dolomite 28	gabbro 50
organic material 7	calcrete 29	dolerite 51
alluvium 8	aeolianite 30	diorite 52
colluvium 9	chert 31	syenite 53
lacustrine 10	jasper 32	granodiorite 54
aeolian 11	**metamorphic** 33	adamellite 55
marine 12	gneiss 34	granite 56
calcareous sand 13	schist/phyllite 35	aplite 57
fill 14	slate 36	quartz porphyry 58
mud 15	hornfels 37	basalt 59
till 16	quartzite 38	andesite 60
sedimentary 17	greenstone 39	trachyte 61
shale 18	amphibolite 40	rhyolite 62
siltstone/mudstone 19	marble 41	obsidian 63
sandstone-quartz 20	**igneous** 42	scoria 64
sandstone-lithic 21	coarse-acidic 43	ash 65
conglomerate 22	coarse-intermediate 44	agglomerate 66
		other 67

Identification Method (1)

personal assessment 1, geology map 2, both assessment & map 3

Rock Outcrop % (1)

nil 1, <2% 2, 2-10% 3, >10-20% 4, >20-30% 5, >30-50% 6, >50% 7

TOPOGRAPHY

Slope Percent

0 0 0 0, 1 1 1 1, 2 2 2, 3 3 3, 4 4 4, 5 5 5, 6 6 6, 7 7 7, 8 8 8, 9 9 9

Site Morphology (1)

flat 1, crest 2, hillock 3, ridge 4, upper slope 5, midslope 6, simple slope 7, lower slope 8, open depression 9, closed depression 10

Slope Measurement Method (1)

inclinometer 1, Abney level 4, total station 5, RTK GPS 6, LIDAR 7

Slope Morphology (1)

waxing 1, waning 2, maximal 3, minimal 4

Aspect (1)

N, NW, NE, W, E, SW, SE, S

Microrelief Type (1)

none 1, normal gilgai 2, crabhole gilgai 3, linear gilgai 4, lattice gilgai 5, melonhole gilgai 6, other 9

HYDROLOGY

Profile Drainage (1)

very poorly drained 1, poorly drained 2, imperfectly drained 3, mod. well-drained 4, well-drained 5, rapidly drained 6

Permeability (1)

very slowly permeable 1, slowly permeable 2, moderately permeable 3, highly permeable 4

Depth (1) & Extent (1)

≤ 500 mm depth 1, > 500 mm depth 2, ≤ 50% area 1, > 50% area 2

SITE CONDITION

Site Disturbance(s) (2)

natural disturbance 1, no effective disturbance 2, limited clearing 3, extensive clearing 4, cleared, no cultivation 5, occasional cultivation 6, rainfed cultivation 7, irrigated cultivation 8, highly disturbed 9

Ground Cover %

0 0 0, 1 1 1, 2 2, 3 3, 4 4, 5 5, 6 6, 7 7, 8, 9 9

Surface Condition

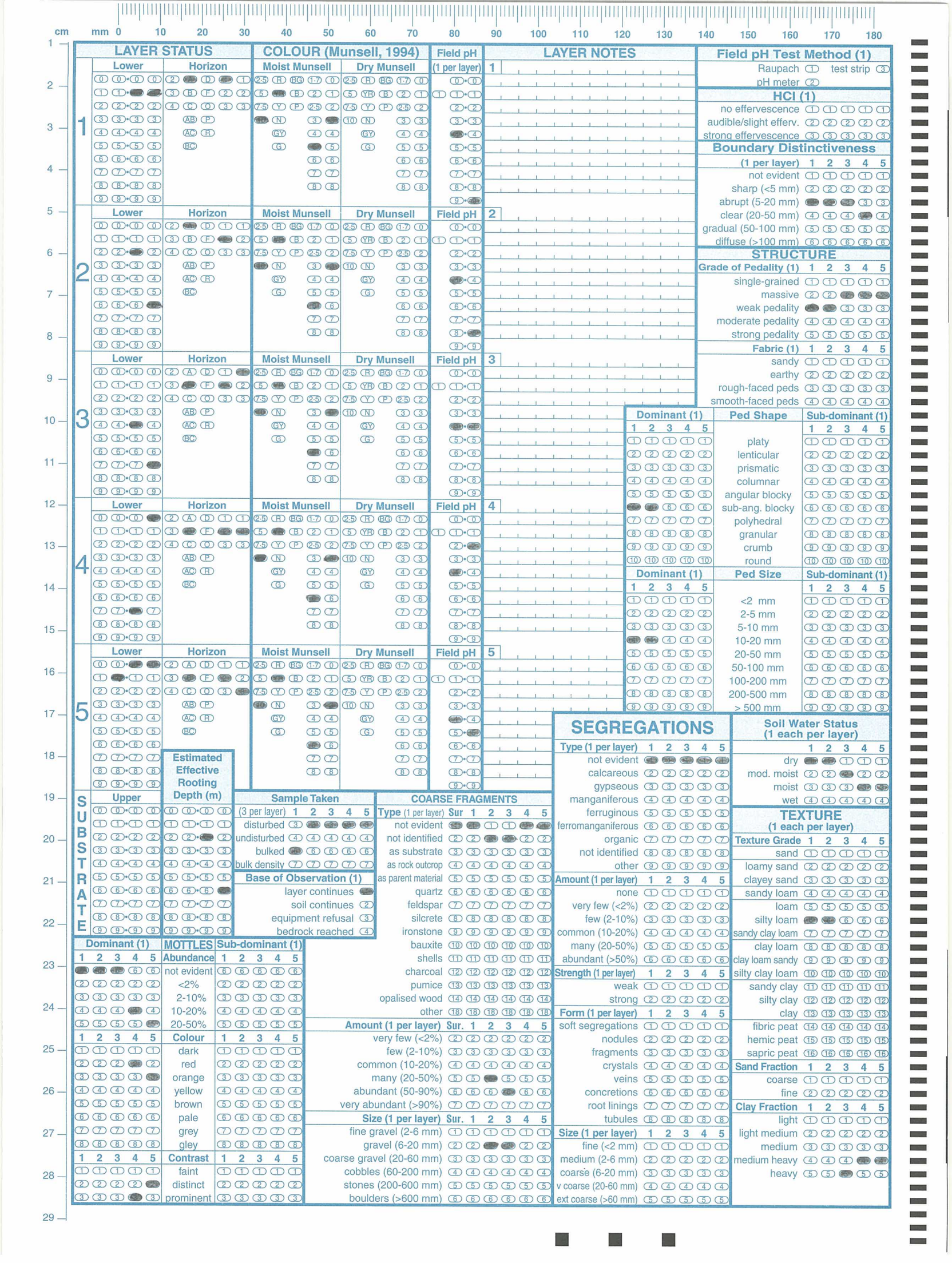
Current (2)	Expected Wet (2)	Expected Dry (2)
cracked 2	2	2
self-mulched 3	3	3
loose 4	4	4
soft 5	5	5
firm 6	6	6
hardset 7		7
surface crust 8	8	8
trampled 9		9
poached 10	10	
recently cultivated 11		
water repellent 12		12
gravelly 1		
other 13	13	13

SITE FIELD NOTES

Photo file name/s:

Please do not mark this space.

4061


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
MOTTLES
Dominant (1)
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: DS1

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site

Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

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- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: SO

SO: AC

GG: FN

SG: AF

FAMILY: B E K O W

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub (3), mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NE, E, SE, S, SW, W

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained, mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

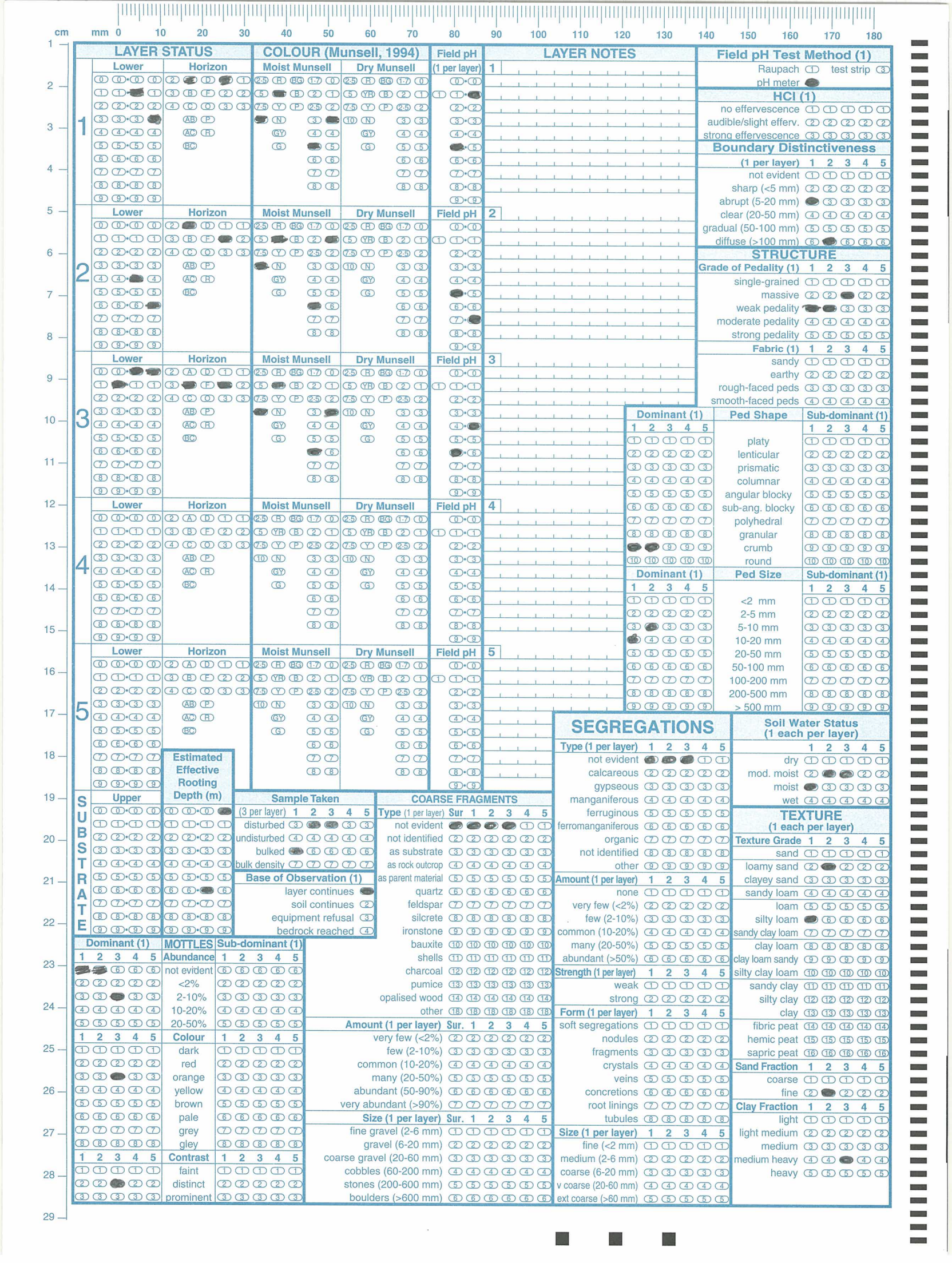
Current (2): cracked (2), self-mulched (3), loose (4), soft (5), firm (6), hardset (7), surface crust (8), trampled (9), poached (10), recently cultivated (11), water repellent (12), gravelly (1), other (13)

Expected: Wet (2), Dry (2)

Photo file name/s:

Please do not mark this space.

4051


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Dominant (1)
Ped Size
Sub-dominant (1)
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
1 2 3 4 5
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
Dominant (1)
MOTTLES
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: GP02

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site, Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

SOIL TYPE: A.S.C. O: SO; SO: AD; GG: FN; SG: DB; FAMILY: B, H, L, O, W; C

G.S.G.: (A), (B) (B) (B), (C) (C), (D) (D), (E) (E) (E), (G) (G) (G), (H) (H) (H), (K) (K) (K), (L) (L), (N) (M), (P) (P) (P), (R) (R), (S) (S) (S), (T) (Z), (W), (X), (Y)

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3):

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing, waning (2), maximal (3), minimal (4)

Aspect (1): (N), (NW), (NE), (E), (SW), (SE), (S)

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

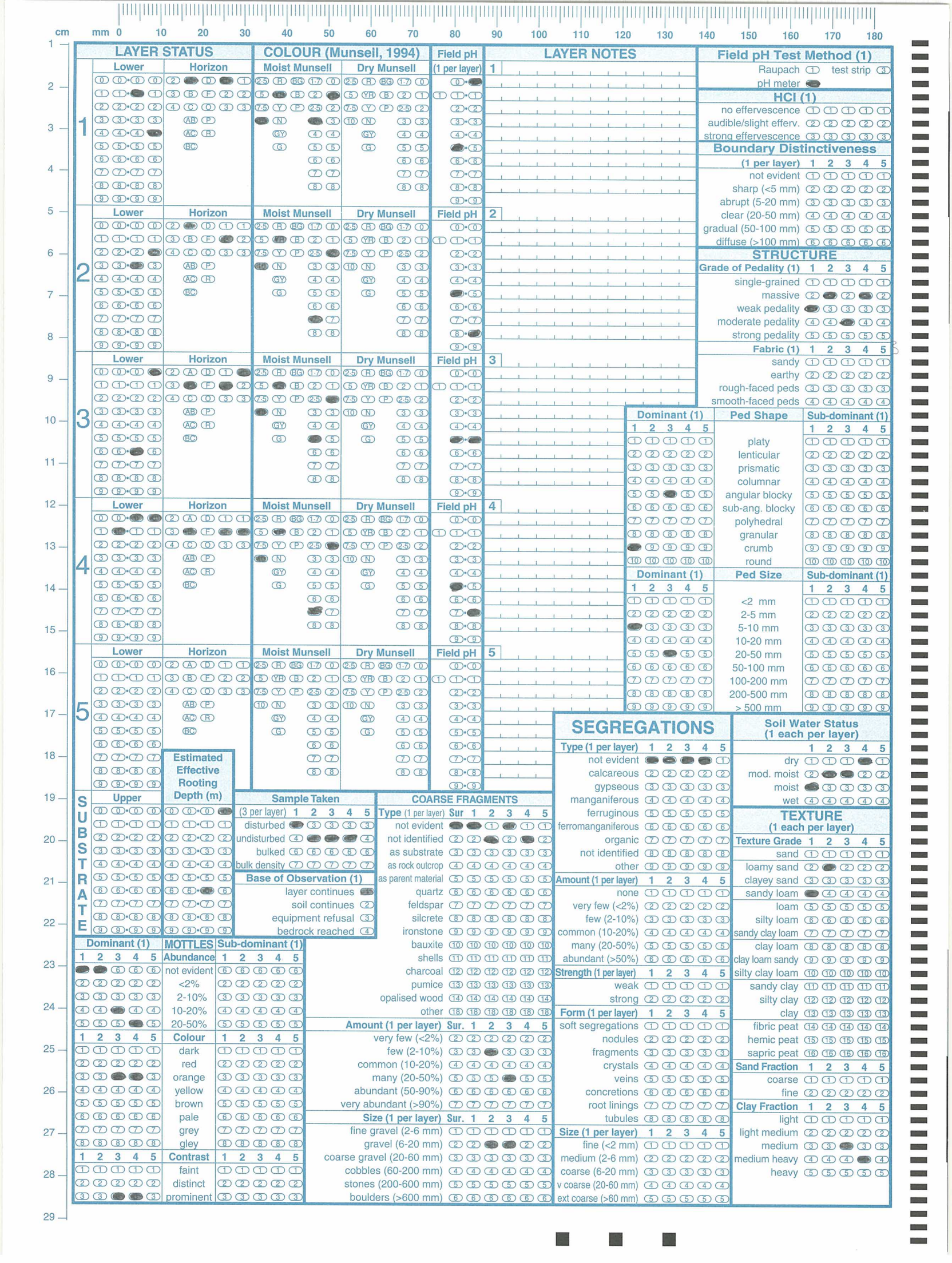
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm (6)		
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4058


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
MOTTLES
Dominant (1)
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: DS2

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site

Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (5)

Potential BSAL? (1): yes (1) no (2)

Site type (1): checked (1), detailed (2), exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: SO

SO: AC

GG: FN

SG: AF

FAMILY: B E K O W

C

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

G.S.G.

