Realty Realizations Pty Ltd c/o Allen Price and Associates Pty Ltd

# Geotechnical Constraints Assessment Lot 61 DP 755971 and Part of Lot 6 DP1065111, Culburra Road, West Culburra, NSW.







WASTEWATER



GEOTECHNICAL



CIVIL



PROJECT MANAGEMENT



P1002842JR02V01 November 2012

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## 1 Introduction

#### 1.1 Overview

The report documents the findings of a geotechnical constraints assessment undertaken by Martens & Associates Pty Ltd for Realty Realizations Pty Ltd C/- Allen, Price & Associates to inform a concept plan for a mixed use sub-division at West Culburra.

The purpose of this assessment is to outline the suitability of the subject site for proposed development. Geotechnical information outlined in this report details preliminary geotechnical properties of sub-surface soils, and possible geotechnical constraints at the subject site. Consideration of the factors likely to affect development is addressed via preliminary development constraints planning.

#### 1.2 Field Investigations

Site investigations included the following:

- A general walkover inspection of the site to assess existing site conditions, presence of geotechnical hazards, and document site geomorphology;
- Excavation of twenty-five (25) testing locations via boreholes using a truck-mounted hydraulic drill rig, and test pitting activities using a backhoe; and
- Dynamic Cone Penetrometer (DCP) testing at twenty-five (25) locations to determine soil strength properties, and compliment borehole log data.

Soil samples were collected from locations across the site for the purposes of salinity, ASS, and Atterberg Limit / Linear Shrinkage assessments. Sampling information for the above assessments is outlined Sections 3.

Sub-surface investigation locations are presented in Attachment A.



#### 1.3 Relevant Guidelines/Standards

This report has been prepared in general accordance with the following guidelines/standards:

- Acid Sulfate Soil Management Advisory Committee (1998) Acid Sulfate Soil Manual;
- Australian Standard 1289 6.3.2 (1997) Methods of testing soils for engineering purposes Soil strength and consolidation tests DCP;
- Australian Standard 1796 (1993) Geotechnical Site Investigations;
- Australian Standard 2870 (1996) Residential Slabs and Footings;
- Department of Land and Water Conservation (2002) Salinity Guidelines; and
- Department of Land and Water Conservation (2002) Site Investigations for Urban Salinity.



## 2 Site Description

#### 2.1 Site Location

The subject site at Culburra Road, West Culburra comprises the following lots:

- o Lot 61 DP 755971;
- Part Lot 5 DP 1065111;
- o Part Lot 6 DP 1065111; and
- Part Lot 7 DP 1065111.

The site is located approximately 15 km east-south-east of Nowra and is within the Shoalhaven City Council Local Government Area.

Total site area is approximately 97 ha consisting mostly of undeveloped remnant forest, although part of Lot 5 DP 1065111 and part of Lot 61 DP 755971 have been cleared.

The location of the site in its regional context is presented in Figure 1.



Figure 1: Location of the subject site.



### 2.2 Physiography and Hydrology

Majority of the site is elevated >5 mAHD above the Crookhaven River estuary. Immediate foreshore areas are moderately steep and transitional between the subject site and the estuary. Relief across the site is approximately 20 m. The landscape is gently undulating with slopes ranging between 2.5 - 5.0 %, with some areas of localised over steepening typically associated with drainage lines.

Site drainage ranges from good to poor across the site, with poor draining areas characteristically associated with lower points of elevation within the landscape. Site drainage likely consists of both infiltration and overland flow (sheet and concentrated).

#### 2.3 Lithology and Soil Landscapes

Reference to the 1:250,000 Wollongong Geological Series Sheet indicates that site is lies upon Wandrawandian Siltstone, a member of the Shoalhaven Group. Wandrawandian Siltstone is dominated by siltstone and silty sandstone lithologies, and is pebbly in parts. Immediate foreshore areas of the site, adjacent to Crookhaven River Estuary consist of Quaternary sedimentary units of gravel, sands, silts, and clays of marine to freshwater environments, and likely overlie Wandrawandian Siltstone in these areas.

Hazelton (1992) indicates that soils within the investigation area belong predominantly to the Greenwell Point Soil Landscape Group. Soils are primarily derived from *in-situ* weathering of the underlying Wandrawandian Siltstone. Soils are characteristically shallow (<50 cm) to moderately deep (50-100 cm) Loams to Yellow Podzolic Soils or Red Solodic Soils.

While not observed during field investigations, soil mapping completed by Hazelton (1992) suggests that the eastern periphery of the site may contain the Seven Mile Soil Landscape group. This soil landscape group is genetically estuarine, and comprises deep (> 1.5 m) Siliceous Sands, Acid Peats, and Humus Podzols.



### 2.4 Hydrogeology

Groundwater was observed during intrusive investigations at the site, and is summarised in Table 1. A more detailed investigation of groundwater at the site is presented in Martens and Associates report P0902521JR03V01.

GMB ID <sup>1</sup>	GMB Surface Level <sup>2</sup>	23.11.2010 mAHD	24.11.2010 mAHD	25.11.2010 mAHD	26.11.2010 mAHD
1	6	5.38	5.38	5.34	5.31
la	6	-	4.84	4.93	4.97
2	22	20.8	20.71	20.63	20.59
2a	22	-	Dry	Dry	Dry
3	15	Dry	Dry	Dry	Dry
4	8	Dry	Dry	Dry	Dry
5	8	Dry	Dry	Dry	Dry
6	5	-	-	4.87	4.86

Table 1: Groundwater level measurements

Note:

<sup>1</sup> GMB – groundwater monitoring bore.

<sup>2</sup> Level approximate mAHD based on Allen, Price and Associates survey (Ref: 25405-02)



## 3 Factors Affecting Development

#### 3.1 Geotechnical

#### 3.1.1 Sub-surface Conditions

Subsurface investigations at the subject indicate that predominantly sandy silts or silty sands (with some organic content) typically overlie medium to high-plasticity clays derived from *in-situ* weathering of the underlying Wandrawandian Siltstone. The soil mantle typically ranges in depths from 1.3 - 1.5 m below ground level (BGL). Extremely to highly-weathered siltstone is encountered below 1.5 mBGL, with rock strength variation ranging from extremely to slightly weathered to depths of 5.5 mBGL. Significant rock outcropping was not observed on the site.

Borehole, test pit and DCP locations are shown on the site plan (Attachment A). Detailed borehole and test pit logs are presented in Attachment B.

Material Description <sup>1</sup>	Depth <sup>2</sup> (m)
SILTY SAND / SANDY SILT	0.0 - 0.3
CLAY	0.3 – 1.3
EW – SW SILTSTONE (weathering patterns variable down profile)	1.3 - >5.5

Table 2: Indicative soil and rock depth range.

#### Notes:

<sup>1</sup> F = Fresh, SW=Slightly weathered, MW = Moderately weathered, HW = Highly weathered, EW = Extremely weathered. Refer to borehole logs for material description details.

<sup>2</sup> Indicative depth range. Material depth may vary across a site depending on site and local geological conditions. Depth of fill variable across the site. Refer to borehole logs for accurate depths of soil materials at each borehole.

#### 3.1.2 Soil Strength Properties

Preliminary soil strength estimates indicate soils below 0.3 m are likely to have allowable bearing capacities (ABC) ranging between 50 - 200 kPa, providing suitable bearing capacity for standard shallow foundations for residential dwellings. Areas of the site identified to contain soft soils are likely to have ABC <50 kPa.

Further investigation is required at detailed design stage to formally assess ABC and related soil strength properties across the site. We also recommend that additional assessment is conducted to formally identify the distribution of soft soil areas and associated ABC and related soil strength properties which may have implications for development in these areas.



#### 3.1.3 Rock Strength Properties

Initial investigations indicate that the rock weathering front occurs between 1.0-1.5 mBGL across the site, with underlying Wandrawandian Siltstone exhibiting rock strength variations down profile. Based upon preliminary investigations, allowable bearing capacities of weathered rock between 300-600 kPa are likely to be encountered below 1.5 mBGL.

Due to observed variation in rock strength it is recommended that where higher rock strength values are required for structural design purposes, further rock coring, RQD assessment, and point-load testing is conducted.

#### 3.1.4 Atterberg Limits Laboratory Analysis

Atterberg limits laboratory testing was conducted upon representative soil samples collected. Results are presented in Table 3. Analytical laboratory certificates are presented in Attachment E.

Sample	LL (%) 1	PL(%) <sup>2</sup>	PI(%) <sup>3</sup>	Ls (%) <sup>4</sup>	USCS 5
2842/10/0.5	120	33	87	21.5	СН
2842/10/1.0	54	17	37	15.0	СН
2842/17/0.5	71	17	54	14.0	СН
2842/17/1.0	68	16	52	17.5	СН
2842/20/1.0	92	19	73	17.5	СН

 Table 3: Laboratory Results for Atterberg Limits and Linear Shrinkage Testing

#### Notes:

<sup>1</sup> Liquid limit.

<sup>2</sup> Plastic Limit.

<sup>3</sup> Plasticity Index.

<sup>4</sup> Linear Shrinkage.

<sup>5</sup> Unified Soil Classification Scheme.

Preliminary laboratory analysis indicates that sub-soils at the site are highly plastic.

Linear shrinkage information relating to site classification for foundation purposes are discussed in Section 4.3.

#### 3.1.5 Soft Soils and Poor Drainage Constraints

Intrusive investigations and site observations indicate typically consistent site geomorphology and subsurface conditions within the subject site. Due to shallow, low-permeability sub-soils, and general low relief, soils across the subject site are likely to exhibit characteristics of poor drainage following incident rainfall.

Localised soft soils were identified during site works, and approximate locations are presented in Attachment A. These areas were observed in drainage depressions or areas of extreme low relief associate with



ridge crests. Due to the preliminary nature of the investigation and limited information available, it is uncertain if soft soil areas are a product of low-permeability sub-soils, perched groundwater, or spring discharge points

#### 3.2 Slope Instability

3.2.1 Assessed Hazards

The slope instability assessment for the subject site has been prepared in accord with Australian Geomechanics (Vol. 42, No.1) "Guidelines for Landslide Susceptibility, Hazard, and Risk Zoning for Landuse Planning".

Observation compiled during the site walkover indicates the following potential slope stability hazards:

- 1. <u>Soil creep</u> Soil creep can be an active process on moderate and steep slopes. The process is very slow and shallow seated. While not directly observed during the site walkover, possibility for the existence of soil creep at the site is likely given sufficient relief.
- <u>Shallow Rotational Slide</u> Where necessary relief is available, particularly within poor drainage areas of the site. Such failures may occur where the soils become saturated, or the slope is over-steep and failure occurs on defects such as joints or bedding planes.
- 3.2.2 Slope Instability Risk Assessment

The site instability risk assessment was undertaken in accordance with Australian Geomechanics 2007 Landslide Management guidelines. Results of the analysis are provided in the table below. **Table 4:** Slope Instability Risk Assessment and Calculation.

Site Features	Poorly Drained Areas	Balance of Site
Average Grade (%)	10%	5%
Peak Grade (%)	25%	10%
Average soil depth (m)	1.3	<1.3
Peak soil depth (m)	2.0	<1.3
Soil materials	Silty Sand/ Sandy Silt / Clay	Silty Sand/ Sandy Silt / Clay
Soil creep observed	No	No
Permanent Groundwater	Not observed	Not observed
Springs	Possible	Not observed
Instability observations	No	No



Site Features	Poorly Drained Areas	Balance of Site
Instability factors	1.Possible springs within drainage depressions leading to increased poor pressure behind structures if not adequately drained.	Site is typically of low relief and limited opportunity for instability.
	2.Locally saturated soil profile without adequate sub-soil drainage.	
Soil Creep		
Likelihood	Almost Certain	Barely Credible
Consequence	Low	Very Low
Risk Rating	Low	Very Low
Treatment Required	Yes	Nil
Shallow Rotational Slide		
Likelihood	Possible	Very Low
Consequence	Medium	Very Low
Risk Rating	Moderate	Very Low
Treatment Required	Yes	Nil

#### 3.2.3 Conclusions

It is recommended that further investigation is undertaken to confirm the existence and possible extent of slope instability, particularly in relation to areas of poor drainage, and proposed development areas in proximity to the foreshore protection zone (where required). Within this landscape position, some degree of over steepening was observed in conjunction with shallow groundwater levels overlying sub-horizontal strata.

Development of remaining areas of the site should be undertaken in accordance with good hillside construction practice and sound engineering principles.

#### 3.3 Salinity

#### 3.3.1 Salinity Risk Mapping

Review of salinity hazard mapping (NSW Natural Resource Atlas, 2010) does not indicate salinity hazards associated with the subject site. Although the regional evidence indicates that the site is in a locality of unidentified salinity potential (NSW Natural Resource Atlas, 2010), local variations can occur and the subject site may experience minor salinity potential.



#### 3.3.2 Observed Site Conditions

Site investigations did indicate the signs of existing salinity at the site:

- Vegetation growth appeared healthy and uninhibited;
- There were no salt crystals on ground surface;
- There were no bare soil patches with black staining or greasy appearance on site;
- There were no bare patches with obvious white crystals or a 'puffy' soil structure on site;
- There was no dieback of trees from outer canopy on site; and
- Drainage on the site was acceptable, except for poor drainage observed in drainage lines, and following rainfall.

#### 3.3.3 Soil Testing

Thirty (30) soil samples from ten (10) of the geotechnical boreholes were submitted to Envirolab Services laboratories for electrical conductivity (EC) testing and soil pH characteristics.

3.3.4 Soil Salinity and Aggressivity

Results indicate that the soils at the site are generally non-saline, except soils at BH6 at the far eastern-end of the site which were moderately to very saline throughout the soil profile.

Soil pH conditions will likely impact on exposed concrete foundations / piles within areas of the site, with a concrete exposure classification of mild for soils assessed. BH8 returned a moderate exposure classification at 1.0 mBGL.

Summary of testing results is presented in Attachment D and laboratory analytical certificates are provided in Attachment F.

#### 3.3.5 Recommendations

It is recommended that at detailed design stage, detailed soil salinity and aggressivity assessment is completed, with particular emphasis on those proposed eastern development blocks where soil salinity has been indicated during this investigation. Given the extent and magnitude of observed salinity it is concluded that soil salinity shall be readily managed with engineering solutions and shall not prevent development of these areas.

Soil sodicity was not assessed as part this investigation, however site observations indicate areas of poor drainage and low-permeability



across the site. Further investigations should assess Cation Exchange Capacity (CEC) of soils in addition to Emerson Aggregate Class, to ascertain the prevalence of soil sodicity and soil dispersion on site.

#### 3.4 Acid Sulfate Soils

#### 3.4.1 Introduction

A preliminary assessment for the presence of Acid Sulfate Soil (ASS) was undertaken within areas of the site <5 mAHD. ASS soil samples were collected for laboratory analysis during the intrusive investigations of the site.

#### 3.4.2 ASS Risk Map Classification

Review of the NSW Natural Resource Atlas acid sulphate soils risk map (see Figure 2) indicates that perimeter areas of the site, most notably adjacent to Crookhaven River Estuary are classified as Class 2 (works below the ground surface). In consideration of ASS risk to the development, it is noted that a 100 m foreshore set-back distance is required for the proposed development.



Figure 2: Acid Sulfate Soils Risk Map (NSW Natural Resource Atlas).



#### 3.4.3 Geomorphic Characteristics

Observations compiled during the site inspection and via aerial photography interpretation (API) were compared against various geomorphic characteristics outlined in ASSMAC (1998) indicating likely ASS occurrence (Table 5).

 Table 5: Geomorphic site features indicative of ASS and their presence or absence at the site.

Geomorphic Feature	Present on site?
Holocene sediments	Adjacent to Shore
Soil horizons less than 5 m AHD	Adjacent to Shore
Marine / estuarine sediments or tidal lakes	Adjacent to Shore
Coastal wetland; backwater swamps; waterlogged or scaled areas; interdune swales or coastal sand dunes.	Adjacent to Shore
Dominant vegetation is mangroves, reeds, rushes and other swamp or marine tolerant species.	Adjacent to Shore
Geologies containing sulphide bearing material	Possibly
Deep older (Pleistocene) estuarine sediments	Unknown

Due to the characteristic local morphology, areas likely to be associated with ASS prevalence likely exist with the immediate perimeter of the site, bordering Crookhaven River Estuary. Two (2) of the seven geomorphic characteristics listed are present on the site. This indicates a likelihood that ASS may be present.



#### **3.4.4** Potential Risk Assessment of Proposed Works.

Table 6 provides a risk assessment based on field investigations undertaken. Due to the preliminary nature of this investigation, and unknown aspects of the proposed development, a number of assumptions have been made in generating the risk assessment in Table 6. Assumptions have based on observed site conditions and our experience working on similar sites.

 Table 6:
 Risk assessment for proposed works on the site based on Table 3.1 of ASSMAC (1998) and Laboratory results of SPOCUS testing.

Factors Affecting Risk Level	Description	Level of Risk
Volume of material to be disturbed	> 50 tonne (across the whole site)	High
Distance between potential acid sulfate soils and depth of disturbance	Unknown	N/A
Change in surface drainage	Likely to be shallow to mid level drains across the site.	Moderate
Duration of disturbance	> 7 days	High
Likely severity of ASS based on peroxide reaction and final pH <sub>ox</sub>	Mild	Low
Connection to natural waterbodies or wetlands	Connected to Crookhaven River Estuary and Lake Wollumboola by surface runoff	Moderate

The assessment suggests a "moderate" risk from proposed site works, and as such, a preliminary laboratory testing regime was conducted for the site.

#### 3.4.5 Preliminary Field Screen Testing

Preliminary field screen testing was completed on thirty (30) soil samples to provide an indication as to the presence of potential ASS (PASS) or actual ASS (AASS). Soil samples were analysed from ten (10) boreholes (BH1, BH4, BH5, BH6, BH11, BH13, BH19, BH20, BH21, and BH24), with sampling aimed at:

- 1) Assessing the soil horizons most likely to contain ASS; and
- 2) Testing of soil horizons most likely to be impacted as a result of proposed development works.

#### 3.4.6 Cl<sup>-</sup> / SO<sub>4</sub><sup>2-</sup> Groundwater Ratio

Presence of ASS was also assessed by examination of  $Cl^2$  /  $SO_4^{2-}$  ratio in groundwater, and results are presented in Table 7.



#### Table 7: ASS groundwater data.

Groundwater bore sampling	Chloride (Cl <sup>.</sup> ) (mg/L)	Sulfate (SO4 <sup>2-</sup> ) (mg/L)	Cl <sup>-</sup> / SO4 <sup>2-</sup> ratio
GMB01	1,300	330	3.9
GMB02	40	22	1.8
GMB06	6,000	720	8.3

While Cl<sup>-</sup> /  $SO_4^{2-}$  ratios <2 are a strong indication of ASS presence, Cland  $SO_4^{2-}$  concentrations are very low within groundwater at GMB02. Additionally GMB02 is located on a residual soil profile, at an elevation >20 mAHD, indicating that ASS presence is unlikely.

#### 3.4.7 sPOCAS Analysis

 Table 8: Results of sPOCAS testing.

