SGD1 Pty Ltd C/- Tattersall Lander Pty Ltd

Geotechnical Assessment: Riverside Estate, Tea Gardens, NSW.



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WASTEWATER



GEOTECHNICAL



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PROJECT MANAGEMENT



P1404136JR03V01 October 2015

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1 Introduction

1.1 Overview

This report presents the results of a Geotechnical Assessment, including salinity assessment and pavement thickness design, carried out by Martens & Associates Pty Ltd (MA) on behalf of the Client for the proposed Riverside Estate development at Tea Gardens, NSW (the 'site'). The report has been prepared to support a Development Application (DA) for the proposed site development. The site location is shown in Figure 2, Attachment B.

Previous rounds of ground investigation works have been undertaken at the site, dating back to February, 1996. The works were undertaken in relation to various development proposals for the site.

This report seeks to collate previous investigation works relevant to the geotechnical assessment and to assess the geotechnical risk at the site in light of the current proposed development proposal. It includes advice on management measures to enable construction activities to limit / negate the geotechnical risks associated with the site development. This study does not intend to provide details of previous works, apart from utilising historic data as summarised within the relevant study elements of this report.

1.2 Development Proposal Description

We understand that development approval is sought for the following key elements:

- Subdivision of the site into 767 small to medium residential lots, carried out in 16 stages.
- o Construction of internal road and buried services networks.
- Creation of areas dedicated to open space, public recreation and stormwater management corridors.
- Creation of a future commercial area.

Refer to the staging plan prepared by Tattersall Lander Pty Ltd (Figure 1, Attachment A) for further details.

Future lot development is likely to consist of construction of residential dwellings, some swimming pools and associated infrastructure, and installation of buried services.



1.3 Assessment Objectives

The study objectives include assessing:

- Geotechnical conditions for management of geotechnical risks that may affect the site and the proposed development.
- Risk of soil and groundwater salinity so that consideration can be given to local prevailing salinity conditions and the impacts of, and on, the proposed development.
- Subgrade conditions to recommend preliminary pavement material thicknesses suitable for expected lightly-trafficked pavements and provide advice on subgrade preparatory and earthworks requirements.

1.4 Assessment Scope of Works

The assessment scope of works is summarised as follows:

- Review results of previous ground investigations, associated with the proposed site development and relevant to the geotechnical assessment, that were completed by MA and other consultants (report copies provided by the Client).
- o Review relevant publicly available documentation.
- A site walkover by a senior geotechnical engineer to assess existing site conditions.

1.5 Relevant Guidelines/Standards

The assessment has been carried out in accordance with the principles of the following guidelines/standards:

- Australian Standard 1726 (1993), Geotechnical site investigations.
- Australian Standard 2870 (2011), Residential slabs and footings.
- Department of Land and Water Conservation (2002), Site Investigations for Urban Salinity.
- Guide to Pavement Technology, Part 2: Pavement Structural Design, Austroads, 2012.



2 Site Investigations

2.1 Previous Site Investigations

The following site investigations, previously carried out at or in the immediate vicinity of the site and considered relevant to this geotechnical assessment, were reviewed:

- Coffey Geotechnics (Coffey, formerly Coffey Partners International), February 1996, Myall Quays development Groundwater and Surface Water Study.
- Coffey (formerly Coffey Geosciences), December 2004, Crighton Properties Groundwater Assessment Myall Quays Development, Tea Gardens.
- Coffey (formerly Coffey Geosciences, October 2007, Groundwater Assessment Crighton Properties Riverside Development, Tea Gardens.
- Coffey, August 2008, Riverside Estate Project Application Masterplan Area, Tea Gardens Geotechnical and Acid Sulfate Soils Assessment.
- Martens & Associates (MA), July 2009, Request for additional groundwater information, Riverside Site, Tea Gardens, NSW.
- MA, January 2013, Concept Integrated Water Cycle Management Strategy (revised), Riverside, Tea Gardens, NSW.

2.2 Previous Site Investigation Scope of Works

Previous investigations included drilling of 34 boreholes, excavation of 40 test pits and installation of 24 groundwater monitoring bores (GMBs)/ piezometers. In addition, a standpipe was installed to monitor lake water quality and levels. Test and GMB locations are shown in Figure 3, Attachment B. It is to be noted that, between 2004 and 2007, vandalism and/or loss of four (4) GMBs (GMBs 1, 2, 3 and 7) reduced the number of operative site GMBs (including standpipes) to 17. Two of these were replaced in 2009 with new GMBs (GMB1A and GMB2A). Previous assessment scope of works are summarised below.

- 2.2.1 DJ Douglas & Partners (now Douglas Partners), 1994 (Coffey, 2004)
 - Drilling of 12 boreholes (BH1 to BH12) and iInstallation of groundwater monitoring bores (GMB1 to GMB12), typically 5m deep



and screened over the bottom 2m, to allow groundwater sampling and level monitoring.

(Further bore details and associated assessment results are not known. Some of these bores were utilised by Coffey for subsequent assessments - refer below).

- 2.2.2 Coffey, 1996
 - Drilling of one (1) borehole (BH13) using augering techniques up to 10.5m below ground level (bgl) to allow characterisation of underlying soils.
 - Installation of 1 groundwater monitoring bore (GMB13) to allow groundwater sampling and level monitoring.
 - Excavation of 1 trial pit between BH10 and BH13 for pump testing.
- 2.2.3 Coffey, 2004
 - Drilling of 4 boreholes (BH21 to BH24) using augering techniques up to 3m bgl to allow characterisation of underlying soils and soil sampling.
 - Installation of 4 groundwater monitoring bores (GMB21 to GMB24) to allow groundwater sampling and level monitoring.
 - Collection of water samples from bores at the site, inclusive of some bores previously installed by Douglas Partners (refer to Section 2.2.1). Thirteen (13) samples were submitted for chemical laboratory analysis.
- 2.2.4 Coffey, 2007
 - Collection of water samples from bores at the site, inclusive of some bores previously installed by Douglas Partners (refer to Section 2.2.1).
 Seven (7) samples were submitted for chemical laboratory analysis.
- 2.2.5 Coffey, 2008
 - Excavation of 40 test pits (TP1 to TP34 and TP39 to TP44) via backhoe up to 2.5m bgl to allow characterisation of underlying soils and soil sampling.
 - Drilling of six (6) boreholes (BH35 to BH38 and BH45 to BH46) by means of a 4WD drilling rig and using augering techniques up to 10.45m bgl to allow characterisation of underlying soils and soil sampling.



 Collection of water samples from groundwater monitoring bores, of which eight (8) samples were submitted for chemical laboratory analysis.

2.2.6 MA, 2009

- Drilling of three (3) boreholes (BH1A, BH2A and BH25) using augering techniques to between approximatley 5.5m and 7m bgl to allow characterisation of underlying soils.
- Installation of 3 groundwataer monitoring bores (GMB1A, GMB2A and GMB25) up to approximately 2.28m bgl and installation of 1 monitoring bore in the existing lake (GMB26) to allow groundwater sampling and level monitoring.
- Collection of water samples from existing bores at the site, of which 6 samples were submitted for chemical laboratory analysis.

2.2.7 MA, 2013

- Drilling of eight (8) boreholes (BH201 to BH208) using augering techniques to between approximatley 0.7m and 7m bgl to allow characterisation of underlying soils.
- Installation of 3 groundwataer monitoring bores (GMB201 to GMB203) up to approximatley 7m bgl to allow groundwater sampling and level monitoring.
- Collection of water samples from existing bores at the site, of which 19 samples were submitted for chemical laboratory analysis.

2.3 Supplementary Site Investigation

One of MA's Senior Geotechnical Engineers visited the site on July 20, 2015, to carry out a site walkover to assess existing site conditions.



3 Site Conditions

3.1 Study Area Description

The site forms part of an approximately northeast – southwest aligned Pleistocene and Holocene coastal barrier mass.

It lies immediately to the north of the existing township of Tea Gardens and is accessed via Myall Street, the main road linking Tea Gardens / Hawks Nest with the Pacific Highway. The site location is shown in Figure 2, Attachment B.

Table 1, overleaf, presents a summary of general site details. Existing site features are shown in Figure 3, Attachment B. Existing site contours are shown on Figure 4, Attachment B.

At the time of MA's site visit, following a rainfall period, surface soils were observed to be saturated and surface water was ponding across the majority of the site. A number of small incised man-made channels drain collected surface water and possibly intermittent shallow groundwater to the lower-lying heath and wetland areas to the east of the site.



Table 1: Summary of general site deta

Item	Description/Detail
Lot/DP	 Lots 10 in DP 270100. Lot 40 in DP270100 Lot 9 in DP 270561.
LGA	Great Lakes.
Site area	Approximately 100 ha.
Topography	Generally low-lying land with grades typically <5%. A series of small sand ridges trend roughly north-south, rising northwards (near the northern site boundary towards Shearwater Estate) with grades typically up to 25%.
Expected geology (DoM, 1996)	Pleistocene beach ridges on the Tomago Coastal Plain, comprising Marine gravel, sand, silt, clay and "Waterloo Rock", overlain in places by Aeolian quartz sands. The northern more elevated site extremes may be underlain by Wootton Beds comprising typically sandstone, siltstone, claystone, shale, limestone or lavas, including possible Glen William Beds.
Expected soil landscape (Murphy, 1995)	Aeolian Tea Gardens soil landscape (tn): narrow beach ridges and swales over Pleistocene quartz sand. Local relief is generally <1m, with elevation ranging between 5m and 8m, or <2m near inner barrier depressions. Slope gradients are generally <5%. Ridges are generally well drained. Swales are generally waterlogged with fresh groundwater table often <1m bgl. Soils are deep (>3m), including acid non-cohesive soils, and humus podzols and peaty humus podzols in crests and swales respectively.
Typical site slopes, aspect	Flat, with a slight fall to the south east (<2%).
Elevation	Between approximately 0.6m above Australian Height Datum (AHD) along the Myall River foreshore to 20m AHD at the northern end of the site, adjacent to Shearwater Estate. Majority of the site varies in elevation from 1.6m AHD to 5m AHD.
Existing site development	Majority of the site was previously cleared of native vegetation for use as a pine plantation, which has since ceased operation. Currently the land remains undeveloped.
Existing vegetation	Variety of coastal vegetation communities, including grasses, reeds and scattered pine and native trees.
Neighbouring conditions	N: Toonang Drive (west) and undeveloped but cleared land (east) followed by forest and rural residential developments (Shearwater Residential Estate).
	E: Approximately 2km frontage to wetlands along the western Myall River shoreline.
	S: Existing commercial (west) and residential (east) developments.
	W: Myall Street (approximately 1km frontage).

3.2 Subsurface Conditions

3.2.1 Subsurface Materials

Subsurface investigations indicate that the site is generally covered by a thin layer of topsoil consisting of clayey/sandy silt, silty sand or sandy clay/clay to depths of up to approximately 0.6m bgl (Figure 5,



Attachment B). Underlying deposits generally comprised medium to very dense sand/ silty sand, overlain in places by generally stiff to very stiff clay of high plasticity and sandy clay/clayey sand layers.

Elevated areas in the north-eastern corner of the site are likely underlain by residual silty / sandy clay / clay, the result of weathering of underlying siltstone, sandstone and claystone (Figure 5, Attachment B). Basement sandstone rock under the site is located at approximately 10m to 20m AHD (Coffey, 2007).

A summary of inferred subsoil profiles at investigation locations is presented in Table 10, Attachment C. Reference should be made to borehole and test pit logs (Attachment D) for further details of the conditions encountered at each borehole/ test pit location and associated notes in Attachment H. Borehole/ test pit locations are shown on Figure 3, Attachment B.

3.2.2 Groundwater

Historical groundwater level measurements at established GMBs are collated in Table 2. Refer to Table 11, Attachment C, for data that was used to compile Table 2. The data includes a long history of instantaneous dipped levels and also some periods of continuous monitoring with data loggers. Approximate GMB locations are presented in Figure 3, Attachment B.