(A)
(B) (B) (B)
(C) (C)
(D) (D)
(E) (E) (E)
(G) (G) (G)
(H) (H) (H)
(K) (K) (K)
(L) (L)
(N) (M)
(P) (P) (P)
(R) (R)
(S) (S) (S)
(T) (Z)
(W)
(X)
(Y)

affinity with ( )

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

HYDROLOGY

Profile Drainage (1): very poorly drained, poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning (2), maximal (3), minimal

Aspect (1): (N), (NW), (NE), (W), (E), (SE), (S)

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

Photo file name/s:

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm (6)	(6)	(6)
hardset (7)		
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

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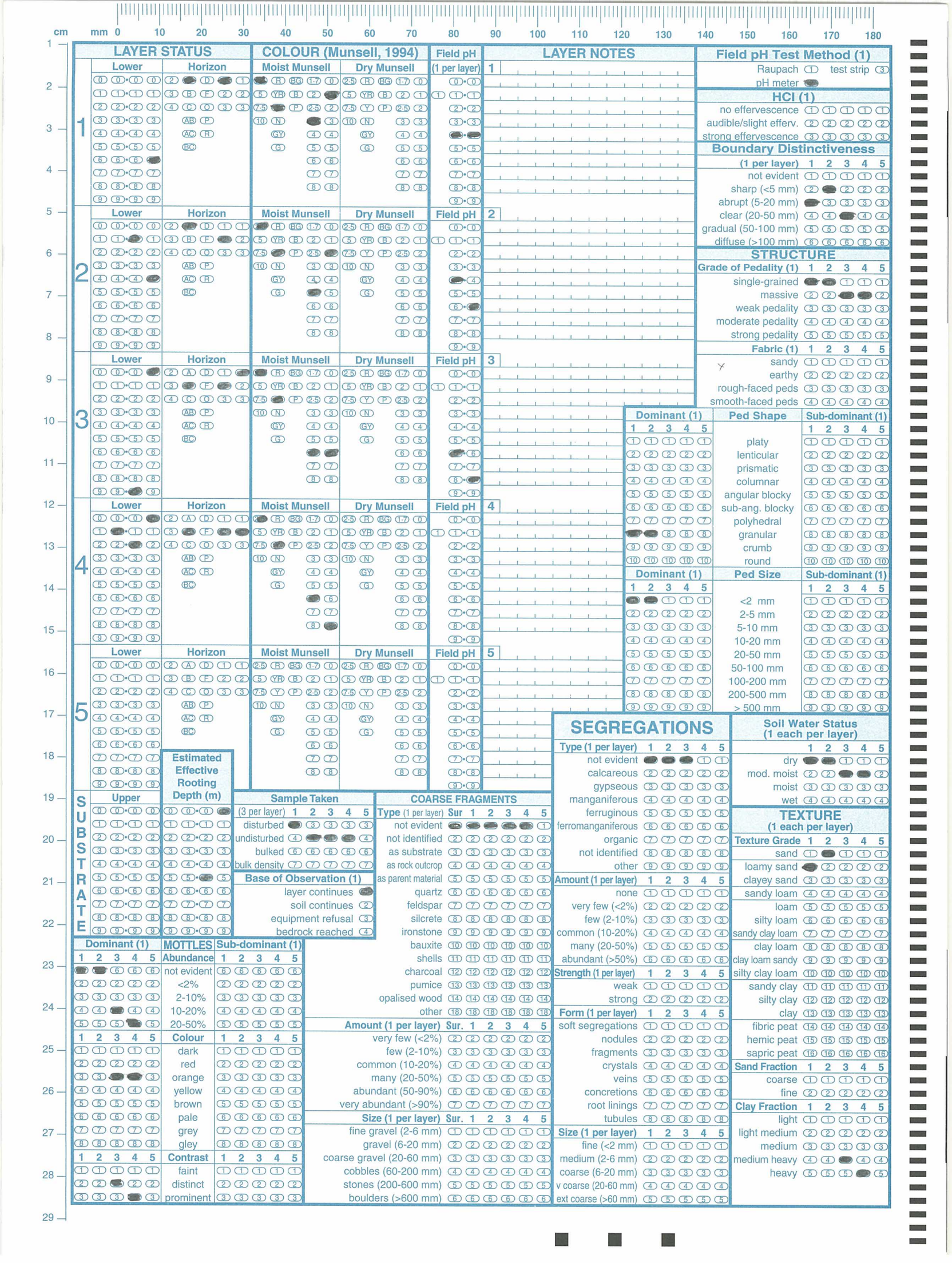
4052


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
MOTTLES
Dominant (1)
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: DS5

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (1)

Nature of Exposure (2): auger (1), pit (3), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: SO

SO: AC

GG: FN

SG: AF

FAMILY: B, E, K, O, W

C

G.S.G.

A, B, B, B, C, C, D, D, E, E, E, G, G, G, H, H, H, K, K, K, L, L, M, N, P, P, P, R, R, S, S, S, T, Z, W, X, Y

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained, poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

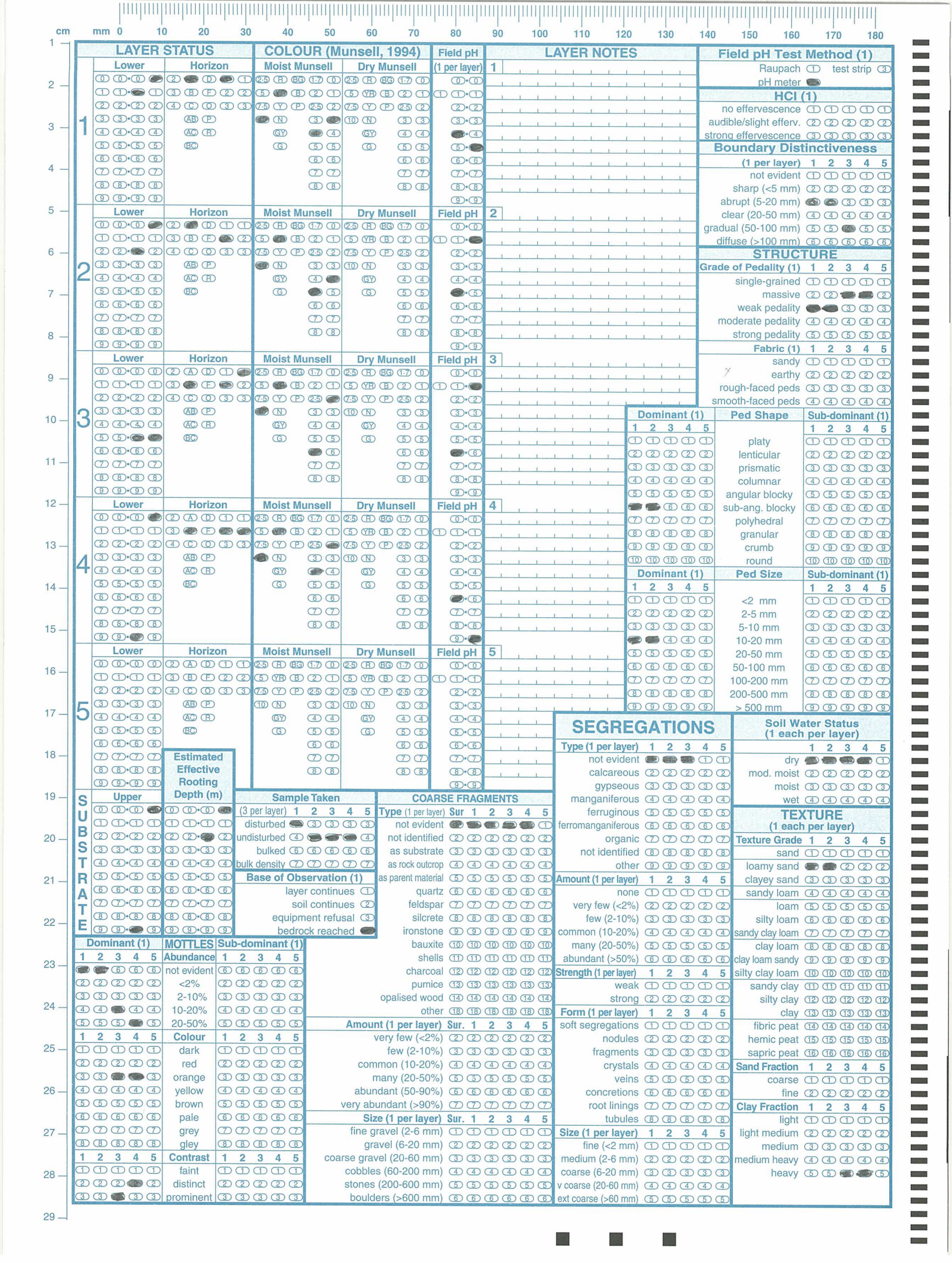
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose	(4)	
soft (5)		(5)
firm (6)	(6)	(6)
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4053


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur.
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
MOTTLES
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: GP03

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site, Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: SO

SO: AD

GG: FN

SG: DB

FAMILY: B, H, L, O, W

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): (N), (NE), (E), (SE), (S), (SW), (W)

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable, highly permeable (4)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

Photo file name/s:

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)		(5)
firm	(6)	
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

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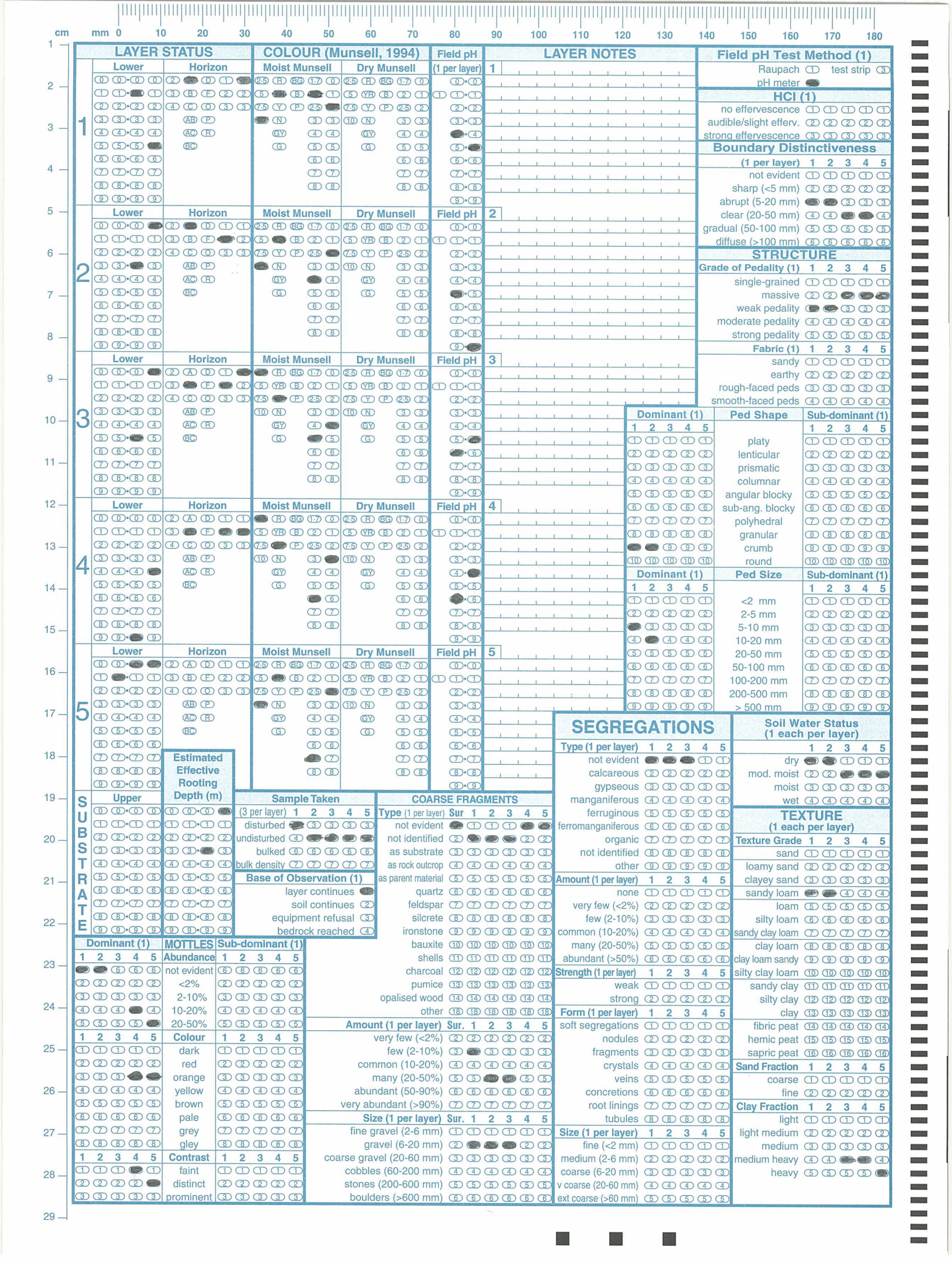
4059


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
Sur.
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
Sur.
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
MOTTLES
Dominant (1)
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent

SURVEY TITLE: WARKWORTH

SITE LOCATION: GP01

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
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- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

SOIL TYPE

A.S.C.

O: SO

SO: AD

GG: FW

SG: DB

FAMILY: B, H, L, O, W

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), serpentine (28), dolomite (29), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained, imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

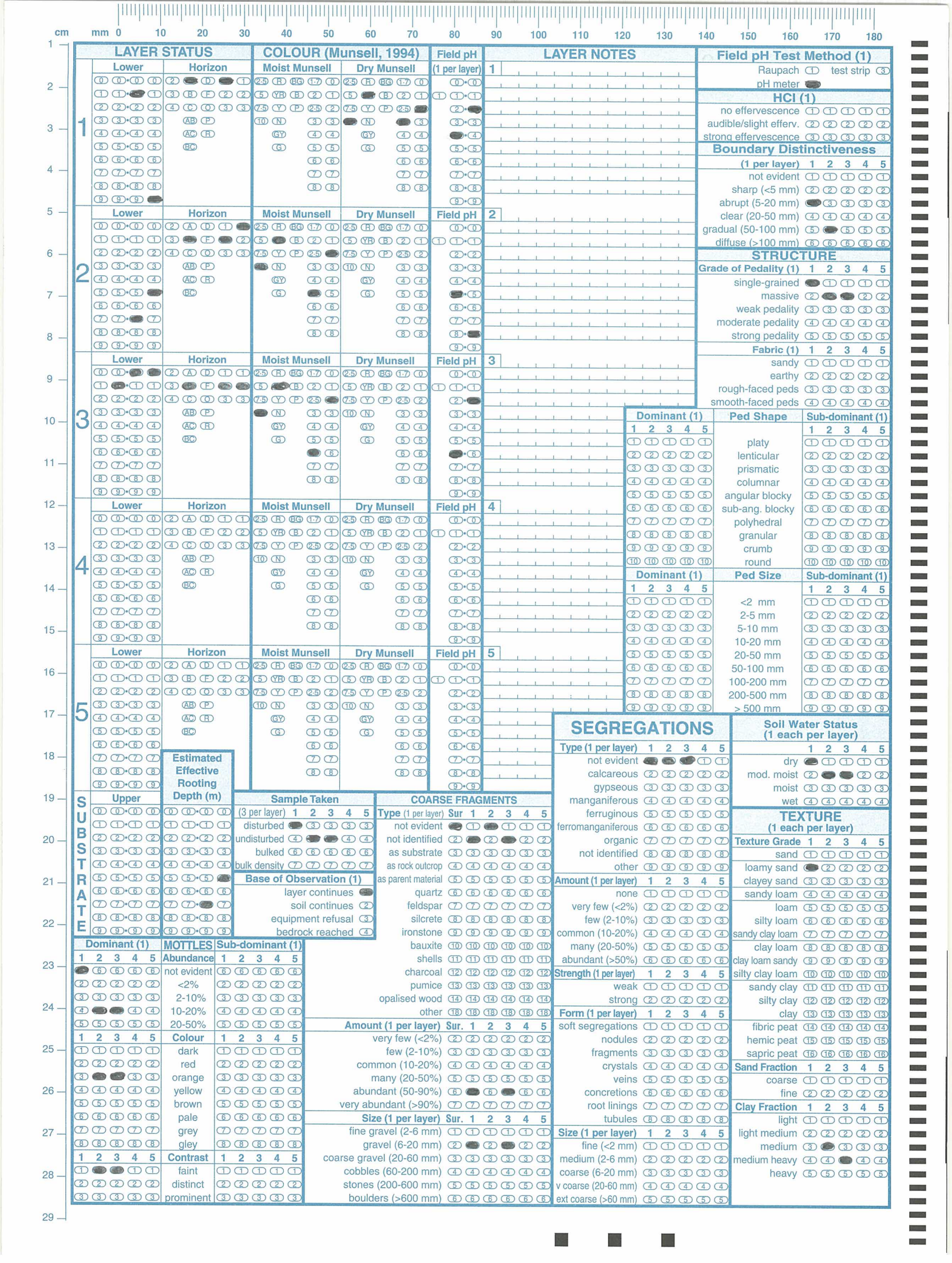
Surface Condition

	Current (2)	Expected Wet (2)	Expected Dry (2)
cracked	(2)	(2)	(2)
self-mulched	(3)	(3)	(3)
loose	(4)	(4)	(4)
soft	(5)		(5)
firm	(6)	(6)	(6)
hardset			
surface crust	(8)	(8)	(8)
trampled	(9)		(9)
poached	(10)	(10)	
recently cultivated	(11)		
water repellent	(12)		(12)
gravelly	(1)		
other	(13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4057


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
Dominant (1)
MOTTLES
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent
cm
mm

SURVEY TITLE: WARKWORTH

SITE LOCATION: US1

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site, Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked (1), detailed, exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: RV

SO: AO

GG

SG

FAMILY

C

G.S.G.