Sample ID	Sample Depth (mBGL)	Soil Type	pH <sub>KCL</sub> ¹	pH <sub>OX</sub> <sup>2</sup>	TPA (mol H+/t) <sup>3</sup>	TSA (mol H+/t)⁴	S <sub>POS</sub> (%S oxidisable)⁵
2842/1/1.0	1.0	Clay	3.5	4.1	143	5.0	0.005
2842/5/1.0	1.0	Clay	3.6	4.2	128	<5.0	<0.005
2842/13/0.5	0.5	Clay	4.3	4.0	<5.0	<5.0	0.007
2842/19/0.5	0.5	Clay	3.5	4.0	173	10	0.007
2842/21/0.5	0.5	Clay	3.8	4.2	108	20	0.010
		Sands	-	-	18	18	0.03
Guideline Limit (Action Criteria)		Sandy Loams, Clays and Silts	-	-	36	36	0.06
		Silty Clays, Clays	-	-	62	62	0.10

Note: <sup>1</sup> Actual pH; <sup>2</sup> Post peroxide oxidation pH; <sup>3</sup> Total Potential Acidity; <sup>4</sup> Total Sulfidic Acidity; <sup>5</sup> Percentage peroxide oxidisable sulfur.

On the basis of this sPOCUS analysis we conclude the following:

- 1. Except for 2842/13/0.5, soil acidity is reduced following oxidation;
- 2. Samples are not considered to be PASS or AASS, however there are a number of soil samples that contain minor acid generating ability when fully oxidised. It unlikely that soil acidity can be attributed to sulfidic acidity, and is most likely a result of pedogenic processes occurring within the soil mantle.



#### 3.4.8 Conclusions and Recommendations

It is considered that soils observed during the investigation are neither AASS nor PASS, but are inherently acidic soils derived from *in-situ* weathering of the underlying siltstone lithology and pedogenic processes.

Should development be considered within the 100 m foreshore setback distance, adjacent to Crookhaven River estuary, further ASS assessment would be required to evaluate ASS constraints in this area.



## 4 Development Constraints Planning

### 4.1 Overview

The following geotechnical constraints are based on slope stability and soil erosion considerations. The constraints are aimed at providing broad guidelines to assist in development planning. It is envisaged that further refinement and delineation of geotechnical constraints, including pavement and foundation designs, will occur with more detailed assessment of separate areas of the site as development proceeds.

### 4.2 Areas of Suitable for Development

It is considered that the site is generally geotechnically suitable for development, however, it is recommend further investigation is undertaken to identify the distribution and ascertain development suitability of areas of the site characterised by soft soils. It is also recommend more detailed salinity assessment is completed in proposed eastern development areas (considering salinisation values identified in BH6) to establish salinity distribution and consider appropriate constraints planning options.

While no pronounced evidence of land instability was observed at the subject site, should development be considered in steeper areas adjacent to Crookhaven River foreshore, and within the 100 m foreshore set-back distance, a detailed land instability assessment would be required.

### 4.3 Foundations

Limited site investigation indicates no specific geotechnical constraint relating to foundations at the site, provided foundations are designed by a suitably qualified geotechnical or structural engineer, in accordance with AS2870-1996 "Residential Slabs and Footings".

Based upon depth of clay saprolite and linear shrinkage values (see Table 3), we consider that the site classification to AS2870-1996 "Residential Slabs and Footings" would be predominantly **Class M**, however, we recommend detailed site classification assessment at a later stage.

It is also envisaged where soft soils occur these may require foundation treatment prior to foundation construction (i.e. dewatering, compaction, bridging layers, piles, etc). Laboratory analysis of identified soft soil should be incorporated within further investigations of soft soils, and should include shrink/swell index testing or further linear shrinkage analysis.



#### 4.4 Site Preparation and Clearance

Soil and erosion control planning will be required during and following construction on the subject site, and should be prepared in accordance with Landcom (2004) 'Blue Book'.

#### 4.5 Excavation

It is anticipated that all materials could be excavated by conventional dozer-blade or backhoe bucket at least to a depth between 1.5 - 2.0 mGBL.

Difficult ripping conditions maybe encountered within deeper excavations, as such, allowance should be made for use of hydraulic rock breakers in localised hard bands, or in confined detail excavations such as footings or service trenches.

Where excavations should exceed 1.5m in depth, constructed retaining walls should be considered on a site by site basis and designed by a qualified and experienced engineer.

#### 4.6 Reuse of Materials

The following comments are made regarding suitability of site materials for re-use in filled areas:

- Where site regrading is proposed, all existing topsoil, vegetation, and geotechnically unsuitable materials should be removed to spoil or stockpiled for reuse as landscaping materials only;
- Stripping is expected to be required to depths of about 0.3 m (topsoil layer), but may be significantly deeper where wet, silty soils are encountered;
- Underlying very stiff clays may be carefully stripped as necessary and stockpiled for re-use as general site fill;
- The clayey soils on-site are expected to be moderately reactive (susceptible to volume changes with variation in moisture content) and will need to be placed and compacted to a minimum density ratio of 95% Standard Compaction within ±2% of OMC to minimise reactive soil movements;
- Where excavation of weathered rock is required there may be some oversize material that requires sorting or crushing prior to reuse as engineering fill.

#### 4.7 Filling

Use of engineered fill on the subject site should be undertaken in accordance with sound engineering principles as set out in AS3798 (2007).



Residual clay soils derived from cuts on the site is likely to be suitable as site regrade fill provided good moisture control is supplied during placement and compaction. Topsoil materials are considered geotechnically unsuitable and are regarded as suitable for landscaping use only.

Where site regrading is proposed, the following general course of action should be taken:

- Strip existing topsoil, root affected material and deleterious material to spoil;
- Following stripping the surface should be assessed for trafficability;
- Following stripping, the exposed sub-grade materials should be proof rolled to indicate any wet or deflecting material. Any such areas should be over excavated and backfilled with an approved select material. The area should also be graded to shed water
- Approved fill should be placed and compacted in accordance with AS3798-2007 'Guidelines for Earthworks for Commercial and Residential Developments'.

#### 4.8 Pavements

It should be anticipated that some degree of moisture conditioning of sub-grade materials may be necessary prior to compaction and placement of pavement materials. The required time period to prepare the sub-grade is likely to be dependent on the prevailing weather conditions at the time of construction. Based upon preliminary site assessment a provisional CBR value of 3% is likely for pavement calculations at clay sub-grade level.

Where siltstone sub-grades are encountered, the bedrock should be ripped and re-compacted to a minimum depth of 250mm to provide a dense homogenous surface for pavement construction. Ripped and re-compacted weathered rock may be assumed to have a design CBR of 10%, however this should be confirmed with further testing.

Where pavements are required in poor drainage areas, a CBR value <3% is likely, and may require sub-grade improvement or replacement, and involve lime-stabilised sub-grades, use of geofabrics or removal of a nominal depth of soil and replacement with select fill to bridge low-strength material.

It is recommended that a detailed pavement investigation be conducted incorporating CBR laboratory testing, when the alignment, level, and traffic loading of proposed roads are determined.



#### Limitations 5

The recommendations presented in this report include specific issues to be addressed during the detailed design phase of the project. In the event that any of the recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Martens & Associates accept no responsibility performance whatsoever for the of the project where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, sub-surface conditions between and below the completed boreholes / test pits / other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.



## 6 References

- Acid Sulfate Soil Management Advisory Committee (1998). Acid Sulfate Soil Manual.
- Australian Geomechanics Society, Sub-Committee on Landslide Risk Management (March 2000) Landslide Risk Management Concepts and Guidelines, Australian Geomechanics 35 (1), p 49 – 92.
- Australian Standard (1997) 1289 6.3.2 Determination of the Penetration Resistance of a Soil using the 9 kg Dynamic Cone Penetrometer.
- Australian Standard 1796 (1993) Geotechnical Site Investigations.
- Australian Standard 2159 (2005) Pliling Design and Installation.
- Australian Standard 2870 (1996) Residential Slabs and Footings.
- Australian Standard 2870 Supplement 1 (1996) Residential Slabs and Footings Construction Commentary.
- Australian Standard 3798 (2007) Guidelines on earthworks for commercial and residential developments.
- Australian Standard 4678 (2002) Earth Retaining Structures.
- Das, B.M., (1995) Principles of Foundation Engineering.
- Department of Land and Water Conservation (2002) Salinity Guidelines.
- Department of Land and Water Conservation (2002) Site Investigations for Urban Salinity.
- Hazelton P.A et.al (2007) What Do All the Numbers Mean?



7 Attachment A – Site Plan





## 8 Attachment B – Borehole and Test Pit Logs



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A	Nil	N	М	-0.25 - -0.45			SC	SILTY CLAYEY SAND	– Light grey inor gravels.	, fine grained sands,		L	A	0.4	2842/1/0	.4		0.5m bal	1 1
А	Nil	N	М	0.6 0.9			CL	SILTY CLAY - Brown/ tending to clay	orange, grave with gravels	els (1-15mm, 35%), decreasing.	F St						2 3	Bentonite S	Seal
А	Nil	N	М	<u>1.0</u> 1.2			СН	CLAY - Gre	y/orange/red	mottled.	VSt		A	1.0	2842/1/1	.0		UPVC P	<sub>ipe.</sub> 1 <u>.0</u>
A	Nil	N	м	- - 1.6			CL	SANDY CLAY/E SILTSTONE - Ligh	XTREMELY	WEATHERED w, cream bands,	VSt	MD	A	1.5	2842/1/1	.5		<u>1.5m</u> bgl	
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A	Nil	N	м	1.0				СН	CLAY – Red, mediu	m plasticity, g	rey/brown mottles.	St							Sand Pack.	1.0
Α	Nil	Ν	M	1.2				СН	CLAY - Grey wit	th minor red/t	prown mottles.	VSt						ŴЕЕ		_
А	Nil	Ν	D M	1.5				CL EW	CLAY TO EXTREME	LY WEATHE	RED SILTSTONE -	VSt		A	1.5	2842/2A/1	.5 1.42m bgl			-
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A	Ni	N	М	- 0.15	8	× × ×	SM	SILTY SAND – Bro	wn/dark brow	n, minor gravels.		L	A	0.2	2842/3/0	0.2		Concrete -
4	Ni	N	М	- -0.35 -			SP	SAND – Light brown gravels (1	/brown, medi -5mm, appro	um grained sands, x 10%).		L	A	0.5	2842/3/0	).5		-
A	Ni	N	м	<u> </u>		   	CL	CLAY - Yellow/br siltstone band	own/orange, ls increasing	red weathered with depth.	F St		А	1.0	2842/3/1	1.0		0.6m bgl Bentonite Seal
A	Ni	Ν	М	- 			CL/ HW	SANDY CLAY/HIGH		RED SILTSTONE	VSt		А	1.2	2842/3/ 1	1.2		
A	Ni	N	м	- - 1.6			CL HW	CLAY - HIGHLY W	/EATHERED	SILTSTONE -	VSt		А	1.5	2842/3/ 1	.5		- - - <u>1.56</u> 5m bgl
4	Ni	N	м	_ _ <u>2.0</u> 2.1			CL MW EW	CLAY - MODERATELY SILTSTONE - C	TO EXTREM Grey with red	MELY WEATHERED	VSt		A	2.0	2842/3/2	2.0		Sand Pack. UPVC Screen.2.0
A	Ni	N	D	-			SC EW	CLAYEY SAND/E SILTSTONE mediur	XTREMELY - Grey/pink/i n grained sai	WEATHERED red, fine to nds.	VSt		А	2.5	2842/3/2	2.5		
A	Ni	N	D	3.0		<u></u>	мw	MODERATELY	VEATHERED	SILTSTONE -								24 3.0 24 24 24
4	Ni	N	D				HW/ EW	HIGHLY/EXTREME	Y WEATHE	RED SILTSTONE.			P	4.0	2842/2/4	10		
4	Ni	N	D	- - - - - -			MW/ SW	MODERATELY. S	/SLIGHTLY V ILTSTONE.	VEATHERED				4.0	204210,4	4 <u>.565</u> m <u>bgl</u>		Well end plug.
4	Ni	N	D	- - 5.5			EW/ MW	EXTREMELY/MC S	DERATELY ILTSTONE.	WEATHERED								
EQUIPMENT / METHOD       SUPPORT       WATER       Moist URE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       P       P       CASSINGTATION       SUPPORT       None observed       D       D       D       P       None observed       D       D       D       D       D       D       V       VIC VS       Very Strift       VL< Very Users       Very Users       Amplitude and P       Support       CASSINGTATION SUPPORT       CASSINGTATION SUPPORT       CASSINGTATION SUPPORT       CASSINGTATION SUPPORT       VIC Very Strift       VL Very Users       Amplitude and P       Support       CASSINGTATION																		
F		_	~			EXCAVATI	ON LO	DG TO BE READ IN CONJU		ACCOMPANYING REP	ORT NOTES		BBRE	VIATIO	ONS			
Colored Second	(	m	a	rte	ns sociates Ptv	Ltd . 2010		Pr mail@m	6/37 Hornsby, ione: (02) 9476 artens.com.au	Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	67 s.com.au		E	ng	jine Bc	erín oreh	g L ole	og -

C	LIE	ENT	•	A	llen Prio	ce & A	ssociate	s Pt	/ Ltd	COMMENCED	23.11.10	COMPLETE	<b>D</b> 23.11	.10			REF	I	BH	4	٦
F	RC	JE	СТ	E	ngineer	ing Se	rvices			LOGGED	GT	CHECKED	AN				Sheet 1	l of '	1		
5			<u>іт</u>	C	ullburra	Road	, West C	ullb	urra	GEOLOGY	Siltstone		None				PROJECT	<b>NO.</b> P1	1002842		_
E	XCA			IMEN	SIONS	0.1mØ X	5.5m depth			NORTHING	NA	ASPECT	North				SLOPE	2-3	%		_
	ļ	EXC	CA	/AT	ION DA	ТА			MA	ATERIAL D	ATA				SA	MPLIN	IG & TE	STING	i		
	MEIHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		RAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, n particle characteristics, org fill, co	PTION OF STR mottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)		WATEF			LS Well Cover	
,	1	Nil	N	м	-			× × sm	SILTY SAND – Brown	, gravels (1-1	0mm, approx 10%).		L	А	0.2	2842/4/0	.2			Concrete	-
,	4	Nil	N	м	0.3			 CL	CLAY - Brown/orange gravels (1-	e, mottles inc 10mm, appre	reasing with depth, ox 10%).	S		A	0.5	2842/4/ (	1.5			.6m bgl	
,	4	Nil	N	м	- - 1.0			- - CL -	CLAY - Grey/brow	n/red mottles	, minor gravels.		F	А	1.0	2842/4/1	.0		В	entonite Seal UPVC Pipe.	- 1 <u>.0</u> -
,	4	Nil	N	м				- CL HW	CLAY - HIGHLY V Grey with red/orange	VEATHERED mottles, silts	) SILTSTONE - one bands/gravels.	VSt		A	1.5	2842/4/ 1	.5			26m bgl Sand Pack. UPVC Screen.	
					1.8 2.0 -									A	2.0	2842/4/2	.0				2 <u>.0</u> -
,	4	Nil	Ν	м	- - - -			CL MW EW	CLAY - MODERATELY SILTSTONE - (	TO EXTREI Grey with red	MELY WEATHERED	VSt		A	2.5	2842/4/2	2.5				
,	A	Nil	N	D	3.0 - - - - - - - - - - - - - - - - - - -				CLAYEY SAND/E SILTSTONE - G mediui	EXTREMELY rey/pink/red/ m grained sa	WEATHERED orange, fine to nds.	VSt		в	4.0	2842/4/4	.0 4 <u>.26m</u> bgl			<u>ll e</u> nd plug.	<u>3.0</u>               4 <u>.0</u>
,	A         NII         N         D         5.0         E <th></th> <th></th> <th>A</th> <th>5.0</th> <th>2842/4/5</th> <th>i.O</th> <th></th> <th></th> <th></th> <th>5.0</th>													A	5.0	2842/4/5	i.O				5.0
EOUPMENT METHOD       SUPPORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       p       Pocket peretoneter       SVMBOLS AND         EDUPMENT METHOD       SUPPORT       None observed       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       p       Pocket peretoneter       SVMBOLS AND         N       Nature sample       None observed       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       p       Pocket peretoneter       SVMBOLS AND         Standard penetration standard       None observed       Motest       Motest       Motest       S Soft       VL Very Lose       S Ampling and testing       p       Pocket peretoneter       SVMBOLS AND         Standard penetration standard       No message       Motest       Motest       S Soft       VL Very Lose       S Ampling and testing       p       Pocket peretoneter       S SVMBOLS AND         S Hand sydee       Water courting       Water work       Motest       S Soft Were       N Ampling Work       P       P       P       P       P       P       P       P       P       P       P       P       P       P       P       P       P       P												5.0 7.1 8.0 9.0 7.1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1									
	S PT A CC	Hai Pus Aug Con	na sp ih tub ger icrete	ade e Core	r		► Wa	ater inf	OG TO BE READ IN CONJI		Hard Friable		ibe sample	(x mm)		> ⊢ield dei S Water si	nsity ample	L	Ag	ricultural	_
frippe	(	r	n	a	rte	<b>NS</b>	/ Ltd . 2010		Pi mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	57 s.com.au		E	ng	ine Bc	erin oreh	g L ole	.og	-	
CL	IEN	Т	A	llen Prio	ce & As	sociates	Pty	Ltd	COMMENCED	23.11.10	COMPLET	<b>ED</b> 23.11	.10			REF		BH	6		
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PR	OJE	СТ	E	ngineer	ing Ser	rvices			LOGGED	GT	CHECKED	AN		_		Sheet 1	of ′	1	•		
SIT	E		C	ullburra	a Road,	West Cu	Ilbu	irra	GEOLOGY	Siltstone	VEGETAT	ION None				PROJECT	NO. P1	002842			
EQU			DIMEN	SIONS	0.1mØ X	5.5m depth				NA	ASPECT	NOrth				SLOPE	1-2	%			
	ΕX	CA\	/AT	ION DA	TA			MA	ATERIAL DA	ТА				SA	MPLIN	IG & TES	STING	i			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION R RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org. fill, cc	PTION OF STR mottling, colour, pla anics, secondary a ontamination, odou	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)		WATER		<b>DETAIL</b>	<b>S</b> Well Cover		
A	Nil	N	М	0.1	**		CL	SILTY SANDY	CLAY – Dark	grey/brown.	S		A	0.2	2842/6/0	.2			oncrete		
А	Nil	N	м	-0.45			CL	SILTY SAND C	LAY – Browr	n/light brown.	S			0.5	2842/6/0	15			-		
А	Nil	N	м	- 0.7			CL	CLAY - Red/orange w	ith light brown	n mottles increasing	St			0.0	2012.07			—0. Ben	5m bgl -		
А	Nil	N	м	- <u>1.0</u> - 1.3			СН	CLAY - Grey/cream wi plastic, gravel	th red/brown ls (1-5mm, ap	mottles, moderately pprox 20%).	St		A	1.0	2842/6/1	.0		U	- IPVC Pipe. 1.0 -		
													A	1.5	2842/6/ 1	.5			-		
А	Nil	N	м	- - 2.0 - -			CL HW	CLAY - HIGHLY V Light grey with red n increa	VEATHERED nottles, siltsto asing with dep	) SILTSTONE - one gravels bands oth.	VSt		A	2.0	2842/6/2	.0	2 2 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	2.3	<u>Sand Pack.</u> - 2 <u>.0</u> 3m bgl -		
				_ _ _ 2.8									A	2.5	2842/6/2	2.5		С. 2. – UI	- - PVC Screen.		
А	Nil	N	м	3.0 3.1			CL MW	SANDY CLAY - M	ODERATELY	WEATHERED	VSt		в	3.0	2842/6/3	.0		1.2	3 <u>.C</u>		
А	Nil	N	D	3.3			CL/ HW	(1-50n	nm, approx 1	5%).	VSt								-		
A	Nil	N	w				CL	CLAY/HIGHLY WEATI	HERED SILT Y WEATHER grey with ban	STONE - Light grey./	VSt		В	3.5 4.5 5.5	2842/6/3 2842/6/4 2842/6/6	.5 .5 <u>5.33m bgl</u>			4 <u>.0</u> 		
				5.5 				Borehole to extremely	erminated at weathered si	5.5m on Itstone.			A	5.5	2842/6/ 5	.5		<u></u>			
	QUIPI Na E B B A A Ha	MENT atural ( xisting cckhoe ccavat	/ ME expos excase buck or ger	6.0 - - - - - - - - - - - - -	UPPORT H Shoring C Shotret B Rock BG I No supp	WATER N Non Not Wat Wat	e obse measu er leve er outt	MOISTURE PENE rved D Dry L Lo red M Moist M Mi W Wet H Hi W Plastic limit R Re low WI Liquid limit	TRATION CON w VS gh F flusal St VSt	SISTENCY DENSITY VerySoft VL VeryLoc Soft L Loose Firm MD Medium I Stiff D Dense VeryStiff VD VeryDens	SAM se A A B E Dense U L se W N	PLING & TI Juger sampi Julis sample Julisturbed Joisturbed Joisturbed	ESTING e sample tent	PPF S V3	<ul> <li>Pocket p</li> <li>Standard</li> <li>Standard</li> <li>S Vane sh</li> <li>CP Dynam</li> <li>Penetra</li> </ul>	enetrometer I penetration ear inic cone meter ometer	test S	CLASSIFIC YMBOLS OIL DES Y USC	6.0 		
P A C	T Pu AL	sh tub Iger Increte	e Core	r		→ Wat									S Water s	ample	L	Agno	carral		
		TC) Cor	a	rte	<b>NS</b>	Ltd . 2010		Pł mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.marten	67 s.com.au		E	'ng	nine Bc	erin oreh	g L ole	og	-		