Table 2:	Groundwater	level s	ummary.
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C110		GIUUII	dwater Level (M AHD)	Min Depth to
GMB	Level (m AHD)	Minimum	Median	Maximum	Groundwater (m)
GMB1	1.02	0.24	0.63	0.93	0.09
GMB2	2.37	0.69	1.02	2.02	0.36
GMB3	0.85	0.06	0.74	0.79	0.06
GMB4	2.05	0.82 4	1.07 4	1.30 4	0.74 4
GMB5	2.61	1.14	1.66	2.56	0.05
GMB6	0.86	0.28 ³	0.67 ³	0.77 ³	0.09 ³
GMB7	2.96	1.55 ²	2.42 ²	2.82 ²	0.15 ²
GMB8	2.60	0.73	1.78	2.46	0.14
GMB9	2.86	1.16 ²	1.71 ²	2.11 ²	0.75 ²
GMB10	1.49	0.39	0.89	1.23	0.26
GMB11	3.40	1.35	2.01	3.01	0.39
GMB12	3.26	1.37	2.12	3.05	0.21
GMB137	-	-	-	-	-
GMB21	1.03	0.78	0.80	0.81	0.21
GMB22	1.10	0.83	0.85	0.88	0.22
GMB23	1.11	0.76 ²	0.93 ²	0.93 ²	0.18 2
GMB24	0.83	0.63	0.65	0.68	0.15
GMB1A ⁵	1.71	0.72 1	0.82 1	1.06 1	0.65 1
GMB2A ⁵	2.48	1.13 ¹	1.20 1	1.32 1	1.16 1
GMB25	1.80	0.78 1	0.86 1	1.00 1	0.80 1
GMB26 (lake) ⁶	0.49	0.63 1	0.70 1	0.90 1	NA 1
GMB201	2.74	1.9	1.99	2.08	0.66
GMB202	3.69	0.9	0.95	1.0	2.69
GMB203	5.14	3.82	3.97	4.11	1.03

Notes:

^{1.} Derived based on continuous data logging data (04/06/2009 to 06/07/2009).

Derived based on dipped data and continuous data logging data (04/06/2009 to 06/07/2009).

 Derived based on dipped data and continuous data logging data (late July to mid-November, 1994).

 Derived based on dipped data and continuous data logging data (late July to late September, 1994).

 $^{\rm 5.}$ $\,$ Replacements for GMB1 and GMB2.

^{6.} Lake bed level at standpipe location.

7. No details available.



The following comments are made based on review of site groundwater level data:

- 1. Groundwater is confined to within a shallow to medium depth marine deposit at or above sea level. The aquifer generally comprises fine to medium grained silty sands and sand with cemented (Coffee Rock) and peaty layers (with surface clay deposits in some areas).
- 2. The groundwater system is bounded by the Myall River to the east and Port Stephens associated bays and creeks to the south/west. The aquifer adjoins a bedrock controlled hill in the north and north west of the site. It is responsive to tidal fluctuations.
- 3. Water table depths are frequently shallow and typically less than 1m-2m below existing ground level. Groundwater depth variations are minimal spatially across the majority of the site, in response to minimum site grades. Water levels within the aquifer are dependent on incident rainfall and sea level rather than other catchment processes, such as run-on.
- 4. The groundwater gradient is down towards the lake to the south east of the site; saline/brackish lake water was not migrating from the lake to the local groundwater system.

Groundwater modelling results (MA, 2013) indicate that the proposed development would result in no discernible impact on groundwater levels within the site or adjacent critical ecosystems (i.e. SEPP 14 wetlands). Development impact on groundwater would be limited to the higher western portions of the site and the north-eastern area with the zone of impact being relatively confined and not extending to downslope critical ecosystems.

For further information on groundwater conditions, refer to MA's report Concept Integrate Water Cycle Management Strategy (Revised) Riverside, Tea Gardens, NSW referenced P1404136JR04V01.



4 Geotechnical Assessment

4.1 Overview

Proposed development works are likely to encounter topsoils to depths of up to 0.6m, overlying generally medium to dense sand/ silty sand. The sands are overlain in places by soft to very stiff clay and contain some sandy clay/clayey sand layers. Layers of very dense iron indurated sand or very stiff to hard clay pans of variable thicknesses are present within the subsoil profile. These were identified at variable locations across the site and at varying depths. A thin layer of loose Aeolian sand covers isolated areas of the site.

The clay soils were inferred to be of medium to high plasticity, with a likely moderate to high reactivity (volume change or shrink/swell potential) to soil moisture content variations.

4.2 Key Geotechnical Constraints

The proposed development is expected to be impacted by the following key geotechnical constraints:

- Poor and variable subgrade/ foundation conditions due to deep and variable soil conditions across the site.
- Compressible clay soils within the upper soil profile, in conjunction with up to about 2.5m of fill to be placed at some areas of the site.
- Possible compressible peat layers within the soil profile (based on experience from previous assessments carried out by MA in the vicinity of the site), in conjunction with up to about 2.5m of fill to be placed at some areas of the site.
- Layers of very dense iron indurated sand or hard clay pans, which may be difficult to excavate using small excavation equipment.
- Potential Acid Sulfate Soils (ASS) within the soil profile (refer MA report reference P1404136JR01V01).
- Shallow groundwater table, typically less than 2m below existing ground level.
- Potential saline soil and groundwater at the site.
- Poor subgrade conditions for proposed pavements and future building foundations.



4.3 Geotechnical Recommendations

Geotechnical recommendations for design and construction of the proposed development are provided in Table 3. Geotechnical design parameters for encountered sub-surface materials presented in Table 3 are based on soil strengths, estimated from borehole logs (Attachment D), and are subject to the recommendations presented in this report. The design parameters are preliminary and should be confirmed by additional investigations and testing prior to issuing of a Construction Certificate or preparation of detailed design.



Table 3:	Geotechnical recommenda	ations.

ltem	Re	commendation
Footings	0	New buildings, swimming pools and other lightly loaded structures may be supported by shallow footings, e.g. pad or strip footings or slab-on-ground.
	0	Footings are to extend through topsoil and be founded on at least medium dense sand or stiff clay or on engineered fill, subject to recommended earthworks presented in Section 7. An allowable end bearing pressure of 100kPa may be adopted for preliminary footing design, assuming a minimum embedment depth of 0.75 and subject to the following recommendations and CSIRO Sheet BTF 18, Attachment F.
	0	All footing excavations should be inspected followed by concrete placement with minimal delay following excavation completion. If a delay in concrete placement is anticipated, a blinding layer of at least 50mm concrete should be placed to protect foundation conditions.
	0	A geotechnical engineer is to confirm conditions encountered at foundation level satisfy design assumptions and that the base of all excavations is free from loose or softened material and water prior to footing construction.
	0	Water ponding in the base of footing excavations should be removed by pumping; any loosened and softened material at the footing excavation base should then be removed.
	0	All footings should found on material with similar end bearing capacity to limit differential movement across building footprints. Similarly, individual pad footings should not span the interface between different foundation materials. All footings should be founded in either medium dense or denser sand or at least stiff clay to achieve a uniform allowable bearing pressure.
Site Classification	0	Considering the variability of site conditions, in particular presence of clay in some site areas, a preliminary site classification of 'M' should be adopted for design of lightly loaded shallow footings in accordance with AS 2870 (2011). This assumes footings found on natural material below root-affected soils or on engineered fill. A preliminary site classification of 'S' may be adopted for areas underlain by at least 2m medium dense sand.
	0	Further assessment of site subsurface conditions, including laboratory testing, should be carried out at Construction Certificate stage to confirm or reduce the preliminary classification and for final design of foundations at future dwelling locations.
	0	Proposed cutting and site filling, including fill material type and placement conditions, may alter the above site classification.
	0	Consideration should be given to impact of existing and former mature trees on design characteristic free surface movements.
	0	All new shallow footings should be design in accordance with AS 2870 (2011), the recommendations presented in this report and site maintenance guidelines presented in CSIRO Sheet BTF 18, Attachment F.
Piled Foundations	0	Where foundations are to extend below the zone of influence of existing or proposed buried infrastructure, piled foundations may be adopted.
	0	The use of CFA piles may be considered. Presence of very dense indurated sand layers / hard clay pans and shallow groundwater levels will likely limit the efficacy of screw, bored in-situ or driven piles.
	0	An allowable end bearing pressure of 300kPa may be adopted for preliminary pile design, assuming a minimum embedment depth of at least 5m and subject to intimate contact between pile and surrounding soil.
	0	For uplift resistance, we recommend adopting 50% of the allowable end bearing pressure.



Item	Re	commendation
Soil Retention/ Batters	0	Excavations and fill embankments exceeding 0.75m in height should be supported by suitably designed and installed retaining or shoring structures.
	0	Alternatively, soil overburden may be excavated or fill material placed without structural support but with a maximum temporary (less than 1 month) batter slope of 1V (vertical) : 2H (horizontal) and permanent batter slope of 1V : 3H.
Retaining Structures	0	Retaining structures, if required, are to be engineer designed and backfilled with suitable gravel and free-draining material.
	0	Retaining wall design should consider impacts of sloping ground and additional surcharge loading from existing structures, construction equipment, backfill compaction and static water pressures unless subsoil drainage is provided behind retaining walls.
	0	Suitable drainage measures, such as a geofabric enclosed Agg-pipe, should be included to collect and redirect seepage water from behind retaining walls.
Overland Flows	0	All surface runoff water should be diverted away from excavation areas during construction works and from any retaining structures, footings or crest / base of embankments to prevent water accumulation, foundation / embankment strength reduction and pore water pressure increases.
Soil erosion	0	Soil overburden should be removed and spoil managed with erosion control measures in a manner that prevents transportation of sediments off-site and reduces risk of sedimentation of natural drainage channels and existing stormwater drainage systems in the vicinity of the site.
	0	Erosion control measures to be considered in conjunction with recommendation by Landcom (2004) to limit surface run-off and associated risk of surface scour, soil erosion and sedimentation, include:
		a) Maintaining vegetation where possible.
		b) Limiting the area of site disturbance.
		c) Landscaping disturbed areas following completion of construction.
		d) Use of gabion mattress, or other suitable energy reduction solutions, where required.
		e) Directing surface water away from excavations/ working platforms.
		f) Covering exposed excavation/ fill batters.

4.4 Salinity

4.4.1 Salinity Processes

Salts occur naturally in soil or groundwater. Salinity generally refers to the mineral salt concentrations in soil or groundwater resulting from hydrological processes. Accumulation of soil or groundwater salinity, known as salinisation, is often attributable to the alteration of natural water cycles due to land-use or water-use changes.

Typical causes of increased salt concentrations within the soil profile/ groundwater, or mobilisation of the salts to the ground surface, include capillary rise of soil moisture in conjunction with increased surface evaporation, increased application of surface water, rising



groundwater tables or changes to groundwater recharge conditions. This salinisation can have detrimental effects on fauna, flora and on man-made materials, including concrete, brick and metal, if in contact with saline soil or groundwater.

4.4.2 Broad Scale Salinity Processes

A list of key broad scale salinity processes likely to impact the site (based on pg. 16 of Western Sydney Salinity Code of Practice, 2004) is presented in Table 4.

4.4.3 Signs of Potential Saline Soils

No obvious signs of saline conditions were observed at the site in dry areas:

- Vegetation growth appeared healthy and uninhibited.
- Water marks or salt crystals were not observed on ground surfaces.
- 4.4.4 Possible Site Conditions Impacting Site Salinity Potential

Site conditions that may impact salinity potential at the site include:

- Poorly draining soils.
- New and existing surface water features.
- Shallow groundwater levels, typically <2m bgl.
- Close proximity to wetlands, Myall River and Port Stephens associated bays.
- 4.4.5 Assessed Salinity Risk Potential

In Table 4, overleaf, the broad scale salinity processes have been assessed in terms of likelihood of occurring at the site, considering the proposed development, site observations and previous investigation findings.

4.4.6 Laboratory Test Results

No laboratory testing has been carried out to date on soils underlying the site. 40 samples from 24 GMB's were submitted to ALS Environmental and Envirolab Services, both National Association of Testing Authorities (NATA) accredited laboratories, for chemical testing. Analytes included electrical conductivity (EC_w), pH, Chloride (CI) and Sulfate (SO₄). Laboratory test results are collated in Table 5. Refer to



Table 11, Attachment C, for data that was used to compile Table 5. Laboratory test certificates are provided in Attachment E.