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad, moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

affinity with

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3): not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope, midslope (6), simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, E, SW, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

Current (2): cracked (2), self-mulched (3), loose, soft (5), firm (6), hardset (7), surface crust (8), trampled (9), poached (10), recently cultivated (11), water repellent (12), gravelly (1), other (13)

Expected Wet (2): (2), (3), (4), (5), (6), (8), (10), (13)

Expected Dry (2): (2), (3), (5), (6), (7), (8), (9), (12), (13)

Photo file name/s:

Please do not mark this space.

4060

LAYER STATUS

	Lower	Horizon
1	0 1 2 3 4 5 6 7 8 9	A B C AB AC BC
2	0 1 2 3 4 5 6 7 8 9	A B C AB AC BC
3	0 1 2 3 4 5 6 7 8 9	A B C AB AC BC
4	0 1 2 3 4 5 6 7 8 9	A B C AB AC BC
5	0 1 2 3 4 5 6 7 8 9	A B C AB AC BC
SUBSTRATE	Upper	Estimated Effective Rooting Depth (m)
	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

COLOUR (Munsell, 1994)

	Moist Munsell	Dry Munsell	Field pH (1 per layer)
1	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	0 1 2 3 4 5 6 7 8 9
2	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	0 1 2 3 4 5 6 7 8 9
3	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	0 1 2 3 4 5 6 7 8 9
4	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	0 1 2 3 4 5 6 7 8 9
5	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	H BG 1-7 0 / YR B 2 1 / Y P 2.5 2 / N 3 / GY 4 / G 5 6 7 8	0 1 2 3 4 5 6 7 8 9

LAYER NOTES

1
2
3
4
5

Field pH Test Method (1)

Raupach 1 test strip 3
pH meter 2

HCl (1)

	1	2	3	4	5
no effervescence	1	1	1	1	1
audible/slight efferv.	2	2	2	2	2
strong effervescence	3	3	3	3	3

Boundary Distinctiveness

(1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
sharp (<5 mm)	2	2	2	2	2
abrupt (5-20 mm)	3	3	3	3	3
clear (20-50 mm)	4	4	4	4	4
gradual (50-100 mm)	5	5	5	5	5
diffuse (>100 mm)	6	6	6	6	6

STRUCTURE

Grade of Pedality (1)	1	2	3	4	5
single-grained	1	1	1	1	1
massive	2	2	2	2	2
weak pedality	3	3	3	3	3
moderate pedality	4	4	4	4	4
strong pedality	5	5	5	5	5

Fabric (1)	1	2	3	4	5
sandy	1	1	1	1	1
earthy	2	2	2	2	2
rough-faced peds	3	3	3	3	3
smooth-faced peds	4	4	4	4	4

Dominant (1)	Ped Shape	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	platy	1 1 1 1 1
2 2 2 2 2	lenticular	2 2 2 2 2
3 3 3 3 3	prismatic	3 3 3 3 3
4 4 4 4 4	columnar	4 4 4 4 4
5 5 5 5 5	angular blocky	5 5 5 5 5
6 6 6 6 6	sub-ang. blocky	6 6 6 6 6
7 7 7 7 7	polyhedral	7 7 7 7 7
8 8 8 8 8	granular	8 8 8 8 8
9 9 9 9 9	crumb	9 9 9 9 9
10 10 10 10 10	round	10 10 10 10 10

Dominant (1)	Ped Size	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	<2 mm	1 1 1 1 1
2 2 2 2 2	2-5 mm	2 2 2 2 2
3 3 3 3 3	5-10 mm	3 3 3 3 3
4 4 4 4 4	10-20 mm	4 4 4 4 4
5 5 5 5 5	20-50 mm	5 5 5 5 5
6 6 6 6 6	50-100 mm	6 6 6 6 6
7 7 7 7 7	100-200 mm	7 7 7 7 7
8 8 8 8 8	200-500 mm	8 8 8 8 8
9 9 9 9 9	> 500 mm	9 9 9 9 9

SEGREGATIONS

Type (1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
calcareous	2	2	2	2	2
gypseous	3	3	3	3	3
manganiferous	4	4	4	4	4
ferruginous	5	5	5	5	5
ferromanganiferous	6	6	6	6	6
organic	7	7	7	7	7
not identified	8	8	8	8	8
other	9	9	9	9	9
Amount (1 per layer)	**1**	**2**	**3**	**4**	**5**
none	1	1	1	1	1
very few (<2%)	2	2	2	2	2
few (2-10%)	3	3	3	3	3
common (10-20%)	4	4	4	4	4
many (20-50%)	5	5	5	5	5
abundant (>50%)	6	6	6	6	6
Strength (1 per layer)	**1**	**2**	**3**	**4**	**5**
weak	1	1	1	1	1
strong	2	2	2	2	2
Form (1 per layer)	**1**	**2**	**3**	**4**	**5**
soft segregations	1	1	1	1	1
nodules	2	2	2	2	2
fragments	3	3	3	3	3
crystals	4	4	4	4	4
veins	5	5	5	5	5
concretions	6	6	6	6	6
root linings	7	7	7	7	7
tubules	8	8	8	8	8
Size (1 per layer)	**1**	**2**	**3**	**4**	**5**
fine (<2 mm)	1	1	1	1	1
medium (2-6 mm)	2	2	2	2	2
coarse (6-20 mm)	3	3	3	3	3
v coarse (20-60 mm)	4	4	4	4	4
ext coarse (>60 mm)	5	5	5	5	5

Soil Water Status (1 each per layer)

	1	2	3	4	5
dry	1	1	1	1	1
mod. moist	2	2	2	2	2
moist	3	3	3	3	3
wet	4	4	4	4	4

TEXTURE (1 each per layer)

Texture Grade	1	2	3	4	5
sand	1	1	1	1	1
loamy sand	2	2	2	2	2
clayey sand	3	3	3	3	3
sandy loam	4	4	4	4	4
loam	5	5	5	5	5
silty loam	6	6	6	6	6
sandy clay loam	7	7	7	7	7
clay loam	8	8	8	8	8
clay loam sandy	9	9	9	9	9
silty clay loam	10	10	10	10	10
sandy clay	11	11	11	11	11
silty clay	12	12	12	12	12
clay	13	13	13	13	13
fibric peat	14	14	14	14	14
hemic peat	15	15	15	15	15
sapric peat	16	16	16	16	16
Sand Fraction	**1**	**2**	**3**	**4**	**5**
coarse	1	1	1	1	1
fine	2	2	2	2	2
Clay Fraction	**1**	**2**	**3**	**4**	**5**
light	1	1	1	1	1
light medium	2	2	2	2	2
medium	3	3	3	3	3
medium heavy	4	4	4	4	4
heavy	5	5	5	5	5

Sample Taken

(3 per layer)	1	2	3	4	5
disturbed	3	3	3	3	3
undisturbed	4	4	4	4	4
bulked	6	6	6	6	6
bulk density	7	7	7	7	7

Base of Observation (1)

layer continues 1
soil continues 2
equipment refusal 3
bedrock reached 4

COARSE FRAGMENTS

Type (1 per layer)	Sur	1	2	3	4	5
not evident				1	1	1
not identified	2	2	2	2	2	2
as substrate	3	3	3	3	3	3
as rock outcrop	4	4	4	4	4	4
as parent material	5	5	5	5	5	5
quartz	6	6	6	6	6	6
feldspar	7	7	7	7	7	7
silcrete	8	8	8	8	8	8
ironstone	9	9	9	9	9	9
bauxite	10	10	10	10	10	10
shells	11	11	11	11	11	11
charcoal	12	12	12	12	12	12
pumice	13	13	13	13	13	13
opalised wood	14	14	14	14	14	14
other	18	18	18	18	18	18
Amount (1 per layer)	**Sur.**	**1**	**2**	**3**	**4**	**5**
very few (<2%)	2	2	2	2	2	2
few (2-10%)	3	3	3	3	3	3
common (10-20%)	4	4	4	4	4	4
many (20-50%)	5	5	5	5	5	5
abundant (50-90%)	6	6	6	6	6	6
very abundant (>90%)	7	7	7	7	7	7
Size (1 per layer)	**Sur.**	**1**	**2**	**3**	**4**	**5**
fine gravel (2-6 mm)		1	1	1	1	1
gravel (6-20 mm)		2	2	2	2	2
coarse gravel (20-60 mm)		3	3	3	3	3
cobbles (60-200 mm)		4	4	4	4	4
stones (200-600 mm)		5	5	5	5	5
boulders (>600 mm)		6	6	6	6	6

MOTTLES

Dominant (1)	Abundance	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 6 6 6	not evident	6 6 6 6 6
2 2 2 2 2	<2%	2 2 2 2 2
3 3 3 3 3	2-10%	3 3 3 3 3
4 4 4 4 4	10-20%	4 4 4 4 4
5 5 5 5 5	20-50%	5 5 5 5 5
1 2 3 4 5	**Colour**	**1 2 3 4 5**
1 1 1 1 1	dark	1 1 1 1 1
2 2 2 2 2	red	2 2 2 2 2
3 3 3 3 3	orange	3 3 3 3 3
4 4 4 4 4	yellow	4 4 4 4 4
5 5 5 5 5	brown	5 5 5 5 5
6 6 6 6 6	pale	6 6 6 6 6
7 7 7 7 7	grey	7 7 7 7 7
8 8 8 8 8	gley	8 8 8 8 8
1 2 3 4 5	**Contrast**	**1 2 3 4 5**
1 1 1 1 1	faint	1 1 1 1 1
2 2 2 2 2	distinct	2 2 2 2 2
3 3 3 3 3	prominent	3 3 3 3 3

SURVEY TITLE: WARKWORTH

SITE LOCATION: US2

PROFILE MAP DETAILS

Profile No.	Map Sheet No.	Eastings	Northings
0 0 0	0 0 0 0 0 0	0 0 0 ● 0 0	0 0 0 0 0 0 0 0
1 1 1	1 1 1 1 1 1	1 ● 1 1 1 1	1 1 1 ● 1 1 1
2 2 2	2 2 2 2 2 2	2 2 2 2 ● ●	2 2 2 2 2 2 ●
3 3 3	3 3 3 3 3 3	● 3 3 3 3 3	3 ● 3 3 3 3 3
4 4 4	4 4 4 4 4 4	4 4 4 4 4 4	4 4 4 4 4 4 4
5 5 5	5 5 5 ● 5 5	5 5 5 ● 5 5	5 5 5 5 ● 5 5
6 6 6	6 6 6 6 6 ●	6 6 6 6 6 6	● 6 6 6 6 6 6
7 7 ●	7 7 7 7 7 7	7 7 7 7 7 7	7 7 7 7 7 7 7
8 8 8	8 8 8 8 8 8	8 8 8 8 8 8	8 8 8 8 8 ● 8
9 9 9	9 9 9 9 9 9	9 9 9 9 9 9	9 9 ● 9 9 9 9

SURVEY DETAILS

Described By	Profile Date	Photo Taken (1)	No. of Layers
0 0 0 0	0 Jan Jul 0 0	profile 1	
● 1 1 1	1 1 Feb Aug ● 1	site 2	0
2 2 ● 2	● 2 Mar Sep 2 2	both profile & site ●	1
3 3 3 3	3 3 Apr Oct 3 3	**Nature of Exposure (2)**	2
4 4 4 4	4 ● Nov 4 ●	auger 1	●
5 5 5 5	5 Jun Dec 5 5	pit ●	4
6 6 6 ●	6 6 6	batter 3	5
7 7 7 7	● 7 7	gully 4	
8 ● 8 8	8 8 8	core sample 5	
9 9 9 9	9 9 9	other 6	

Potential BSAL? (1) yes 1 no ●

Site type (1) checked 1, detailed ●, exclusion 3

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY: ○ ● ○ ○

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- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O RV

SO AO

GG

SG

FAMILY

C

G.S.G.

A

B B B

C C

D D

E E E

G G G

H H H

K K K

L L

N M

P P P

R R

S S S

T Z

W

X

Y

affinity with ○

VEGETATION

Vegetation Community (1)

unknown 1, rainforest 2, wet sclerophyll forest 3, dry sclerophyll forest 4, woodland grass u'storey 5, woodland shrub u'storey ●, tall shrubland 7, low shrubland 8, heath 9, grassland/herbland 10, swamp complex 11, littoral complex 12, no vegetation 13

Growth Forms (4)

tree ●, tree mallee 2, shrub ●, mallee shrub 4, heath shrub 5, chenopod shrub 6, hummock grass 7, tussock grass 8, sod grass 9, sedge 10, rush 11, forb 12, fern/cycad ●, moss 14, lichen 15, liverwort 16, vine 17

LAND USE (1)

national/state parks 1, timber/scrub/unused 2, logged native forest 3, hardwood plantation 4, softwood plantation 5, volun./native pasture ●, improved pasture 7, cropping 8, orchard/vineyard 9, vegetables/flowers 10, urban 11, industrial 12, quarry/mining 13, other 14

LANDFORM ELEMENT (1)

alcove 43	cone 3	footslope 21	ox-bow 57	sink hole/doline 52
backplain 31	crater 51	foredune 12	pan/playa 56	stream channel 46
bank 25	cut face 28	gully 42	pediment 22	streambed 45
bar 6	cut-over surface 39	hillcrest 1	pit 60	summit surface 2
beach 26	dam 16	hillslope ●	plain 30	swale 47
beach ridge 7	drainage depression 41	lagoon 54	prior stream 9	swamp 58
bench 19	dune 11	lake 55	rock flat 34	talus 23
berm 29	embankment 14	landslide 20	rock platform 35	tidal creek 48
blow-out 59	estuary 44	levee 8	scald 36	tidal flat 37
channel bench 33	fan 27	lunette 13	scarp 18	tor 4
cirque 50	fill top 40	maar 53	scree 24	trench 49
cliff 5	flood-out 32	mound 15	scroll 10	valley flat 38

LITHOLOGY

Substrate (3)

not identified 1	limestone 23	coarse-basic 45
unconsolidated 2	tuff 24	fine-acidic 46
gravel 3	breccia 25	fine-intermediate 47
sand 4	greywacke 26	fine-basic 48
silt 5	arkose 27	serpentine 49
clay 6	dolomite 28	gabbro 50
organic material 7	calcrete 29	dolerite 51
alluvium 8	aeolianite 30	diorite 52
colluvium 9	chert 31	syenite 53
lacustrine 10	jasper 32	granodiorite 54
aeolian 11	**metamorphic** 33	adamellite 55
marine 12	gneiss 34	granite 56
calcareous sand 13	schist/phyllite 35	aplite 57
fill 14	slate 36	quartz porphyry 58
mud 15	hornfels 37	basalt 59
till 16	quartzite 38	andesite 60
sedimentary ●	greenstone 39	trachyte 61
shale 18	amphibolite 40	rhyolite 62
siltstone/mudstone 19	marble 41	obsidian 63
sandstone-quartz 20	**igneous** 42	scoria 64
sandstone-lithic 21	coarse-acidic 43	ash 65
conglomerate 22	coarse-intermediate 44	agglomerate 66
		other 67

Identification Method (1)

personal assessment 1, geology map ●, both assessment & map 3

Rock Outcrop % (1)

nil ● >20-30% 5, <2% 2 >30-50% 6, 2-10% 3 >50% 7, >10-20% 4

TOPOGRAPHY

Slope Percent

0 0 ●, 1 1 1 1, 2 2 2, 3 3 3, 4 ● 4, 5 5 5, 6 6 6, 7 7 7, 8 8 8, 9 9 9

Site Morphology (1)

flat 1, crest 2, hillock 3, ridge 4, upper slope 5, midslope ●, simple slope 7, lower slope 8, open depression 9, closed depression 10

Slope Measurement Method (1)

inclinometer ●, Abney level 4, total station 5, RTK GPS 6, LIDAR 7

Slope Morphology (1)

waxing 1, waning ●, maximal 3, minimal 4

Aspect (1)

N, NW, NE, W, E, SE ●, S

Microrelief Type (1)

none ●, normal gilgai 2, crabhole gilgai 3, linear gilgai 4, lattice gilgai 5, melonhole gilgai 6, other 9

Depth (1) & Extent (1)

≤ 500 mm depth 1, > 500 mm depth 2, ≤ 50% area 1, > 50% area 2

HYDROLOGY

Profile Drainage (1)

very poorly drained 1, poorly drained 2, imperfectly drained 3, mod. well-drained 4, well-drained 5, rapidly drained ●

Permeability (1)

very slowly permeable 1, slowly permeable 2, moderately permeable 3, highly permeable ●

SITE CONDITION

Site Disturbance(s) (2)

natural disturbance 1, no effective disturbance 2, limited clearing ●, extensive clearing 4, cleared, no cultivation 5, occasional cultivation 6, rainfed cultivation 7, irrigated cultivation 8, highly disturbed 9

Ground Cover %

0 ●, 1 1 1, 2 2, 3 3, 4 4, 5 5, 6 6, ● 7, 8 8, 9 9

Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked 2	2	2
self-mulched 3	3	3
loose ●	4	●
soft 5	●	5
firm 6	6	6
hardset 7		7
surface crust 8	8	8
trampled 9		9
poached 10	10	
recently cultivated 11		
water repellent 12		12
gravelly 1		
other 13	13	13

SITE FIELD NOTES

Photo file name/s:

Please do not mark this space.