CL	IEN'	Т	A	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED	24.11.10			REF	TP9						
PR	OJE	СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED		AN			Sheet 1 of	1						
SI	E	NT	C	ullburra	Backhoe	West Cu	illbu	irra		Siltstone						PROJECT NO.	P1002842						
EXC	AVAT			ISIONS	0.4m X 2.0	0m X 2.5m de	pth		NORTHING	NA	ASPECT		Sourth			SLOPE	2-3%						
	ΕX	CA\	/AT	ION DA	ТА			MA	TERIAL D	ТА	•			SA	MPLIN	G & TESTIN	IG						
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M FENETRATION R R R R R R R R R R R R R R R R R R R	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary a ntamination, odor	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	A	RESULT DDITIONAL OF	S AND 3SERVATIONS						
BH	Nil	N	М	0.1		× × ×	SM	ORGANIC SILTY	′ SAND – Da	rk grey/brown.		L	В	0.2	2842/9/0	.2							
BH	Nil	N	М	-0.35		× × × ×	SM	SILTY SAND – Light g	grey/grey, gra	vels (1-5mm, 10%).		L											
вн	Nil	N	м	0.6		 	CL	CLAY - Orange/brov	vn mottled, m	oderately plastic.	F St		В	0.5	2842/9/0	.5							
вн	Nil	N	м	<u>1.0</u>  1.4		 	CL	CLAY - Grey/red/orar	nge mottled, i	moderately plastic.	VSt		В	1.0	2842/9/1	.0	Ū.						
вн	Nil	N	м				CL/ HW	CLAY/HIGHLY W Grey/pink/red/orange, to extremely we	EATHERED siltstone gra athered siltst	SILTSTONE - vels bands, tending one at 1.8m.	VSt		В	1.5	2842/9/1	0	2						
вн	Nil	N	м	  			мw	MODERATELY V With grey	VEATHERED	SILTSTONE - nottling.	VSt												
							It be extremely weathered sittstone at 1.8m.         Image: the extremely weathered sittstone at 1.8m.       B       2.0       28429/20         MW       MODERATELY WEATHERED SILTSTONE - With grey/orange/red mottling.       vst       I       I       I         Test pit terminated at 2.5m on moderately weathered siltstone.       I       I       I       I       I																
E N E H S P A C	QUIPI Na EX H Ba EX A Ha Ha T Pu Au C Co	MENT atural existing ackhoe accavate and au and sp sh tub uger ncrete	/ ME expos exca e buck or ger ade e e Core	<u>명</u> .0 THOD SL ure SH vation SC et RE Nil	JPPORT Shoring Shotcrete Rock Bo No suppo	U WATER N Non e X Not Its ⊻ Wat - Wat → Wat	e obse measu er leve er outf er inflo	MOISTURE PENE rved D Dry L Lo red M Moist M M W Wet H Hi Wp Plastic limit R Re low WI Liquid limit	TRATION CON w VS oderate S gh F fusal St VSt H F	SISTENCY DENSITY Very Soft VL Very Loos Soft L Loose Firm MD Medium [ Stiff D Dense Very Stiff VD Very Dens Hard Friable	SAM se A A Dense U U D E se M N Ux T	PLING Auger s Bulk sa Jndistu Jndistur Disturb Toisturb	& TESTING ample mple ed sample ed sample e content ample (x mm	) FI	<ul> <li>Pocket pr Standard</li> <li>S Vane shr</li> <li>CP Dynam</li> <li>penetro</li> <li>D Field der</li> <li>S Water sa</li> </ul>	enetrometer penetration test aar ic cone meter sity imple	9. CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural						
		TC) Cor	EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS  MARTENS & ASSOCIATES PTY LTD 6/37 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767  Excavation													ering avatio	Log - on						

CLI	IEN	Г	A	len Pric	ce & As	ssociates	; Pty	/ Ltd	COMMENCED	24.11.10	COMPLET	ED	24.11.10			REF	TP10		
PR	OJE	СТ	E	ngineer	ing Se	rvices			LOGGED	GT	CHECKED		AN			Sheet <b>1</b> o	of <b>1</b>		
SIT	E	лт	C	ullburra	Road,	, West Cı	Illbu	urra	GEOLOGY	Siltstone			None			PROJECT NO	. P1002842		
EXC			DIMEN	SIONS	0.4m X 2		epth		NORTHING	NA	ASPECT	CE	North West			SLOPE	2-3%		
	EX	CA	/AT	ION DA	TA			MA	TERIAL D	АТА				SA	MPLIN	G & TEST	ING		
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)		RAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, r particle characteristics, org fill, cc	PTION OF STE nottling, colour, p anics, secondary ntamination, odo	RATA lasticity, rocks, oxidation, and minor components, ur.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	А	RESUL DDITIONAL (	TS AND DBSERVATIONS		
BH BH	Nil	N	M	0.1		× * * *	SM	ORGANIC SILTY	′ SAND – Da	ark grey/brown.		L	В	0.2	2842/10/	0.2			
БП	INII	IN		0.3				SILTY SAND – Light g	grey/grey, gra	avels (1-5mm, 10%).	F	L	•						
вн	Nil	N	м	0.5 			CL	CLAY - Orange/brow	vn mottled, n	noderately plastic.	St		В	0.5	2842/10/	0.5	-		
вн	Nil	Ν	м	<u>1.0</u> - 1.3			CL	CLAY - Grey/red/ora	nge mottled,	moderately plastic.	VSt		В	1.0	2842/10/	1.0	1 <u>.0</u> - -		
вн	Nil	N	м	-			EW	CLAY/EXTREMELY Grey minor mott siltstone band	WEATHER les, moderat ls, tending to	FHERED SILTSTONE - oderately weathered ving to moderately siltstone.     VSt     B     1.5     2842/10/ 1.5       B     2.0     2842/10/ 2.0									
				2.0				weat	hered siltsto	2.0	2.0								
	QUIPM Nates	AENT Attivation disting ckavate nd aup sh tub ger	/ ME expos pexca s buck or ger e e core		JPPORT + Shortary 2 Shotare 3 Rock B 1 No supj	wATEF the Nor the Nor toits ¥ Wa port √ Wa ▷ Wa	e obs measure ter lev ter out ter infl	MOISTURE PENE eved D Dry L Lo ured M Moist M M el W Wet Liquid limit fow WI Liquid limit DW	TRATION CON w VS oderate S ph F fusal St VS H F	ISISTENCY DENSITY Very Soft VL Very Loo Soft L Loose Firm MD Medium E Stiff D Dens Very Soft VD Very Dens Handle	SAM se A A bense U L D D L se M M U X T	PLING Juger s Bulk sa Judistur Joistur Joistur Joistur	S & TESTING mple mple e content ample (x mm) ID ABBRE	pr S S V D ) FI	<ul> <li>Pocket pi Standard</li> <li>Svane shi</li> <li>CP Dynam</li> <li>penetrc</li> <li>Direld der</li> <li>S Water sa</li> </ul>	enetrometer penetration test aar ic cone meter sisty mple	3.0 3.0 		
						EXCAVATI	ON L	OG TO BE READ IN CONJU		H ACCOMPANYING REP	ORT NOTE	S AN	ID ABBRE	VIATI	ONS				
(	ľ			rte	<b>NS</b> sociates Pty	r. Ltd . 2010		Pł mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 3 9999 Fax: (02) 9476 876 WEB: http://www.martens	67 s.com.au		E	ng	jine Exc	ering avati	Log - on		

CL		г	A	llen Pric	ce & As	sociates	Pty	Ltd		24.11.10	COMPLET	ED	24.11.10			REF	<b>TP12</b>	
PR	OJE .c	СТ	E	ngineer	ing Ser	vices				GT	VEGETAT		AN			Sheet 1	of 1	
EQU		NT.	C	uliburra	Backhoe	west Cl		Irra		NA	RL SURFA		NA			PROJECT NO	<b>U.</b> P1002042	
EXC	AVAT		IMEN	SIONS	0.4m X 2.0	)m X 2.2m de	pth		NORTHING	NA	ASPECT		North			SLOPE	2-3%	
	EX	CAV	/AT	ION DA	TA			MA	TERIAL D	ATA				SA	MPLIN	G & TEST	TING	
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STF nottling, colour, p anics, secondary ntamination, odo	RATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY			DEPTH (M)	A	RESU DDITIONAL	LTS AND OBSERVATIONS	
BH BH	Nil	N	M	0.1		× * *	SM	ORGANIC SILTY	′ SAND – Da	irk grey/brown.			- B	0.2	2842/12/	0.2		
БП	INII		IVI	0.3			, 510	SILTY SAND – Light g	grey/grey, gra	avels (1-5mm, 10%).	F		-					
BH	Nil	N	м	<u>0.5</u> 				CLAY - Orange/brov	vn mottled, n	noderately plastic.	St		В	0.5	2842/12/	0.5		-
вн	Nil	N	м	<u>1.0</u> - 1.3			CL	CLAY - Grey/red/orar	nge mottled,	moderately plastic.	VSt		В	1.0	2842/12/	1.0		1 <u>.0</u> –
вн	Nil	N	М	  <u>2.0</u> 			CL/ EW	CLAY/EXTREMELY Grey minor mott siltstone band weat	WEATHER les, moderat ls, tending to hered siltstor	ED SILTSTONE - ely weathered moderately ne.	VSt		В	1.5	2842/12/	1.5		- - - 2 <u>.0</u> -
								Test pit termina weat	ted at 2.2m o hered siltsto	on moderately ne.								
				- <u>3.0</u> -														3 <u>.0</u>
				-														-
				- - 4.0														4 <u>.0</u>
				- - -														-
				 5.0														- 5 <u>.0</u>
				-														-
																		-
				<u>6.0</u>														6 <u>.0</u>
				-														-
				-														-
				<u>7.0</u> 														7 <u>.0</u> -
				-														_
				-														-
				- 8.0														- 8.0
				-														-
				-														-
				-														-
				<u>9</u> .0														9. <u>0</u>
E N X B E H S P A G	QUIPN Na E> H Ba Ex A Ha Ha T Pus	IENT tural e cisting ckhoe cavate nd au nd sp sh tub ger	/ ME expos exca buck or ger ade e	THOD SU ure SH /ation SC et RE Nil	JPPORT Shoring Shotcrete Rock Bol No suppo	WATER N Non e X Not tts 型 Wat ort ┙ Wat ← Wat	e obse measu er leve er out!	MOISTURE PENE rved D Dry L Lo red M Moist M M, W Wet H Hig Wp Plastic limit R Re Now WI Liquid limit	TRATION CON w VS oderate S gh F ifusal St VSt H F	ISISTENCY DENSITY Very Soft VL Very Loo Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Dens Hard Friable	SAM Ise A / B I Dense U D I Se M I Ux <sup>-</sup>	IPLING Auger Bulk sa Undist Undist Disturt Moistu Fube s	G & TESTIN sample urbed sample bed sample re content ample (x mm	G PI S V D ) FI W	<ul> <li>Pocket po Standard</li> <li>S Vane sho</li> <li>CP Dynam penetro</li> <li>D Field der</li> <li>/S Water sa</li> </ul>	enetrometer penetration tes ear ic cone meter isity imple	CLASSIFICATIO SYMBOLS AND SOIL DESCRIPT Y USCS N Agricultural	N
	C Cor	crete	Core		E	EXCAVATI	ON L	OG TO BE READ IN CONJU		H ACCOMPANYING REP		ES AI		VIATI	ONS			
(	ľ		a	rte	<b>ns</b>	td . 2010		Pr mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	67 s.com.au		E	ing	gine Exc	ering avati	y Log - ion	

CL	IEN	Г	A	llen Pric	ce &	As	sociates	Pty	' Ltd	COMMENCED	24.11.10	COMPLET	ED 2	24.11.10			REF	TP14
PR	OJE .e	СТ	E	ngineer	ing :	Ser	vices				GT	VECETAT		AN			Sheet 1	of 1
EQU		лт		uliburra	Back	aa, hoe	west Cl	וווסנ	Irra	EASTING	NA	RL SURFA		NA			PROJECT N	0. P 1002042
EXC	AVAT		DIMEN	ISIONS	0.4m	X 2.0	)m X 1.5m de	pth		NORTHING	NA	ASPECT	1	North			SLOPE	2-3%
	EX	CA	/AT	ION DA	TA				M <i>A</i>	ATERIAL D	ATA				SA	MPLIN	G & TES	ΓING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)			GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STF nottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, ar.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A	RESU DDITIONAL	ILTS AND OBSERVATIONS
BH BH	Nil Nil	N N	M	0.1			× × ×	SM SM	ORGANIC SILTY	′ SAND – Da	rk grey/brown.		L	В	0.2	2842/14/	0.2	
вн	Nil	N	М	- 0. <u>35</u>				CL	SILTY SAND – Light g	grey/grey, gra	vels (1-5mm, 10%).	F						-
БЦ	Nii	N	м	0.5					CLAY Light grov/g	rev with brow	vn/orange mottled	Vet		B	0.5	2842/14/	0.5	
БП			IVI	0.8								vəi						
вн	Nil	N	М	1.0				EW	EXTREMELY WEAT	HERED SIL	TSTONE BANDS.	VSt		В	1.0	2842/14/	1.0	1.0
вн	Nil	N	м	_				мw	MODERATELY V	VEATHERE	SILTSTONE -	VSt		В	1.2	2842/14/	1.2	-
				1.5					Grey	, minor mottl	es.			В	1.5	2842/14/	1.5	
				-					Test pit termina	ted at 1.5m c	n moderately							_
				_					weat	hered siltstor	ne.							-
				2.0														2 <u>.0</u>
				-														-
1				E														-
1				F														-
				_														-
				<u>3.0</u>														3.0
				_														-
																-		
																-		
																-		
																	4 <u>.0</u> -	
				_														-
																-		
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				-														- -
				-														-
				-														-
				_														-
				6.0														6.0
				E														-
				-														-
				_														-
1				-														-
1				7.0														7.0
1				-  -														-
				F														-
				-														-
1				-														-
1				<u>8.0</u>														8 <u>.0</u>
1				E														-
1				E														-
1				Ē														-
																		-
E	QUIPI	I VENT	/ ME	THOD SU	JPPOF	<u>।</u> रा	WATER	<u> </u>	MOISTURE PENE	TRATION CON	SISTENCY DENSITY	I SAM	I IPLING	& TESTIN	G	<u> </u>		9.0 CLASSIFICATION
N X	Na E:	atural ( kisting	expos exca	ure SH vation SC	H Sho	oring otcrete	N Non X Not	e obsi measi	erved D Dry L Lo ured M Moist M M	oderate S	Very Soft VL Very Loo Soft L Loose	ose A A B E	Auger s Bulk sar	ample mple	pr S	Standard	enetrometer I penetration tes	SYMBOLS AND SOIL DESCRIPTION
E	п Ва Ех д Ц~	cknoe cavat	: DUCK or ner	et RE Nil	B Roc	к Bol suppc	ns <u>▼</u> Wat	er lev	ei w Wet H Hi Wp Plastic limit R Re	gn F efusal St	Firm MD Medium Stiff D Dense	Dense U U D [	Undistu Disturbe	rbed sample ed sample	e V D	S Vane sh CP Dynan	ear lic cone	Y USCS
S P	Ha Ha T Pu	ind sp sh tub	ade e				⊸ wat	er infl		vət H F	Hard Friable	Ux 1	Tube sa	ample (x mm	) FI VA	D Field de S Water s	nsity	N Agricultural
A	1 Push tube → Water inflow F Friable WS Water sample → Auger SC Concrete Corer																	
Ĺ		EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS																
	MARTENS & ASSOCIATES PTY LTD 6/37 Leighton Place Final Con-																	
	martens																	
	- (	C) Cop	oyright	- Martens & Ass	sociates	s Pty. L	.td . 2010		Pr mail@m	artens.com.au	WEB: http://www.marten	s.com.au				Exc	avat	ion