Key Salinity Process	Description	Potential at Subject Site
Localised concentration of salinity	 Localised concentration of salts due to relatively high evaporation rates. Usually associated with waterlogged soil and poor drainage. Increased water use associated with urban development can exacerbate the problem. 	High – area impacted by poor surface water drainage and water logged soil. Drainage inhibited due to low slopes and underlying very dense sand/ very stiff clay. No evidence of salt concentrations was observed.
Shale Soil Landscapes	 Where there are poorly drained duplex (texture contrast) soils and shallow ground water flows laterally across the upper B-horizon, salt usually accumulates in the clayey sub-soil. The situation is worsened when subsoils are exposed by deep cutting, when buildings are installed into the B-horizon, and when subsurface water flows are impeded. 	Low – Site is underlain predominantly by Quaternary and Pleistocene deposits. Sub-surface water flows are expected not to be impeded.
Deep Groundwater Salinity	 Brackish or saline groundwater rises to a level where capillary action in the soil results in the water and dissolved salts reaching the surface. Groundwater rises typically caused by increased water infiltration (above average rainfall, vegetation loss, irrigation, increased water use in urban areas). 	 Moderate - groundwater typically 1m to 2m bgl. Proposed development is expected to: Not intercept or raise groundwater levels. Include installation of appropriate drainage measures. Include appropriate management of surface water infiltration.
Deeply Weathered Soil Landscape	 High salt loads related to un- mapped deeply weathered soil landscapes, comprising fluvial gravel, sand and clay. 	Low – Unlikely presence of deeply weathered soil landscapes.

Table 4: Potential for broad scale salinity processes at the site.

Table 4 indicates a possible high potential for broad scale salinity within the site sub-soils.



Well ID	pH 1	ECw² (d\$/m	² Chloride ² Sulfate n (mg/L) S04		Exposure Classification ³		
)		(mg/L)	Concrete	Steel	
GMB1 4	6.4	NT ⁵	220	33	NT ⁵	NT ⁵	
GMB2 ⁴	5.3	NT ⁵	82	16	NT ⁵	NT ⁵	
GMB3 4	5.9	18.00	7600	1200	Moderate	Severe	
GMB4	5.2	0.32	75	10	Moderate	Mild	
GMB5	5.1	0.26	49	10	Moderate	Mild	
GMB6	5.7	8.40	2900	360	Mild	Severe	
GMB7 ⁴	5.5	0.20	38	7	Moderate	Mild	
GMB8	5.2	0.32	71	24	Moderate	Mild	
GMB9	4.0	0.18	37	13	Very severe	Moderate	
GMB10	5.6	0.30	150	3	Non-aggressive	Mild	
GMB11	5.6	4.70	1400	180	Non-aggressive	Severe	
GMB12	5.0	0.27	65	25	Moderate	Mild	
GMB13	NT 5	NT ⁵	NT ⁵	NT ⁵	NT ⁵	NT ⁵	
GMB21	5.6	15.50	5300	702	Mild	Severe	
GMB22	5.9	1.61	430	39	Non-aggressive	Severe	
GMB23	5.6	0.28	65	6	Non-aggressive	Mild	
GMB24	5.5	2.73	800	344	Moderate	Severe	
GMB1A	6.2	0.28	30	39	Non-aggressive	Mild	
GMB2A	5.1	0.20	50	5	Moderate	Mild	
GMB25	5.6	0.26	36	5	Non-aggressive	Mild	
Lake26	6.3	16.0	5800	850	Mild	Severe	
Lake	5.8	0.18	37	12	Non-aggressive	Non-aggressive	
GMB201	5.3	2.00	6400	26	Moderate	Severe	
GMB202	5.4	0.11	18	5	Moderate	Non-aggressive	
GMB203	5.3	0.19	43	5	Moderate	Non-aggressive	

Table 5: Results of pH, ECw, Cl and SO4 testing on water samples.

<u>Notes:</u>

- 1. Actual pH; lowest recorded value.
- 2. Highest recorded values.
- 3. Exposure classification for buried reinforced concrete or metal based on Appendix Two, Tables 6.1 and 6.2, of DLWC (2002).
- 4. GMB lost, destroyed or vandalised sometime between 2004 and 2007.
- 5. Not tested.

4.4.7 Conclusions

The following comments are made based on the review of the site groundwater quality data:

 Electrical conductivity of groundwater (EC_w) samples collected from GMBs ranges from 0.11dS/m (non-saline) to 18dS/m (highly saline).



- The median EC_w concentration is indicative of fresh water (MA, 2011).
- Although, in accordance with AS2159 (2009), exposure classification for concrete ranges from 'non-aggressive' to 'very severe' and for steel from 'non-aggressive' to 'severe', we consider the majority of the site to be affected by an exposure classification ranging between 'mild' and 'moderate'.
- Apart from groundwater collected from GMB11 and GMB201, located in the north western part of the site, severe and very severe exposure classifications are limited to groundwater collected from close proximity to the wetlands and the Myall River to the east of the site.
- EC_w measurements typically cannot be used to infer soil salinity at the site due to variations in groundwater quality in time, soil permeability and porosity across the site and GMB positioning within the site. However, general groundwater chemistry appears to be consistent throughout previous monitoring periods.
- 4.4.8 Recommendations

The salinity assessment indicates that EC_w concentrations of site groundwater are indicative of fresh groundwater but that the groundwater is typically mildly to moderately aggressive to buried concrete and steel. However, it is likely that higher EC_w concentrations and more severe exposure classifications affect some site areas. Furthermore, assessment of broad scale salinity processes indicates a possible high potential for salinity within the site sub-soils.

We recommend that saline soil management strategies are prepared at Construction Certificate stage for inclusion in design and adoption in construction of the proposed development, subject to the results of further testing (refer Section 8).

Saline soil management strategies for earthworks and landscaping should include, but not be limited to:

- Maintaining natural water balance.
- Limiting irrigation.
- Limiting soil disturbance, such as cut and fill, so saline or sodic subsoils are not exposed or groundwater is not intercepted.
- Planting of suitable salt-tolerant plant species.



- Retention of existing deep-rooted vegetation.
- Offset landscaping and gardens from building and retaining walls.
- Treating soils with gypsum before landscaping to suit selective species.
- Where consistent with future land use and landscaping plan, planting of deep-rooted, preferably native, trees to increase water absorption.
- Sealing, e.g. by lining, of stormwater detention ponds and water features to reduce infiltration.
- Preparing sediment and erosion control plans that take into account saline soils.
- Replacing excavated soils in their original order.
- Any long term irrigation or watering on-site is to be at a level that does not cause groundwater to become perched.

Management strategies for new buildings and services should include, but not be limited to:

- Limiting soil disturbance, such as compaction of soils, cutting and filling.
- Designing and building structures to limit interference with natural water flow on site.
- Using appropriate construction materials and techniques to salt proof buildings and infrastructure.
- Correctly installing and maintaining damp proof courses in buildings.
- Utilising damp proof courses and water proofing of slabs.
- Using exposure grade bricks/masonry below damp course or in retaining walls.
- Providing concrete strength and cover to steel reinforcing in accordance with AS 3600 (2009) and the exposure classifications outlined in Table 5.



• Limiting excess surface water infiltration into the soil by designing, installing and maintaining appropriate stormwater drainage (gutters, downpipes, pits and pipes).

4.5 Preliminary Pavement Design

4.5.1 Overview

Preliminary pavement designs were previously undertaken by Coffey (Coffey, 2008) for proposed access and collector roads associated with the site development. The designs adopted a traffic loading of Equivalent Standard Axles (ESA) in accordance with Great Lakes Council guidelines (Table 6). These values fall within Austroads guidelines for design traffic ESA values assuming a 20 year design life (Austroads, 2012).

Road Type	N (ESA)
Collector	1x10¢
Local access road	5x10 ⁵

CBR values adopted by Coffey for the pavement thickness designs (Table 7) were based on Coffey's experience from the adjoining Myall Quays Estate development.

Additional CBR testing is recommended to provide a better indication of subgrade conditions across proposed pavement areas and/or provide statistical means to support higher CBR values. The additional testing should be undertaken prior to final design and Construction Certification stage.

Material Type	CBR Value (%)
Clay	2
Sand	10

4.5.2 Pavement Thickness

The designs were prepared by Coffey in accordance with ARRB Special Report No.41, APRG Report 21 and Austroads – Pavement Design 2004. These designs should be reviewed in conjunction with findings associated with additional CBR laboratory testing to comply with Austroads 2012.



Table 8 presents preliminary recommended pavement material thicknesses for the proposed collector and local access roads adopting ESA and CBR values presented in Tables 6 and 7 respectively. Further integration with final pavement details will be required during the construction phase of the development to complete this pavement design.

Road Type / ESA 1	CBR (%)	Layer	Thickness (mm)
Collector / 1 x 10 ⁶	2	Wearing course (1 layer of AC10)	40 1
		Base (DGB)	150 ²
		Sub-base (DGS)	150 ²
		Select fill (CBR>15%) 3	500
		Total pavement thickness	840
	10	Wearing course (1 layer of AC10)	40 1
		Base (DGB)	150
		Sub-base (DGS)	150
		Total pavement thickness	340
Local access roads / 5 x 10 ⁵	2	Wearing course (1 layer of AC10)	40 1
		Base (DGB)	150 ²
		Sub-base (DGS)	150 ²
		Select fill (CBR>15%) ³	500
		Total pavement thickness	840
	10	Wearing course (1 layer of AC10)	40 1
		Base (DGB)	150
		Sub-base (DGS)	150
		Total pavement thickness	340

 Table 8: Preliminary pavement material thickness design summary.

Notes:

¹ RTA QA Specification R116.

² RTA QA Specification 3051.

³ Well graded granular material with maximum particle size = 100mm and minimum CBR = 15%.

4.5.3 Subgrade Preparation

The subgrade is to be trimmed and compacted with density testing of the upper 300 mm layer at a rate of 1 test per 50m of road length. The natural subgrade material and the final 300mm of fill material placed to reach design subgrade level should be compacted to a minimum density index (DI) for sands of 80% or minimum density ratio(DR) for



cohesive soils of 100% Standard Maximum Dry Density (SMDD), within 2% of optimum moisture content (OMC). Prior to placement of pavement material, the subgrade should be proof rolled and approved by a geotechnical engineer.

Soft or wet spots can be treated by one of the following methods subject to final design by MA:

- 1.Removal to a depth of at least 500mm and replacement with approved select fill material under the direction of a geotechnical engineer.
- 2.*In-situ* stabilisation with cement/lime or similar binding agent to a depth of at least 300 mm below finished level. Use of this method and extent will depend on the condition of material to be stabilised.
- 3. The use of a geofabric as bridging layer beneath the select fill.

General earthworks should be carried out in accordance with recommendations presented in Section 7.1.

4.5.4 Placement and Testing of Pavement Material

Pavement materials shall be placed in layers (loose) not thicker than 250mm or less than 75 mm. Pavement materials shall be compacted to the following condition:

- Select fill Minimum DI of 80% for non-cohesive soils or DR of 100%
 SMDD for cohesive soils, at ±2% OMC.
- Sub-base Minimum 95% Modified Maximum Dry Density (MMDD) at ±2% OMC.
- $\circ~$ Base Minimum 98% MMDD at ±2% OMC.

Compaction testing shall be undertaken at a rate of 1 per 250m² per layer or 3 per pavement layer placed, whichever is the greater. Each pavement layer shall be proof rolled under geotechnical engineering supervision. Subsequent layers of pavement shall not be placed prior to approval of underlying layer.

4.5.5 Subsoil Drainage

Adequate surface and sub-soil drainage is to be provided. Subsurface drains are to be installed typically on the upslope side of roads and generally extend 500 mm below pavement level. Where clay soils



are located at subgrade level, it is recommended that subsoil drains are installed on both sides of the roads.

Lot drainage design will need to consider the impact of road fill on drainage of adjacent lots, particularly where surface materials comprise clay soils. The use of column drains, extending through the clay soils into underlying more permeable sands, may be considered.

4.6 Acid Sulfate Soils

Earthworks should be carried out in general accordance with the ASSMAC (1998) guidelines, considering potential environmental impacts from site development relating to ASS in and around the site.

Recommendations on possible mitigation measures for ASS management during proposed earthworks that are likely to disturb ASS, e.g. cut and fill activities and trenching works, are presented in an Acid Sulfate Soils Management Plan (ASSMP) provided in MA report reference P1404136JR02V01.

4.7 Further Construction Considerations

4.7.1 Material Excavations

Most soils should generally be readily excavated using conventional earthmoving equipment. Larger equipment may be requird to excavate very dense iron indurated sand or hard clay pans. Overdisturbace of soils below design excavation levels should be avoided. This may be achieved with the use of a 'mud bucket' fitted to an excavator.

4.7.2 Earthworks for Site Preparation

All earthworks should be carried out in accordance with AS3798 (2007) Guidelines on Earthworks for Commercial and Residential Development.