4062

LAYER STATUS

	Lower	Horizon
1	0 1 2 3 4 5 6 7 8 9	D B F C O AB AC BC P R
2	0 1 2 3 4 5 6 7 8 9	D B F C O AB AC BC P R
3	0 1 2 3 4 5 6 7 8 9	A D B F C O AB AC BC P R
4	0 1 2 3 4 5 6 7 8 9	A D B F C O AB AC BC P R
5	0 1 2 3 4 5 6 7 8 9	A D B F C O AB AC BC P R
SUBSTRATE	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

COLOUR (Munsell, 1994)

	Moist Munsell	Dry Munsell	Field pH (1 per layer)
1	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 / 10 N / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
2	H BG 1-7 0 / YR B 2 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
3	H BG 1-7 0 / YR B 2 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
4	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
5	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9

LAYER NOTES

1
2
3
4
5

Field pH Test Method (1)

Raupach 1 test strip 3
pH meter 2

HCl (1)

	1	2	3	4	5
no effervescence	1	1	1	1	1
audible/slight efferv.	2	2	2	2	2
strong effervescence	3	3	3	3	3

Boundary Distinctiveness

(1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
sharp (<5 mm)	2	2	2	2	2
abrupt (5-20 mm)	3	3	3	3	3
clear (20-50 mm)	4	4	4	4	4
gradual (50-100 mm)	5	5	5	5	5
diffuse (>100 mm)	6	6	6	6	6

STRUCTURE

Grade of Pedality (1)	1	2	3	4	5
single-grained	1	1	1	1	1
massive	2	2	2	2	2
weak pedality	3	3	3	3	3
moderate pedality	4	4	4	4	4
strong pedality	5	5	5	5	5

Fabric (1)	1	2	3	4	5
sandy	1	1	1	1	1
earthy	2	2	2	2	2
rough-faced peds	3	3	3	3	3
smooth-faced peds	4	4	4	4	4

Dominant (1)	Ped Shape	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	platy	1 1 1 1 1
2 2 2 2 2	lenticular	2 2 2 2 2
3 3 3 3 3	prismatic	3 3 3 3 3
4 4 4 4 4	columnar	4 4 4 4 4
5 5 5 5 5	angular blocky	5 5 5 5 5
6 6 6 6 6	sub-ang. blocky	6 6 6 6 6
7 7 7 7 7	polyhedral	7 7 7 7 7
8 8 8 8 8	granular	8 8 8 8 8
9 9 9 9 9	crumb	9 9 9 9 9
10 10 10 10 10	round	10 10 10 10 10

Dominant (1)	Ped Size	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	<2 mm	1 1 1 1 1
2 2 2 2 2	2-5 mm	2 2 2 2 2
3 3 3 3 3	5-10 mm	3 3 3 3 3
4 4 4 4 4	10-20 mm	4 4 4 4 4
5 5 5 5 5	20-50 mm	5 5 5 5 5
6 6 6 6 6	50-100 mm	6 6 6 6 6
7 7 7 7 7	100-200 mm	7 7 7 7 7
8 8 8 8 8	200-500 mm	8 8 8 8 8
9 9 9 9 9	> 500 mm	9 9 9 9 9

SEGREGATIONS

Type (1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
calcareous	2	2	2	2	2
gypseous	3	3	3	3	3
manganiferous	4	4	4	4	4
ferruginous	5	5	5	5	5
ferromanganiferous	6	6	6	6	6
organic	7	7	7	7	7
not identified	8	8	8	8	8
other	9	9	9	9	9

Amount (1 per layer)	1	2	3	4	5
none	1	1	1	1	1
very few (<2%)	2	2	2	2	2
few (2-10%)	3	3	3	3	3
common (10-20%)	4	4	4	4	4
many (20-50%)	5	5	5	5	5
abundant (>50%)	6	6	6	6	6

Strength (1 per layer)	1	2	3	4	5
weak	1	1	1	1	1
strong	2	2	2	2	2

Form (1 per layer)	1	2	3	4	5
soft segregations	1	1	1	1	1
nodules	2	2	2	2	2
fragments	3	3	3	3	3
crystals	4	4	4	4	4
veins	5	5	5	5	5
concretions	6	6	6	6	6
root linings	7	7	7	7	7
tubules	8	8	8	8	8

Size (1 per layer)	1	2	3	4	5
fine (<2 mm)	1	1	1	1	1
medium (2-6 mm)	2	2	2	2	2
coarse (6-20 mm)	3	3	3	3	3
v coarse (20-60 mm)	4	4	4	4	4
ext coarse (>60 mm)	5	5	5	5	5

Soil Water Status (1 each per layer)

	1	2	3	4	5
dry	1	1	1	1	1
mod. moist	2	2	2	2	2
moist	3	3	3	3	3
wet	4	4	4	4	4

TEXTURE (1 each per layer)

Texture Grade	1	2	3	4	5
sand	1	1	1	1	1
loamy sand	2	2	2	2	2
clayey sand	3	3	3	3	3
sandy loam	4	4	4	4	4
loam	5	5	5	5	5
silty loam	6	6	6	6	6
sandy clay loam	7	7	7	7	7
clay loam	8	8	8	8	8
clay loam sandy	9	9	9	9	9
silty clay loam	10	10	10	10	10
sandy clay	11	11	11	11	11
silty clay	12	12	12	12	12
clay	13	13	13	13	13
fibric peat	14	14	14	14	14
hemic peat	15	15	15	15	15
sapric peat	16	16	16	16	16

Sand Fraction	1	2	3	4	5
coarse	1	1	1	1	1
fine	2	2	2	2	2

Clay Fraction	1	2	3	4	5
light	1	1	1	1	1
light medium	2	2	2	2	2
medium	3	3	3	3	3
medium heavy	4	4	4	4	4
heavy	5	5	5	5	5

Estimated Effective Rooting Depth (m)

Upper: 0 1 2 3 4 5 6 7 8 9
0 0 0 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9

Sample Taken

(3 per layer)	1	2	3	4	5
disturbed	3	3	3	3	3
undisturbed	4	4	4	4	4
bulked	6	6	6	6	6
bulk density	7	7	7	7	7

Base of Observation (1)

layer continues 1
soil continues 2
equipment refusal 3
bedrock reached 4

COARSE FRAGMENTS

Type (1 per layer)	Sur	1	2	3	4	5
not evident					1	1
not identified	2	2	2	2	2	2
as substrate	3	3	3	3	3	3
as rock outcrop	4	4	4	4	4	4
as parent material	5	5	5	5	5	5
quartz	6	6	6	6	6	6
feldspar	7	7	7	7	7	7
silcrete	8	8	8	8	8	8
ironstone	9	9	9	9	9	9
bauxite	10	10	10	10	10	10
shells	11	11	11	11	11	11
charcoal	12	12	12	12	12	12
pumice	13	13	13	13	13	13
opalised wood	14	14	14	14	14	14
other	18	18	18	18	18	18

Amount (1 per layer)	Sur.	1	2	3	4	5
very few (<2%)	2	2	2	2	2	2
few (2-10%)	3	3	3	3	3	3
common (10-20%)	4	4	4	4	4	4
many (20-50%)	5	5	5	5	5	5
abundant (50-90%)	6	6	6	6	6	6
very abundant (>90%)	7	7	7	7	7	7

Size (1 per layer)	Sur.	1	2	3	4	5
fine gravel (2-6 mm)	1	1	1	1	1	1
gravel (6-20 mm)	2	2	2	2	2	2
coarse gravel (20-60 mm)	3	3	3	3	3	3
cobbles (60-200 mm)	4	4	4	4	4	4
stones (200-600 mm)	5	5	5	5	5	5
boulders (>600 mm)	6	6	6	6	6	6

MOTTLES

Dominant (1)	Abundance	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
	not evident	6 6 6 6 6
2 2 2 2 2	<2%	2 2 2 2 2
3 3 3 3 3	2-10%	3 3 3 3 3
4 4 4 4 4	10-20%	4 4 4 4 4
5 5 5 5 5	20-50%	5 5 5 5 5
1 2 3 4 5	Colour	1 2 3 4 5
1 1 1 1 1	dark	1 1 1 1 1
2 2 2 2 2	red	2 2 2 2 2
3 3 3 3 3	orange	3 3 3 3 3
4 4 4 4 4	yellow	4 4 4 4 4
5 5 5 5 5	brown	5 5 5 5 5
6 6 6 6 6	pale	6 6 6 6 6
7 7 7 7 7	grey	7 7 7 7 7
8 8 8 8 8	gley	8 8 8 8 8
1 2 3 4 5	Contrast	1 2 3 4 5
1 1 1 1 1	faint	1 1 1 1 1
2 2 2 2 2	distinct	2 2 2 2 2
3 3 3 3 3	prominent	3 3 3 3 3

SURVEY TITLE: WARKWORTH

SITE LOCATION: US3

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no (2)

Site type (1): checked (1), detailed (2), exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: RK

SO: AO

GG

SG

FAMILY

C

G.S.G.

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture, improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3): not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing, waning (2), maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SW, SE

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing, cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

Current (2): cracked (2), self-mulched (3), loose, soft (5), firm (6), hardset (7), surface crust (8), trampled (9), poached (10), recently cultivated (11), water repellent (12), gravelly (1), other (13)

Expected: Wet (2), Dry (2)

Photo file name/s:

Please do not mark this space.

4063

LAYER STATUS

	Lower	Horizon
1	0 1 2 3 4 5 6 7 8 9	2 3 4 BC
2	0 1 2 3 4 5 6 7 8 9	2 3 4 BC
3	0 1 2 3 4 5 6 7 8 9	2 3 4 BC
4	0 1 2 3 4 5 6 7 8 9	2 3 4 BC
5	0 1 2 3 4 5 6 7 8 9	2 3 4 BC

COLOUR (Munsell, 1994)

	Moist Munsell	Dry Munsell	Field pH (1 per layer)
1	R BG 1:7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 R BG 1:7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
2	R BG 1:7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 R BG 1:7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
3	R BG 1:7 0 / YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 R BG 1:7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
4	R BG 1:7 0 / YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 R BG 1:7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9
5	R BG 1:7 0 / YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	2.5 R BG 1:7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 / 6 6 / 7 7 / 8 8	0 1 2 3 4 5 6 7 8 9

LAYER NOTES

1
2
3
4
5

Field pH Test Method (1)

Raupach 1 test strip 3
pH meter

HCl (1)

	1	2	3	4	5
no effervescence	1	1	1	1	1
audible/slight efferv.	2	2	2	2	2
strong effervescence	3	3	3	3	3

Boundary Distinctiveness

(1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
sharp (<5 mm)	2	2	2	2	2
abrupt (5-20 mm)	3	3	3	3	3
clear (20-50 mm)	4	4	4	4	4
gradual (50-100 mm)	5	5	5	5	5
diffuse (>100 mm)	6	6	6	6	6

STRUCTURE

Grade of Pedality (1)	1	2	3	4	5
single-grained			1	1	1
massive	2	2	2	2	2
weak pedality	3	3	3	3	3
moderate pedality	4	4	4	4	4
strong pedality	5	5	5	5	5

Fabric (1)	1	2	3	4	5
sandy	1	1	1	1	1
earthy	2	2	2	2	2
rough-faced peds	3	3	3	3	3
smooth-faced peds	4	4	4	4	4

Dominant (1)	Ped Shape	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	platy	1 1 1 1 1
2 2 2 2 2	lenticular	2 2 2 2 2
3 3 3 3 3	prismatic	3 3 3 3 3
4 4 4 4 4	columnar	4 4 4 4 4
5 5 5 5 5	angular blocky	5 5 5 5 5
6 6 6 6 6	sub-ang. blocky	6 6 6 6 6
7 7 7 7 7	polyhedral	7 7 7 7 7
8 8 8 8 8	granular	8 8 8 8 8
9 9 9 9 9	crumb	9 9 9 9 9
10 10 10 10 10	round	10 10 10 10 10

Dominant (1)	Ped Size	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	<2 mm	1 1 1 1 1
2 2 2 2 2	2-5 mm	2 2 2 2 2
3 3 3 3 3	5-10 mm	3 3 3 3 3
4 4 4 4 4	10-20 mm	4 4 4 4 4
5 5 5 5 5	20-50 mm	5 5 5 5 5
6 6 6 6 6	50-100 mm	6 6 6 6 6
7 7 7 7 7	100-200 mm	7 7 7 7 7
8 8 8 8 8	200-500 mm	8 8 8 8 8
9 9 9 9 9	> 500 mm	9 9 9 9 9

SEGREGATIONS

Type (1 per layer)	1	2	3	4	5
not evident			1	1	1
calcareous	2	2	2	2	2
gypseous	3	3	3	3	3
manganiferous	4	4	4	4	4
ferruginous	5	5	5	5	5
ferromanganiferous	6	6	6	6	6
organic	7	7	7	7	7
not identified	8	8	8	8	8
other	9	9	9	9	9

Amount (1 per layer)	1	2	3	4	5
none	1	1	1	1	1
very few (<2%)	2	2	2	2	2
few (2-10%)	3	3	3	3	3
common (10-20%)	4	4	4	4	4
many (20-50%)	5	5	5	5	5
abundant (>50%)	6	6	6	6	6

Strength (1 per layer)	1	2	3	4	5
weak	1	1	1	1	1
strong	2	2	2	2	2

Form (1 per layer)	1	2	3	4	5
soft segregations	1	1	1	1	1
nodules	2	2	2	2	2
fragments	3	3	3	3	3
crystals	4	4	4	4	4
veins	5	5	5	5	5
concretions	6	6	6	6	6
root linings	7	7	7	7	7
tubules	8	8	8	8	8

Size (1 per layer)	1	2	3	4	5
fine (<2 mm)	1	1	1	1	1
medium (2-6 mm)	2	2	2	2	2
coarse (6-20 mm)	3	3	3	3	3
v coarse (20-60 mm)	4	4	4	4	4
ext coarse (>60 mm)	5	5	5	5	5

Soil Water Status (1 each per layer)

	1	2	3	4	5
dry		1	1	1	1
mod. moist	2		2	2	2
moist	3	3	3	3	3
wet	4	4	4	4	4

TEXTURE (1 each per layer)

Texture Grade	1	2	3	4	5
sand	1		1	1	1
loamy sand		2	2	2	2
clayey sand	3	3	3	3	3
sandy loam	4	4	4	4	4
loam	5	5	5	5	5
silty loam	6	6	6	6	6
sandy clay loam	7	7	7	7	7
clay loam	8	8	8	8	8
clay loam sandy	9	9	9	9	9
silty clay loam	10	10	10	10	10
sandy clay	11	11	11	11	11
silty clay	12	12	12	12	12
clay	13	13	13	13	13
fibric peat	14	14	14	14	14
hemic peat	15	15	15	15	15
sapric peat	16	16	16	16	16

Sand Fraction	1	2	3	4	5
coarse	1	1	1	1	1
fine	2	2	2	2	2

Clay Fraction	1	2	3	4	5
light	1	1	1	1	1
light medium	2	2	2	2	2
medium	3	3	3	3	3
medium heavy	4	4	4	4	4
heavy	5	5	5	5	5

SUBSTRATE

Upper	Estimated Effective Rooting Depth (m)
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

Sample Taken (3 per layer)	1	2	3	4	5
disturbed	3		3	3	3
undisturbed	4	4	4	4	4
bulked		6	6	6	6
bulk density	7	7	7	7	7

Base of Observation (1)	
layer continues	1
soil continues	2
equipment refusal	3
bedrock reached	4

Dominant (1)	MOTTLES	Sub-dominant (1)
1 2 3 4 5	Abundance	1 2 3 4 5
	not evident	6 6 6 6 6
2 2 2 2 2	<2%	2 2 2 2 2
3 3 3 3 3	2-10%	3 3 3 3 3
4 4 4 4 4	10-20%	4 4 4 4 4
5 5 5 5 5	20-50%	5 5 5 5 5
1 2 3 4 5	Colour	1 2 3 4 5
1 1 1 1 1	dark	1 1 1 1 1
2 2 2 2 2	red	2 2 2 2 2
3 3 3 3 3	orange	3 3 3 3 3
4 4 4 4 4	yellow	4 4 4 4 4
5 5 5 5 5	brown	5 5 5 5 5
6 6 6 6 6	pale	6 6 6 6 6
7 7 7 7 7	grey	7 7 7 7 7
8 8 8 8 8	gley	8 8 8 8 8
1 2 3 4 5	Contrast	1 2 3 4 5
1 1 1 1 1	faint	1 1 1 1 1
2 2 2 2 2	distinct	2 2 2 2 2
3 3 3 3 3	prominent	3 3 3 3 3