CL	IEN	Т	A	llen Pric	ce & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	<b>ED</b> 24	.11.10			REF	TP15	
PR		СТ	E	ngineer	ing Ser	vices				GT	CHECKED	IA N	N			Sheet 1 o	of <b>1</b>	
EQI		NT	C	ullburra	Backhoe	West Ci	illbi	irra	GEOLOGY	NA	VEGETAT		A A			PROJECT NO	. P1002842	
EXC	AVAT		DIMEN	ISIONS	0.4m X 2.0	0m X 2.7m de	pth		NORTHING	NA	ASPECT	N	orth			SLOPE	1-2%	
	EX	CA\	/AT	ION DA	TA			MA	TERIAL D	ATA				SA	MPLIN	IG & TEST	ING	
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	<b>CLASSIFICATION</b>	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, Ir.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	Δ	RESUI DDITIONAL (	TS AND OBSERVATION	s
BH BH	Nil Nil	N N	M	0.1 0.2		× × × ×	SM SM	ORGANIC SILTY	′ SAND – Da	rk grey/brown.		L	В	0.2	2842/15/	0.2		
вн	Nil	N	м				CL	SILTY SAND – Light c	prey/grey, gra	ivels (1-5mm, 10%).	F St		В	0.5	2842/15/	0.5		
вн	Nil	N	м	<u>1.0</u> - - - - 1.7			CL	CLAY - Grey/red/orar	nge mottled, i	moderately plastic.	VSt		В	1.0	2842/15/ 2842/15/	1.0		1 <u>.0</u> - - - -
вн	Nil	N	м	- 2.0 - - -			CL∕ HW	CLAY/HIGHLY W Grey/pink/red, silt to extremely wea	EATHERED stone gravels thered siltsto	SILTSTONE - bands, tending ne past 2.3m.	VSt		В	2.0 2.5	2842/15/ 2842/15/	2.0		- 2 <u>.0</u> - - -
				- 2.7 - 3.0 - - - - - - - - - - - - - - - - - - -				Test pit termina weat	ated at 2.7m hered siltstor	on extremely le.			B	2.6	2842/15/	2.6		
E	QUIP	MENT	- / ME	- - - - - - - - - - - - - - - - - - -	JPPORT	WATER		MOISTURE PENE	FRATION CON	SISTENCY DENSITY	SAM	PLING 8	R TESTING				CLASSIFICAT	6.0 
F F	A Na E E A Ha A Ha B Ha C C Co	atural xisting ackhoe cavat and au and sp sh tub uger ncrete	expos g exca e buck or iger pade e e Core	ure SF vation SC et RE Nil	H Shoring C Shotcrete B Rock Bo I No support	e X Not Its ⊻ Wat ort √ Wat → Wat	e obse measu er leve er out er infle	erved D Dry L Lo rred M Moist M M al W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit	w VS oderate S gh F ifusal St VSt H F	Very Soft VL Very Loo Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Dens Hard Friable	se A A B E Dense U U D I se M N Ux T	Juger sa Bulk sam Jndisturb Disturber Ioisturbe Ube san	mple ple led sample l sample content nple (x mm)	pr S V: D FI W	<ul> <li>Pocket p Standard</li> <li>S Vane sh</li> <li>CP Dynan penetro</li> <li>D Field dei</li> <li>Vater si</li> </ul>	enetrometer I penetration test ear nic cone ometer nsity ample	SYMBOLS AN SOIL DESCRII Y USCS N Agricultu	D PTION ral
			a	rte Martens & Ass	<b>NS</b> sociates Pty. I	EXCAVATIO	ON L	OG TO BE READ IN CONJU Pr mail@m	INCTION WITH MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ACCOMPANYING REP ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	ORT NOTE		ABBRE	ng	ons gine Exc	ering avati	Log - on	

					-		Fty	Lla		24.11.10	COMPLET	ED 2	24.11.10			REF	<b>TP16</b>							
PRO	IEC.	TI	Engi	neeri	ng Ser	vices				GT	CHECKED	4	AN			Sheet 1	of 1							
SILE	ENT		Cull	burra	Road,	West Cu	illbu	irra		Siltstone	VEGETAT		None			PROJECT NO	<b>).</b> P1002842							
EXCAV			NSIO	NS	0.4m X 2.0	0m X 2.4m de	pth		NORTHING	NA	ASPECT	1	North			SLOPE	2-3%							
E	xc	AVA	TIO	N DAT	Γ <b>A</b>			MA	TERIAL D	ATA				SA	MPLIN	G & TEST	ING							
	WATED	MOISTURE		DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, n particle characteristics, orga fill, co	PTION OF STF nottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A	RESU DDITIONAL	LTS AND OBSERVATION	s						
BH N	il N	N M	0.1		**	× × ×	SM	ORGANIC SILTY	′ SAND – Da	rk grey/brown.		L	В	0.2	2842/16/	0.2								
BH N	il N	м м	0.4		**	<	SM	SILTY SAND – Light g	grey/grey, gra	avels (1-5mm, 10%).		L		0.2	2042/10/	0.2		-						
			-	0.6							F		В	0.5	2842/16/	0.5		_						
BH N	il N	N M	E				CL	CLAY - Light brown/g	rey mottles,	moderately plastic.	St							-						
			0.9 <u>1.0</u>					CLAY - Grev with	n minor red/o	range mottles			В	1.0	2842/16/	1.0		1.0						
BH N	il N	N M	1.2				CL	minor gravels, moder	ately plastic,	mottles increasing	VSt													
BH N	il M	N M	   				CL HW	CLAY - HIGHLY WEAT minor red/orange mo plastic, mottles ind bands/gravels tending to extre	with depth. THERED SIL ttles, minor g creasing with (1-10mm, a mely weathe	TSTONE - Grey with ravels, moderately depth, siltstone pprox 20%), red siltstone.	VSt		В	1.5	2842/16/ 2842/16/	1.5 2.0		- - - 2 <u>.0</u> - - -						
			2.4	-		<u> </u> -		Test sit termine	ted at 0.4m			B 2.4 2842/16/2.4												
								Test pit termina weat	ated at 2.4m hered siltstor	on extremely ne.														
EQU N X BH E HA S PT A CC C	EQUIPMENT / METHOD       SUPPORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       pp Pocket penetrometer       SYMBOLS AND         EQUIPMENT / METHOD       SUPPORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       pp Pocket penetrometer       SYMBOLS AND         EQUIPMENT / METHOD       SUPPORT       Norme observed       D       Dy       Low       VS       Very Soft       VL       Very Lorse       Auger sample       SAMPLING & TESTING       SYMBOLS AND       SVIBOLS AND         BH       Boolsover ketek       RS       Rock Bools       Moist       High       F       Firm       D       Dense       D       Disturbed sample       SV are share       SVIBOLS AND       SOL DESCRIPTIC         H       Hadd auger       Water outflow       W       Low       VS       Visity Visitif       VV Very Dense       Moist Testing       DO Dynamic core       VV       Very Dense       Moist Testing       VV Very Dense       V																							

CLIENT	A	llen Pric	e & As	sociates	Pty	Ltd	COMMENCED	24.11.10	COMPLETE	<b>D</b> 2	4.11.10			REF	Т	P20	
PROJECT	E	ngineeri	ing Serv	vices				GT	CHECKED		N			Sheet 1	of 1	040	
	C	ullburra	Road,	West Cu	illbu	irra		Siltstone			Ione			PROJECT	NO. P1002	842	
EXCAVATION D	DIMEN	ISIONS	0.4m X 2.0	)m X 2.2m de	pth		NORTHING	NA	ASPECT		lorth West			SLOPE	1-2%		
EXCAV	/AT	ION DA	ГА			MA	TERIAL D	ATA				SA	MPLIN	G & TES	STING		
METHOD SUPPORT WATER	MOISTURE	DEPTH (M)	L M FENETRATION R R R R R R R R R R R R SISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIF Soil type, texture, structure, n particle characteristics, org; fill, cc	PTION OF STR nottling, colour, pl anics, secondary antamination, odo	ATA asticity, rocks, oxidation, and minor components, ar.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A	RES DDITIONA	SULTS AND	) /ATIONS	
BH Nil N	М	0.2		× × × × ×	SM	SILTY SAM	ND – Dark gr	ey/grey.		L	В	0.2	2842/20/	0.2			
BH Nil Y	W	-0.35		***	SM	SILTY CLAYEY	SAND – Brov	vn/light brown.	F	L							1
BH Nii Y	м	- 0.55 - - - - - - - - - - - - - - - - - -			CL	CLAY - Orange/brown,	minor gravels	s, moderately plastic. , orange mottled, plastic.	vst		B	0.5 1.0 1.5 2.0	2842/20/ 2842/20/ 2842/20/ 2842/20/	0.5 1.0 1.5 2.0			
			Image:														
EQUIPMENT N Natural e X Existing BH Backhoe E Excavato HA Hand aug S Hand spa PT Push tube A Auger CC Concrete	7/ME excavosi pucká ger ade e core	THOD SL vre SL vation SC et Ref	JPPORT i Shoring Shortrete Rock Bud No suppo	WATER N None a x Noti Ist ¥ Wat → Wat → Wat	e obse measu er leve er outt er infic	MOISTURE PENE srved D Dry L Lo red M Moist M Mu W Wet H Hig Wp Plastic limit R Re flow Wi Liquid limit WW OG TO BE READ IN CONJL	TRATION CON w VS oderate S fusal St VSt H F JNCTION WITI MARTENS & 6/37 Hornsby,	SISTENCY DENSITY Very Soft VL Very Loo Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Dens Hard Friable I ACCOMPANYING REP ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia	SAMF se A A bense U D D se M M Ux Tu	PLING uger sa ulk sam ndistur isturbe ube san S ANI	& TESTING ample nple scontent d sample c content D ABBRE D ABBRE		<ul> <li>Pocket p Standards</li> <li>S Vane sh</li> <li>CP Dynan penetro</li> <li>Field der</li> <li>S Water si</li> <li>ONS</li> <li>ONS</li> </ul>	enetrometer I penetration t aar nic cone ometer sisty ample	CLAS SYMi est SOIL Y N <b>g Lo</b>	SSIFICATION 30LS AND DESCRIPTIC USCS Agricultural	

CL	EN	Г	A	llen Pric	ce & As	sociates	s Pty	' Ltd	COMMENCED	24.11.10	COMPLET	ED 24.11.	10			REF	<b>TP21</b>	
PR		СТ	E	ngineer	ing Ser	vices			LOGGED	GT	CHECKED	AN				Sheet 1	of <b>1</b>	
FOU		лт	C	ullburra	Backhoe	West C	ulibu	ırra	GEOLOGY	NA	VEGETAT	CF NA				PROJECT NO	. P1002842	
EXC			DIMEN	SIONS	0.4m X 2.0	0m X 2.6m d	epth		NORTHING	NA	ASPECT	North	West			SLOPE	1-2%	
	EX	CA	/AT	ION DA	TA			MA	TERIAL D	ATA	•			SA	MPLIN	G & TEST	ING	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M FENETRATION R R R R R R R R R R R R R R R R R N R R R R R N N R R R R R N N N R	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	А	RESUI DDITIONAL	LTS AND OBSERVATION	IS
BH	Nil	Ν	М	_0.12			CL	SILTY SANDY	CLAY – Dark	grey/brown.	S		в	02	2842/20/	0.2		_
вн	Nil	Ν	м	0.5			CL	SILTY SAND C	LAY – Browr	n/light brown.	s		в	0.2	2842/20/	0.5		-
вн	Nil	N	м	0.8			CL	CLAY - Red/orange wi with depth, minor g	th light brown ravels (1-10	n mottles increasing mm, approx 5%).	St							1 1
вн	Nil	N	м	<u>1.0</u> - - -			СН	CLAY - Grey/cream wi plastic, gravel	th red/brown s (1-5mm, ap	mottles, moderately pprox 20%).	St		В	1.0	2842/20/	1.0		1 <u>.0</u> 
				1.6			-						D	1.5	2042/20/			
вн	Nil	N	м	_ _ _ _ _ _			CL HW	CLAY - HIGHLY V Light grey with red n increa	VEATHERED nottles, siltsto asing with de	) SILTSTONE - one gravels bands oth.	VSt		В	2.0	2842/20/	2.0		- 2 <u>.0</u> - -
_			2.6       B       2.6       B       2.6       2842/20/2.6         1       1       Test pit terminated at 2.6m on moderately weathered siltstone.       B       2.6       2842/20/2.6															
BH     NI     N     A     Z0     Example of the constraint																		
E N X B E H S P A C	QUIPM Nata Ex A Haa Ha F Puu Au C Cor	MENT tural é issting cavate nd au nd sp cavate nd sp ger ncrete	/ ME exposi l excase b buckk or ger ade e e € Core		JPPORT I Shoring 2 Shotcret 3 Rock Bo I No supp	WATER Nord tts ⊻ Wa ort ↓ Wa ▷ Wa EXCAVAT	Re obsimeasi ter levi ter out ter infil	MOISTURE PENE erved D Dry L Lo rred M Moist M M al W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit ow OG TO BE READ IN CONJU	TRATION CON w VS oderate S gh F fusal St VSt H F NCTION WITH	SISTENCY DENSITY Very Soft VL Very Loo Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Dens Hard Friable	SAM Ise A A Belense U L Se M N Ux T	PLING & TE Auger sample Julk sample Indisturbed s foisture cont ube sample	STING sample ent (x mm) BBRE\	pp S VS DC FE WX	Pocket pr Standard S Vane sh CP Dynam Field der S Water sa DNS	enetrometer penetration test sar ic cone meter sity imple	CLASSIFICA SYMBOLS AT SOIL DESCR Y USCS N Agricult	
	ľ		a	rte Martens & Ass	<b>NS</b>	Ltd . 2010		Pr mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	67 s.com.au		E	ng	ine Exc	ering avati	Log - on	,

СІ	IEN	Т	A	llen Prie	ce & As	ssociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED 24.11	.10			REF		Bŀ	15	
PF	OJE	СТ	E	ngineer	ing Sei	rvices			LOGGED	JSF	CHECKED	) GT				Sheet 1	of	1		
SI			C	ullburra	a Road,	, West Cu	llbu	irra	GEOLOGY	Siltstone	VEGETAT	ION Eucal	ypts			PROJECT	<b>NO.</b> P'	1002842		
EQ				ISIONS	0.95mØ >	K 5.5m depth			NORTHING	NA	ASPECT	North				SLOPE	5%	5		
	ΕX	CA\	/AT	ION DA	TA			MA	TERIAL D	ATA				SA	MPLIN	G & TE	STING	;		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary a ontamination, odo	ATA asticity, rocks, oxidation, and minor components, r.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)		WATER			I <b>LS</b> - Well Cover	
А	Nil	N	м	-		× × × × ×	OL	ORGANIC SA	NDY SILT -	Dark brown.	s		А	0.2	2842/5/0	2			Concrete	_
-				0.3		× × × ×							A	0.2	2842/5/0	.5				
A	Nil	N	м	   			CL	CLAY - Orange/bro tending grey with mino	own mottles, f or brown and	irm grading stiff, red mottles at depth.	F- St		А	1.0	2842/5/ 1	.0	•		entonite Seal	- - 1 <u>.0</u> -
А	Nil	N	D	-			EW	EXTREMELY W Orange	EATHERED	SILTSTONE - , dry.			А	1.5	2842/5/ 1	.5			69m hal	
A	Nil	N	D	1.7 <u>2.0</u> - - - - - - - 3.0			MW	MODERATELY V Orange	VEATHERED	) SILTSTONE - , dry.			A	2.5	2842/5/2	.5			<u>Sand Pack.</u>	2.0
A	Nil	N	D	_ _ _ _ _ _ 4.0			EW	EXTREMELY W Orange	EATHERED /grey mottled	SILTSTONE - , dry.										4.0
А	Nil	N	D	- 4.3			SW	SLIGHTLY WE	EATHERED S	SILTSTONE.										-
А	Nil	N	D	- - - 5.0 - 5.5			MW	MODERATELY WE. WEATHERE	ATHERED W	ITH EXTREMELY IE BANDS.			В	5.5	2842/5/5	<u>4.68</u> m bgl		W	<u>end</u> plug.	5.0
				-				Borehole t	erminated at	5.5m on										
	QUIPI QUIPI C E BH Ba A HA F E S HA HA S HA FT Pu	MENT tatural i xisting ccavat and sp sh tub iger	7/ME expos g exca b buck or ger aade ee		JPPORT H Shoring C Shotcre 3 Rock BG I No supp	WATER N None te X Note Johs ¥ Wate → Wate	e obse neasu er leve er outf	MOISTURE PENE rived D Dry L Lo red M Moist M M H W Wet H Hi Wp Vestic limit R Re low WI Liquid limit	y weathered s reaction con w VS gh F fusal St VSt H F	SISTENCY DENSITY Very Soft VL Very Loc Soft L Loose Firm MD Medium I Stiff D Dens Very Stiff VD Very Den Hard Friable	SAM ose A / B I Dense U Se M I Ux -	IPLING & TE Auger sample Julis sample Undisturbed a Voisturbe con Fube sample	ESTING Sample tent (x mm)	FE W	Pocket p Standard S Vane sh CP Dynam D Field dei S Water si	enetrometer penetration sar icic cone meter sity ample	test [	CLASSI SYMBO SOIL DE Y N Ag	FICATION S AND S CRIPTIC SCS ricultural	
Ľ		EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS																		
			a	rte	<b>NS</b> sociates Ptv.	.Ltd . 2010		Pł mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 870 WEB: http://www.marten	67 s.com.au		E	ng	jine Bo	erin oreh	g L ole	.0g	-	

CL	IEN	Г	A	llen Pric	ce & As	sociates	s Pty	Ltd	COMMENCED	24.11.10	COMPLE	TED 24.11	.10		REF BH7									
PR		СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKE	D GT			Sheet 1 of 1									
SI	E	лт	C	ullburra	Road,	West Cu	ıllbı	irra	GEOLOGY	Siltstone		CE NA	5		PROJECT NO. P1002842									
EXC				SIONS	0.95mØ X	2.5m depth			NORTHING	NA	ASPECT	North	West		SLOPE 4%									
	EX	CA	/AT	ION DA	ТА			MA		ATA				SA	MPLING & TESTING									
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org. fill, cc	PTION OF STF nottling, colour, pl anics, secondary intamination, odo	CATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS									
A	Nil	N	M	0.1	## **	× × × ×	OL	ORGANIC SA	NDY SILT -	Dark brown.	S		A	0.2	2842/7/ 0.2									
A	Nil	N	M	0.3		<u>* * * *</u>	sc	CLAYEY SAND - Br	own, moist (a	almost wet), loose.		L		0.2										
A	Nil	N	м	  			CL	CLAY - Orange/bro tending grey with mino	wn mottles, <sup>-</sup> r brown and	firm grading stiff, red mottles at depth.	F		A	0.5	2842/7/ 0.5 2842/7/ 1.0	- - - 1 <u>.0</u>								
A	Nil	Ν	D	-			EW	EXTREMELY W	EATHERED	SILTSTONE -			A	1.5	2842/7/ 1.5	-								
A	Nil	N	D	<u>1.6</u> - <u>2.0</u> - - - <u>2.5</u>			MW	MODERATELY WEATHERE	ATHERED W D SILTSTON	/ITH EXTREMELY NE BANDS.			A     1.5     2842/7/1.5       Borehole left open and checked 2 hours after drillinh and found dry.     2.       3.     3.											
				- - <u>3.0</u> -				Borehole to moderately	erminated at v weathered s	2.5m on siltstone.		Borehole left open and checked 2 hours after drillinh and found dry.												
				- - - -									Borehole left open and checked 2 hours after drillinh and found dry.											
				<u>4.0</u>    												4 <u>.0</u> - - - - -								
				<u>5.0</u>   												5.0								
				 6.0 												6 <u>.0</u>								
				  												- - 7 <u>.0</u>								
				- - - -																				
				<u>8.0</u>      9.0												8 <u>.0</u> 								
E N B E H S P A C	QUIPI Na E: H Ba Ex A Ha T Pu Au C Co	MENT itural of kisting ckhoe cavat nd au nd sp sh tub ger ncrete	/ ME excave bucket or ger ade e Core	THOD SL Jre SH vation SC et RE Nil	JPPORT JPPORT Shoring Shotcret Rock Bo No supp	WATER N Non bits ⊻ Wat ort √ Wat	e obse measu ter leve ter out	MOISTURE PENE erved D Dry L Lo rred M Moist M Mi el W Wet H Hi Wp Plastic limit R Re low WI Liquid limit	FRATION CON w VS oderate S gh F fusal St VSt H F	SISTENCY DENSITY Very Soft VL Very Lo Soft L Loose Firm MD Medium Stiff D Dense Very Stiff VD Very Der Hard Friable	SAM ose A B Dense U D nse M Ux	MPLING & TE Auger sample Bulk sample Undisturbed sa Disturbed sa Moisture con Tube sample	STING e sample mple tent (x mm)	FI W	CLASSIFICATION Standard penetration test SVane shear CP Dynamic cone penetrometer D Field density X Water sample	<u></u> 1 ION								
			a	rte	<b>NS</b> sociates Ptv.	EXCAVATI	ON L	DG TO BE READ IN CONJU Pr mail@m	INCTION WITH MARTENS & 6/37 Hornsby, ione: (02) 9476 artens.com.au	ACCOMPANYING REF ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marter	PORT NOT	ES AND A	BBRE	ng	gineering Log - Borehole									