We recommend the following general earthworks are carried out for site preparation:

- a) Strip topsoil and / or root affected soils, encountered to depths typically between 0.15m and 0.45m and up to 0.6m bgl, and stockpile for either re-use on site or off-site disposal.
- b) Where required, excavate natural soils to design levels, segregating and stockpiling materials for either re-use as site filling or removal from site.



- c) A suitably gualified geotechnical engineer should inspect the condition of the exposed material at design level to assess the ability of the prepared surface to act as pavement subgrade, foundation for future fill placement or foundation for new buildings and other structures. It is expected that the moisture content within site soils will typically be high and exceed the OMC typical for the material types. The likely need for drying back of clayey subsoils or over-excavation and replacement of wet materials prior to site filling should be considered. Furthermore, allowance should be made for the sensitivity of subgrade preparation times to prevailing weather conditions at the time of construction and associated impacts on construction Mixing of clayey material with lime may be proarammina. considered to assist material placement or achieve earthworks specifications.
- d) Unsuitable, soft or wet material or heaving areas identified by proof rolling are to be removed and replaced to a minimum depth of 500mm below subgrade level, or as directed by the Geotechnical Engineer.
- e) Fill material comprising site-won granular material or approved imported granular fill material should be placed in horizontal layers of not more than 300 mm loose thickness. However, the layer thickness should be appropriate for the compaction plant adopted.
- f) Earthworks compliance testing should be carried out in accordance with Table 8.1of AS3798 (2007), with testing to be provided by a NATA accredited testing authority.

For areas likely to be subjected to a loading of up to 20 kPa, fill material should be moisture conditioned and compacted to a minimum DI of 75% or DR of 98% SMDD, within 2% of Optimum Moisture Content (OMC). For areas loaded to greater than 20 kPa, the material should be moisture conditioned and compacted to a DI of 80% or DR of 100% SMDD, within 2% of OMC. For general fill areas, fill should be compacted to a DI of 70% or DR of 95% SMDD and moisture conditioned to be within 2% of OMC.

In addition to the above, consideration should be given to additional earthwork requirements/ mitigation measures to limit surface settlement as a result of long-term consolidation of subsurface clay soils and peat, e.g. soil improvement or pre-loading of development platform. Further associated site assessments and laboratory testing may be necessary.



4.7.3 Trafficability

Trafficability of site plant and haulage trucks on clayey sub-soils or loose to medium dense sands is expected to be poor, particualry when the material is wet. A cover of crushed concrete/ aggregate will likely be required in high trafficked areas.

4.7.4 Working platforms

Working platforms for construction plant, piling rigs and crane pads, placed on in-situ material or on new fill, should be designed by an experienced and qualified geotechnical engineer.

4.7.5 Material Re-use

Topsoil may be re-used on site for landscaping purposes only.

Excavated natural granular material, such as sand or silty/clayey sand, could be re-used on site for subgrade replacement and as general fill, subject to approval by a geotechnical engineer.

Clayey soils may be re-used on site as general fill. However, strict moisture conditioning and compaction close to the previously outlined specifications will be essential to limit soil movements due to the reactivity of the soil to changes in soil moisture content.

Over-excavated clayey soils that are over wet are considered unsuitable for re-use as fill material at the site and should be disposed of off-site.

4.7.6 Material Import

Imported granular fill material should comply with AS3798 (2007) and should not contain particles with dimension exceeding 2/3rds of the loose layer thickness or unsuitable material, such as:

- Organic soils, root affected soil, decaying vegetation or other deleterious substances;
- Materials contaminated through past site history;
- Silts or materials subject to volume change; and
- Material that contains wood, metal, plastic, boulders, soluble or perishable material.



4.7.7 Material Disposal

All material to be removed from site for off-site disposal, following treatment in accordance with the ASSMP, must be classified in accordance with NSW DEC (2009) Waste Classification Guidelines Part 1- Classifying Waste, confirming its suitability for re-use or for disposal at an appropriate licensed landfill facility. MA can assist in providing such classification, if required.



5 Adequacy and Additional Assessment Requirements

5.1 Site Suitable for Proposed Development

From a geotechnical perspective, we consider the site is suitable for the proposed development, subject to the recommendations outlined in this report. Recommendations of this report should be reviewed by MA in the context of final development details once this information becomes available (i.e. at CC stage) and with reference to the results of further assessments carried out for the site development.

5.2 Additional Assessment Requirements

We recommend the following additional assessments are carried out during development of final design and prior to issuing of a construction certificate to better manage geotechnical risks, where applicable:

- Settlement analyses for areas likely underlain by loose sand or clay and peat layers, susceptible to settlement/ consolidation upon loading as a result of proposed fill placement. The analyses should include further assessment of soil conditions, such as by cone penetrometer testing (CPT) and laboratory testing of clay/ peat soils.
- Assessment of foundation condition beneath future building platforms and infrastructure locations and up to at least 3m below pile foundation levels, as applicable.
- Laboratory testing of soil, as necessary, for more accurate assessment of subsurface conditions and associated design parameters, including shrink/swell and Atterberg Limit testing, and to confirm or alter preliminary site classifications and design assumptions.
- Assessment of site specific foundation material capacity considering adopted footing types.
- Review of construction staging plans by a geotechnical engineer.
- Further salinity assessments in keeping with final development details and earthwork requirements to delineate salinity conditions in soil profiles across the site and development areas and to assess potential ensuing implications on the proposed development and mitigation requirements. The assessments are to include laboratory



testing of site sub-soils to improve characterisation of site salinity conditions, particularly in proposed development areas.

- Assessment of pavement subgrade conditions along final road alignments, including laboratory soil testing, and of associated design parameters, such as CBR values.
- Detailed pavement designs in accordance with Austroads (2012) by further integrating preliminary and supplementary assessment results with final pavement details.

5.3 Proposed Monitoring and Inspection Program

To maintain site stability, limit adverse geotechnical impacts on site and surrounding areas and reduce the risk of sediment transport off-site due to erosion during site works, we recommend the following (Table 9) be monitored during site works.

Scope of Works	Frequency/Duration	Who to Complete
Inspect excavation retention (shoring, retaining wall) installations and batters and monitor associated performance.	Daily/ As required.	Builder/ MA ¹
Monitor groundwater seepage from excavation faces to assess adequacy of drainage provision.	When encountered.	Builder/MA
Monitor sedimentation downslope of excavated areas.	During and after rainfall events.	Builder
Monitor sediment and erosion control structures to assess adequacy and for removal of built up spoil.	After rainfall events.	Builder
Inspect exposed material to verify suitability as foundation/lateral support/subgrade.	Prior to reinforcement set-up and concrete placement for footings, and prior to fill/ pavement material placement.	MA
Inspect subgrade treatment methodologies (to limit long-term settlement/ consolidation) during bulk filling and monitor associated performance, e.g. by means of survey or appropriate soil settlement gauges.	During construction; verification prior to approval for pavement construction or lot development.	Builder/ MA
Verify the suitability of ASS treatment by monitoring pH after oxidisation and laboratory testing of excavated soil and groundwater.	As outlined in MA report reference P1404136JR01V01.	Builder

 Table 9: Recommended inspections/monitoring requirements during site works.

Notes:

1. Martens & Associates geotechnical engineer



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5.4 Contingency Plan

In the event that the proposed development works cause an adverse impact on site conditions or the surrounding environment, works shall cease immediately. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated. This might require site inspection by a qualified geotechnical or structural engineer.



6 Limitations

Alluvial and marine environments are particularly variable due to their depositional history. Rapid changes in material type and condition can occur over short lateral distances. Recommendations outlined in this report must be observed to assist in mitigating against this variability.

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

In the event that there are any significant changes to the development proposal described in this report, then all recommendations should be reviewed by Martens & Associates.

Occasionally sub-surface soil conditions between completed boreholes / test pits may be found to be different from those expected. This can also occur with groundwater conditions, especially after climatic changes. Should, during site works, soil or water conditions be found to be significantly different to those detailed in this report, works shall cease immediately and the new conditions should be addressed by Martens & Associates to determine any implications before recommencement.

This report was prepared by collating results of previous assessments and considering the current proposed development proposal. It is assumed that the data supplied by others is correct, unless otherwise stated. No responsibility is accepted for incomplete or inaccurate data. Any assessments made in this document are based on conditions indicated in published documents. No warranty is included, either express or implied, that actual conditions will conform exactly to the assessment contained in this document.



7 References

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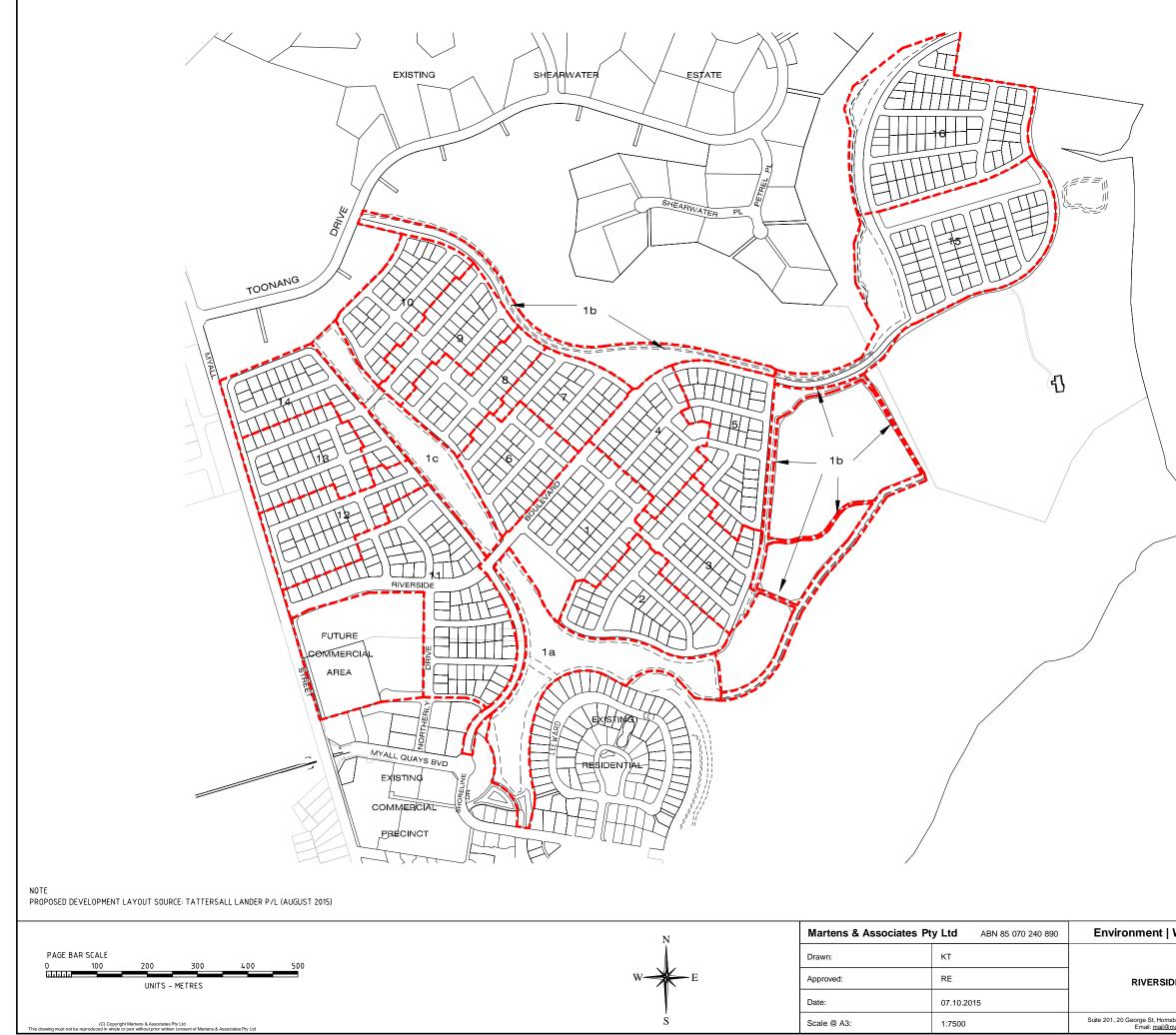


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8 Attachment A – Staging Plan