COARSE FRAGMENTS

Type (1 per layer)	Sur	1	2	3	4	5
not evident				1	1	1
not identified	2	2	2	2	2	2
as substrate	3	3	3	3	3	3
as rock outcrop	4	4	4	4	4	4
as parent material	5	5	5	5	5	5
quartz	6	6	6	6	6	6
feldspar	7	7	7	7	7	7
silcrete	8	8	8	8	8	8
ironstone	9	9	9	9	9	9
bauxite	10	10	10	10	10	10
shells	11	11	11	11	11	11
charcoal	12	12	12	12	12	12
pumice	13	13	13	13	13	13
opalised wood	14	14	14	14	14	14
other	18	18	18	18	18	18

Amount (1 per layer)	Sur.	1	2	3	4	5
very few (<2%)	2	2	2	2	2	2
few (2-10%)	3	3	3	3	3	3
common (10-20%)	4	4	4	4	4	4
many (20-50%)	5	5	5	5	5	5
abundant (50-90%)	6	6	6	6	6	6
very abundant (>90%)	7	7	7	7	7	7

Size (1 per layer)	Sur.	1	2	3	4	5
fine gravel (2-6 mm)	1	1	1	1	1	1
gravel (6-20 mm)	2	2	2	2	2	2
coarse gravel (20-60 mm)	3	3	3	3	3	3
cobbles (60-200 mm)	4	4	4	4	4	4
stones (200-600 mm)	5	5	5	5	5	5
boulders (>600 mm)	6	6	6	6	6	6

SURVEY TITLE: WARKWORTH

SITE LOCATION: DS3

PROFILE MAP DETAILS

Profile No.	Map Sheet No.	Eastings	Northings
0 0 0	0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
1 1 1	1 1 1 1	1 1 1 1 1 1	1 1 1 1 1 1
2 2 2	2 2 2 2	2 2 2 2 2 2	2 2 2 2 2 2
3 3 3	3 3 3 3	3 3 3 3 3 3	3 3 3 3 3 3
4 4 4	4 4 4 4	4 4 4 4 4 4	4 4 4 4 4 4
5 5 5	5 5 5 5	5 5 5 5 5 5	5 5 5 5 5 5
6 6 6	6 6 6 6	6 6 6 6 6 6	6 6 6 6 6 6
7 7 7	7 7 7 7	7 7 7 7 7 7	7 7 7 7 7 7
8 8 8	8 8 8 8	8 8 8 8 8 8	8 8 8 8 8 8
9 9 9	9 9 9 9	9 9 9 9 9 9	9 9 9 9 9 9

SURVEY DETAILS

Described By	Profile Date	Photo Taken (1)	No. of Layers
0 0 0 0	0 Jan Jul 0 0	profile 1	
1 1 1	1 1 Feb Aug 1	site 2	0
2 2 2	2 2 Mar Sep 2 2	both profile & site	1
3 3 3 3	3 3 Apr Oct 3 3	**Nature of Exposure (2)**	
4 4 4 4	4 Nov 4	auger 1	3
5 5 5 5	5 Jun Dec 5 5	pit	4
6 6 6	6 6	batter 3	5
	7 7 7	gully 4	
8 8 8	8 8 8	core sample 5	
9 9 9 9	9 9 9	other 6	

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

Potential BSAL? (1): yes 1, no

Site type (1): checked 1, detailed, exclusion 3

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

SOIL TYPE

A.S.C.

O: Ru, Ao

SO

GG

SG

FAMILY

C

G.S.G.

A

B B B

C C

D D

E E E

G G G

H H H

K K K

L L

N M

P P P

R R

S S S

T Z

W

X

Y

affinity with

VEGETATION

Vegetation Community (1)

unknown 1
rainforest 2
wet sclerophyll forest 3
dry sclerophyll forest 4
woodland grass u'storey 5
woodland shrub u'storey
tall shrubland 7
low shrubland 8
heath 9
grassland/herbland 10
swamp complex 11
littoral complex 12
no vegetation 13

Growth Forms (4)

tree
tree mallee 2
shrub
mallee shrub 4
heath shrub 5
chenopod shrub 6
hummock grass 7
tussock grass
sod grass 9
sedge 10
rush 11
forb 12
fern/cycad
moss 14
lichen 15
liverwort 16
vine 17

LAND USE (1)

national/state parks 1
timber/scrub/unused 2
logged native forest 3
hardwood plantation 4
softwood plantation 5
volun./native pasture
improved pasture 7
cropping 8
orchard/vineyard 9
vegetables/flowers 10
urban 11
industrial 12
quarry/mining 13
other 14

LANDFORM ELEMENT (1)

alcove 43	cone 3	footslope 21	ox-bow 57	sink hole/doline 52
backplain 31	crater 51	foredune 12	pan/playa 56	stream channel 46
bank 25	cut face 28	gully 42	pediment 22	streambed 45
bar 6	cut-over surface 39	hillcrest 1	pit 60	summit surface 2
beach 26	dam 16	hillslope	plain 30	swale 47
beach ridge 7	drainage depression 41	lagoon 54	prior stream 9	swamp 58
bench 19	dune 11	lake 55	rock flat 34	talus 23
berm 29	embankment 14	landslide 20	rock platform 35	tidal creek 48
blow-out 59	estuary 44	levee 8	scald 36	tidal flat 37
channel bench 33	fan 27	lunette 13	scarp 18	tor 4
cirque 50	fill top 40	maar 53	scree 24	trench 49
cliff 5	flood-out 32	mound 15	scroll 10	valley flat 38

LITHOLOGY

Substrate (3)

not identified 1	limestone 23	coarse-basic 45
unconsolidated 2	tuff 24	fine-acidic 46
gravel 3	breccia 25	fine-intermediate 47
sand 4	greywacke 26	fine-basic 48
silt 5	arkose 27	serpentine 49
clay 6	dolomite 28	gabbro 50
organic material 7	calcrete 29	dolerite 51
alluvium 8	aeolianite 30	diorite 52
colluvium 9	chert 31	syenite 53
lacustrine 10	jasper 32	granodiorite 54
aeolian 11	**metamorphic** 33	adamellite 55
marine 12	gneiss 34	granite 56
calcareous sand 13	schist/phyllite 35	aplite 57
fill 14	slate 36	quartz porphyry 58
mud 15	hornfels 37	basalt 59
till 16	quartzite 38	andesite 60
sedimentary	greenstone 39	trachyte 61
shale 18	amphibolite 40	rhyolite 62
siltstone/mudstone 19	marble 41	obsidian 63
sandstone-quartz 20	**igneous** 42	scoria 64
sandstone-lithic 21	coarse-acidic 43	ash 65
conglomerate 22	coarse-intermediate 44	agglomerate 66
		other 67

Identification Method (1)

personal assessment 1
geology map
both assessment & map 3

Rock Outcrop % (1)

nil >20-30% 5
<2% 2 >30-50% 6
2-10% 3 >50% 7
>10-20% 4

TOPOGRAPHY

Slope Percent

0 0 · 1 1 1 1 · 2 2 2 · 3 3 3 · 4 · 4 · 5 5 5 · 6 6 6 · 7 7 7 · 8 8 8 · 9 9 9

Site Morphology (1)

flat 1
crest 2
hillock 3
ridge 4
upper slope 5
midslope
simple slope 7
lower slope 8
open depression 9
closed depression 10

Slope Measurement Method (1)

inclinometer
Abney level 4
total station 5
RTK GPS 6
LIDAR 7

Slope Morphology (1)

waxing 1
waning
maximal 3
minimal 4

Aspect (1)

N, NW, NE, W, E, SW, SE

Microrelief Type (1)

none
normal gilgai 2
crabhole gilgai 3
linear gilgai 4
lattice gilgai 5
melonhole gilgai 6
other 9

Depth (1) & Extent (1)

≤ 500 mm depth 1
> 500 mm depth 2
≤ 50% area 1
> 50% area 2

HYDROLOGY

Profile Drainage (1)

very poorly drained 1
poorly drained 2
imperfectly drained 3
mod. well-drained 4
well-drained 5
rapidly drained

Permeability (1)

very slowly permeable 1
slowly permeable 2
moderately permeable 3
highly permeable

SITE CONDITION

Site Disturbance(s) (2)

natural disturbance 1
no effective disturbance 2
limited clearing 3
extensive clearing
cleared, no cultivation 5
occasional cultivation 6
rainfed cultivation 7
irrigated cultivation 8
highly disturbed 9

Ground Cover %

0 0 · 1 1 1 · 2 2 · 3 3 · 4 · 5 · 6 6 · 7 7 · 8 · 9 9

Surface Condition

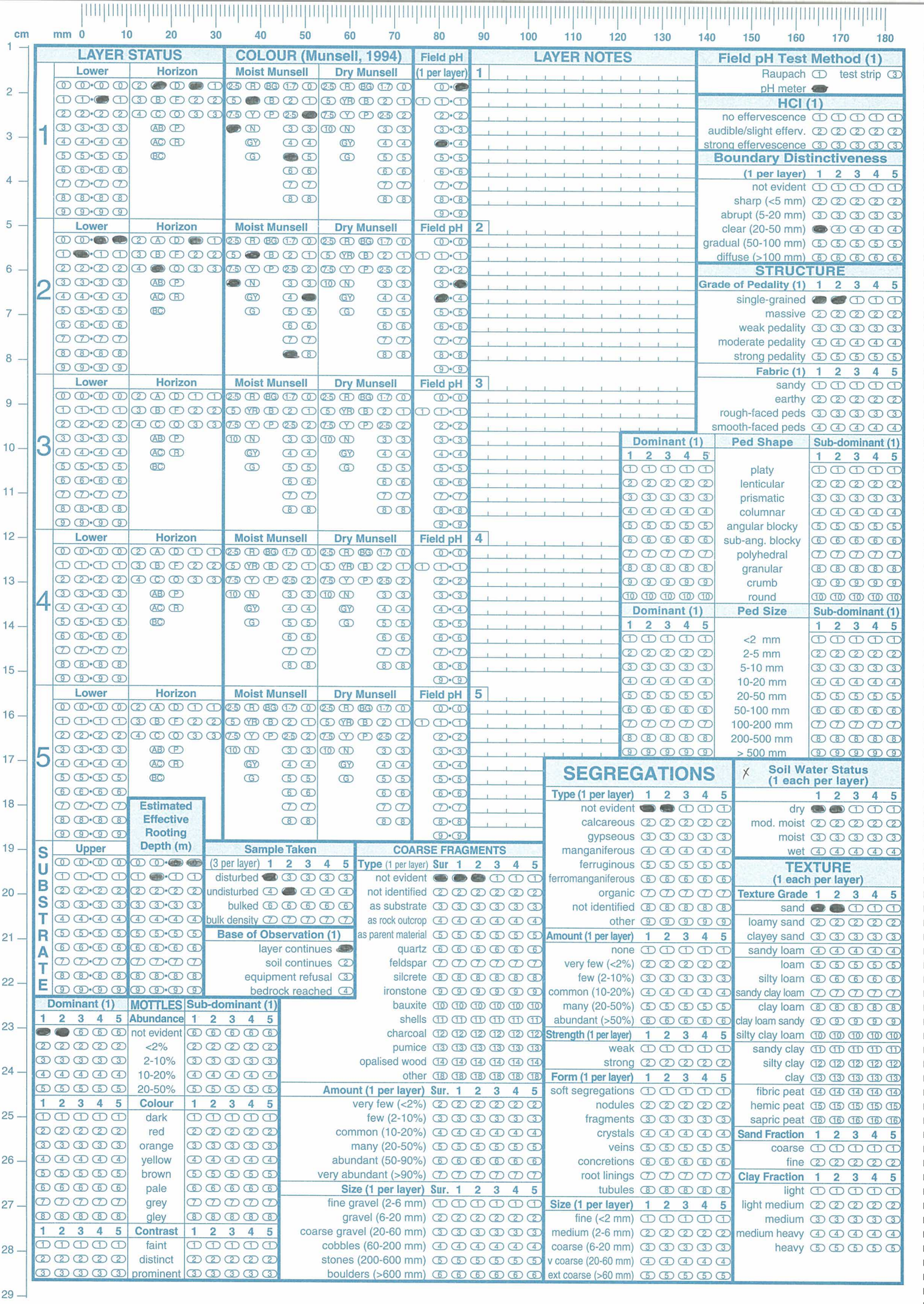
Current (2)	Expected Wet (2)	Expected Dry (2)
cracked 2	2	2
self-mulched 3	3	3
loose	4	
soft 5		5
firm 6	6	6
hardset 7		7
surface crust 8	8	8
trampled 9		9
poached 10	10	
recently cultivated 11		
water repellent 12		12
gravelly 1		
other 13	13	13

SITE FIELD NOTES

Photo file name/s:

Please do not mark this space.

4069


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
MOTTLES
Dominant (1)
Abundance
Sub-dominant (1)
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
1 2 3 4 5
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy

SURVEY TITLE: WARKWORTH

SITE LOCATION: DS4

PROFILE MAP DETAILS

Profile No.	Map Sheet No.	Eastings	Northings
0 0 0	0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0
1 1	1 1 1 1	1 1 1 1 1	1 1 1 1 1 1
2 2 2	2 2 2 2	2 2 2 2 2 2	2 2 2 2 2 2
3 3 3	3 3 3 3	3 3 3 3 3 3	3 3 3 3 3 3
4 4 4	4 4 4 4	4 4 4 4 4 4	4 4 4 4 4 4
5 5 5	5 5 5 5	5 5 5 5 5 5	5 5 5 5 5 5
6 6 6	6 6 6 6	6 6 6 6 6 6	6 6 6 6 6 6
7 7 7	7 7 7 7	7 7 7 7 7 7	7 7 7 7 7 7
8 8 8	8 8 8 8	8 8 8 8 8 8	8 8 8 8 8 8
9 9 9	9 9 9 9	9 9 9 9 9 9	9 9 9 9 9 9

SURVEY DETAILS

Described By	Profile Date	Photo Taken (1)	No. of Layers
0 0 0 0	0 Jan Jul 0 0	profile 1	
1 1 1	1 1 Feb Aug 1	site 2	0
2 2 2	2 2 Mar Sep 2 2	both profile & site	1
3 3 3 3	3 3 Apr Oct 3 3	**Nature of Exposure (2)**	2
4 4 4 4	4 Nov 4	auger 1	
5 5 5 5	5 Jun Dec 5 5	pit	4
6 6 6	6 6	batter 3	5
	7 7 7	gully 4	
8 8 8	8 8 8	core sample 5	
9 9 9 9	9 9 9	other 6	

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Potential BSAL? (1): yes 1 no

Site type (1): checked 1, detailed, exclusion 3

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

Please MARK LIKE THIS ONLY:

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- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: RU

SO: AO

GG

SG

FAMILY

C

G.S.G.