CL	IEN	г	A	llen Pri	ce & /	Ass	ociates	Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED 24.	11.10			REF	BH8	;					
PF	OJE	CT	E	ngineer	ring S	erv	vices				JSF	CHECKED	GT				Sheet 1	of 1						
SI FOI		NT	C	ullburra	a Roa	i <b>d, V</b> ulic A	Nest Cu	illbu	irra		Siltstone		CE NA	SS			PROJECT NO	<b>)</b> . P1002842						
EXC				ISIONS	0.95m	ØX2	2.5m depth			NORTHING	NA	ASPECT	Noi	th West			SLOPE	5%						
	ΕX	CA	/AT	ION DA	TA				MA	TERIAL D	TA				SA	MPLIN	G & TEST	ING						
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)			GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, n particle characteristics, org. fill, cc	PTION OF STR nottling, colour, pla anics, secondary i ontamination, odor	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	Д	RESU DDITIONAL	LTS AND OBSERVATIO	INS					
A	Nil Nil	N	M	0.1		Ħ	× × × × × ×	OL SC	ORGANIC SA	NDY SILT -	Dark brown.	S	1	A	0.2	2842/7/0	.2							
<u> </u>				0.3		+	<u> </u>	30	CLAYEY SAND - Br	own, moist (a	Imost wet), loose.		L	A	0.5	2842/7/0	.5							
А	Nil	N	м	- - - 1.0 - 1.3				CL	CLAY - Orange/bro tending grey with mino	own mottles, f r brown and	irm grading stiff, red mottles at depth.	F		A	1.0	2842/7/1	.0		- - - 1 <u>.0</u> -					
А	Nil	N	D	-				EW	EXTREMELY W		SILTSTONE -			А	1.5	2842/7/ 1	.5		-					
	NII	N	<u> </u>	1.6		$\left  \right $		EW	EXTREMELY W	EATHERED	SILTSTONE -			-										
Ĺ			Ľ	1.9					Orange,	clay like prop	erties.			A	2.0	2842/7/2	.0		2.0					
	Nii	N		E				M/M/	MODERATELY V	VEATHERE	SILTSTONE -								-					
A	NII	N						MVV		Grey.							Borehole dry	after 2 hours.	-					
				2.5 					Borehole to moderately	erminated at / weathered s	2.5m on iltstone.			A         1.5         2842///1.5           A         2.0         2842/7/2.0           Borehole dry after 2 hours.         Borehole dry after 2 hours.										
E N E E F F A	QUIPI I Na E E IA Ha IA Ha T Pu C Co	MENT atural e xisting ackhoe ccavat and au and sp ish tub uger increte	/ ME expos j exca e buck or iger ade ie e Core	THOD Si ure Si vation Si et R N	UPPORT H Shori C Shotc B Rock ii No st	ORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       pp       Pocket penetrometer       symbol       symbol       SYMBOLS AND         horing       N       None observed       D       D       Dry       L       Low       VS       Very Soft       VL       Very Loose       A Auger sample       pp       Pocket penetrometer       SYMBOLS AND       SYMBOLS AND         horing       Y       Water level       W       Wet       H       High       F       Firm       MD       Medium Dense       U       Undisturbed sample       DCP       Dynamic cone       DDP       Disturbed sample       DCP       DP       Disturbed sample       DCP       DP       Disturbed sample       DCP       DP       SIL DESCRIPTION         VSt       Very Stiff       D       Dense       D       Disturbed sample       DCP       DP       DP       DCP       DP       DP       DP       DP       DP       DP       VSt       Very Stiff       VD       Very Dense       M       Moisture content       FD       FD       Field density       N       Agricultural         W       Water inflow       F       Friable       F       Field																		
			a	rte	ns	E S Pty. Lt	XCAVATI(	ON LO	DG TO BE READ IN CONJU Pr mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ACCOMPANYING REP ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.marten	PORT NOTE 67 s.com.au	ES AND	ABBREY E	ng	ons gine Bc	ering oreho	ı Log le	-					

СГ	IEN	Т	A	llen Pric	ce & As	sociates	s Pty	Ltd	COMMENCED	24.11.10	COMPLETE	<b>D</b> 2	4.11.10			REF	BH11
PF		СТ	E	ngineer	ing Ser	vices			LOGGED	JSF	CHECKED	G	эт 			Sheet 1	of <b>1</b>
SI		NT	C	ullburra	Hydraulic	West Cu	ıllbı	irra		Siltstone		DN E	ucalypts			PROJECT NO	. P1002842
EX	CAVAT		DIMEN	SIONS	0.95mØ X	2.0m depth			NORTHING	NA	ASPECT		lorth East			SLOPE	4%
	EX	CA\	/AT	ION DA	ТА			MA	TERIAL D	ATA				SA	MPLIN	G & TEST	ING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M FENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	Α	RESUI DDITIONAL	LTS AND OBSERVATIONS
A	Nil	N	м	0.2 		× × × ×	OL	ORGANIC SA	NDY SILT -	Dark brown.	S		A	0.2	2842/11/ 2842/11/	0.2	
А	Nil	N	м	- - 1.0			CL	CLAY - Orange/bro tending grey with mino	own mottles, t or brown and	irm grading stiff, red mottles at depth.	F- St		A	1.0	2842/11/	1.0	- - 1 <u>.0</u> -
A	Nil	N	D	1.3 - -			EW	EXTREMELY W Gre	EATHERED by with mottle	SILTSTONE - d.			A	1.5	2842/11/	1.5	
A	Nil	N	D	2.0			мw	MODERATELY V Gre	VEATHERED y with mottle	) SILTSTONE - d.							2.0
				-				Borehole t moderately	erminated at / weathered s	2.0m on siltstone.							- - - -
				- <u>3.0</u> -													- - 3 <u>.0</u> -
				-													
				- <u>4.0</u> -													
				-													
				- 5.0 -													- 5 <u>.0</u> - -
				- - - -													- - - - -
				6.0   													6 <u>.0</u> - - - -
				- - - 7.0													- - - 7.0
				_ _ <u>8.</u> 0 _													- - 8.0 -
																	- - - - - -
E M D E E E F A O	EQUIPI N Na K E BH Ba E Ex HA Ha C C Co	MENT atural of xisting ickhoe ccavate and au and sp sh tub iger ncrete	/ ME exposi excar bucke or ger eade e e <u>core</u>	THOD SU Ire SH vation SC et RE Nil	JPPORT H Shoring C Shotcret 3 Rock Bo I No supp	WATER N Non e X Not ofts 型 Wat oft ④ Wat	e obse measu ter leve ter out	MOISTURE PENE erved D Dry L Lo rred M Moist M M el W Wet H Hi Wp Plastic limit R Re Tow WI Liquid limit	ISTURE PENETRATION CONSISTENCY DENSITY SAMPLING & TESTING Dry L Low VS Very Soft VL Very Loose A Auger sample pp Pocket penetrometer SYMBOLS AND Moist M Moderate S Soft L Loose B Bulk sample S Standard penetration test Vet H High F Firm MD Medium Dense U Undisturbed sample VS Vane shear Plastic limit R Refusal St Stiff D Dense D Disturbed sample DCP Dynamic cone Liquid limit VS Very Stiff VD Very Dense M Moisture content penetrometer H Hard Ux Tube sample (x mm) FD Field density F Friable								
						EXCAVATI	ON L	OG TO BE READ IN CONJU	JNCTION WITH	ACCOMPANYING REP	ORT NOTE	S ANI	D ABBRE	VIATI	ONS		
		n (c) Cop	a	rte Martens & Ass	<b>NS</b> sociates Pty.	Ltd . 2010		Pł mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marter	67 is.com.au		E	ng	gine Bo	ering oreho	Log - le

CL	IEN	T	A	llen Pri	ce & A	ssociat	es I	Pty L	td		24.11.10	COMPLE	TED	24.11.10			REF	BH1	3
PR		СТ	E	ngineer	ring Se	ervices	0				JSF	VECETA		GT			Sheet 1	of <b>1</b>	
EQL		NT	10	uliburra	Hvdrauli	c Auger	Cui	Iburr	a		NA	RLSURF		NA			PROJECT NO	<b>U.</b> P1002642	
EXC	AVAT			SIONS	0.95mØ	X 2.5m dep	oth			NORTHING	NA	ASPECT		North			SLOPE	6%	
	ΕX	CA\	/AT	ION DA	TA				MA	TERIAL D	ATA				S	AMPLIN	IG & TEST	ING	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L PENETRATION H RESISTANCE	RAPHIC LOG		CLASSIFICATION	DESCRII Soil type, texture, structure, n particle characteristics, org fill, co	PTION OF STF nottling, colour, p anics, secondary ntamination, odo	RATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY			DEPTH (M)	ļ	RESU DDITIONAL	ILTS AND OBSERVATIO	NS
А	Nil	N	м	-		× ×	× ×	ML	ORGANIC SILTY/CLA	YEY SAND	- Dark brown, moist	. s		А	0.2	2842/13	0.2		
A	Nil	0.4	м	-0.25 0.4		· —		CL	SANDY CLA	Y - Light bro	wn, moist.	F							
А	Nil	¥ N	w	_		·	-	CL	GRAVELLY CLA	AY - Brown, N	vet (perched),	S- F		A	0.5	2842/13	0.5		
A	Nil	N	м	0.7 - 1.0 -				CL	CLAY - Brown and or	ange mottled	I, firm to stiff, moist.	F- St		A	1.0	2842/13	1.0		
A	Nil	N	м	1.3 - 1.7				EW	EXTREMELY W Brown/grey m	EATHERED ottled, dry si	SILTSTONE - de of moist.			A	1.5	2842/13/	1.5		
A	Nil	N	м	- 2.0 - - 2.5				мw	MODERATELYW	/EATHERE[ Light grey.	) SILTSTONE -			A	2.0	2842/13	2.0		2 <u>.0</u> - - -
				- - <u>3.0</u>					Borehole to moderately	erminated at	2.5m on siltstone.								
				-															
				<u>4.0</u>    															
				<u>5.0</u>  															5 <u>.0</u> - -
				-															-
				<u>6.0</u>   															6 <u>.0</u> - - -
				  7.0															- - 7 <u>.0</u>
				-															
				- - 8.0															- - 8 <u>.0</u>
E N B E F A O	QUIPMENT / METHOD       SUPPORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       pp       CLASSIFICATION       SYMBOLS AND         Natural exposure       SH Shoring       SC       Shoring       None observed       D       D       D       D       D       VS       Very Soft       VL       Very Loose       A Auger sample       Standard penetration test       SVMBOLS AND       SVMBOLS AND       SOIL       SOIL																		
			a	rte	<b>NS</b>	EXCAV		N LOG	G TO BE READ IN CONJU Pr mail@m	INCTION WITH MARTENS & 6/37 Hornsby, ione: (02) 9476 artens.com.au	H ACCOMPANYING R ASSOCIATES PTY LT Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 WEB: http://www.mar	EPORT NOT D 8767 ens.com.au	TES A		eviat E <b>n</b> (	ons gine Bo	ering oreho	r Log · le	•

CL	IEN	Г 	A	llen Pric	e & As	ssociates	Pty	Ltd		24.11.10	COMPLET	ED 24.11	.10			REF	BH17	
PR	OJE	СТ		ngineer	ing Sei	rvices				Siltetone	VEGETAT	GT	unte			Sheet 1 o	f <b>1</b>	
EQU		NT.		uliburra	Hydraulic	Auger		Irra	EASTING	NA	RL SURFA		ypis			PROJECT NO.	F 1002042	
EXC	AVAT		DIMEN	SIONS	0.95mØ >	K 2.5m depth			NORTHING	NA	ASPECT	North	West			SLOPE	5%	
	EΧ	CAV	/AT	ION DA	ΤΑ			MA	ATERIAL D	ATA				SA	MPLIN	IG & TESTI	NG	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odor	ATA asticity, rocks, oxidation, and minor components, Jr.	CONSISTENCY	DENSITY INDEX	ЭЧҮТ	DEPTH (M)	A	RESUL DDITIONAL C	TS AND DBSERVATION	s
A	Nil	N	м	- 0.3		× * * * * × * *	ML	ORGANIC SILTY/CLA	YEY SAND -	Dark brown, moist.		L	A	0.2	2842/17/	0.2		
A	Nil	N	м	- - - 1.0 - - 1.4			- CL	CLAY - Orange/bro tending grey with mino	own mottles, f or brown and	irm grading stiff, red mottles at depth.	F		A	0.5	2842/17/ 2842/17/ 2842/17/	1.0		- - - 1 <u>.0</u> - - -
A	Nil	N	м	    2.5			CL	CLAY - Grey with r moist, sand in p SANDY CLAY - Gre	ninor red mo rofile from 1.4 ey, with red m	ttled, firm to stiff, 8m, grades to ottles, moist, stiff.	St		A	2.0	2842/17/ 2842/17/ 2842/17/	2.0		- - - 2 <u>.0</u> - - - -
								Borehole termina	ated at 2.5m	on sandy clay.			A	2.5	2842/17/	2.5		3.0 3.0 - - - - - - - - - - - - -
X B H S P A C	E H Ba Ex A Ha Ha T Pu Au C Co	kisting ckhoe cavate nd au nd sp sh tub ger ncrete	excav bucke or ger ade e e Core	vation SC et RE Nil	Shotcref Rock Bo No supp	te X Not olts <u>¥</u> Wat oort <u>√</u> Wat	measu er leve	rred M Moist M M sl W Wet H Hi Wp Plastic limit R Re Now WI Liquid limit	oderate S gh F sfusal St VSt H F	Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Den Hard Friable	Dense U D se M I Ux	Bulk sample Undisturbed sa Disturbed sa Moisture con Tube sample	sample mple tent (x mm)	S V D F W	Standard Standard Vane sh CP Dynan penetro O Field dei S Water si	a penetration test ear nic cone ometer nsity ample	SOIL DESCRIF Y USCS N Agricultu	PTION
		n	a	rte Martens & Ass	ns	EXCAVATION	ON LO	DG TO BE READ IN CONJU Pr mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ACCOMPANYING REF ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 870 WEB: http://www.marten	PORT NOT	ES AND A	BBRE	ng 'ng	ine Bc	ering prehol	Log - le	

CL	IEN	г	A	llen Pric	ce & As	ssociates	. Pty	Ltd	COMMENCED	24.11.10	COMPLET	<b>ED</b> 24.11.	10			REF	BH18	
PR	OJE	СТ	E	ngineer	ing Se	rvices			LOGGED	JSF	CHECKEI	D GT				Sheet 1 of	1	
SI	Е		С	ullburra	Road	, West Cı	ıllbı	ırra	GEOLOGY	Siltstone	VEGETAT	TION Eucaly	/pts			PROJECT NO.	P1002842	
EQU				CIONE	Hydraulic	Auger			EASTING	NA	RL SURF	ACE NA				CLODE	1.00/	
	EX				TA	< 2.5m deptn		MA			ASPECT	NOTIN		SA	MPLIN		I-2%	
МЕТНОD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary intamination, odoi	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)	A	RESULT	'S AND BSERVATIONS	6
А	Nil	N	м	_	<u></u>	× × × ×	OL	ORGANIC SA	NDY SILT -	Dark brown.	s		A	0.2	2842/18/	0.2		
				0.3 -		<u> </u>	-						A	0.5	2842/18/	0.5		
A	Nil	N	м	- - - 1.0 - - -			CL	CLAY - Orange/bro tending grey with mino	own mottles, i or brown and	irm grading stiff, red mottles at depth.	F- St		A	1.0	2842/18/	1.0		
A	Nil	N	D	1.5 - - -			EW	EXTREMELY WEAT properties, grey wit	HERED SILT	STONE - Clay like , stiff to very stiff.	St- VSt		A	1.5	2842/18/	1.5		
A	Nil	N	D	2.0  			мw	MODERATELY WE	ATHERED S	ILTSTONE - Grey.			A	2.0	2842/18/	2.0		<u>2.0</u> – –
	QUIPI	ΛΕΝΤ tural e	//ME	2.5 	JPPORT Shoring	WATER N Non	e obs	MOISTURE PENE rived D Dry L LG Moist URE Moist	Borehole terminated at 2.5 m on moderately weathered silisione.									
BEH SPAC	H Ba Ex A Ha Ha T Pu Au <u>C</u> Co	ckhoe cavate nd au nd sp sh tub ger ncrete	e buck or ger ade e <u>Core</u>	et RE Nil	B Rock Bo No supp	olts <u>▼</u> Wat → Wat → Wat	ter leve	al W Wet H Hi Wp Plastic limit R Re Now WI Liquid limit	gh F Ifusal St VSt H F	Firm MD Medium Stiff D Dense Very Stiff VD Very Den Hard Friable	Dense U D Ise M Ux	Undisturbed s Disturbed sar Moisture cont Tube sample	sample nple cent (x mm)	VS DC FE W	S Vane sh CP Dynam penetro O Field der S Water sa	ear nic cone ometer nsity ample	Y USCS N Agricultur	al
			a	rte Martens & Ass	<b>NS</b> sociates Pty.	EXCAVATIO	ON L	DG TO BE READ IN CONJU Pł mail@m	JNCTION WITH MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	I ACCOMPANYING REF ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marten	PORT NOT 67 Is.com.au	ES AND A	E	ng	ons gine Bo	ering orehole	Log - e	