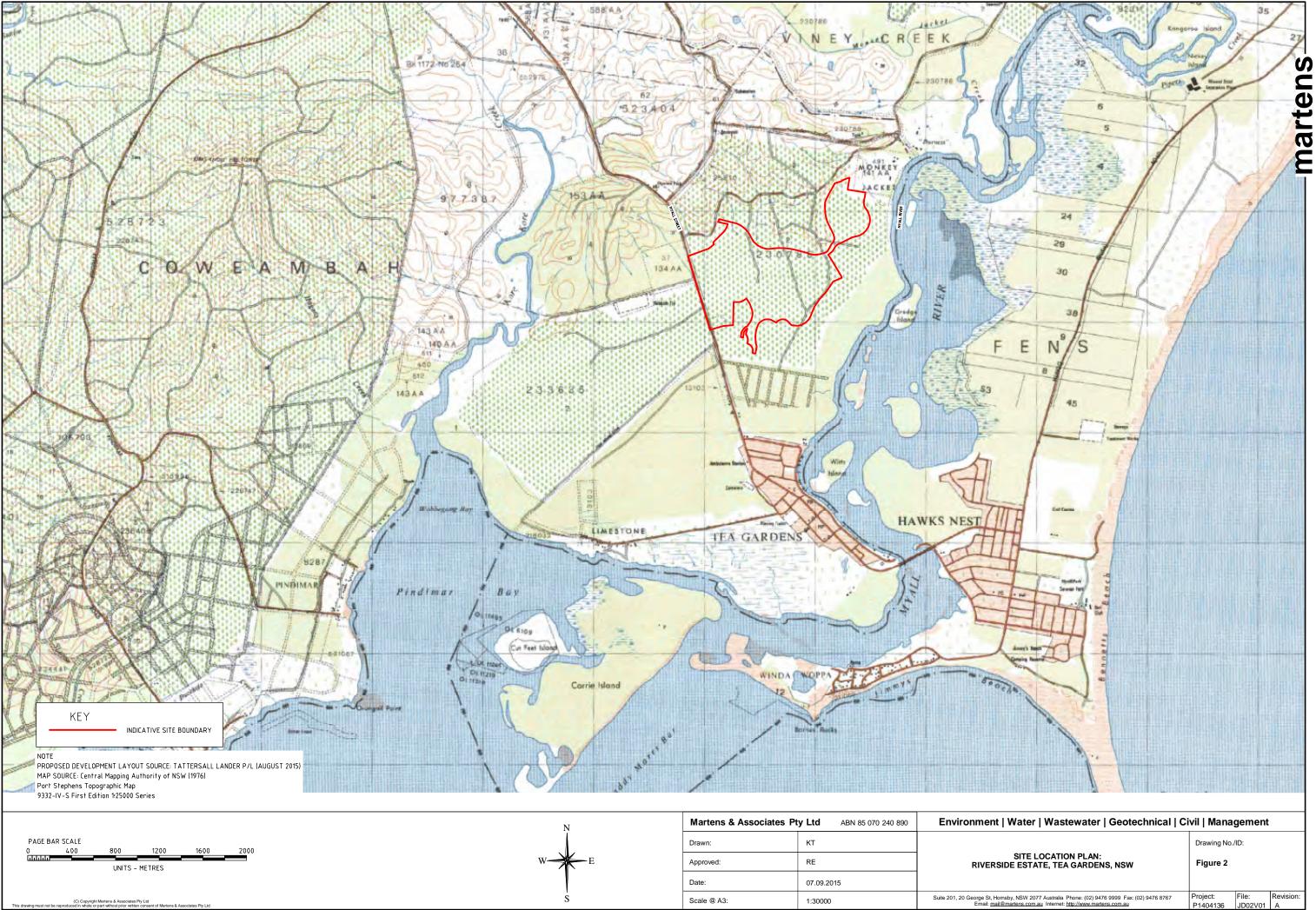
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1	45
2	41
3	47
4	42
5	52
6	39
7	36
8	32
9	38
10	40
11	89
12	44
13	43
14	37
15	58
16	84
TOTAL	767
TUTAL	/67

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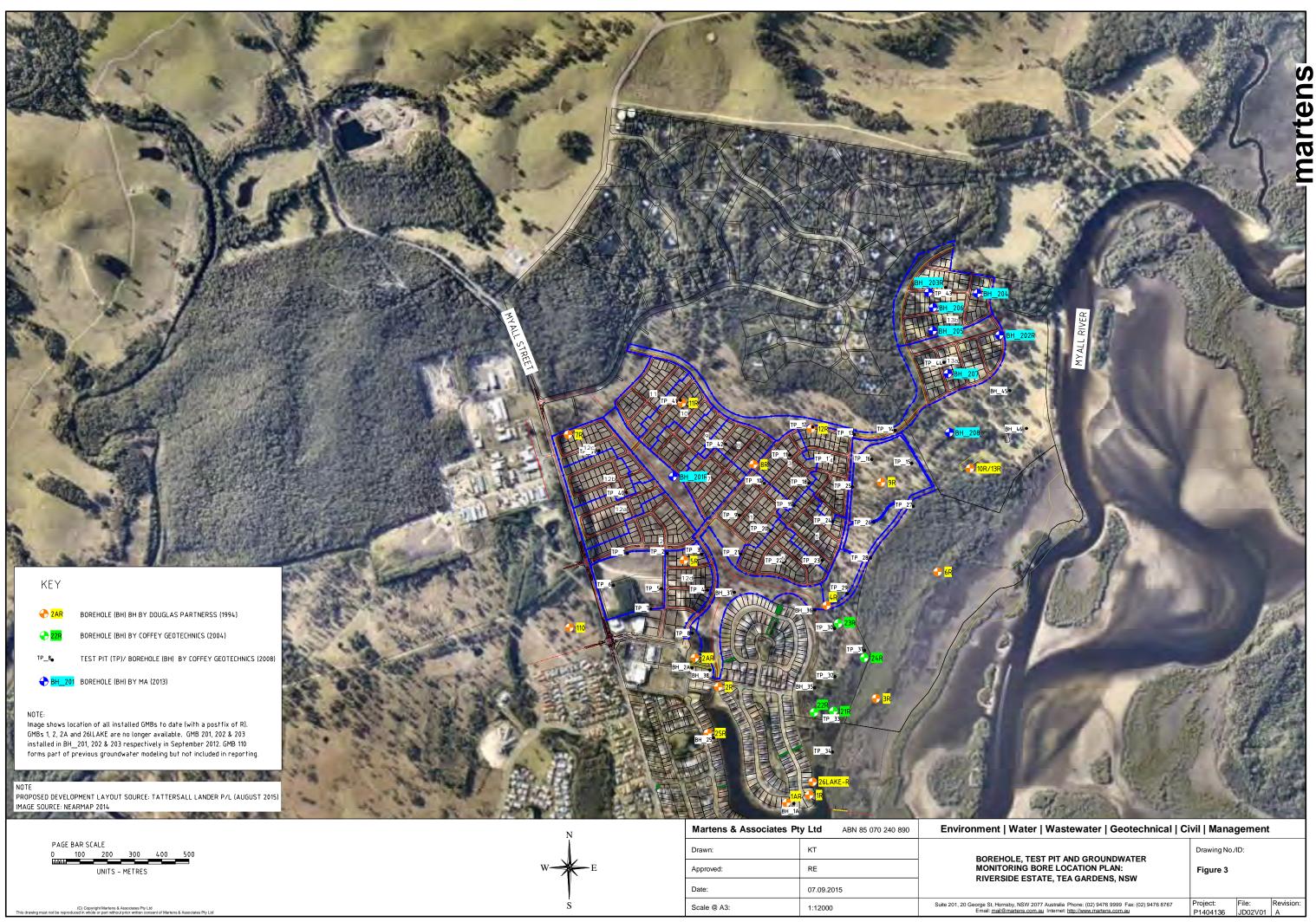
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9 Attachment B – Figures



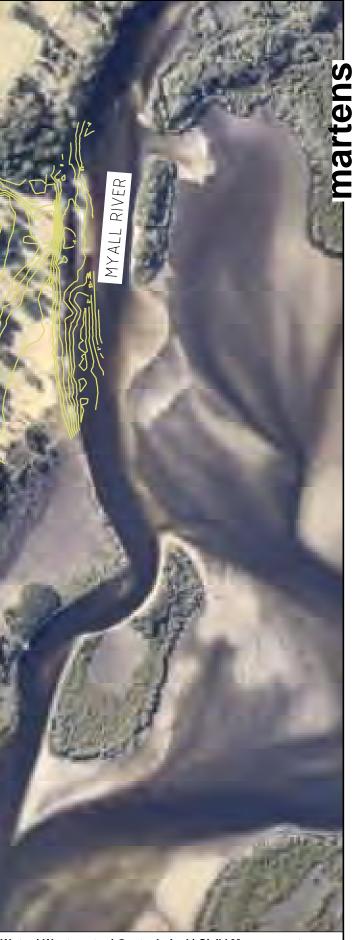


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10 Attachment C – Tables



Table 10: Soil profile summary.

Test ID		Soil Profile ^{1,2}		
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay
Bore 13	0-0.5	NE	0.5-10.2	10.2-10.5
BH 21	0-0.1	NE	0.1-3.0	NE
BH 22	NE	NE	0-3.0	NE
BH 23	0-0.2	NE	0.2-3.1	NE
BH 24	0-0.3	NE	0.3-3.0	NE
TP1	0-0.3	0.3-0.6	0.6-1.9	NE
TP2	0-0.4	0.4-1.5	1.5-1.9	NE
TP3	0-0.5	0.5-0.8	0.8-1.8	NE
TP4	0-0.4	0.4-2.0	2.0-2.1	NE
TP5	0-0.4	0.4-0.75	0.75-1.9	NE
TP6	0-0.6	NE	0.6-2.1	NE
TP7	NE	0-1.0	NE	NE
TP8	0-0.6	0-0.6	NE	NE
TP9	0-0.6	0.6-1.1	1.1-2.0	NE
TP10	0-0.45	0.45-0.8	0.8-1.9	NE
TP11	0-0.2	0.2-1.0	1.0-1.9	NE
TP12	0-0.4	0.4-1.0	1.0-2.0	NE
TP13	0-0.6	NE	0.6-2.0	NE
TP14	0-0.4	NE	NE	0.4-1.8
TP15	0-0.5	NE	0.5-1.7	NE
TP16	0-0.25	NE	0.25-1.8	NE
TP17	0-0.5	0.5-1.1	1.1-2.0	NE
TP18	0-0.4	0.4-0.8	0.8-1.9	NE
TP19	0-0.35	0.35-1.2	1.2-1.8	NE
TP20	0-0.2	0.2-1.7	NE	NE
TP21	0-0.45	0.45-0.6	0.6-2.0	NE



Test ID	Soil Profile ^{1,2}				
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay	
TP22	0-0.5	0.5-0.8	0.8-1.9	NE	
TP23	0-0.3	0.3-0.8	0.8-2.0	NE	
TP24	0-0.4	0.4-0.7	0.7-2.0	NE	
TP25	0-0.5	0.5-1.1	1.1-2.0	NE	
TP26	0-0.3	NE	0.3-1.5	NE	
TP27	0-0.6	0.6-0.8	0.8-1.8	NE	
TP28	0-0.6	0.6-1.2	1.2-1.8	NE	
TP29	0-0.5	0.5-1.4	1.4-1.7	NE	
TP30	0-0.3	NE	0.3-1.7	NE	
TP31	0-0.1	0.1-1.1	1.1-1.8	NE	
TP32	0-0.3	0.3-1.7	NE	NE	
TP33	0-0.25	0.25-1.9	1.9-2.0	NE	
TP34	0-0.25	0.25-1.9	1.9-2.0	NE	
BH35	NE	NE	0-4.0	NE	
BH36	0-0.5	NE	0.5-7.0	NE	
BH37	0-0.25	NE	0.25-7.0	NE	
BH38	0-0.1	0.1-2.2	2.2-7.0	NE	
TP39	0-0.15	0.15-1.4	1.4-1.7	NE	
TP40	0-0.2	0.2-1.1	1.1-1.7	NE	
TP41	0-0.3	0.3-1.5	1.5-2.5	NE	
TP42	0-03	0.3-1-1	1.1-1.7	NE	
TP43	NE	NE	0-1.85	NE	
TP44	NE	NE	0-1.8	NE	
BH45	NE	NE	0-10.45	NE	
BH46	0-0.5	NE	0.5-7.45	NE	
GMB1A	NE	NE	0-5.5	NE	
GMB2A	NE	NE	0-7.0	NE	



Test ID	Soil Profile ^{1,2}					
	Topsoil Silty/clayey sand / Sandy/silty clay	Marine deposits Clay / sandy/silty clay / silty/clayey sand	Marine deposits Sand / silty sand	Residual soil Clay		
GMB25	NE	NE	0-5.5	NE		
BH201	0-0.25	0.25-1.9	1.9-5.5	NE		
BH202	0-0.1	NE	0.1-7.0	NE		
BH203	0-0.2	0.2-1.2	1.2-7.0	NE		
BH204	0-0.3	0.3-1.0	NE	NE		
BH205	0-0.2	NE	0.2-1.0	NE		
BH206	0-0.25	0.25-1.0	NE	NE		
BH207	0-0.2	NE	0.2-0.7	NE		
BH208	0-0.2	NE	0.2-1.0	NE		

Notes:

1 Refer to borehole and test pit logs for more detailed material descriptions at test locations.

2 Indicative depth range below ground level.



Table 11: Groundwater quality summary.