A; B B B; C C; D D; E E E; G G G; H H H; K K K; L L; N M; P P P; R R; S S S; T Z; W; X; Y

affinity with

VEGETATION

Vegetation Community (1): unknown 1, rainforest 2, wet sclerophyll forest 3, dry sclerophyll forest 4, woodland grass u'storey 5, woodland shrub u'storey, tall shrubland 7, low shrubland 8, heath 9, grassland/herbland 10, swamp complex 11, littoral complex 12, no vegetation 13

Growth Forms (4): tree, tree mallee 2, shrub, mallee shrub 4, heath shrub 5, chenopod shrub 6, hummock grass 7, tussock grass 8, sod grass 9, sedge 10, rush 11, forb 12, fern/cycad, moss 14, lichen 15, liverwort 16, vine 17

LAND USE (1)

national/state parks 1, timber/scrub/unused 2, logged native forest 3, hardwood plantation 4, softwood plantation 5, volun./native pasture, improved pasture 7, cropping 8, orchard/vineyard 9, vegetables/flowers 10, urban 11, industrial 12, quarry/mining 13, other 14

LANDFORM ELEMENT (1)

alcove 43	cone 3	footslope 21	ox-bow 57	sink hole/doline 52
backplain 31	crater 51	foredune 12	pan/playa 56	stream channel 46
bank 25	cut face 28	gully 42	pediment 22	streambed 45
bar 6	cut-over surface 39	hillcrest 1	pit 60	summit surface 2
beach 26	dam 16	hillslope	plain 30	swale 47
beach ridge 7	drainage depression 41	lagoon 54	prior stream 9	swamp 58
bench 19	dune 11	lake 55	rock flat 34	talus 23
berm 29	embankment 14	landslide 20	rock platform 35	tidal creek 48
blow-out 59	estuary 44	levee 8	scald 36	tidal flat 37
channel bench 33	fan 27	lunette 13	scarp 18	tor 4
cirque 50	fill top 40	maar 53	scree 24	trench 49
cliff 5	flood-out 32	mound 15	scroll 10	valley flat 38

LITHOLOGY

Substrate (3)

not identified 1	limestone 23	coarse-basic 45
unconsolidated 2	tuff 24	fine-acidic 46
gravel 3	breccia 25	fine-intermediate 47
sand 4	greywacke 26	fine-basic 48
silt 5	arkose 27	serpentine 49
clay 6	dolomite 28	gabbro 50
organic material 7	calcrete 29	dolerite 51
alluvium 8	aeolianite 30	diorite 52
colluvium 9	chert 31	syenite 53
lacustrine 10	jasper 32	granodiorite 54
aeolian 11	**metamorphic** 33	adamellite 55
marine 12	gneiss 34	granite 56
calcareous sand 13	schist/phyllite 35	aplite 57
fill 14	slate 36	quartz porphyry 58
mud 15	hornfels 37	basalt 59
till 16	quartzite 38	andesite 60
sedimentary	greenstone 39	trachyte 61
shale 18	amphibolite 40	rhyolite 62
siltstone/mudstone 19	marble 41	obsidian 63
sandstone-quartz 20	**igneous** 42	scoria 64
sandstone-lithic 21	coarse-acidic 43	ash 65
conglomerate 22	coarse-intermediate 44	agglomerate 66
		other 67

Identification Method (1): personal assessment 1, geology map, both assessment & map 3

Rock Outcrop % (1): nil, <2% 2, 2-10% 3, >10-20% 4, >20-30% 5, >30-50% 6, >50% 7

HYDROLOGY

Profile Drainage (1)	Permeability (1)
very poorly drained 1	very slowly permeable 1
poorly drained 2	slowly permeable 2
imperfectly drained 3	moderately permeable 3
mod. well-drained 4	highly permeable
well-drained 5	
rapidly drained	

TOPOGRAPHY

Slope Percent: 0 0 · ; 1 1 1 · 1; 2 2 · 2; 3 · 3; 4 4 · 4; 5 5 · 5; 6 6 · 6; 7 7 · 7; 8 8 · 8; 9 9 · 9

Site Morphology (1): flat 1, crest 2, hillock 3, ridge 4, upper slope, midslope 6, simple slope 7, lower slope 8, open depression 9, closed depression 10

Slope Measurement Method (1): inclinometer, Abney level 4, total station 5, RTK GPS 6, LIDAR 7

Slope Morphology (1): waxing 1, waning, maximal 3, minimal 4

Aspect (1): N, NW, NE, W, E, SE, S

Microrelief Type (1): none, normal gilgai 2, crabhole gilgai 3, linear gilgai 4, lattice gilgai 5, melonhole gilgai 6, other 9

Depth (1) & Extent (1): ≤ 500 mm depth 1, > 500 mm depth 2, ≤ 50% area 1, > 50% area 2

SITE CONDITION

Site Disturbance(s) (2): natural disturbance 1, no effective disturbance 2, limited clearing 3, extensive clearing, cleared, no cultivation 5, occasional cultivation 6, rainfed cultivation 7, irrigated cultivation 8, highly disturbed 9

Ground Cover %: 0, 1 1 1, 2 2, 3 3, 4 4, 5 5, 6 6, 7, 8 8, 9 9

Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked 2	2	2
self-mulched 3	3	3
loose	4	
soft 5		5
firm 6	6	6
hardset 7		7
surface crust 8	8	8
trampled 9		9
poached 10	10	
recently cultivated 11		
water repellent 12		12
gravelly 1		
other 13	13	13

SITE FIELD NOTES

Photo file name/s:

Please do not mark this space.

4068

LAYER STATUS

	Lower	Horizon
1	0 1 2 3 4 5 6 7 8 9	D B F C AB AC BC P R O
2	0 1 2 3 4 5 6 7 8 9	D B F C AB AC BC P R O
3	0 1 2 3 4 5 6 7 8 9	A D B F C AB AC BC P R O
4	0 1 2 3 4 5 6 7 8 9	A D B F C AB AC BC P R O
5	0 1 2 3 4 5 6 7 8 9	A D B F C AB AC BC P R O

COLOUR (Munsell, 1994)

	Moist Munsell	Dry Munsell
1	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 5 / G 5 5 6 6 7 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8
2	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 5 / G 5 6 6 7 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8
3	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 4 / GY 4 5 / G 5 5 6 6 7 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8
4	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8
5	H BG 1-7 0 / YR B 2 1 / 7.5 P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8	2.5 H BG 1-7 0 / 5 YR B 2 1 / 7.5 Y P 2.5 2 / 10 N 3 3 / GY 4 4 / G 5 5 6 6 7 7 8 8

Field pH (1 per layer)

1 2 3 4 5

LAYER NOTES

Field pH Test Method (1)

Raupach 1 test strip 3
pH meter 2

HCl (1)

	1	2	3	4	5
no effervescence	1	1	1	1	1
audible/slight efferv.	2	2	2	2	2
strong effervescence	3	3	3	3	3

Boundary Distinctiveness

(1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
sharp (<5 mm)	2	2	2	2	2
abrupt (5-20 mm)	3	3	3	3	3
clear (20-50 mm)	4	4	4	4	4
gradual (50-100 mm)	5	5	5	5	5
diffuse (>100 mm)	6	6	6	6	6

STRUCTURE

Grade of Pedality (1)	1	2	3	4	5
single-grained	1	1	1	1	1
massive	2	2	2	2	2
weak pedality	3	3	3	3	3
moderate pedality	4	4	4	4	4
strong pedality	5	5	5	5	5

Fabric (1)	1	2	3	4	5
sandy	1	1	1	1	1
earthy	2	2	2	2	2
rough-faced peds	3	3	3	3	3
smooth-faced peds	4	4	4	4	4

Dominant (1)	Ped Shape	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	platy	1 1 1 1 1
2 2 2 2 2	lenticular	2 2 2 2 2
3 3 3 3 3	prismatic	3 3 3 3 3
4 4 4 4 4	columnar	4 4 4 4 4
5 5 5 5 5	angular blocky	5 5 5 5 5
6 6 6 6 6	sub-ang. blocky	6 6 6 6 6
7 7 7 7 7	polyhedral	7 7 7 7 7
8 8 8 8 8	granular	8 8 8 8 8
9 9 9 9 9	crumb	9 9 9 9 9
10 10 10 10 10	round	10 10 10 10 10

Dominant (1)	Ped Size	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	<2 mm	1 1 1 1 1
2 2 2 2 2	2-5 mm	2 2 2 2 2
3 3 3 3 3	5-10 mm	3 3 3 3 3
4 4 4 4 4	10-20 mm	4 4 4 4 4
5 5 5 5 5	20-50 mm	5 5 5 5 5
6 6 6 6 6	50-100 mm	6 6 6 6 6
7 7 7 7 7	100-200 mm	7 7 7 7 7
8 8 8 8 8	200-500 mm	8 8 8 8 8
9 9 9 9 9	> 500 mm	9 9 9 9 9

SUBSTRATE

Upper	Estimated Effective Rooting Depth (m)
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

Sample Taken (3 per layer)	1	2	3	4	5
disturbed	3			3	3
undisturbed	4	4	4	4	4
bulked		6	6	6	6
bulk density	7	7	7	7	7

Base of Observation (1)
layer continues 1
soil continues 2
equipment refusal 3
bedrock reached 4

COARSE FRAGMENTS

Type (1 per layer)	Sur	1	2	3	4	5
not evident				1	1	1
not identified	2	2	2	2	2	2
as substrate	3	3	3	3	3	3
as rock outcrop	4	4	4	4	4	4
as parent material	5	5	5	5	5	5
quartz	6	6	6	6	6	6
feldspar	7	7	7	7	7	7
silcrete	8	8	8	8	8	8
ironstone	9	9	9	9	9	9
bauxite	10	10	10	10	10	10
shells	11	11	11	11	11	11
charcoal	12	12	12	12	12	12
pumice	13	13	13	13	13	13
opalised wood	14	14	14	14	14	14
other	18	18	18	18	18	18

Amount (1 per layer)	Sur.	1	2	3	4	5
very few (<2%)	2	2	2	2	2	2
few (2-10%)	3	3	3	3	3	3
common (10-20%)	4	4	4	4	4	4
many (20-50%)	5	5	5	5	5	5
abundant (50-90%)	6	6	6	6	6	6
very abundant (>90%)	7	7	7	7	7	7

Size (1 per layer)	Sur.	1	2	3	4	5
fine gravel (2-6 mm)	1	1	1	1	1	1
gravel (6-20 mm)	2	2	2	2	2	2
coarse gravel (20-60 mm)	3	3	3	3	3	3
cobbles (60-200 mm)	4	4	4	4	4	4
stones (200-600 mm)	5	5	5	5	5	5
boulders (>600 mm)	6	6	6	6	6	6

MOTTLES

Dominant (1)	Abundance	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
	not evident 1	
2 2 2 2 2	<2% 2	2 2 2 2 2
3 3 3 3 3	2-10% 3	3 3 3 3 3
4 4 4 4 4	10-20% 4	4 4 4 4 4
5 5 5 5 5	20-50% 5	5 5 5 5 5
1 2 3 4 5	Colour	1 2 3 4 5
1 1 1 1 1	dark	1 1 1 1 1
2 2 2 2 2	red	2 2 2 2 2
3 3 3 3 3	orange	3 3 3 3 3
4 4 4 4 4	yellow	4 4 4 4 4
5 5 5 5 5	brown	5 5 5 5 5
6 6 6 6 6	pale	6 6 6 6 6
7 7 7 7 7	grey	7 7 7 7 7
8 8 8 8 8	gley	8 8 8 8 8
1 2 3 4 5	Contrast	1 2 3 4 5
1 1 1 1 1	faint	1 1 1 1 1
2 2 2 2 2	distinct	2 2 2 2 2
3 3 3 3 3	prominent	3 3 3 3 3

SEGREGATIONS

Type (1 per layer)	1	2	3	4	5
not evident				1	1
calcareous	2	2	2	2	2
gypseous	3	3	3	3	3
manganiferous	4	4	4	4	4
ferruginous	5	5	5	5	5
ferromanganiferous	6	6	6	6	6
organic	7	7	7	7	7
not identified	8	8	8	8	8
other	9	9	9	9	9
Amount (1 per layer)	**1**	**2**	**3**	**4**	**5**
none	1	1	1	1	1
very few (<2%)	2	2	2	2	2
few (2-10%)	3	3	3	3	3
common (10-20%)	4	4	4	4	4
many (20-50%)	5	5	5	5	5
abundant (>50%)	6	6	6	6	6
Strength (1 per layer)	**1**	**2**	**3**	**4**	**5**
weak	1	1	1	1	1
strong	2	2	2	2	2
Form (1 per layer)	**1**	**2**	**3**	**4**	**5**
soft segregations	1	1	1	1	1
nodules	2	2	2	2	2
fragments	3	3	3	3	3
crystals	4	4	4	4	4
veins	5	5	5	5	5
concretions	6	6	6	6	6
root linings	7	7	7	7	7
tubules	8	8	8	8	8
Size (1 per layer)	**1**	**2**	**3**	**4**	**5**
fine (<2 mm)	1	1	1	1	1
medium (2-6 mm)	2	2	2	2	2
coarse (6-20 mm)	3	3	3	3	3
v coarse (20-60 mm)	4	4	4	4	4
ext coarse (>60 mm)	5	5	5	5	5

Soil Water Status (1 each per layer)

	1	2	3	4	5
dry	1	1	1	1	1
mod. moist	2	2	2	2	2
moist	3	3	3	3	3
wet	4	4	4	4	4

TEXTURE (1 each per layer)

Texture Grade	1	2	3	4	5
sand	1			1	1
loamy sand		2	2	2	2
clayey sand	3	3	3	3	3
sandy loam	4	4	4	4	4
loam	5	5	5	5	5
silty loam	6	6	6	6	6
sandy clay loam	7	7	7	7	7
clay loam	8	8	8	8	8
clay loam sandy	9	9	9	9	9
silty clay loam	10	10	10	10	10
sandy clay	11	11	11	11	11
silty clay	12	12	12	12	12
clay	13	13	13	13	13
fibric peat	14	14	14	14	14
hemic peat	15	15	15	15	15
sapric peat	16	16	16	16	16
Sand Fraction	**1**	**2**	**3**	**4**	**5**
coarse	1	1	1	1	1
fine	2	2	2	2	2
Clay Fraction	**1**	**2**	**3**	**4**	**5**
light	1	1	1	1	1
light medium	2	2	2	2	2
medium	3	3	3	3	3
medium heavy	4	4	4	4	4
heavy	5	5	5	5	5

SURVEY TITLE: WARKWORTH

SITE LOCATION: DSC1

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site

Nature of Exposure (2): auger (1), pit, batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked, detailed (2), exclusion (3)

SOIL TYPE

A.S.C.: O, SO, GG, SG, FAMILY, C

G.S.G.

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad, moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3): not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): NW, NE, W, E, SW, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

Current (2): cracked (2), self-mulched (3), loose, soft (5), firm (6), hardset (7), surface crust (8), trampled (9), poached (10), recently cultivated (11), water repellent (12), gravelly (1), other (13)

Expected: Wet (2), Dry (2)

Photo file name/s:

Please do not mark this space.

4064

LAYER STATUS

	Lower	Horizon
1	0 0 0	2 A D 1 1
	1 1 1	3 B F 2 2
	2 2 2	4 C O 3 3
	3 3 3	AB P
	4 4 4	AC R
	5 5 5	BC
	6 6 6	
	7 7 7	
	8 8 8	
	9 9 9	
2	0 0 0	2 A D 1 1
	1 1 1	3 B F 2 2
	2 2 2	4 C O 3 3
	3 3 3	AB P
	4 4 4	AC R
	5 5	BC
	6 6 6	
	7 7 7	
	8 8 8	
	9 9 9	
3	0 0 0	2 A D 1 1
	1 1 1	3 B F 2 2
	2 2 2	4 C O 3 3
	3 3 3	AB P
	4 4 4	AC R
	5 5 5	BC
	6 6 6	
	7 7 7	
	8 8 8	
	9 9 9	
4	0 0 0	2 A D 1 1
	1 1 1	3 B F 2 2
	2 2 2	4 C O 3 3
	3 3 3	AB P
	4 4 4	AC R
	5 5 5	BC
	6 6 6	
	7 7 7	
	8 8 8	
	9 9 9	
5	0 0 0	2 A D 1 1
	1 1 1	3 B F 2 2
	2 2 2	4 C O 3 3
	3 3 3	AB P
	4 4 4	AC R
	5 5 5	BC
	6 6 6	
	7 7 7	
	8 8 8	
	9 9 9	

COLOUR (Munsell, 1994)

	Moist Munsell	Dry Munsell
1	2.5 R BG 1.7 0	2.5 R BG 1.7 0
	5 YR B 2 1	5 YR B 2 1
	7.5 Y P 2.5 2	7.5 Y P 2.5 2
	10 N 3 3	10 N 3 3
	GY 4 4	GY 4 4
	G 5 5	G 5 5
	6 6	6 6
	7 7	7 7
	8 8	8 8
2	2.5 R BG 1.7 0	2.5 R BG 1.7 0
	5 YR B 2 1	5 YR B 2 1
	7.5 Y P 2.5 2	7.5 Y P 2.5 2
	10 N 3 3	10 N 3 3
	GY 4 4	GY 4 4
	G 5 5	G 5 5
	6 6	6 6
	7 7	7 7
	8 8	8 8
3	2.5 R BG 1.7 0	2.5 R BG 1.7 0
	5 YR B 2 1	5 YR B 2 1
	7.5 Y P 2.5 2	7.5 Y P 2.5 2
	10 N 3 3	10 N 3 3
	GY 4 4	GY 4 4
	G 5 5	G 5 5
	6 6	6 6
	7 7	7 7
	8 8	8 8
4	2.5 R BG 1.7 0	2.5 R BG 1.7 0
	5 YR B 2 1	5 YR B 2 1
	7.5 Y P 2.5 2	7.5 Y P 2.5 2
	10 N 3 3	10 N 3 3
	GY 4 4	GY 4 4
	G 5 5	G 5 5
	6 6	6 6
	7 7	7 7
	8 8	8 8
5	2.5 R BG 1.7 0	2.5 R BG 1.7 0
	5 YR B 2 1	5 YR B 2 1
	7.5 Y P 2.5 2	7.5 Y P 2.5 2
	10 N 3 3	10 N 3 3
	GY 4 4	GY 4 4
	G 5 5	G 5 5
	6 6	6 6
	7 7	7 7
	8 8	8 8

Field pH

	(1 per layer)
1	0 0
	1 1
	2 2
	3 3
	4 4
	5 5
	6 6
	7 7
	8 8
	9 9
2	0 0
	1 1
	2 2
	3 3
	4 4
	5 5
	6 6
	7 7
	8 8
	9 9
3	0 0
	1 1
	2 2
	3 3
	4 4
	5 5
	6 6
	7 7
	8 8
	9 9
4	0 0
	1 1
	2 2
	3 3
	4 4
	5 5
	6 6
	7 7
	8 8
	9 9
5	0 0
	1 1
	2 2
	3 3
	4 4
	5 5
	6 6
	7 7
	8 8
	9 9