СГ	IEN	т	A	llen Pri	ce & As	ssociates	s Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED 2	24.11.10			REF	BH19	Γ
PF	OJE	СТ	E	ngineer	ing Se	rvices			LOGGED	JSF	CHECKED	(	ЭТ			Sheet 1 o	of <b>1</b>	
SI		NT	C	ullburra	A Road	, West Ci	ıllbı	irra		Siltstone			Eucalypts			PROJECT NO	P1002842	
EX			DIMEN	SIONS	0.95mØ 2	X 2.5m depth			NORTHING	NA	ASPECT	1	North			SLOPE	2-3%	
	EX	CA	/AT	ION DA	ТА			MA	TERIAL D	ATA	-			SA	MPLIN	G & TEST	NG	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		<b>F</b> GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STF nottling, colour, pl anics, secondary ntamination, odo	tATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A	RESUL DDITIONAL (	TS AND DBSERVATIONS	
Α	Nil	N	М	0.1		× ×	< OL	ORGANIC SA	NDY SILT -	Dark brown.	S		A	0.2	2842/19/	0.2		
А	Nil	N	м	- - - - - - - - - - - - - - - - - - -			CL	CLAY - Orange/bro tending grey with mino	own mottles, or brown and	firm grading stiff, red mottles at depth.	F- St		A A A	0.5 1.0 1.5	2842/19/ 2842/19/ 2842/19/	0.5 1.0 1.5		
A	Nil	N	D	<u>-</u> <u>-</u> - - 2.5			EW	EXTREMELY WE/ and grey mot highly weath	ATHERED S tles, clay like hered layers f	LTSTONE - Red properties, rom 2.0m.			A	2.0	2842/19/ 2842/19/	2.0		- 2 <u>.0</u> - - -
				-				Borehole to moderately	erminated at weathered s	2.5m on siltstone.								
				<u>3.0</u>     4.0														3 <u>.0</u>    4 <u>.0</u> 
				- - - -														
				<u>5.</u> 0   														5.0
				 6.0 														6.0
				  7.0 														- - 7 <u>.0</u> -
				- - - - <u>8.</u> 0														
E E E F F	I Na QUIPI I Na I E I E I E I E I E I I A Ha I I T Pu I I CO Co	9.0       9.0       9.0       9.0       9.0         JIPMENT / METHOD       SUPPORT       WATER       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       CLASSIFICATION       CASSIFICATION         Natural exposure       SH       Shoring       N None observed       D       Dry       L       Low       VS       Very Soft       VL       Very Loose       A Auger sample       pp       Pocket penetrometer       SYMBOLS AND       SOIL DESCRIPTION       SOIL DESCRIPTI																
			a	rte Martens & As	<b>NS</b> sociates Ptv	EXCAVATI	ON L	OG TO BE READ IN CONJU Př mail@m	INCTION WITH MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	H ACCOMPANYING REF ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marter	PORT NOTE 67 is.com.au	S AN	ID ABBRE	ng 'ng	ons gine Bc	ering orehol	Log - le	_

CL	IEN	T	A	llen Pri	ce &	Ass	sociates	Pty	Ltd		24.11.10	COMPLET	ED 2	4.11.10			REF	BH22	2
S	(UJE FF	:01	C	ngineer ullburr	ny . Ro	Serv and N	Vices	illhi		GFOLOGY	BK Siltstone	VEGETAT		Frass			Sheet 1 PROJECT N	of <b>1</b>	
EQ	JIPME	NT		unburre	Hydra	aulic A	uger		110	EASTING	NA	RL SURFA	CE 1	IA A					
EX	AVAT		DIMEN	SIONS	0.95n	nØ X :	2.5m depth			NORTHING	NA	ASPECT	١	lorth East			SLOPE	1-2%	
L	EX	CA		ION DA	TA				MA	TERIAL D	ATA				SA	MPLIN	IG & TES	TING	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)			GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STF nottling, colour, p anics, secondary ntamination, odo	RATA lasticity, rocks, oxidation, and minor components, ur.	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A	RESU DDITIONAL	JLTS AND . OBSERVATIO	NS
A	Nil	N	м	- 0.3			× × × × × × × ×	OL	ORGANIC SILT – Darl	k brown, grav	vels (5-10mm, 30%).	s		A	0.2	2842/22/	0.2		
А	Nil	N	м	- - 0.8			 	CL	CLAY - Variable colo	ours (grey, re	ed, yellow, brown).	F		A	0.5	2842/22	0.5		-
A	Nil	N	D	1.0 1.2				EW	EXTREMELY WE SILTSTO	EATHERED NE - Reddisł	FINE GRAINED			A	1.0	2842/22/	1.0		1.0
A	Nil	N	D	- - -			  	EW	EXTREMELY WE SILT	EATHERED STONE - Gr	FINE GRAINED ey.			A	1.5	2842/22/	1.5		
A	Nil	N	D	1.9 2.0 - -				EW	EXTREMELY WE SILTSTONE - (	EATHERED Grey, strengt	FINE GRAINED h decreasing.			A	2.0	2842/22	2.0		2 <u>.0</u> 
				2.5 	<u> </u>				Borehole to	erminated at	2.5m on			A	2.5	2842/22	2.5		
				- <u>3.0</u> - -					extremely	weathered s	iltstone.								- 3 <u>.0</u> - -
				- - -															-
				<u>4.0</u>  															4 <u>.0</u> - - -
				-															-
				<u>5.0</u>   															5 <u>.0</u> - - -
				  															- - 6 <u>.0</u>
				-															-
				- - 7.0															- - 7.0
				- - -															-
				  <u>8.0</u>															- - 8 <u>.0</u>
				-															
				  9.0															9.0
E F F	EQUIPMENT / METHOD       SUPPORT       WATER       MOISTURE       PENETRATION       CONSISTENCY       DENSITY       SAMPLING & TESTING       CLASSIFICATION       CLASSIFICATION         N Natural exposure       SH Shoring       N None observed       D       Dry       L low       VS Very Soft       VL Very Loose       A Auger sample       pp Pocket penetration test       SYMBOLS AND         K Existing excavation       SC Shotrate       X Not measured       M Moist       M Moderate       S Soft       L loose       B Bulk sample       S Standard penetration test       SOIL DESCRIPTION         BH Backhoe bucket       RB Rock Bolts       W Water level       W Wet       H High       F Firm       MD Medium Dense       U Undisturbed sample       VS Vane shear       OCP Dynamic cone       VI       USCS         HA Hand auger       Water outflow       W Liquid limit       VS Very Stiff       VD Very Dense       M Moisture content       DCP Dynamic cone       Y       USCS         S Hand spade       Water inflow       F Friable       F Friable       VS Very Stiff       VD Very Dense       WS Water sample       VS Water sample       N Agricultural         A Loger       A Auger       F Friable       F Friable       VS Very Stiff       VD Very Dense       VS Very Stiff       VS Very Stiff																		
F	<i>i</i> u U0	rete	: core			E	XCAVATIO	ON L'	OG TO BE READ IN CONJU	INCTION WITI	H ACCOMPANYING REF	PORT NOTE	ES AN	D ABBRE		ONS			
			a	rte	n	S	td_2010		Pł mail@m	MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marter	67 is.com.au		E	'ng	gine Bc	ering	g Log - ole	,

С	LIEN	Т	A	llen Pric	e & As	sociates	s Pty	Ltd	COMMENCED	24.11.10	COMPLET	ED 24.11.	10		REF	BH23
P	ROJ	ЕСТ	E	ngineeri	ing Ser	vices			LOGGED	BR	CHECKED	) GT			Sheet 1 o	f 1
s	TE		C	ullburra	Road,	West Cu	ullbu	irra	GEOLOGY	Siltstone	VEGETAT	ION Grass			PROJECT NO.	P1002842
E		IN I		ISIONS	0.95mØ X	1.0m depth				NA	ASPECT	North	Fast		SLOPE	1-2%
F	E		VAT		ГА			MA			/10/ 201		Luot	SAMPLI	NG & TEST	NG
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odor	ATA asticity, rocks, oxidation, and minor components, ir.	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)	RESUL ADDITIONAL (	TS AND DBSERVATIONS
A	Nil	Ν	М	0.2		× × × ×	OL	ORGANIC SILT – Dar	k brown, grav	rels (5-10mm, 30%).	S		А	0.2 2842/2	3/ 0.2	
Α	Nil	N	М	0.3	33 55		CL	C	LAY - Grey.	/	s		۵	0.5 2842/2	3/ 0 5	
A	Nil	N	м			 	CL	CLAY - Variable colo	ours (grey, re	d, yellow, brown).	s		~	0.5 204272	0,0.0	
A	Nil	N	D	0.9 1.0			EW	EXTREMELY WE	EATHERED	FINE GRAINED			А	1.0 2842/2	3/ 1.0	1.0
		MENT Matural ackhooxxaval and au	D T / MEs e exposs g excat g excat tor uger	1.0 	JPPORT Shoring Shoring Rock Bol No suppo	WATER N Non X Not X Not X Not X Wat	e obsa ier leve	MOISTURE PENE srved D Dry L Lo red M Moist M M W Wet H Hi W Plastic limit R Re low Wi Liquid limit R Re	TRATION CON weathered at weathered s TRATION CON weathered s Trust St fusal St VSt	SISTENCY DENSITY 1.0m on Itstone. SISTENCY DENSITY Very Soft VL Very Loc Soft L Loose Firm MD Medium Stiff D Dense Very Stiff VD Very Den	SAM JSE A / B f Dense U D JSE M H	IPLING & TEI Auger sample Judisturbed sa Disturbed sa	STING sample pple	pp Pocket S Standa VS Vane s DCP Dyne	penetrometer red penetration test inear infic cone trometer	10 10 20 20 30 40 50 50 50 60 50 50 50 50 50 50 50 50 50 5
	PT P A A	T Push tube Auger														
$\vdash$	<u>cc ć</u>	oncrete	e Core	r	r	-XCV/V4-							RDE			
		_	-						MARTENS &	ASSOCIATES PTY LTD	JAT NUT				-	
		<b>m</b>	a	rte Martens & Ass	ns sociates Pty. L	.td . 2010		Pł mail@m	6/37 Hornsby, none: (02) 9476 artens.com.au	Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marten	67 is.com.au		E	ngino Bo	eering orehol	Log - le

СГ	IEN	Г	A	llen Pric	ce & A	ssociates	s Pty	Ltd	COMMENCED	24.11.10	COMPLET	TED	24.11.10			REF	BH24	
PF		СТ	E	ngineer	ing Se	ervices				JSF	CHECKEI		GT			Sheet 1 o	f <b>1</b>	
EQ		лт	C	uliburra	Hydraulio	c Auger	ומווט	Irra	EASTING	NA	RL SURF		NA			PROJECT NO.	P 1002042	
EX	AVAT	ION D	IMEN	SIONS	0.95mØ	X 2.6m depth			NORTHING	NA	ASPECT		North East			SLOPE	5%	
	EX	CA	/AT	ION DA	ТА			MA	ATERIAL D	ATA				S	AMPLIN	IG & TESTI	NG	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		RAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org fill, cc	PTION OF STR nottling, colour, pl anics, secondary ontamination, odor	RATA asticity, rocks, oxidation, and minor components, ur.	CONSISTENCY			DEPTH (M)	A	RESUL DIITIONAL C	TS AND DBSERVATIONS	
A	Nil	N	М	0.2		× × × ×	× OL	ORGANIC SA	NDY SILT –	Dark brown.	S		A	0.2	2842/24/	0.2		-
А	Nil	N	М	- - - - - - - - - - - - - - - - - - -			CL	CLAY - Orange/bro tending grey with mino	own mottles, i r brown and	firm grading stiff, red mottles at depth	St- VSt		а А А А	0.5 1.0 1.5 . 2.0	2842/24/ 2842/24/ 2842/24/ 2842/24/	0.5 1.0 1.5 2.0		
A	Nil	N	D	-			EW	EXTREMELY WEA	THERED SI	LTSTONE - Grey			A	2.5	2842/24	2.5		
			D				EW	with red mott Borehole t extremely	EXTREMELY WEATHERED SILTSTONE - Grey with red motiles, clay like properties.       A       25       284/224/2.5         Borehole terminated at 2.6 m on extremely weathered siltstone.       A       I       I       I         Borehole terminated at 2.6 m on extremely weathered siltstone.       I       I       I       I         Borehole terminated at 2.6 m on extremely weathered siltstone.       I       I       I       I         I       I       I       I       I       I       I         I       I       I       I       I       I       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII							80		
E F F F	QUIPI A Ra H Ba Ex A Ha Ha Ha C Co	MENT atural e xisting ckhoe cavate ind au ind au ind sp sh tub iger ncrete	/ ME exposi excar buck or ger ade e Core	THOD SL ure SH vation SC et RE Nil	JPPORT Shoring Shotcre Rock B No sup	WATEF g N Not Bolts ⊻ Wa pport √ Wa	ter out	MOISTURE PENE prved D Dry L Lo rred M Moist M M W Wet H Hi Wp Plastic limit R Re Row WI Liquid limit W	TRATION CON w VS oderate S gh F ffusal St VSt H F	SISTENCY DENSITY Very Soft VL Very L Soft L Loose Firm MD Mediur Stiff D Dense Very Stiff VD Very Dr Hard Friable	SAN bose A B n Dense U D ense M Ux	I IPLING Auger Bulk sa Undist Undist Disturb Moistu Tube s	G & TESTII sample ample urbed sample bed sample ire content sample (x m	NG P S Ile V m) F V	p Pocket p S Standard /S Vane sh OCP Dynan penetr D Field de VS Water s	enetrometer d penetration test ear nic cone ometer nsity ample	CLASSIFICATIO SYMBOLS AND SOIL DESCRIPT Y USCS N Agricultural	J.U N ION
		n C) Cor	a	rte Martens & Ass	<b>NS</b> sociates Ph	EXCAVAT	ONL	DG TO BE READ IN CONJU Pr mail@m	INCTION WITH MARTENS & 6/37 Hornsby, none: (02) 9476 artens.com.au	HACCOMPANYING RE ASSOCIATES PTV LTI Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 8 WEB: http://www.marte	PORT NOT ) 767 :ns.com.au	ES AI		EVIAT	ons gine Bc	ering prehol	Log - le	

Design \$ 8 2 2 1 5 12 13 18 18 35 ٩ <u>•</u> 5 mártens consulting engineers since 1989 DCP8 3 1 9 2 2 DCP7 33 12 DCP11 22/11 - 25/11/10 P1002842 DCP24 93 49124912 4 19 4 ₫ 2 DCP17 <u>ب</u> 1 45 6/37 Leighton Place, Homsby, NSW 2159, Ph.: (02) 94769999 Fax: (02) 9476 8767, DCP18 2 9 ۱۵ **Dynamic Cone Penetrometer Test Log Summary** TEST DATA DCP 19 9999999 19 8 DCP Group Reference DCP 5 2 9 a ដ å Culburra Mixed Use Subdivision 33 Allen Price and Associates S D BR/GT/JF DCP 3 MO 8 DCP 6 3 5 4 9 2 0 DCP 1 Checked by Logged by Comments Client Site 

## Attachment C – DCP Test Data



## Attachment D – Salinity and Aggressivity Results Table

Sample ID	Borehole	Sample	Soil Type	EC(1:5)	Multiplier	ECe	Salinity	Ph	Concrete Exposure
		Depth (m)		(d\$/m)		(d§/m)	Rating		Classification 2
2842/1/0.5	1	0.5	Sand	0.057	17	0.969	Non-saline	5.1	Non-aggressive
2842/1/1.0	1	1	Clay	0.097	8	0.776	Non-saline	5	Non-aggressive
2842/1/1.5	1	1.5	Clay	0.08	8	0.64	Non-saline	8.1	Non-aggressive
2842/2/0.2	2	0.2	Silty Clay	0.023	8.5	0.1955	Non-saline	5.5	Non-aggressive
2842/2/0.5	2	0.5	Clay	0.043	8	0.344	Non-saline	4.7	Mild
2842/2/1.5	2	1.5	Clay	0.023	8	0.184	Non-saline	5	Non-aggressive
2842/24/0.2	24	0.2	Sandy Silt	0.021	14	0.294	Non-saline	5.3	Non-aggressive
2842/24/1.0	24	1	Clay	0.055	8	0.44	Non-saline	4.8	Mild
2842/24/1.5	24	1.5	Clay	0.058	8	0.464	Non-saline	4.8	Mild
2842/24/2.0	24	2	Clay	0.058	8	0.464	Non-saline	4.9	Mild
2842/13/0.2	13	0.2	Silty Sand	0.033	14	0.462	Non-saline	5.1	Non-aggressive
2842/13/0.5	13	0.5	Clay	0.024	8	0.192	Non-saline	5.5	Non-aggressive
2842/13/1.0	13	1	Clay	0.066	8	0.528	Non-saline	5.2	Non-aggressive
2842/3/0.2	3	0.2	Sand	0.035	17	0.595	Non-saline	5.3	Non-aggressive
2842/3/0.5	3	0.5	Sandy	0.056	8.5	0.476	Non-saline	5.2	Non-aggressive
2842/3/1.0	3	1	Sandy	0.052	8.5	0.442	Non-saline	4.9	Mild
2842/4/1.0	4	1	Clay	0.063	8	0.504	Non-saline	4.8	Mild
2842/4/1.5	4	1.5	Clay	0.068	8	0.544	Non-saline	4.7	Mild
2842/4/2.0	4	2	Clay	0.076	8	0.608	Non-saline	4.6	Mild
2842/18/0.2	18	0.2	Silty Sand	0.018	14	0.252	Non-saline	5.3	Non-aggressive
2842/18/0.5	18	0.5	Clay	0.034	8	0.272	Non-saline	5.1	Non-aggressive
2842/18/1.0	18	1	Clay	0.044	8	0.352	Non-saline	4.9	Mild
2842/19/0.2	19	0.2	Clay	0.03	8	0.24	Non-saline	5.5	Non-aggressive
2842/19/0.5	19	0.5	Clay	0.051	8	0.408	Non-saline	4.9	Mild
2842/19/1.5	19	1.5	Clay	0.083	8	0.664	Non-saline	4.7	Mild
2842/22/0.2	22	0.2	Organic	0.021	10	0.21	Non-saline	5.7	Non-aggressive
2842/22/0.5	22	0.5	Clay	0.058	8	0.464	Non-saline	5.3	Non-aggressive
2842/6/0.2	6	0.2	Sandy	0.48	8.5	4.08	Moderately	4.7	Mild
2842/6/0.5	6	0.5	Clay	1.2	8	9.6	Very Saline	4.5	Mild
2842/6/2.5	6	2.5	Clay	0.71	8	5.68	Moderately	6.1	Non-aggressive
Notes:									
Salinity Rating	based on th	ne Departme	ent of Conse	rvation and	d Land Mana	gement (1	992), What Do	All The Nun	nbers Mean and
able 6.2 of	Dep	artment of	Land and	d Water (	Conservation	(2002), S	ite Investiga	tions for	Urban Salinity.
From Australian	n Standard 2	2159 (1995) T	able 6.3 – Ex	posure Cla	ssification fo	r Steel Piles			



10

## 11 Attachment E – Geotechnical Laboratory Analytical Certificates





# Soil Description

Client Sample ID Date Sampled

Specification Location Sampled By

Boring No.