Source	Sample date		GMB1	GMB2	GMB3	GMB4	GMB5	GMB6	GMB7	GMB8	GMB9	GMB10	GMB11	GMB12	GMB13	GMB21	GMB22	GMB23	GMB24	GMB1A	GMB2A	GMB25	Lake 26	Lake	GMB201	GMB202	GMB203
		рH	6.40	5.30	6.20			6.00				5.60	6.00	5.30													
		TDS (mg/L)	490.00	190.00	13900.00			1900.00				420.00	2300.00	220.00													
Coffey	Average result 13/12/94 to	Chloride (mg/L)	220.00	82.00	7600.00			1100.00				150.00	1200.00	60.00													
(Feb, 1996)	29/8/1995	Sulphate (mg/L)	33.00	16.00	1200.00			170.00				5.00	170.00	25.00													
		Magnesium (mg/L)	36.00	6.00	540.00			76.00				8.40	85.00	5.20													
		Calcium (mgLL)	9.00	1.20	160.00			33.00				7.20	22.00	2.20													
		рН				5.32								5.02		5.62	6.05	5.60	5.46								
		TDS (mg/L)				155.00								1210.00		11500.00	1350.00	212.00	2250.00								
		Chloride (mg/L)				50.40								64.60		5300.00	430.00	58.70	800.00								
		Sulphate (mg/L)				10.00								22.00		702.00	39.00	6.00	344.00								
Coffey (Oct, 2007)	29/03/2007	Magnesium (mg/L)				4.00								6.00		420.00	23.00	7.00	54.00								
		Calcium (mgLL)				2.00								2.00		126.00	11.00	3.00	31.00								
		EC (us/cm)				202.00								268.00		15500.00	1610.00	234.00	2730.00								
		TN (mg/L)				0.93								3.07		12.13	7.24	2.51	9.33								
		TP (mg/L)				0.14								0.76		1.38	0.79	0.32	1.12								
		рН									3.99													5.83			
		TDS (mg/L)									200.00													129.00			
		Chloride (mg/L)									34.40													37.40			
Coffey	/ /	Sulphate (mg/L)									13.00													12.00			
(Oct, 2007)	30/03/2007	Magnesium (mg/L)									3.00													3.00			
		Calcium (mgLL)									1.00													8.00			
		EC (us/cm)									178.00													182.00			
		TN (mg/L)									2.53													0.72			
		TP (mg/L)									1.00							6 30		6.00		F (0)	6.00	0.08			
		pH TDS (mg/L)									4.30 96.00							5.70 180.00		6.20 170.00	5.10 120.00	5.60 160.00	6.30 11000.00				
																				30.00							
		Chloride (mg/L)									37.00 5.00							65.00 5.00		39.00	50.00 5.00	25.00 5.00	5800.00 850.00				
Martens and Associates (July,	6/07/2009	Sulphate (mg/L) Magnesium (mg/L)									2.90							7.80		8.20	3.40	4.40	360.00				
2009)	0/07/2005	Calcium (mgLL)									0.30							3.60		5.60	1.20	4.40 3.60	110.00				
		EC (us/cm)									160.00							280.00		280.00	200.00	260.00	14000.00				
		TN (mg/L)									1.00							0.60		7.10	3.80	30.00	0.60				
		TP (mg/L)									1.90							0.05		6.10	2.80	1.20	0.05				
		pH			6.7	6.20	6.30	6.40		5.80	4.00		6.10					0.05		0.10	2.00	6.30	7.30				
		TDS (mg/L)			7300	120.00	200.00	3500.00		200.00	160.00		2800.00									130.00	10000.00				
		Chloride (mg/L)			5500	75.00	49.00	1700.00		62.00	27.00		1300.00									36.00	4900.00				
Martens and		Sulphate (mg/L)			760	4.00	10.00	210.00		20.00	1.00		170.00									1.00	600.00				
Associates (Sept,	4/09/2012	Magnesium (mg/L)			370	6.10	2.10	130.00		4.80	3.10		77.00									4.20	300.00				
2012)		Calcium (mgLL)			110	2.40	0.90	49.00		2.80	0.50		18.00									4.20	97.00				
		EC (us/cm)			18000	320.00	260.00	6400.00		310.00	170.00		4700.00									240.00	16000.00				
		TN (mg/L)			2.2	1.90	1.90	0.90		1.90	2.80		0.70									5.30	0.90				
		TP (mg/L)			0.05	0.05	0.09	0.05		0.10	1.30		0.50									0.20	0.05				
		рН					5.80	5.70	5.50	5.20	4.10	6.00	5.60												5.30	5.40	5.30
		TDS (mg/L)					180.00	4900.00	120.00	160.00	150.00	160.00	2700.00												65.00	1200.00	110.00
		Chloride (mg/L)					44.00	2900.00	38.00	71.00	29.00	53.00	1400.00												640.00	18.00	43.00
Martens and		Sulphate (mg/L)					10.00	360.00	7.00	24.00	1.00	3.00	180.00												26.00	5.00	5.00
Associates (Sept,	27/09/2012	Magnesium (mg/L)					1.50	170.00	3.70	5.00	3.10	10.00	87.00												42.00	1.90	4.00
2012)		Calcium (mgLL)					0.60	67.00	3.60	3.10	0.50	6.20	21.00												13.00	1.70	1.10
		EC (us/cm)					230.00	8400.00	200.00	320.00	170.00	300.00	4600.00												2000.00	110.00	190.00
		TN (mg/L)					1.10	1.20	3.00	1.60	1.90	1.60	0.70												9.90	3.30	4.10
		TP (mg/L)					0.05	0.05	0.20	0.30	1.30	0.10	0.07												1.20	0.30	0.60

Value is less than laboratory PQL

11 Attachment D – Borehole and Test Pit Logs



engineering log -

	en ex	gir čav	nee /at	er ti	ing l on	09	-									Diffice jot	70		₹/1	Sh	eet	1 0	if 1	
	clie prie proj pit	ent: ncipal: ject: locati	00:		P C M 1	ATTERS RIGHTO YALL Q Om nor	ON BRITT N PROPER WAYS RES th of Bo	RTIES F GIDENTI	TY LTD AL OEVELO 10m sout		9 13					bit commer bit comple logged by: checked by	nced: eted:	11/8 11/8 GNR RA IC	3/95 3/95	so: N	OT MEAS			
	•	ipment svatior				ACKHOE 0 m			10	m wide		•		orienta	ition:			datu			OT MEAS			
B2	method	E penetration	support	water	samples, tests,etc	H	depth metres	graphic log	classification symbol	soil		asticity	erial or particle minor compo	characteri		moisture condition	consistency/ density index	buen ke oos	300 Åpenetro- 400 meter	addi	str itiona	ucturi 1 obse	e and rvations	5
COFEXCA VERSION	H		NIC	Δ				RR	PT SP	fragmen SAND: f	ts, str ine to	ong organ medium gr	ic_odour	peat, wood ngular to w ight odour		W	L							
by. Ltd. 1989 10 /11 /95 15 :48 :29										due Termina	to ref tion de nflow w	usal at s pth appro ater very	ximate.	2.00 m rated layer										
(C) Copyright Coffey Partners International Pty. Ltd.	N BH B E HA HT SU SH	ex ba bu bu ex ha ha PPORT	istir ckhoe lldoz lldoz cavat nd au nd to .ng uppor	ng ex e buc ren b ren n ron ngen ools SC t			none not m water water	4]i	d ow	istance progress	SAMF U D BS E VS DP FD WS	disturbe bulk sam environm vane she	bed sample d sample ple mental samp ar penetrometo nsity	le	SYMBO DESCR based	dry moist wet plast	OIL d system		V 5 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	it ISt ID ID	very soft firm stif very hard fria very loos medi dens	soft f stiff ble loose e um dens		

pit no

Ν

PIT 1

T88-239

borehole no: **BORE 13** engineering log -borehole VDDDA sheet 1 of 2 office job no: G398/1 11/8/95 hole commenced: PATTERSON BRITTON & PARTNERS PTY LTD client: hole completed: 11/8/95 CRIGHTON PROPORATIES PTY LTD principal: GNR logged by: MYALL QUAYS RESIDENTIAL DEVELOPMENT project: checked by: (HB 20m north of Bore 10 borehole location: R.L.Sunface NOT MEASURED -90 DEG Bobcat mounted rig; hollow flight augers slope: drill model and mounting: NOT MEASURED datum: bearing: 150mm hole diameter consistency/ density index abenetro-meter 6 structure and material moisture condition assificati svmbol 109 additional observations penetrat: method samoles. soil type:plasticity or particle characteristics metres depth water graphic colour, secondary and minor components tests, etc E. R З 123 TOPSOIL: black to dark grey, sandy peat, wood fragments, strong organic odour Ð Backfill 0.0-5.5m L ΡŢ 83 VERSION 11/8/95 SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour M Ľ SP ∇ COFBORE 1 2 SAND: fine to medium grained, grey, subangular to well rounded, indurated layer Sp 3 43 Ę <u>/</u>62 SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy. slight odour ςp 4 /11 9 5 Bentonite seal 5.5-6.5m 6 ŜΡ SAND: fine to medium grained, grey, subangular to well rounded, indurated layer SAND: fine to medium grained, grey, subangular to well rounded, slightly greasy, slight odour ŠΡ Filter pack 6.5-10.5m 1989 Ltd. International Pty. CLASSIFICATION SYMBOLS AND SOIL CONSISTENCY/DENSITY INDEX SUPPORT SAMPLES, TESTS, ETC METHOD undisturbed sample (mm) VS very soft U Nil no support AS auger screwing* М mud DESCRIPTION S soft D disturbed sample casing AD auger drilling* PENETRATION Partners bulk sample F firm ßs RR roller/tricone based on unified St stiff environmental sample M washbore little resistance Ε classification system ----٧St very stiff standard penetration test: ranging to _very slow progress Ν CT cable tool MOISTURE hard NX SPT + sample recovered Н Coffey hand auger HA Fb friable WATER ¥ not measured D none observed SPT with solid cone NC ΩT diatube Π drv ٧L very loose *bit shown by suffix ٧S vane shear moist М ght water level loose ∇ РМ pressuremeter blank bit R W wet MD medium dense ΟP dynamic penetrometer plastic limit Copyr ۷ V hit WD water outflow \mathbb{A} ₩S water sample D dense TC bit W) liquid limit Т water inflow very dense ٧D piezometer ΡZ ADT 0 e.q

Coffey Partners International Pty. Ltd. ACN 003 692 019

187-230

engineering log -

		101	e						office jo		1 6398/1	sheet 2 of 2
prir proj	ent: ncipal: gect: ehole			CRIGHT MYALL	SON BRITTO ON PROPOER QUAYS RESI nth of Bor	TIES PI DENTIAL	IY LTD		hole comm hole comp logged by: checked b	leted: :	11/8/95 11/8/95 GNR FALLS	
	ll mode e diame			Bobcat 150mm	mounted r	ig; hol	low flig	ht augers -90 DE bearing:		,	A.L.Surface: datum;	NOT MEASURED NOT MEASURED
B2 method	ວັ penetration	support water	samples tests, e		depth metres	graphic log	classification symbol	material soil type:plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/ density index	100 Hand 200 Hand 300 Penetro- 400 meter	structure and additional observations
COFBORE VERSION ASB					9 9 10		SP	SAND: fine to medium grained, grey, subangu]ar to wel] rounded, slightly greasy, slight odour	М	L	₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩	
			_		-		SC	CLAYEY SAND: medium to coarse subangular quartz in clay matrix, low plasticity, grey, weathered becomeet exception exceptions	-			
15 :43 :13					- - - - - -			basement, possibly sandstone Borehole BORE 13 Terminated at 10.50 m				
10 /11 /95					12 - - 13			Sandstone basement confirmed by examination of recovered rock fragments.			1	ezometer casing 0-10.5m onstruction screen 7.5-10.5m stickup 0.15m
1.1969								Note: indurated layers indicated by change in penetration rate; samples returned do not indicate changes in lithology				
ME IIII ME IIII ME IIII ME IIII ME IIIII ME IIIIIIII	a a r W C C V Shown D V T T	uger d oller/ ashbor able ti and au iatube	ool ger fix	C PENE 1 WATE	no support casing TRATION 2 3 4	litt rang very ed D evel utflow	le resis ing to slow pr	U undisturbed sample (mm) SYMBOL D disturbed sample DESCRI Bs bulk sample based o classif N standard penetration test: Nx SPT + sample recovered MOISTU	n unified ication sy	stem : limit	CONSI VS S St VSt H Fb VL L MD D	ISTENCY/DENSITY INDEX very soft soft firm stiff very stiff hard friable very loose loose medium dense dense

borehole no:

BORE 13

7 ΠΠΛ

~~	1	.	~ ` 7)		<u>-</u> t-	obnics					
CO			ey	10	ç	jeu	JIE	chnics		Ē	Excava	ition No.	TP 1
Eng	in	ee	ering	j L	.og	- E	Exc	avation			Sheet Project		1 of 1 GEOTSGTE20248AA
Client:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD		τ	Date st	arted:	4.4.2007
Principal:								DO FOT ADDU OATION TEA	~ 4 - 5 - 5			ompleted:	
Project: Test pit lo		ion			IDE I TO F			PROJECT APPLICATION, TEA	GARL		Loggec Checke		CW Mi
equipment					Backho			Pit Orientation: Easting	: m			,	Surface: 2.586
excavation				1.5m	ong ().4m w		Northing	g: m			datur	n: AHD
excavati	on	into	rmation			mat		ubstance			> X	֍.	
method 5 T penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characterist colour, secondary and minor componen		moisture condition	consistency/ density index	100 × pocket 200 × penetro- 300 × meter	structure and additional observations
BH	N			_2.5		~ ~		TOPSOIL: SAND, fine to medium grained, dar brown with approximately 30% low plasticity fir 300mm of rootlets.	nes, with	М			TOPSOL
			D	2.0	0. <u>5</u>		CI	Sandy CLAY: medium plasticity, dark brown-o sand fine to medium grained.					
							SP	SAND: fine to medium grained, pale grey-white	Э.		VD		-
			D	1.5	1. <u>0</u> –			Becoming pale grey-brown.		w			
				1.0	1. <u>5</u>								-
			D		-								-
		-07 8:54am		_0.5	2.0			Test pit TP 1 terminated at 1.9m					
		04-04-07			_ 								-
X e 8H t 8 t R r	existi backi	ng exi noe bu ozer b		S pe 1 wa wa wa wa wa wa wa wa wa wa	iter water le	t io resista anging to efusal evel e shown nflow	1	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	W we Wp pla	ription n unified of y oist	dassifical		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

a 3 Rev 2

Engine					chnics					TP 2	
lient:	ering	g Log	j - E	Exc	avation			Sheet ^P roject	No:	1 of 1 GEOTS	GTE20248A
nent.	ΤΑΤ	TERSA	LL SU	RVE	YORS PTY LTD			Date st		4.4.200	
rincipal:							ſ	Date co	omplete	: 4.4.200	7
roject:	RIVI	ERSIDE	ESTA	TE F	PROJECT APPLICATION, TEA	GARI	DENS	oggeo	l by:	CW	
est pit locatior		ER TO		RE 1			(Checke	ed by:		
uipment type an		4WD Backh 1.5m long	oe 0.4m wi	da	Pit Orientation: Eastin	-			R.L. dati		.433 HD
excavation inf		1.51/1 long			ubstance	ig. II			Gau	nn. A	טח
5 penetration 5 support water	notes samples, tests, etc	dept RL metre		classification symbol	material soil type: plasticity or particle characteris colour, secondary and minor compone	tics, nts.	moisture condition	consistency/ density index	200 x pocket 200 b penetro- 400 meter		cture and I observations
N		-2.0 0.5		CI	TOPSOIL: Silty Clayey SAND, fine to mediur grained, dark brown with approximately 30% plasticity fines, with approximately 300mm of Sandy CLAY: medium plasticity, dark brown- with some sand lenses.	of low rootlets.	M 	St	X	TOPSOIL	
F	D	1.0			win some sand lenses.				×××		
04-04-07 9:13am	D	1. <u>5</u>		SP	SAND: fine to medium grained, brown-dark g		w				
		0.5	-	3r	Test pit TP 2 terminated at 1.9m		vv			Rapid inflow of collapsing below	groundwater and p w 1.7m depth.
		2. <u>0</u>									
Sketch		2.5	•								
ethod natural e; existing e H backhoe buildozer ripper excavato	xcavation bucket blade	support S shoring penetrati 1 2 3 4		nil	notes, samples, tests Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample	soil des based o system moistur	cation syn cription n unified a re ry			consistency/o VS S F St VSt H	lensity index very soft soft firm stiff very stiff hard

GEO 5.2 Issue 3 Rev 2

				∍y	-424	2	<i>,</i>			chnics		E	Excava	ition No	o. TP 3
Eng	gi	ne)	ering	J L	og	-	E	xc	avation			Sheet Project	No:	1 of 1 GEOTSGTE20248AA
lient:	:			ΤΑΤ	TER	SAL	LS	UF	RVE	YORS PTY LTD		£	Date st	arted:	4.4.2007
rincip	oal:											[Date co	omplete	ed: 4.4.2007
Projec	t:			RIVE	ERS	IDE I	EST	ΓAΊ	TE P	PROJECT APPLICATION, TEA G	GARD	ENS	.oggec	l by:	CW
est pi				REF				JR	Ξ1			(Checke		
quipme xcavat	-				4WD t 1.5m l	Backho ona (wide	•	Pit Orientation: Easting: Northing:	m m				.L. Surface: 2.571 atum: AHD
		n in	for	mation	1		_	ater	ial s	ubstance					1
neurou A nenetration	perietration	support	arci	notes samples, tests, etc		depth	graphic log		symbol	material soil type: plasticity or particle characteristics	s,	moisture condition	consistency/ density index	a pocket benetro- meter	
- 12	2.0	ة N	\$		RL 1	netres	ء الکا	2	0 6	colour, secondary and minor components. TOPSOIL: Silty Clayey SAND, fine to coarse		Еð М	ŏΰ	830 <u>3</u> 0	
1						-				grained, pale brown-brown, low plasticity fines w some rootlets to 300mm.	vith			1999 1999 1999 1999 1999 1999 1999 199	
				D	_2.0	0. <u>5</u> –	рц //		ŚĊ	Clayey SAND: fine to medium grained, orange-brown / pale brown, low plasticity fines.			VD		
						1.0			SP	SAND: fine to coarse grained to fine to medium grained, pale grey-white.		M/W			
				D	1.5	-				Becoming pale brown-white,					
	ter les set se se se se se se se				_1.0	 1. <u>5</u>		· •							
		¥20	5	D		-		•		Becoming white.					Rapid inflow of groundwater and pi collapsing below 1.7m depth.
at here are a set of the feet per the part		04-04			_0.5	2. <u>0</u>				Test pit TP 3 terminated at 1.8m					-
						-									
											f				
Sketu						2.5									
nethod H H	na exi ba bu rip	tural e isting ckhoe Ildoze per cavate	exc. bu r bl:	avation cket	S s	ra Sinte re	n anging efusal evel evel shov			Use undisturbed sample 50mm diameter Uses undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal		ription unified o			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

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C	J		ey	S	5	jci		CHINGS	-	Excava	ation No.	TP 4
Enç Client:	gir	e						avation		Sheet Project Date s		1 of 1 GEOTSGTE20248AA 5.4.2007
Principa	al:										ompleted	
Project	:		RIV	ERS	IDE	EST	ATE I	PROJECT APPLICATION, TEA GAR	DENS	Logge	d by:	CW
Test pit	loca	tion:	REF	ER	TO F	IGU	RE 1			Check	ed by:	llll
equipme excavatio					Backho	е 0.4m м	ide	Pit Orientation: Easting: m				Surface: 2.260
	_		rmation	1.5m	iong			Northing: m ubstance	1		datu	im: AHD
method 5 penetration	5	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 ∞ penetro- 400 meter	structure and additional observations
H	N			_2.0				TOPSOIL: Silty CLAY, medium plasticity, dark grey-black, small percentage of sand <10% with some rootlets.			×	TOPSOIL - - -
			D		0. <u>5</u>		СН	CLAY: medium to high plasticity, dark grey.	M>Wp	St	×	-
				1.5	-							-
			D	-	1.0							
				_1.0	-							-
		07 12:12pm		0.5	1. <u>5</u>						XXXX	-
		1 05-04-07	D		- 2. <u>0</u>		SP	SAND: fine to coarse grained, pale grey.			X I	Rapid inflow of groundwater at 2.0m depth.
				0.0	_	• • • •		Test pit TP 4 terminated at 2.1m	-			
				_0.0	2.5							-
Sketc	h											
method N X BH B R E	existi backi	ng exi noe bu ozer b		s 1 Wa Wa	n n	o resista anging to efusal evel e shown		Uso undisturbed sample 50mm diameter soil des Uso undisturbed sample 63mm diameter based o D disturbed sample system V vane shear (kPa) moistur Bs bulk sample moistur E environmental sample D d R refusal W w	scription an unified	mbols an classifical		VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loase L loose MD medium dense D dense VD very dense

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COLLE	y 9			E	Excavation N	lo. TP 5
Engineer	· · · · · · · · · · · · · · · · · · ·	- Excavation	D		Sheet Project No: Date started:	1 of 1 GEOTSGTE20248AA 4.4.2007
Principal:					Date complet	ted: 4.4.2007
Project:		STATE PROJECT APF	PLICATION, TEA GAR		,	CW
Test pit location: equipment type and mo	REFER TO FIG	Pit Orientation:	Easting: n	r. (Checked by:	R.L. Surface: 2.765
excavation dimensions:		4m wide		n		atum: AHD
excavation inform	ation	material substance	· · · · · · · · · · · · · · · · · · ·			
bo tient to sa	notes amples, sts, etc RL metres	b c c c c c c c c c c c c c c c c c c c	material Sity or particle characteristics, lary and minor components.	moisture condition	consistency/ density index ¹⁰⁰ A pocket ²⁰⁰ A penetro-	
H	_2.5	brown, with low plast fines with some root	e to medium grained, dark licity fines, approximately 30% lets to approximately 150mm.	M		TOPSOIL
	D 0.5	sand fine to medium	m plasticity, orange-brown, grained. m grained, pale grey-white.	_	VSt *	
-07 8:35am	<u> </u>	Becoming pale grey-				- - -
↑ 04-04-07						- - - -
	_1.0	Tant 25 TO 6 formula		W		Rapid groundwater inflow below 1.7m depth.
	_0.5	Test pit TP 5 termina	ied at 1.9m			
	2.5		······			-
Sketch						
method N natural exposur X existing excava BH backhoe bucke B bulkdozer blade R ripper E excavator	tion t penetration 1 2 3 4	U _{so} undisturbed D disturbed sa V vane shear (Bs bulk sample E environment R refusal	sample 50mm diameter sample 63mm diameter mple kPa) al sample D c M n W v V/p p		ibols and lassification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb fnable VL very loose L loose MD medium dense D dense VD very dense