LAYER NOTES

1
2
3
4
5

Field pH Test Method (1)

Raupach 1 test strip 3
pH meter 2

HCl (1)

	1	2	3	4	5
no effervescence	1	1	1	1	1
audible/slight efferv.	2	2	2	2	2
strong effervescence	3	3	3	3	3

Boundary Distinctiveness

(1 per layer)	1	2	3	4	5
not evident	1	1	1	1	1
sharp (<5 mm)	2	2	2	2	2
abrupt (5-20 mm)	3	3	3	3	3
clear (20-50 mm)	4	4	4	4	4
gradual (50-100 mm)	5	5	5	5	5
diffuse (>100 mm)	6	6	6	6	6

STRUCTURE

Grade of Pedality (1)	1	2	3	4	5
single-grained	1	1	1	1	1
massive	2	2	2	2	2
weak pedality	3	3	3	3	3
moderate pedality	4	4	4	4	4
strong pedality	5	5	5	5	5

Fabric (1)	1	2	3	4	5
sandy	1	1	1	1	1
earthy	2	2	2	2	2
rough-faced peds	3	3	3	3	3
smooth-faced peds	4	4	4	4	4

Dominant (1)	Ped Shape	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	platy	1 1 1 1 1
2 2 2 2 2	lenticular	2 2 2 2 2
3 3 3 3 3	prismatic	3 3 3 3 3
4 4 4 4 4	columnar	4 4 4 4 4
5 5 5 5 5	angular blocky	5 5 5 5 5
6 6 6 6 6	sub-ang. blocky	6 6 6 6 6
7 7 7 7 7	polyhedral	7 7 7 7 7
8 8 8 8 8	granular	8 8 8 8 8
9 9 9 9 9	crumb	9 9 9 9 9
10 10 10 10 10	round	10 10 10 10 10

Dominant (1)	Ped Size	Sub-dominant (1)
1 2 3 4 5		1 2 3 4 5
1 1 1 1 1	<2 mm	1 1 1 1 1
2 2 2 2 2	2-5 mm	2 2 2 2 2
3 3 3 3 3	5-10 mm	3 3 3 3 3
4 4 4 4 4	10-20 mm	4 4 4 4 4
5 5 5 5 5	20-50 mm	5 5 5 5 5
6 6 6 6 6	50-100 mm	6 6 6 6 6
7 7 7 7 7	100-200 mm	7 7 7 7 7
8 8 8 8 8	200-500 mm	8 8 8 8 8
9 9 9 9 9	> 500 mm	9 9 9 9 9

SEGREGATIONS

Type (1 per layer)	1	2	3	4	5
not evident			1	1	1
calcareous	2	2	2	2	2
gypseous	3	3	3	3	3
manganiferous	4	4	4	4	4
ferruginous	5	5	5	5	5
ferromanganiferous	6	6	6	6	6
organic	7	7	7	7	7
not identified	8	8	8	8	8
other	9	9	9	9	9

Amount (1 per layer)	1	2	3	4	5
none	1	1	1	1	1
very few (<2%)	2	2	2	2	2
few (2-10%)	3	3	3	3	3
common (10-20%)	4	4	4	4	4
many (20-50%)	5	5	5	5	5
abundant (>50%)	6	6	6	6	6

Strength (1 per layer)	1	2	3	4	5
weak	1	1	1	1	1
strong	2	2	2	2	2

Form (1 per layer)	1	2	3	4	5
soft segregations	1	1	1	1	1
nodules	2	2	2	2	2
fragments	3	3	3	3	3
crystals	4	4	4	4	4
veins	5	5	5	5	5
concretions	6	6	6	6	6
root linings	7	7	7	7	7
tubules	8	8	8	8	8

Size (1 per layer)	1	2	3	4	5
fine (<2 mm)	1	1	1	1	1
medium (2-6 mm)	2	2	2	2	2
coarse (6-20 mm)	3	3	3	3	3
v coarse (20-60 mm)	4	4	4	4	4
ext coarse (>60 mm)	5	5	5	5	5

Soil Water Status (1 each per layer)

	1	2	3	4	5
dry			1	1	1
mod. moist	2	2	2	2	2
moist	3	3	3	3	3
wet	4	4	4	4	4

TEXTURE (1 each per layer)

Texture Grade	1	2	3	4	5
sand			1	1	1
loamy sand	2	2	2	2	2
clayey sand	3	3	3	3	3
sandy loam	4	4	4	4	4
loam	5	5	5	5	5
silty loam	6	6	6	6	6
sandy clay loam	7	7	7	7	7
clay loam	8	8	8	8	8
clay loam sandy	9	9	9	9	9
silty clay loam	10	10	10	10	10
sandy clay	11	11	11	11	11
silty clay	12	12	12	12	12
clay	13	13	13	13	13
fibric peat	14	14	14	14	14
hemic peat	15	15	15	15	15
sapric peat	16	16	16	16	16

Sand Fraction	1	2	3	4	5
coarse	1	1	1	1	1
fine	2	2	2	2	2

Clay Fraction	1	2	3	4	5
light	1	1	1	1	1
light medium	2	2	2	2	2
medium	3	3	3	3	3
medium heavy	4	4	4	4	4
heavy	5	5	5	5	5

SUBSTRATE

Upper
0 0 0 0
1 1 1 1
2 2 2 2
3 3 3 3
4 4 4 4
5 5 5 5
6 6 6 6
7 7 7 7
8 8 8 8
9 9 9 9

Estimated Effective Rooting Depth (m)

0 0 0 0
1 1 1 1
2 2 2 2
3 3 3 3
4 4 4 4
5 5 5 5
6 6 6 6
7 7 7 7
8 8 8 8
9 9 9 9

Sample Taken

(3 per layer)	1	2	3	4	5
disturbed	3	3	3	3	3
undisturbed	4	4	4	4	4
bulked	6	6	6	6	6
bulk density	7	7	7	7	7

Base of Observation (1)

layer continues
soil continues 2
equipment refusal 3
bedrock reached 4

COARSE FRAGMENTS

Type (1 per layer)	Sur	1	2	3	4	5
not evident				1	1	1
not identified	2	2	2	2	2	2
as substrate	3	3	3	3	3	3
as rock outcrop	4	4	4	4	4	4
as parent material	5	5	5	5	5	5
quartz	6	6	6	6	6	6
feldspar	7	7	7	7	7	7
silcrete	8	8	8	8	8	8
ironstone	9	9	9	9	9	9
bauxite	10	10	10	10	10	10
shells	11	11	11	11	11	11
charcoal	12	12	12	12	12	12
pumice	13	13	13	13	13	13
opalised wood	14	14	14	14	14	14
other	18	18	18	18	18	18

Amount (1 per layer)	Sur.	1	2	3	4	5
very few (<2%)	2	2	2	2	2	2
few (2-10%)	3	3	3	3	3	3
common (10-20%)	4	4	4	4	4	4
many (20-50%)	5	5	5	5	5	5
abundant (50-90%)	6	6	6	6	6	6
very abundant (>90%)	7	7	7	7	7	7

Size (1 per layer)	Sur.	1	2	3	4	5
fine gravel (2-6 mm)	1	1	1	1	1	1
gravel (6-20 mm)	2	2	2	2	2	2
coarse gravel (20-60 mm)	3	3	3	3	3	3
cobbles (60-200 mm)	4	4	4	4	4	4
stones (200-600 mm)	5	5	5	5	5	5
boulders (>600 mm)	6	6	6	6	6	6

Dominant (1)	MOTTLES	Sub-dominant (1)
1 2 3 4 5	Abundance	1 2 3 4 5
	not evident	6 6 6 6 6
2 2 2 2 2	<2%	2 2 2 2 2
3 3 3 3 3	2-10%	3 3 3 3 3
4 4 4 4 4	10-20%	4 4 4 4 4
5 5 5 5 5	20-50%	5 5 5 5 5
1 2 3 4 5	Colour	1 2 3 4 5
1 1 1 1 1	dark	1 1 1 1 1
2 2 2 2 2	red	2 2 2 2 2
3 3 3 3 3	orange	3 3 3 3 3
4 4 4 4 4	yellow	4 4 4 4 4
5 5 5 5 5	brown	5 5 5 5 5
6 6 6 6 6	pale	6 6 6 6 6
7 7 7 7 7	grey	7 7 7 7 7
8 8 8 8 8	gley	8 8 8 8 8
1 2 3 4 5	Contrast	1 2 3 4 5
1 1 1 1 1	faint	1 1 1 1 1
2 2 2 2 2	distinct	2 2 2 2 2
3 3 3 3 3	prominent	3 3 3 3 3

SURVEY TITLE: N.A.R.K.N.O.R.T.H.

SITE LOCATION: D.S.C.2.

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

No. of Layers: (0), (1)

Nature of Exposure (2): auger (1), pit (3), batter (4), gully (5), core sample (6), other (6)

Potential BSAL? (1): yes (1), no

Site type (1): checked, detailed (2), exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

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- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: Rud

SO

GG

SG

FAMILY

C

G.S.G.

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey, tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad, moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest, hillslope (17), lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent

Site Morphology (1): flat (1), crest (2), hillock (3), ridge, upper slope (5), midslope (6), simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing, waning (2), maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SW, SE

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %

Surface Condition

Current (2): cracked (2), self-mulched (3), loose, soft (5), firm (6), hardset (7), surface crust (8), trampled (9), poached (10), recently cultivated (11), water repellent (12), gravelly (1), other (13)

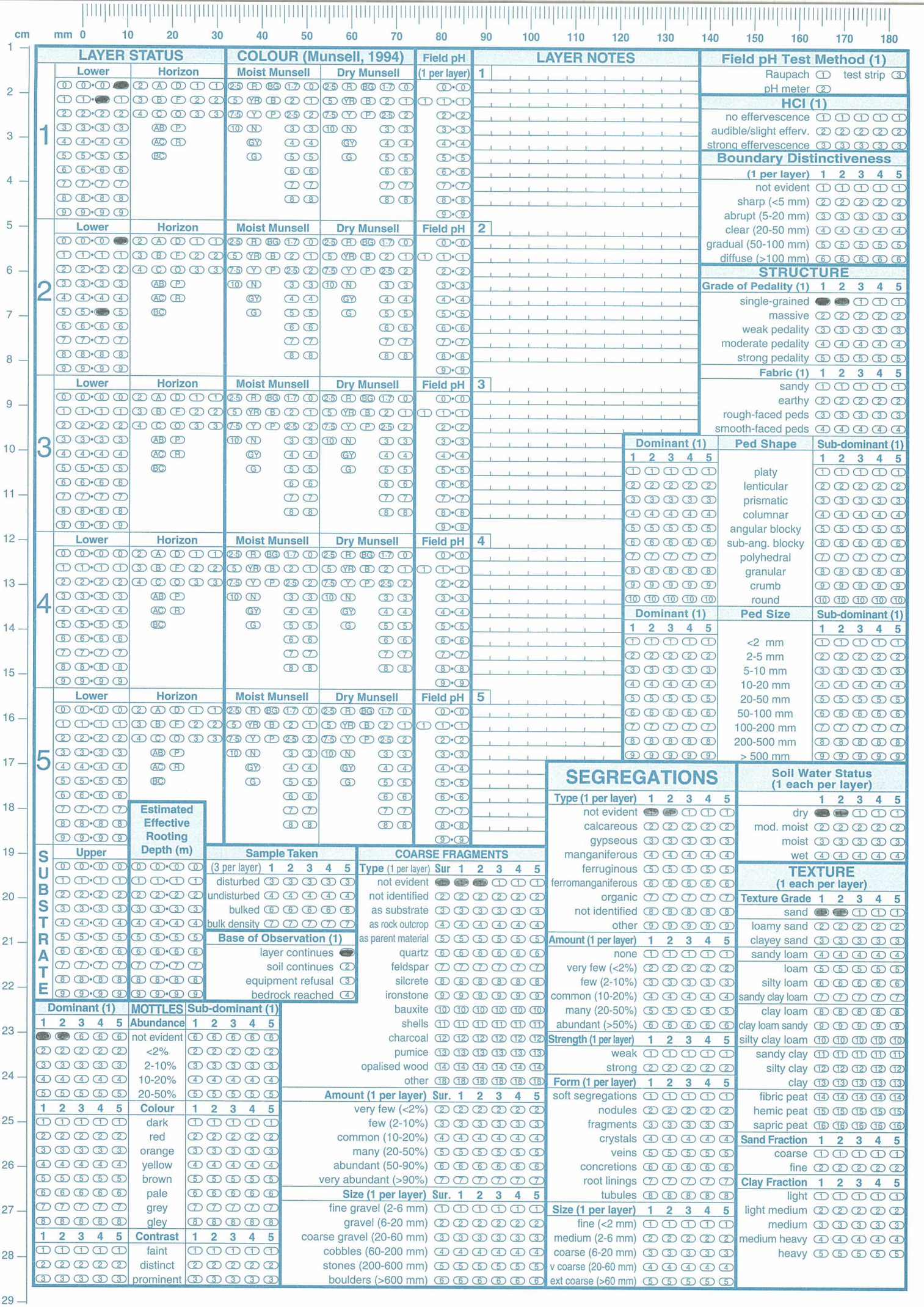
Expected: Wet (2), Dry (2)

SITE FIELD NOTES

Photo file name/s:

Please do not mark this space.

4065


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
Dominant (1)
MOTTLES
Sub-dominant (1)
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent
Field pH Test Method (1)
Raupach test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Dominant (1)
Ped Size
Sub-dominant (1)
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
1 2 3 4 5
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy

SURVEY TITLE: WARKWORTH

SITE LOCATION: DSC3

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (2), (3), (4), (5)

Potential BSAL? (1): yes (1), no (2)

Site type (1): checked (1), detailed (2), exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

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NSW SOIL AND LAND INFORMATION SYSTEM

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- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: Ru

SO

GG

SG

FAMILY

C

G.S.G.

A, B, C, D, E, F, G, H, K, L, M, N, P, R, S, T, W, X, Y

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey (5), woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree (1), tree mallee (2), shrub (3), mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass (8), sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused (2), logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope (2), lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary** (17), shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), serpentine (28), gabbro (29), dolerite (30), diorite (31), syenite (32), granodiorite (33), **metamorphic** (34), gneiss (35), schist/phyllite (36), slate (37), hornfels (38), quartzite (39), greenstone (40), amphibolite (41), marble (42), **igneous** (43), coarse-acidic (44), coarse-intermediate (45), coarse-basic (46), fine-acidic (47), fine-intermediate (48), fine-basic (49), serpentine (50), gabbro (51), dolerite (52), diorite (53), syenite (54), granodiorite (55), adamellite (56), granite (57), aplite (58), quartz porphyry (59), basalt (60), andesite (61), trachyte (62), rhyolite (63), obsidian (64), scoria (65), ash (66), agglomerate (67), other (68)

Identification Method (1): personal assessment (1), geology map (2), both assessment & map (3)

Rock Outcrop % (1): nil (1), <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent: (0)·(0)·(0), (1)·(1)·(1)·(1), (2)·(2)·(2), (3)·(3), (4)·(4)·(4), (5)·(5)·(5), (6)·(6)·(6), (7)·(7)·(7), (8)·(8)·(8), (9)·(9)·(9)

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope (6), simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer (1), Abney level (2), total station (3), RTK GPS (4), LIDAR (5)

Slope Morphology (1): waxing (1), waning (2), maximal (3), minimal (4)

Aspect (1): N (1), NW (2), NE (3), W (4), E (5), SW (6), SE (7), S (8)

Microrelief Type (1): none (1), normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained (6)

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable (4)

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing (3), extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