Depth

26/11/2010

TP10

0.5

Sampled by client

CLAY: Yellow brown (CH)

Test Results			
Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	21.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	120	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	33	
Plasticity Index (%)	AS 1289.3.3.1	87	

## Comments

N/A



#### Client Sample ID

Date Sampled 26/11/2010 Specification Location Sampled By Sampled by client Boring No. TP10 Depth 1.0 Soil Description CLAY: Grey (CH)

## Test Results

Description	Method	Result Limits
Sample History	AS 1289.1.1	Oven-dried
Preparation	AS 1289.1.1	Dry Sieved
Linear Shrinkage (%)	AS 1289.3.4.1	15.0
Mould Length (mm)		125
Crumbling		No
Curling		No
Liquid Limit (%)	AS 1289.3.1.2	54
Method		One Point
Plastic Limit (%)	AS 1289.3.2.1	17
Plasticity Index (%)	AS 1289.3.3.1	37

## Comments

N/A



Sample ID	SYD10-7999
Client Sample ID	
Date Sampled	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP17
Depth	0.5
Soil Description	CLAY: brown (CH)

Test	Resu	lts

Description	Method	Result Limits
Sample History	AS 1289.1.1	Oven-dried
Preparation	AS 1289.1.1	Dry Sieved
Linear Shrinkage (%)	AS 1289.3.4.1	14.0
Mould Length (mm)		254
Crumbling		No
Curling		No
Liquid Limit (%)	AS 1289.3.1.2	71
Method		One Point
Plastic Limit (%)	AS 1289.3.2.1	17
Plasticity Index (%)	AS 1289.3.3.1	54



Sample ID	SYD10-8000
Date Sample ID	26/11/2010
Specification	
Location	
Sampled By	Sampled by client
Boring No.	TP17
Depth	1.0
Soil Description	CLAY: Grey/brown (CH)

Te	est	Resu	lts

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	17.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	68	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	52	



# Sample IDSYD10-7998Client Sample ID26/11/2010Date Sampled26/11/2010Specification26/11/2010LocationSampled by clientBoring No.TP20Depth1.0Soil DescriptionCLAY: mottled red/grey (CH)

## Test Results

Description	Method	Result Limits
Sample History	AS 1289.1.1	Oven-dried
Preparation	AS 1289.1.1	Dry Sieved
Linear Shrinkage (%)	AS 1289.3.4.1	17.5
Mould Length (mm)		254
Crumbling		No
Curling		No
Liquid Limit (%)	AS 1289.3.1.2	92
Method		One Point
Plastic Limit (%)	AS 1289.3.2.1	19
Plasticity Index (%)	AS 1289.3.3.1	73

## Comments

N/A

Form No: 18909.s, Report No: SYD105751

# 12 Attachment F – Acid Sulfate Soil and Salinity Laboratory Analytical Certificates





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## CERTIFICATE OF ANALYSIS 48959

Client: Martens & Associates Pty Ltd 6/37 Leighton Place Hornsby NSW 2077

Attention: Ben Rose

## Sample log in details:

Your Reference: No. of samples: Date samples received: Date completed instructions received:

## P1002842JC01V01, Culburra

3 Waters, 60 Soils 30/11/10 30/11/10

## Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data. Samples were analysed as received from the client. Results relate specifically to the samples as received. Results are reported on a dry weight basis for solids and on an as received basis for other matrices. *Please refer to the last page of this report for any comments relating to the results.* 

Report Details:	
Date results requested by:	7/12/10
Date of Preliminary Report:	01/12/2010
Issue Date:	7/12/10
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This document is issued in accordance with	NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 170	25.
Tests not covered by NATA are denoted	with *.

**Results Approved By:** 

Paulewicz. Kasjan Paciuszkiewicz Chemist

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Nick Sarlamis Inorganics Supervisor

Envirolab Reference: 48959 Revision No: R 01

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Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-4	48959-5	48959-6	48959-7	48959-8
Your Reference		2842/1	2842/1	2842/1	2842/2	2842/2
Depth		0.5	1.0	1.5	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	5.0	8.1	5.5	4.7
Electrical Conductivity 1:5 soil:water	µS/cm	57	97	80	23	43

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-9	48959-10	48959-11	48959-12	48959-13
Your Reference		2842/2	2842/24	2842/24	2842/24	2842/24
Depth		1.5	0.2	1.0	1.5	2.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.0	5.3	4.8	4.8	4.9
Electrical Conductivity 1:5 soil:water	µS/cm	23	21	55	58	58

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-14	48959-15	48959-16	48959-17	48959-18
Your Reference		2842/13	2842/13	2842/13	2842/3	2842/3
Depth		0.2	0.5	1.0	0.2	0.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	5.5	5.2	5.3	5.2
Electrical Conductivity 1:5 soil:water	μS/cm	33	24	66	35	56

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-19	48959-20	48959-21	48959-22	48959-23
Your Reference		2842/3	2842/4	2842/4	2842/4	2842/18
Depth		1.0	1.0	1.5	2.0	0.2
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	4.9	4.8	4.7	4.6	5.3
Electrical Conductivity 1:5 soil:water	μS/cm	52	63	68	76	18

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-24	48959-25	48959-26	48959-27	48959-28
Your Reference		2842/18	2842/18	2842/19	2842/19	2842/19
Depth		0.5	1.0	0.2	0.5	1.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.1	4.9	5.5	4.9	4.7
Electrical Conductivity 1:5 soil:water	µS/cm	34	44	30	51	83

Miscellaneous Inorg - soil						
Our Reference:	UNITS	48959-29	48959-30	48959-31	48959-32	48959-33
Your Reference		2842/22	2842/22	2842/6	2842/6	2842/6
Depth		0.2	0.5	0.2	0.5	2.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
Date analysed	-	6/12/2010	6/12/2010	6/12/2010	6/12/2010	6/12/2010
pH 1:5 soil:water	pH Units	5.7	5.3	4.7	4.5	6.1
Electrical Conductivity 1:5 soil:water	µS/cm	21	58	480	1,200	710

Client Reference:

P1002842JC01V01, Culburra

aPOCAS field test								
Our Poforonco:		48050-34	18050-35	48050-36	48050-27	18050-28		
Vour Reference.	UNITS	28/2/1	40909-00	40909-30	40909-07	40909-00		
Dopth		0.5	1.0	1.5	2042/11	1.0		
Type of sample		0.0 Soil	1.0 Soil	1.5 Soil	0.0 Soil	Soil		
			301		001	3011		
pH⊧ (field pH test)*	pH Units	5.4	5.1	5.1	5.3	4.7		
pHFox (field peroxide test)*	pH Units	4.5	4.1	4.2	4.4	3.8		
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight		
sPOCAS field test								
Our Reference:	UNITS	48959-39	48959-40	48959-41	48959-42	48959-43		
Your Reference		2842/24	2842/24	2842/24	2842/24	2842/13		
Depth		0.5	1.0	1.5	2.0	0.5		
Type of sample		Soil	Soil	Soil	Soil	Soil		
pH⊧ (field pH test)*	pH Units	5.1	5.0	5.1	5.2	5.3		
pHFox (field peroxide test)*	pH Units	4.0	4.0	4.1	4.2	4.2		
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight		
sPOCAS field test								
Our Reference:	UNITS	48959-44	48959-45	48959-46	48959-47	48959-48		
Your Reference		2842/13	2842/4	2842/4	2842/4	2842/4		
Depth		1.0	0.5	1.0	1.5	2.0		
Type of sample		Soil	Soil	Soil	Soil	Soil		
pH⊧ (field pH test)*	pH Units	5.4	5.3	4.9	4.8	4.9		
pHFox (field peroxide test)*	pH Units	4.4	4.3	4.0	4.0	4.0		
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight		
sPOCAS field test								
Our Reference:	UNITS	48959-49	48959-50	48959-51	48959-52	48959-53		
Your Reference		2842/4	2842/19	2842/19	2842/19	2842/5		
Depth		2.5	0.5	1.0	1.5	0.5		
Type of sample		Soil	Soil	Soil	Soil	Soil		
pHF (field pH test)*	pH Units	4.5	5.1	4.8	4.9	5.5		
pHFox (field peroxide test)*	pH Units	3.8	4.2	3.9	3.9	4.5		
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight		
	1	1	1	1		1		
sPOCAS field test								
Our Reference:	UNITS	48959-54	48959-55	48959-56	48959-57	48959-58		
Your Reference		2842/5	2842/6	2842/6	2842/6	2842/6		
Depth		1.0	0.5	1.0	1.5	2.0		
Type of sample		Soil	Soil	Soil	Soil	Soil		
pHF (field pH test)*	pH Units	5.2	4.5	4.7	5.0	5.2		
pHFox (field peroxide test)*	pH Units	4.1	3.6	4.0	4.5	4.4		
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight		

sPOCAS field test						
Our Reference:	UNITS	48959-59	48959-60	48959-61	48959-62	48959-63
Your Reference		2842/6	2842/6	2842/21	2842/21	2842/20
Depth		2.5	3.0	0.5	1.0	1.5
Type of sample		Soil	Soil	Soil	Soil	Soil
pH⊧ (field pH test)*	pH Units	5.8	5.6	5.2	5.3	5.0
pHFox (field peroxide test)*	pH Units	5.7	5.3	4.1	4.7	4.2
Reaction Rate*	-	Slight	Slight	Slight	Slight	Slight

Miscellaneous Inorganics				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
		25.11.2010	25.11.2010	26.11.2010
Depth		-	-	-
Type of sample		Water	Water	Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Electrical Conductivity	μS/cm	4,900	250	18,000
Total Dissolved Solids (grav)	mg/L	2,900	180	13,000
рН	pH Units	5.2	5.1	5.6
Nitrate as N in water	mg/L	0.01	0.1	<0.005
Hardness	mgCaCO <sub>3</sub>	280	8	2,600
	/L			
NOx as N in water	mg/L	0.02	0.1	0.007
Ammonia as N in water	mg/L	0.3	0.02	0.1
Total Nitrogen in water	mg/L	0.7	0.4	0.3
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05
Phosphate as P in water	mg/L	<0.05	<0.05	<0.05
Silicon*- Dissolved	mg/L	36	36	15
Strontium - Dissolved	mg/L	0.2	<0.01	1.2
Titanium - Dissolved	mg/L	<0.02	<0.02	<0.02

Ion Balance				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
		25.11.2010	25.11.2010	26.11.2010
Depth		-	-	-
Type of sample		Water	Water	Water
Date prepared	-	30/11/2010	30/11/2010	30/11/2010
Date analysed	-	30/11/2010	30/11/2010	30/11/2010
Calcium - Dissolved	mg/L	10	0.6	130
Potassium - Dissolved	mg/L	8.0	0.6	13
Sodium - Dissolved	mg/L	950	38	3,400
Magnesium - Dissolved	mg/L	62	1.6	560
Hydroxide Alkalinity (OH <sup>-</sup> ) as CaCO3	mg/L	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as CaCO3	mg/L	23	7	46
Carbonate Alkalinity as CaCO3	mg/L	<0.1	<0.1	<0.1
Total Alkalinity as CaCO3	mg/L	23	7	46
Sulphate, SO4	mg/L	330	22	720
Chloride, Cl	mg/L	1,300	40	6,000
Ionic Balance	%	3.5	3.1	3.9
## Client Reference: P1002842JC

P1002842	JC01V01,	Culburra
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All metals in water-dissolved				
Our Reference:	UNITS	48959-1	48959-2	48959-3
Your Reference		2842/GMB01/	2842/GMB02/	2842/GMB06/
		25.11.2010	25.11.2010	26.11.2010
Depth		-	-	-
I ype of sample		Water	Water	Water
Date prepared	-	2/12/2010	2/12/2010	2/12/2010
Date analysed	-	2/12/2010	2/12/2010	2/12/2010
Aluminium-Dissolved	µg/L	260	39	210
Boron-Dissolved	µg/L	200	70	40
Barium-Dissolved	µg/L	71	7	93
Beryllium-Dissolved	µg/L	<0.5	<0.5	0.6
Cadmium-Dissolved	µg/L	1.9	1	3.2
Cobalt-Dissolved	µg/L	52	<1	67
Chromium-Dissolved	µg/L	<1	<1	<1
Copper-Dissolved	µg/L	3	<1	7
Iron-Dissolved	µg/L	1,800	11	13
Manganese-Dissolved	µg/L	950	7	1,100
Molybdenum-Dissolved	µg/L	<1	<1	<1
Nickel-Dissolved	µg/L	38	<1	67
Vanadium-Dissolved	µg/L	<1	<1	<1
Zinc-Dissolved	µg/L	100	42	140
Arsenic-Dissolved	µg/L	2	<1	9
Mercury-Dissolved	µg/L	<0.4	<0.4	<0.4
Lead-Dissolved	µg/L	15	<1	3
Selenium-Dissolved	µg/L	<1	<1	<1

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Method ID	Methodology Summary
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.63	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.
LAB.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.55	Nitrate - determined colourimetrically based on EPA353.2. Soils are analysed following a water extraction.
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.57	Ammonia - determined colourimetrically based on EPA350.1, Soils are analysed following a water extraction.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
LAB.60	Phosphate water extractable - determined colourimetrically based on EPA365.1
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.81	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st ED, 4110-B.
LAB.41	Gravimetric determination of the total solids content of water.
Metals.22 ICP-MS	Determination of various metals by ICP-MS.
Metals.21 CV-AAS	Determination of Mercury by Cold Vapour AAS.

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike %
								Recovery
Miscellaneous Inorg - soil						Base II Duplicate II %RPD		
Date prepared	-			6/12/20 10	48959-4	6/12/2010    6/12/2010	LCS-1	6/12/2010
Date analysed	-			6/12/20 10	48959-4	6/12/2010    6/12/2010	LCS-1	6/12/2010
pH 1:5 soil:water	pH Units		LAB.1	[NT]	48959-4	5.1    5.1    RPD: 0	LCS-1	100%
Electrical Conductivity 1:5 soil:water	µS/cm	1	LAB.2	<1.0	48959-4	57    53    RPD: 7	LCS-1	107%

QUALITY CONTROL	UNITS	PQL	METHOD	Blank
sPOCAS field test				
pHF (field pH test)*	pH Units		LAB.63	[NT]
pHFox (field peroxide test)*	pH Units		LAB.63	[NT]

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike %
Miscellaneous Inorganics						Base II Duplicate II %RPD		Recovery
Date prepared	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2 010	[NT]	[NT]	LCS-W1	2/12/2010
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	[NT]	[NT]	LCS-W1	104%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	[NT]	[NT]	LCS-W1	106%
рН	pH Units		LAB.1	[NT]	[NT]	[NT]	LCS-W1	102%
Nitrate as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Hardness	mgCaCO 3/L	3	Metals.20 ICP-AES	<3	[NT]	[NT]	[NR]	[NR]
NOx as N in water	mg/L	0.005	LAB.55	<0.005	[NT]	[NT]	LCS-W1	91%
Ammonia as N in water	mg/L	0.005	LAB.57	<0.005	[NT]	[NT]	LCS-W1	93%
Total Nitrogen in water	mg/L	0.1	LAB.66	<0.1	[NT]	[NT]	LCS-W1	86%
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.05	[NT]	[NT]	LCS-W1	97%
Phosphate as P in water	mg/L	0.005	LAB.60	<0.005	[NT]	[NT]	LCS-W1	101%
Silicon*- Dissolved	mg/L	0.2	Metals.20 ICP-AES	<0.2	[NT]	[NT]	LCS-W1	100%
Strontium - Dissolved	mg/L	0.01	Metals.20 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	90%
Titanium - Dissolved	mg/L	0.02	Metals.20 ICP-AES	<0.02	[NT]	[NT]	LCS-W1	96%

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Ion Balance						Base II Duplicate II %RPD		
Date prepared	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Date analysed	-			30/11/2 010	[NT]	[NT]	LCS-W1	30/11/2010
Calcium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	91%
Potassium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	103%
Sodium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	100%
Magnesium - Dissolved	mg/L	0.5	Metals.20 ICP-AES	<0.5	[NT]	[NT]	LCS-W1	92%
Bicarbonate Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Carbonate Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	[NR]	[NR]
Total Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	[NT]	[NT]	LCS-W1	104%
Sulphate, SO4	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	108%
Chloride, Cl	mg/L	1	LAB.81	<1.0	[NT]	[NT]	LCS-W1	94%
Ionic Balance	%		LAB.41	[NT]	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
All metals in water-dissolved						Base II Duplicate II %RPD		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Date prepared	-			2/12/20 10	48959-1	2/12/2010    2/12/2010	LCS-W1	02/12/2010
Date analysed	-			2/12/20 10	48959-1	2/12/2010    2/12/2010	LCS-W1	02/12/2010
Aluminium-Dissolved	µg/L	10	Metals.22 ICP-MS	<10	48959-1	260    260    RPD: 0	LCS-W1	103%
Boron-Dissolved	µg/L	5	Metals.22 ICP-MS	<5	48959-1	200    190    RPD: 5	LCS-W1	83%
Barium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	71    67    RPD: 6	LCS-W1	99%
Beryllium-Dissolved	µg/L	0.5	Metals.22 ICP-MS	<0.5	48959-1	<0.5    <0.5	LCS-W1	80%
Cadmium-Dissolved	µg/L	0.1	Metals.22 ICP-MS	<0.1	48959-1	1.9    2.0    RPD: 5	LCS-W1	100%
Cobalt-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	52    52    RPD: 0	LCS-W1	96%
Chromium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1    <1	LCS-W1	95%
Copper-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	3    3    RPD: 0	LCS-W1	91%
Iron-Dissolved	µg/L	10	Metals.22 ICP-MS	<10	48959-1	1800    1800    RPD: 0	LCS-W1	91%
Manganese-Dissolved	µg/L	5	Metals.22 ICP-MS	<5	48959-1	950    950    RPD: 0	LCS-W1	91%

Envirolab Reference: Revision No: 48959

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		Clie	ent Referen	ce: P	1002842JC01V	/01, Culburra			
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results		Spike Sm#	Spike % Recovery
All metals in water-dissolved						Base II Duplicate II %RPD	)		
Molybdenum-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1    <1		LCS-W1	99%
Nickel-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	38    38    RPD: 0		LCS-W1	89%
Vanadium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1    <1		LCS-W1	95%
Zinc-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	100    100    RPD: 0		LCS-W1	95%
Arsenic-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	2    2    RPD: 0		LCS-W1	90%
Mercury-Dissolved	µg/L	0.4	Metals.21 CV-AAS	<0.4	48959-1	<0.4    <0.4		LCS-W1	100%
Lead-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	15    15    RPD: 0		LCS-W1	96%
Selenium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1	48959-1	<1    <1		LCS-W1	92%
QUALITY CONTROL	UNITS	S	Dup. Sm#		Duplicate	Spike Sm#	Spi	ke % Recovery	
Miscellaneous Inorg - soil				Base +	Duplicate + %RPD	)			
Date prepared	-		48959-14	6/12/2	2010    6/12/2010	LCS-2		6/12/2010	
Date analysed	-		48959-14	6/12/2	2010    6/12/2010	LCS-2		6/12/2010	
pH 1:5 soil:water	pH Uni	its	48959-14	5.1	5.0    RPD: 2	LCS-2		100%	
Electrical Conductivity 1:5 soil:water	5 μS/cn	n	48959-14	33	34    RPD: 3	LCS-2		106%	
QUALITY CONTROL	UNITS	5	Dup. Sm#		Duplicate				<u>+</u>
Miscellaneous Inorg - soil				Base +	Duplicate + %RPD	)			
Date prepared	-		48959-25	6/12/2	2010    6/12/2010				
Date analysed	-		48959-25	6/12/2	2010    6/12/2010				
pH 1:5 soil:water	pH Uni	its	48959-25	4.9	5.0    RPD: 2				
Electrical Conductivity 1:5 soil:water	5 μS/cn	n	48959-25	44	54    RPD: 20				

#### **Report Comments:**

Phosphate:PQL raised due to sample matrix.