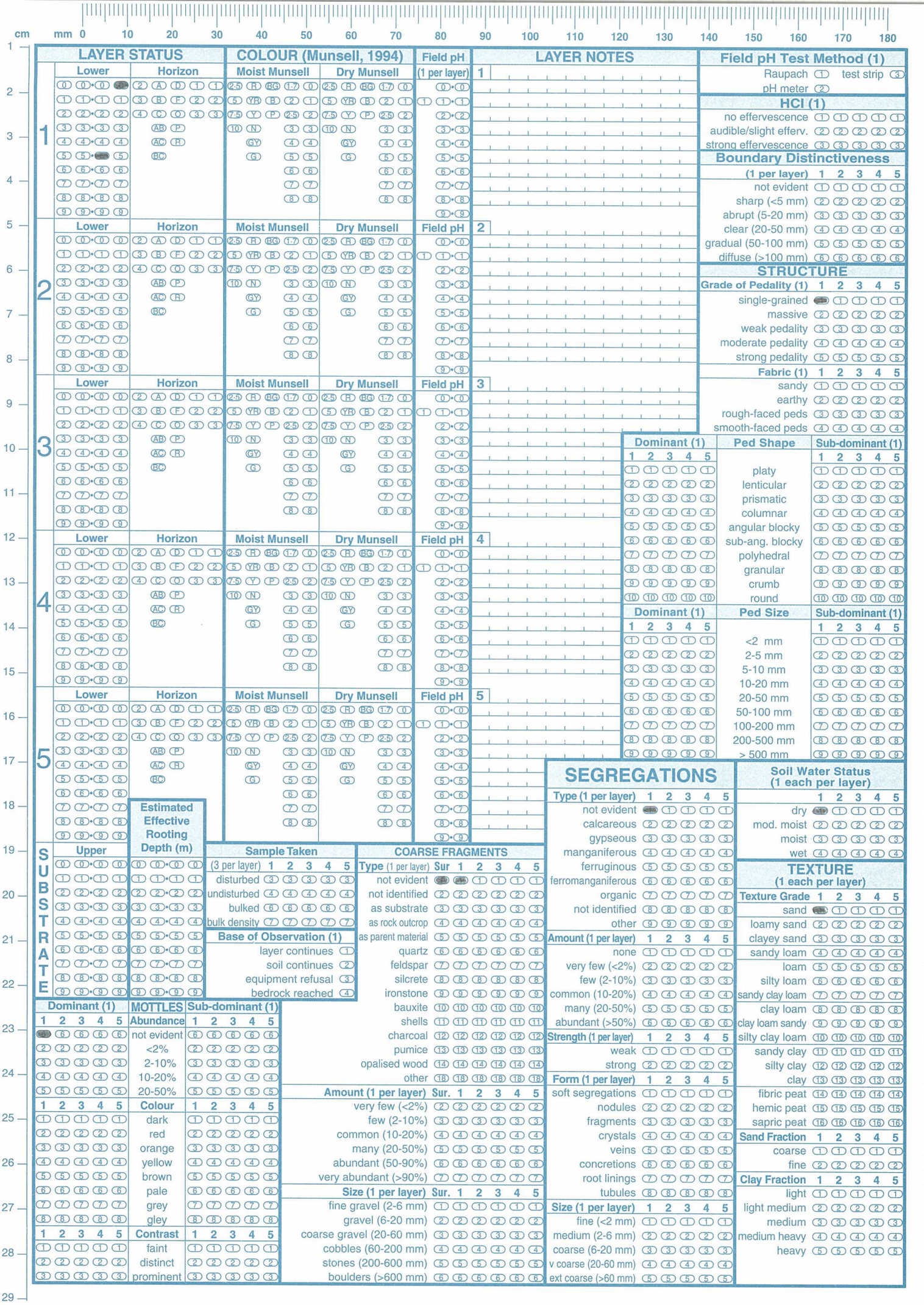
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose (4)	(4)	(4)
soft (5)	(5)	(5)
firm (6)	(6)	(6)
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4066


cm
mm 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer) 1 2 3 4 5
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer) Sur 1 2 3 4 5
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer) Sur. 1 2 3 4 5
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer) Sur. 1 2 3 4 5
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
MOTTLES
Dominant (1)
Abundance
Sub-dominant (1)
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent
Field pH Test Method (1)
Raupach 1
test strip 3
pH meter 2
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer) 1 2 3 4 5
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1) 1 2 3 4 5
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1) 1 2 3 4 5
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Dominant (1)
Ped Size
Sub-dominant (1)
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer) 1 2 3 4 5
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer) 1 2 3 4 5
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer) 1 2 3 4 5
weak
strong
Form (1 per layer) 1 2 3 4 5
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer) 1 2 3 4 5
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status (1 each per layer)
1 2 3 4 5
dry
mod. moist
moist
wet
TEXTURE (1 each per layer)
Texture Grade 1 2 3 4 5
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction 1 2 3 4 5
coarse
fine
Clay Fraction 1 2 3 4 5
light
light medium
medium
medium heavy
heavy

SURVEY TITLE: WARKWORTH

SITE LOCATION: D.S.C.4

PROFILE MAP DETAILS

Profile No. | Map Sheet No. | Eastings | Northings

SURVEY DETAILS

Described By | Profile Date | Photo Taken (1) | No. of Layers

Photo Taken (1): profile (1), site (2), both profile & site (3)

Nature of Exposure (2): auger (1), pit (2), batter (3), gully (4), core sample (5), other (6)

No. of Layers: (0), (1), (3), (4), (5)

Potential BSAL? (1): yes (1), no

Site type (1): checked, detailed (2), exclusion (3)

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND SOIL DATA CARD

NSW GOVERNMENT

NSW SOIL AND LAND INFORMATION SYSTEM

Please MARK LIKE THIS ONLY:

- Use 2B pencil
- No pen or biro
- Fully erase mistakes
- Make no stray marks
- Numbers in ( ) show max. entries allowed

SOIL TYPE

A.S.C.

O: Ru

SO

GG

SG

FAMILY

C

G.S.G.

affinity with

VEGETATION

Vegetation Community (1): unknown (1), rainforest (2), wet sclerophyll forest (3), dry sclerophyll forest (4), woodland grass u'storey, woodland shrub u'storey (6), tall shrubland (7), low shrubland (8), heath (9), grassland/herbland (10), swamp complex (11), littoral complex (12), no vegetation (13)

Growth Forms (4): tree, tree mallee (2), shrub, mallee shrub (4), heath shrub (5), chenopod shrub (6), hummock grass (7), tussock grass, sod grass (9), sedge (10), rush (11), forb (12), fern/cycad (13), moss (14), lichen (15), liverwort (16), vine (17)

LAND USE (1)

national/state parks (1), timber/scrub/unused, logged native forest (3), hardwood plantation (4), softwood plantation (5), volun./native pasture (6), improved pasture (7), cropping (8), orchard/vineyard (9), vegetables/flowers (10), urban (11), industrial (12), quarry/mining (13), other (14)

LANDFORM ELEMENT (1)

alcove (43), backplain (31), bank (25), bar (6), beach (26), beach ridge (7), bench (19), berm (29), blow-out (59), channel bench (33), cirque (50), cliff (5), cone (3), crater (51), cut face (28), cut-over surface (39), dam (16), drainage depression (41), dune (11), embankment (14), estuary (44), fan (27), fill top (40), flood-out (32), footslope (21), foredune (12), gully (42), hillcrest (1), hillslope, lagoon (54), lake (55), landslide (20), levee (8), lunette (13), maar (53), mound (15), ox-bow (57), pan/playa (56), pediment (22), pit (60), plain (30), prior stream (9), rock flat (34), rock platform (35), scald (36), scarp (18), scree (24), scroll (10), sink hole/doline (52), stream channel (46), streambed (45), summit surface (2), swale (47), swamp (58), talus (23), tidal creek (48), tidal flat (37), tor (4), trench (49), valley flat (38)

LITHOLOGY

Substrate (3)

not identified (1), **unconsolidated** (2), gravel (3), sand (4), silt (5), clay (6), organic material (7), alluvium (8), colluvium (9), lacustrine (10), aeolian (11), marine (12), calcareous sand (13), fill (14), mud (15), till (16), **sedimentary**, shale (18), siltstone/mudstone (19), sandstone-quartz (20), sandstone-lithic (21), conglomerate (22), limestone (23), tuff (24), breccia (25), greywacke (26), arkose (27), dolomite (28), calcrete (29), aeolianite (30), chert (31), jasper (32), **metamorphic** (33), gneiss (34), schist/phyllite (35), slate (36), hornfels (37), quartzite (38), greenstone (39), amphibolite (40), marble (41), **igneous** (42), coarse-acidic (43), coarse-intermediate (44), coarse-basic (45), fine-acidic (46), fine-intermediate (47), fine-basic (48), serpentine (49), gabbro (50), dolerite (51), diorite (52), syenite (53), granodiorite (54), adamellite (55), granite (56), aplite (57), quartz porphyry (58), basalt (59), andesite (60), trachyte (61), rhyolite (62), obsidian (63), scoria (64), ash (65), agglomerate (66), other (67)

Identification Method (1): personal assessment (1), geology map, both assessment & map (3)

Rock Outcrop % (1): nil, <2% (2), 2-10% (3), >10-20% (4), >20-30% (5), >30-50% (6), >50% (7)

TOPOGRAPHY

Slope Percent: (0)·(0), (1)·(1), (2)·(2), (3)·(3), (4)·(4), (5)·(5), (6)·(6), (7)·(7), (8)·(8), (9)·(9)

Site Morphology (1): flat (1), crest (2), hillock (3), ridge (4), upper slope (5), midslope, simple slope (7), lower slope (8), open depression (9), closed depression (10)

Slope Measurement Method (1): inclinometer, Abney level (4), total station (5), RTK GPS (6), LIDAR (7)

Slope Morphology (1): waxing (1), waning, maximal (3), minimal (4)

Aspect (1): N, NW, NE, W, E, SW, SE, S

Microrelief Type (1): none, normal gilgai (2), crabhole gilgai (3), linear gilgai (4), lattice gilgai (5), melonhole gilgai (6), other (9)

HYDROLOGY

Profile Drainage (1): very poorly drained (1), poorly drained (2), imperfectly drained (3), mod. well-drained (4), well-drained (5), rapidly drained

Permeability (1): very slowly permeable (1), slowly permeable (2), moderately permeable (3), highly permeable

Depth (1) & Extent (1): ≤ 500 mm depth (1), > 500 mm depth (2), ≤ 50% area (1), > 50% area (2)

SITE FIELD NOTES

SITE CONDITION

Site Disturbance(s) (2): natural disturbance (1), no effective disturbance (2), limited clearing, extensive clearing (4), cleared, no cultivation (5), occasional cultivation (6), rainfed cultivation (7), irrigated cultivation (8), highly disturbed (9)

Ground Cover %: (0), (1), (2), (3), (4), (5), (6), (7), (8), (9)

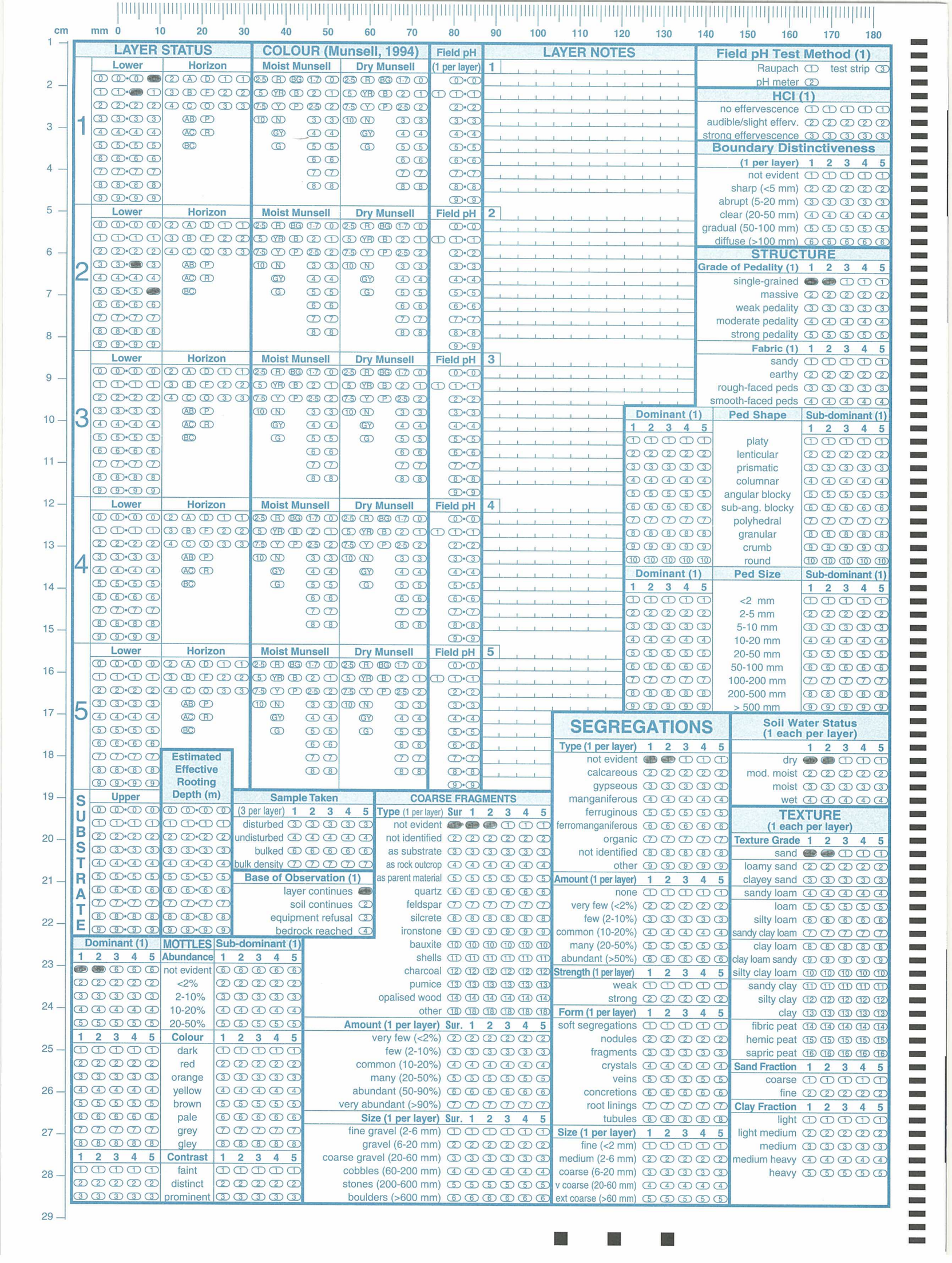
Surface Condition

Current (2)	Expected Wet (2)	Expected Dry (2)
cracked (2)	(2)	(2)
self-mulched (3)	(3)	(3)
loose	(4)	
soft (5)		(5)
firm (6)	(6)	(6)
hardset (7)		(7)
surface crust (8)	(8)	(8)
trampled (9)		(9)
poached (10)	(10)	
recently cultivated (11)		
water repellent (12)		(12)
gravelly (1)		
other (13)	(13)	(13)

Photo file name/s:

Please do not mark this space.

4067


LAYER STATUS
Lower
Horizon
COLOUR (Munsell, 1994)
Moist Munsell
Dry Munsell
Field pH
(1 per layer)
LAYER NOTES
1
2
3
4
5
Field pH Test Method (1)
Raupach
test strip
pH meter
HCl (1)
no effervescence
audible/slight efferv.
strong effervescence
Boundary Distinctiveness
(1 per layer)
not evident
sharp (<5 mm)
abrupt (5-20 mm)
clear (20-50 mm)
gradual (50-100 mm)
diffuse (>100 mm)
STRUCTURE
Grade of Pedality (1)
single-grained
massive
weak pedality
moderate pedality
strong pedality
Fabric (1)
sandy
earthy
rough-faced peds
smooth-faced peds
Dominant (1)
Ped Shape
Sub-dominant (1)
platy
lenticular
prismatic
columnar
angular blocky
sub-ang. blocky
polyhedral
granular
crumb
round
Ped Size
<2 mm
2-5 mm
5-10 mm
10-20 mm
20-50 mm
50-100 mm
100-200 mm
200-500 mm
> 500 mm
SEGREGATIONS
Type (1 per layer)
not evident
calcareous
gypseous
manganiferous
ferruginous
ferromanganiferous
organic
not identified
other
Amount (1 per layer)
none
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (>50%)
Strength (1 per layer)
weak
strong
Form (1 per layer)
soft segregations
nodules
fragments
crystals
veins
concretions
root linings
tubules
Size (1 per layer)
fine (<2 mm)
medium (2-6 mm)
coarse (6-20 mm)
v coarse (20-60 mm)
ext coarse (>60 mm)
Soil Water Status
(1 each per layer)
dry
mod. moist
moist
wet
TEXTURE
(1 each per layer)
Texture Grade
sand
loamy sand
clayey sand
sandy loam
loam
silty loam
sandy clay loam
clay loam
clay loam sandy
silty clay loam
sandy clay
silty clay
clay
fibric peat
hemic peat
sapric peat
Sand Fraction
coarse
fine
Clay Fraction
light
light medium
medium
medium heavy
heavy
SUBSTRATE
Upper
Estimated Effective Rooting Depth (m)
Sample Taken
(3 per layer)
disturbed
undisturbed
bulked
bulk density
Base of Observation (1)
layer continues
soil continues
equipment refusal
bedrock reached
COARSE FRAGMENTS
Type (1 per layer)
Sur
not evident
not identified
as substrate
as rock outcrop
as parent material
quartz
feldspar
silcrete
ironstone
bauxite
shells
charcoal
pumice
opalised wood
other
Amount (1 per layer)
very few (<2%)
few (2-10%)
common (10-20%)
many (20-50%)
abundant (50-90%)
very abundant (>90%)
Size (1 per layer)
fine gravel (2-6 mm)
gravel (6-20 mm)
coarse gravel (20-60 mm)
cobbles (60-200 mm)
stones (200-600 mm)
boulders (>600 mm)
MOTTLES
Abundance
not evident
<2%
2-10%
10-20%
20-50%
Colour
dark
red
orange
yellow
brown
pale
grey
gley
Contrast
faint
distinct
prominent