Asbestos ID was analysed by Approved	Identifier:	Not applicable	e for this job	
Asbestos ID was authorised by Approve	d Signatory:	Not applicable	e for this job	
Asbestos counting was analysed by App	proved Counter:	@ERROR		
Asbestos counting was authorised by Ap	oproved Signatory:	@ERROR		
INS: Insufficient sample for this test	PQL: Practical Qua	antitation Limit	NT: Not tested	
NA: Test not required	RPD: Relative Perc	ent Difference	NA: Test not required	
<: Less than	>: Greater than		LCS: Laboratory Control Sample	

## **Quality Control Definitions**

**Blank**: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. **Duplicate**: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample. Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

### Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable. Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.



Envirolab Services Pty Ltd ABN 37 112 535 645 12 Ashley St Chatswood NSW 2067 ph 02 9910 6200 fax 02 9910 6201 enquiries@envirolabservices.com.au www.envirolabservices.com.au

# CERTIFICATE OF ANALYSIS 48959-A

Client: Martens & Associates Pty Ltd 6/37 Leighton Place Hornsby NSW 2077

Attention: Ben Rose

# Sample log in details:

Your Reference: No. of samples: Date samples received: Date completed instructions received:

# P1002842JC01V01, Culburra

Additional Testing on 5 Soils 30/11/10 02/12/10

# Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data. Samples were analysed as received from the client. Results relate specifically to the samples as received. Results are reported on a dry weight basis for solids and on an as received basis for other matrices. *Please refer to the last page of this report for any comments relating to the results.* 

## **Report Details:**

 Date results requested by:
 9/12/10

 Date of Preliminary Report:
 Not Issued

 Issue Date:
 10/12/10

 NATA accreditation number 2901. This document shall not be reproduced except in full.

 This document is issued in accordance with NATA's accreditation requirements.

 Accredited for compliance with ISO/IEC 17025.

 Tests not covered by NATA are denoted with \*.

## **Results Approved By:**

M. Maugjeld

Matt Mansfield Approved Signatory



sPOCAS						
Our Reference:	UNITS	48959-A-35	48959-A-43	48959-A-50	48959-A-54	48959-A-61
Four Reference		2842/1	2842/13	2842/19	2842/5	2842/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	7/12/2010	7/12/2010	7/12/2010	7/12/2010	7/12/2010
Date analysed	_	7/12/2010	7/12/2010	7/12/2010	7/12/2010	7/12/2010
	pH units	3.5	4.3	3.5	3.6	3.8
TAA pH 6.5	moles H <sup>+</sup> /t	138	27	163	125	87
s-TAA pH 6.5	%w/w S	0.22	0.044	0.26	0.20	0.14
pH ox	pH units	4.1	4.0	4.0	4.2	4.2
TPA pH 6.5	moles H <sup>+</sup> /t	143	<5.0	173	128	108
s-TPA pH 6.5	%w/w S	0.23	<0.01	0.28	0.20	0.17
TSA pH 6.5	moles H <sup>+</sup> /t	5.0	<5.0	10	<5.0	20
s-TSA pH 6.5	%w/w S	<0.01	<0.01	0.016	<0.01	0.032
ANCE	% CaCO3	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANCe	moles H <sup>+</sup> /t	<5	<5	<5	<5	<5
s-ANCe	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
Skci	%w/w S	0.012	<0.005	0.011	0.035	0.097
SP	%w/w	0.018	0.008	0.018	0.038	0.11
Spos	%w/w	0.005	0.007	0.007	<0.005	0.010
a-Spos	moles H <sup>+</sup> /t	<5.0	<5.0	<5.0	<5.0	5.9
Саксі	%w/w	0.009	<0.005	0.016	0.014	0.014
Сар	%w/w	0.008	0.005	0.017	0.014	0.014
Сал	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Мдксі	%w/w	0.037	0.008	0.029	0.031	0.074
Мдр	%w/w	0.036	0.009	0.031	0.032	0.074
MgA	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
SRAS	%w/w	0.006	<0.005	<0.005	0.005	0.013
Sнсі	%w/w S	0.017	<0.005	0.011	0.029	0.084
SNAS	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
a-Snas	moles H <sup>+</sup> /t	<5	<5	<5	<5	<5
S-SNAS	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H <sup>+</sup> /t	143	32	167	127	93
Liming rate	kg CaCO₃/t	11	2.4	13	9.6	7.0
a-Net Acidity without ANCE	moles H⁺/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg CaCO₃/t	NA	NA	NA	NA	NA

Method ID	Methodology Summary
LAB.64	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

Envirolab Reference: 48959-A Revision No: R 00

# Client Reference:

# P1002842JC01V01, Culburra

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
sPOCAS						Base II Duplicate II %RPD		
Date prepared	-			7/12/20 10	48959-A-35	7/12/2010    7/12/2010	LCS	7/12/2010
Date analysed	-			7/12/20 10	48959-A-35	7/12/2010    7/12/2010	LCS	7/12/2010
рН ксі	pH units		LAB.64	5.9	48959-A-35	3.5    3.4    RPD: 3	LCS	101%
TAA pH 6.5	moles H <sup>+</sup> /t	5	LAB.64	<5	48959-A-35	138    138    RPD: 0	LCS	103%
s-TAA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	0.22    0.22    RPD: 0	LCS	100%
pH ox	pH units		LAB.64	3.6	48959-A-35	4.1    4.1    RPD: 0	LCS	106%
TPA pH 6.5	moles H <sup>+</sup> /t	5	LAB.64	<5.0	48959-A-35	143    140    RPD: 2	LCS	88%
s-TPA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	0.23    0.22    RPD: 4	LCS	88%
TSA pH 6.5	moles H <sup>+</sup> /t	5	LAB.64	<5.0	48959-A-35	5.0    <5.0	LCS	85%
s-TSA pH 6.5	%w/w S	0.01	LAB.64	<0.01	48959-A-35	<0.01    <0.01	LCS	84%
ANCE	% CaCO3	0.05	LAB.64	<0.05	48959-A-35	<0.05    <0.05	[NR]	[NR]
a-ANCE	moles H <sup>+</sup> /t	5	LAB.64	<5	48959-A-35	<5    <5	[NR]	[NR]
s-ANCe	%w/w S	0.05	LAB.64	<0.05	48959-A-35	<0.05    <0.05	[NR]	[NR]
Sксі	%w/w S	0.005	LAB.64	<0.005	48959-A-35	0.012    0.010    RPD: 18	LCS	103%
Sp	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.018    0.017    RPD: 6	LCS	86%
Spos	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.005    0.007    RPD: 33	LCS	82%
a-Spos	moles H <sup>+</sup> /t	5	LAB.64	<5.0	48959-A-35	<5.0    <5.0	LCS	83%
Саксі	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.009    0.009    RPD: 0	LCS	74%
Сар	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.008    0.009    RPD: 12	[NR]	[NR]
Сал	%w/w	0.005	LAB.64	<0.005	48959-A-35	<0.005    <0.005	LCS	82%
Мдксі	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.037    0.036    RPD: 3	LCS	91%
Мgр	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.036    0.036    RPD: 0	[NR]	[NR]
MgA	%w/w	0.005	LAB.64	<0.005	48959-A-35	<0.005    <0.005	[NR]	[NR]
SRAS	%w/w	0.005	LAB.64	<0.005	48959-A-35	0.006    0.008    RPD: 29	[NR]	[NR]
<b>S</b> нсі	%w/w S	0.005	LAB.64	<0.005	48959-A-35	0.017    0.017    RPD: 0	LCS	78%
Snas	%w/w S	0.005	LAB.64	<0.005	48959-A-35	<0.005    0.006	[NR]	[NR]
a-Snas	moles H <sup>+</sup> /t	5	LAB.64	<5	48959-A-35	<5    <5	[NR]	[NR]
s-Snas	%w/w S	0.01	LAB.64	<0.01	48959-A-35	<0.01    <0.01	[NR]	[NR]
a-Net Acidity	moles H <sup>+</sup> /t	10	LAB.64	<10	48959-A-35	143    145    RPD: 1	LCS	83%

Envirolab Reference: 48959-A **Revision No:** 

R 00

Client Reference: P1002842JC01V01, Culburra								
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
sPOCAS						Base II Duplicate II %RPD		
Liming rate	kg CaCO3 /t	0.75	LAB.64	<0.75	48959-A-35	11    11    RPD: 0	LCS	84%
a-Net Acidity without ANCE	moles H <sup>+</sup> /t	10	LAB.64	<10	48959-A-35	NA    NA	[NR]	[NR]
Liming rate without ANCE	kg CaCO <sub>3</sub>	0.75	LAB.64	<0.75	48959-A-35	NA    NA	[NR]	[NR]

## **Report Comments:**

Asbestos ID was analysed by Approved Identifier: Asbestos ID was authorised by Approved Signatory: Asbestos counting was analysed by Approved Counter: Asbestos counting was authorised by Approved Signatory: Not applicable for this job Not applicable for this job @ERROR @ERROR

INS: Insufficient sample for this test NA: Test not required <: Less than

PQL: Practical Quantitation Limit RPD: Relative Percent Difference >: Greater than NT: Not tested NA: Test not required LCS: Laboratory Control Sample

## **Quality Control Definitions**

**Blank**: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. **Duplicate**: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample. Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

#### Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable. Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

# 13 Attachment G – Notes About This Report



# Information

# Important Information About Your Report

Subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all of course, are necessarily relevant to all reports, but are included as general reference.

#### **Engineering Reports - Limitations**

Geotechnical reports are based on information gained from limited sub-surface site testing and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

#### Engineering Reports - Project Specific Criteria

Engineering reports are prepared by qualified personnel and are based on the information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relative if the design proposal is changed (eg. to a twenty storey building). Your report should not be relied upon if there are changes to the project without first asking Martens to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes if they are not consulted.

#### **Engineering Reports – Recommendations**

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced and therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

#### Engineering Reports – Use For Tendering Purposes

Where information obtained from this investigation is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Attention is drawn to the document 'Guidelines for the Provision of Geotechnical Information in Tender Documents', published by the Institution of Engineers, Australia.

The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

#### Engineering Reports – Data

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings etc are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

#### Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

#### Subsurface Conditions - General

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions the potential for will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency which are often limited by project imposed budgetary constraints.
- Changes in guidelines, standards and policy or interpretation of guidelines, standards and

policy by statutory authorities.

- The actions of contractors responding to commercial pressures.
- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions

If these conditions occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

#### **Subsurface Conditions - Changes**

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

#### **Subsurface Conditions - Site Anomalies**

In the event that conditions encountered on site during construction appear to vary from those that were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved at the time when conditions are exposed, rather than at some later stage well after the event.

#### **Report Use By Other Design Professionals**

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a report, retain Martens to work with other project professionals who are affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

#### Subsurface Conditions - Geoenvironmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of the Company's proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geoenvironmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

#### Responsibility

Geotechnical reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognize their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

#### **Site Inspections**

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

# Soil Data Explanation of Terms (1 of 3)

#### Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726 and the S.A.A Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

#### **Particle Size**

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision	Size
BOULDERS		>200 mm
COBBLES		60 to 200 mm
	Coarse	20 to 60 mm
GRAVEL	Medium	6 to 20 mm
	Fine	2 to 6 mm
	Coarse	0.6 to 2.0 mm
SAND	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

#### **Plasticity Properties**

Plasticity properties can be assessed either in the field by tactile properties, or by laboratory procedures.



#### **Moisture Condition**

- Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
- Moist Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
- Wet As for moist but with free water forming on hands when handled.

# Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

Term	C₀ (kPa)	Approx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail.
Friable	-		Crumbles or powders when scraped by thumbnail

#### **Density of Granular Soils**

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration test (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	%	SPT 'N' Value (blows/300mm)	CPT Cone Value (q₀ Mpa)
Very loose	< 15	< 5	< 2
Loose	15 – 35	5 - 10	2 -5
Medium dense	35 – 65	10 - 30	5 - 15
Dense	65-85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

#### **Minor Components**

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Term	Assessment	Proportion of Minor component In:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to	Coarse grained soils: < 5 %
	general properties of primary component.	Fine grained soils: < 15 %
	Presence easily detectable by feel or eye, soil properties little	Coarse grained soils: 5 – 12 %
will some	different to general properties of primary component.	Fine grained soils: 15 – 30 %

**martens** <sup>consulting engineers</sup>

# Soil Data Explanation of Terms (2 of 3)

#### Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) The factual key for the recognition of Australian Soils, Rellim Technical Publications, NSW, p 26 - 28.

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch: dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL-	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt Ioam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
мс	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
НС	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

# Soil Data Explanation of Terms (3 of 3)

# Symbols for Soil and Rock

SOIL





# IGNEOUS ROCK GRANITE OLERITE /





### Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)							USCS	Primary Name
ger than 0.075		ction is	AN VELS or no	Wi	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Gravel
	VELS coarse frc n 2.0 mm.	CLE GRA (Little fine		Predominantly one	size or a range of sizes with more intermediate sizes missing	GP	Gravel	
OILS mm is lar	(e)	GRA an half of larger tha	VELS FINES sciable unt of es)		Non-plastic fine	es (for identification procedures see ML below)	GM	Silty Gravel
AINED So than 63 m	laked ey	More th	GRA WITH (Appre amou		Plastic fines	(for identification procedures see CL below)	GC	Clayey Gravel
ARSE GR erial less m	to the r	iction is	AN DS or no		Wide range in grair	n sizes and substantial amounts of intermediate sizes missing.	SW	Sand
% of mate	cle visible	NDS <sup>c</sup> coarse fro an 2.0 mm	CLE, SAN (Little ( fine		Predominantly one size or a range of sizes with some intermediate sizes missing			Sand
than 50 5	han 50 %	SAN an half of smaller the	S WITH IES sciable unt of es)		Non-plastic fine	es (for identification procedures see ML below)	SM	Silty Sand
More	More t le smalle		SANDS FIN (Appre amou	Plastic fines		fines (for identification procedures see CL below)		Clayey Sand
	out th				IDENTIFICATIO	N PROCEDURES ON FRACTIONS < 0.2 MM		
53 mm is	3 mm is e is abc		TH DILATANC cs)	Y	TOUGHNESS	DESCRIPTION	USCS	Primary Name
ILS s than e mm	n partic	None to Lo	Quick to Slow	0	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
LED SOI	075 mn	Medium t High	o None		Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL	Clay
: GRAIN of mate er than	(A 0.0	Low to Medium	Slow to Ve Slow	əry	Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
FINE an 50 % o small		Low to Medium	ow to Slow to Ve edium Slow		Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	мн	Silt
ore the		High	ligh None		High	Inorganic clays of high plasticity, fat clays	СН	Clay
		o None		Low to Medium	Organic clays of medium to high plasticity	ОН	Organic Silt	
HIGHLY ORGAN SOILS	í IC	Rec	adily identified by	y col	our, odour, spong	gy feel and frequently by fibrous texture	Pt	Peat
Low Plastic	Low Plasticity – Liquid Limit $W_L < 35\%$ Medium Plasticity – Liquid limit $W_L 35$ to 60\% High Plasticity - Liquid limit $W_L > 60\%$							

# Rock Data Explanation of Terms (1 of 2)

#### Definitions

Descriptive terms used to	or Rock by Martens are give	en below and include rock	substance, rock detects	and rock mass.

lock [	Data	<b>IS</b> ngineers
Explanatio	n of Terms (1 of 2)	ng e
Definitions		
Descriptive terms used fo	r Rock by Martens are given below and include rock substance, rock defects and rock mass.	
Rock Substance	In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot, unless extremely weathered, be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.	B
Rock Defect	Discontinuity or break in the continuity of a substance or substances.	
Rock Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.	

#### **Degree of Weathering**

Rock weathering is defined as the degree in rock structure and grain property decline and can be readily determined in the field.

Term	Symbol	Definition
Residual Soil	Rs	Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering

#### **Rock Strength**

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance is the direction normal to the bedding. The test procedure is described by the international Society of Rock Mechanics.

Term	ls (50) MPa	Field Guide	Symbol
Extremely weak	< 0.03	Easily remoulded by hand to a material with soil properties.	EW
Very weak	0.03 - 0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	vw
Weak	0.1 - 0.3	A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	w
Medium strong	0.3 - 1	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	MS
Strong	1 - 3	A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife.	S
Very Strong	3 - 10	A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife.	VS
Extremely strong	> 10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	ES

# Rock Data Explanation of Terms (2 of 2)

# Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but excludes fractures such as drilling breaks.

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Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20mm-40mm with occasional fragments.
Fractured	Core lengths are mainly 30mm-100mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300mm-1000mm with occasional longer sections and occasional sections of 100mm-300mm.
Unbroken	The core does not contain any fractures.

# Test Methods

#### Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thinwalled sample tube into the soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

#### **Drilling Methods**

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

<u>Hand Excavation</u> – in some situations, excavation using hand tools such as mattock and spade may be required due to limited site access or shallow soil profiles.

<u>Hand Auger</u> - the hole is advanced by pushing and rotating either a sand or clay auger generally 75-100mm in diameter into the ground. The depth of penetration is usually limited to the length of the auger pole, however extender pieces can be added to lengthen this.

<u>Test Pits</u> - these are excavated with a backhoe or a tracked excavator, allowing close examination of the *insitu* soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

<u>Continuous Sample Drilling</u> - the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

<u>Continuous Spiral Flight Augers</u> - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or *insitu* testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and

returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

<u>Rotary Mud Drilling</u> - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

<u>Continuous Core Drilling</u> - a continuous core sample is obtained using a diamond tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

#### **Standard Penetration Tests**

Standard penetration tests are used mainly in noncohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in AS 1289 Methods of Testing Soils for Engineering Purposes - Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

(i) In the case where full penetration is obtained with successive blow counts for each 150mm of say 4, 6 and 7 blows:

#### as 4, 6, 7

N = 13

(ii) In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

#### as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

#### CONE PENETROMETER TESTING AND INTERPRETATION

Cone penetrometer testing (sometimes referred to as Dutch Cone - abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in AS 1289 - Test F4.1.

In the test, a 35mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on separate 130mm long sleeve, immediately behind the cone. Tranducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart

# Test Methods Explanation of Terms (2 of 2)

recorders. The plotted results given in this report have been traced from the original records.

The information provided on the charts comprises: Cone resistance - the actual end bearing force divided by the cross sectional area of the cone - expressed in MPA. Sleeve friction - the frictional force of the sleeve divided by the surface area - expressed in kPa.

Friction ratio - the ratio of sleeve friction to cone resistance - expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%-2% are commonly encountered in sands and very soft clays rising to 4%-10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

#### $q_c$ (Mpa) = (0.4 to 0.6) N (blows/300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

#### $q_c$ = (12 to 18) $c_u$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

#### **DYNAMIC CONE (HAND) PENETROMETERS**

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer - a 16 mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS 1289 - Test F 3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

Cone penetrometer (sometimes known as the Scala Penetrometer) - a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289 - Test F 3.2). The test was developed initially for pavement sub-grade investigations, with correlations of the test results with California bearing ratio published by various Road Authorities.

#### LABORATORY TESTING

Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

#### TEST PIT / BORE LOGS

The test pit / bore log(s) presented herein are an engineering and/or geological interpretation of the subsurface conditions and their reliability will depend to some extent on frequency of sampling and the method of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the boreholes.

#### GROUND WATER

Where ground water levels are measured in boreholes, there are several potential problems:

In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it is left open.

A localised perched water table may lead to an erroneous indication of the true water table.

Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are indicated in the report.

The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.