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		Су		2	9-			E	xcava	tion N	o <i>.</i>	TP 6
-	۱e						avation	Ρ	heet roject			of 1 GEOTSGTE20248AA
Client:		TAT	TE	RSAL	L SU	JRVE	YORS PTY LTD			arted:		5.4.2007
Principal:		DIV	-		- e T	ATE 1	PROJECT APPLICATION, TEA GARDEI			omplet	ed:	5.4.2007 CW
Project: Test pit loca	ation			TO F			ROJECT AFFLICATION, TEA GARDEI			a by: ed by:		All.
equipment typ				Backho			Pit Orientation: Easting: m		necke	· · ·	LL SI	////* urface: 2.846
excavation dir			1.5m	long	0.4m w		Northing: m			di	atum:	AHD
excavation	info	ormation			mat	1	ubstance		. ×	6		
method 5 penetration support	water	notes samples, tests, etc	RL	depth metres		classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	condition	consistency/ density index	100 200 Ay pocket 300 benetro-		structure and additional observations
H			_2.5	0. <u>5</u>				D		2.2		OPSOIL -
		D	2.0			SM	Silty SAND: fine to medium grianed, brown / red Komented sand nodules.	M	VD		IN	DURATED SAND?
		D .	-1.5	1.0		SP	SAND: fine to medium grained, pale brown-white with some cemented sand nodules.				Annual for an under a manufacture of the state of the s	-
	T 05-04-07 12:33pm		_1.0	1. <u>5</u> - - 2. <u>0</u>			Lenses of cemented sand nodules dark brown-red	w				ater visible. Pit collapsing due to oundwater.
							Test pit TP 6 terminated at 2.1m					
			_0.5	-								
Sketch	I			2.5				<u> </u>				
X exist BH back B build R rippe	ing ex hoe b ozer b		S pe 1 wa wa		n o resista anging to efusal evel e shown	,	notes, samples, tests classification U _{sc} undisturbed sample 50mm diameter soil descripti D disturbed sample 63mm diameter based on unif D disturbed sample system V vane shear (kPa) moisture Bs bulk sample D R refusal D W wet Wp V jlastic liquid lin	find cla			_	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

TESTPIT 20248A

(20)f	f	ev		<u>ا</u>	geo	ote	chnics							
												E	Excava	ition No.	TP 7	
Ε	ng	in	e	erinç	j L	.og	- E	Ēxo	avation				Sheet Project		1 of 1 GEOTSO	GTE20248A
Cli	ent:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD			[Date st	arted:	13.4.200	7
Pri	ncipa	ŀ:												ompleted:	13.4.200	7
	oject:								PROJECT APPLICA	TION, TEA G	ARDI				JJT Mu	
	st pit lipmen			model:	ER	TO F	GUI		Pit Orientation:	Easting:	m	(Checke		Surface: 2.3	88
exc	avatio	n dim	nensi	ons:	m lon	g mv	vide			Northing:	m			datur		
ex		tion	info	rmation			mat	1	ubstance				- ×	_ ¢		
method	5 penetration	support	water	notes samples, tests, etc	RL	depth metres		classification symbol	mate soil type: plasticity or pa colour, secondary and	article characteristics		moisture condition	consistency/ density index	100 × pocket 200 × penetro- 400 meter		ure and observations
ЧA		N						СН	Sandy CLAY: high plasticity. to medium grained.	dark brown, sand fi	ne	M				
						-										
				D	2.0	0.5										
						-										
						-		SC	Clayey SAND; fine to mediu				VD			
			_	D	1.5	1.0	/.	00				w	VD			
						-			Hole terminated at 1.0m, hol groundwater. Test pit TP 7 terminated at 1		eof					
						-					ĺ					
					_1.0	1. <u>5</u>										
						_										
					0.5											
					_0.5	2.0										
						-										
					0.0	_										
					_0.0	2.5										
S	ketch															
met	thod				su	pport			notes, samples, tests	c	lassificat	ion syn	nbols an	d T	consistency/der	nsity index
N X BH		existi		iosure cavation icket	s	shoring		nil	U ₅₀ undisturbed sample 5 U ₆₃ undisturbed sample 6 D disturbed sample	50mm diameter si 53mm diameter b	oil descri ased on u ystem	ption			VS v S s	rery soft oft
B R		bulldo ripper	ozer b r		1	netration	io resistai	псе	V vane shear (kPa) Bs bulk sample	 m	noisture				St s VSt v	itiff rery stiff
E		excav	vator		wa	ter	anging to efusal		E environmental sample R refusal	e D M	f mois	st			Fb fi	iard nable rery loose
							e shown			v	Vp plas	tic limit d limit			L id MD n	oose nedium dense
						water i water o										lense rery dense

coffey	a a a a a a a a a a a a a a a a a a a	chnice			
coney	Sector Sector		Excava	ation No.	TP 8
Principal: Project: RIV Test pit location: RE equipment type and model:	TTERSALL SURVI TERSIDE ESTATE FER TO FIGURE 1	EYORS PTY LTD PROJECT APPLICATION, TEA	GARDENSLogged Checke	No: arted: ompleted: t by: ed by: R.L. St	
excavation dimensions: excavation information	m long m wide material s	Northing	: m	datum:	AHD
Po use to the second se	1 12150	material soil type: plasticity or particle characteristic colour, secondary and minor components		100 x pocket 200 x pocket 300 b penetro- 400 meter	structure and additional observations
H		Clayey SAND: fine to medium grained, black. Hole terminated at 0.6m, sand too dry to retriev Test pit TP 8 terminated at 0.6m	e.		
method N natural exposure X existing excavation BH backhoe bucket B bulklozer blade R ripper E excavator	support S shoring N mil penetration 1 2 3 4 refusal water water level on date shown water inflow water outflow	U _∞ undisturbed sample 50mm diameter U _∞ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification symbols an soil description based on unified classificati system molsture D dry M moist W wet W p plastic limit W_ liquid limit	ion	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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C	U		ey	1997 1997	2	jei		chnics		-	Excava	ition N	No.	TP 9
Client Princi Projec Test p	t: pal: ct: pit loca	ation	TA1 RIV : REF	TEF ERS	RSAL IDE I TO F Backho	L SU EST/ IGUI	JRVE ATE F RE 1	PROJECT APPLICATION, TEA Pit Orientation: Eastin	g: m) DENS	Sheet Project Date st Date co Loggec Checke	arted omple I by: ed by: F	ted:	CW //// Surface: 2.735
<u> </u>	. 1	n info	rmation			mat	1	ubstance				4		
ଥ	5 penetration support	water	notes samples, tests, étc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteris colour, secondary and minor compone		moisture condition	consistency/ density index	100 A pocket	a	structure and additional observations
BH	N			_2.5	0. <u>5</u>			TOPSOIL: Silty Clayey SAND, fine to mediun grained, dark grey, low plasticity fines, with so rootlets and thick roots to 100mm.)me	M				TOPSOIL - - - - -
			D	2.0	- - 1. <u>0</u>		SC	Clayey SAND: fine to medium grained, dark brown-black, low plasticity fines with some bla cemented sand nodules up to approximately diameter.			D/VD			
)7 10:41am	D	_1.5	- - 1. <u>5</u>		SP	SAND: medium to coarse grained, pale grey-	white.					
		▼ 04-04-07	D	_1.0	2.0			Becoming pale grey-brown.		w				Groundwater inflow below 1.8m
				_0.5	2.5			Test pit TP 9 terminated at 2m						- - -
Sket method N X BH B R E	1 natu exisi back bullo	ting ex choe b tozer t		S pei 1	n Ning n		nil	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample	classific; soil desc based on system moisture D dry	ription 1 unified o			_	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard D hard
-				<u>▼</u>	iter water k	evel e shown nflow		R refusal	M mo W we Wp pla	oist				Fb friable VL very loose L loose MD medium dense D dense VD very dense

Sheet 1 of 1 Project No: GEOTSGTE20248AA Date started: 4.4.2007 Date completed: 4.4.2007 RDENS_ogged by: CW Checked by: M m R.L. Surface: 2.585 m datum: AHD Organization of the second se
Date completed: 4.4.2007 RDENS_ogged by: CW Checked by: m R.L. Surface: 2.585 m datum: AHD
RDENSLogged by: CW m R.L. Surface: 2.585 m datum: AHD additional observations additional observations additional observations 28888 M Exercise MD TOPSOIL VD No obvious groundwater level or
Checked by: m R.L. Surface: 2.585 m datum: AHD additional observations additional observations B B
m datum: AHD additional observations additional observations additional observations B additional observations B M B MD B VD B No obvious groundwater level or
and the second secon
No No
M TOPSOIL
- D
- D VD VD
VD No obvious groundwater level or
No obvious groundwater level or
inflow but pit collapsing.

		J		ey		ل ک	y C (echnics	-	Excava	ation No	• TP11
	ng	ji	ne	erinç	j L	.og	- E	Exc	avation		Sheet Project	t No:	1 of 1 GEOTSGTE20248A
lie	ent:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD		Date st	tarted:	4.4.2007
rin	ncipa	d:									Date c	omplete	d: 4.4.2007
roj	ject:			RIV	ERS	IDE E	EST/	ATE	PROJECT APPLICATION, TEA GAR	DENS	Logged	d by:	CW
	t pit					TO F		RE 1			Checke	-	
	evatio					long (ide	Pit Orientation: Easting: m Northing: m				Surfače: 2.732 tum: AHD
xo		tior	n info	rmation	1		mat		ubstance	1		1.	
	penetration	ellboort	water	notes samples, tests, etc	RI	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	o x pocket o d penetro- o meter	
	123	N					BIB	0 0	TOPSOIL: Silty SAND, fine to medium grained,	<u> </u>		200 300 400 200	TOPSOIL
					_2.5			SC	grey-brown, low plasticity fines? with some rootlets. Clayey SAND: fine to medium grained, pale grey-brown, low plasticity fines.	-	VD		
				D		0. <u>5</u>		SC	Clayey SAND: fine to medium grained, orange-brown, dark brown-black, low plasticity fines, with cemented sand nodules up to approximately	-			
000000000000000000000000000000000000000					_2.0				0.13mm dia.				
000000000000000000000000000000000000000				D		1. <u>0</u>	<u></u>	SP	SAND: fine to coarse grained, pale grey-brown.	w			
000000000000000000000000000000000000000					_1.5				Colour change.				
022002000000000000000000000000000000000					_1.0	1.5							
600000000		-	15am	D		2.0			Test pit TP11 terminated at 1.9m				
			04-04-07 11:15		_0.5	-							
			8			- 2.5							
34	ketch	1											
tł	hod				SU	oport			notes, samples, tests classifi	cation syr	nhois an	d	consistency/density index
1		exis bacl build ripp	ting ex khoe b lozer b		S per	shoring netration 2 3 4 ra		nil	U _{so} undisturbed sample 50mm diameter soil des U _{so} undisturbed sample 63mm diameter based c D disturbed sample system V vane shear (kPa)	scription on unified o			VS very soft S soft F firm St stiff VSt very stiff H hard
					wa		vel		R refusal M m W w Wp p	roist /et lastic limit quid limit			Fb friable VL very loose L loose MD medium dense

		1	Сy		- C	,		chnics			Excav	ation No	D TP12
Eng	ıir	ie	erinc	۱L	oa	- E	Exc	avation			Sheet		1 of 1
lient:			-			·····		YORS PTY LTD			Projec Date s	t No: started:	GEOTSGTE20248A 4.4.2007
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roject:			RIVI	ERS	IDE I	EST	ATE	PROJECT APPLICATION	I. TEA GA	RDEN		•	CW
est pit i	loca	tion:			TO F				.,			ed by:	
uipmen	t typ	e and			Backho			Pit Orientation:	Easting:	m			L. Surface: 3.126
cavatio				1.5m l	ong (0.4m w			Northing:	m		dai	tum: AHD
		Into	rmation			mat		ubstance			- X	÷ ė	
benetration	support	water	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle c	haracteristics,	moisture	condition consistency/ density index	A pocket ed penetro- meter	structure and additional observations
IZO	N N	Ŵ		RL	metres I	5	S C	colour, secondary and minor TOPSOIL: Silty Clayey SAND, fine t	components.	Ĕ		200 300 400	TOPSOIL
				_3.0				grained, dark grey, low plasticity fine rootlets to approximately 350mm.	es, with some				
					0.5		SC	Clayey SAND / Sandy CLAY: fine to grained, dark grey-brown, medium	medium		St	- x	
			D	2.5	-	/////	CL	Sandy CLAY: low to medium plastic	 	[
				1				orange-brown, sand fine to medium	grained,				
					1.0						,		
			Ð	_2.0	_		SP	SAND: fine to coarse grained, pale	grey-white.		VD		
					-								
					1.5			Becoming pale grey-brown.					
				_1.5	1. <u>9</u>								
					-								
			D	-									
		am		1.0	2.0	<u></u>		Test pit TP12 terminated at 2m					
	ŀ	11:30am			-								
		- 7007											
Sketch		8			2.5]
H	exist back	ng exi hoe bi ozer b r		S s	Silver P	a no resista anging to efusal	nil nce	notes, samples, tests U _{so} undisturbed sample 50mm di U _{so} undisturbed sample 63mm di D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	ameter soll ameter basi syst	description and on unifi	symbols a সা ed classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose

С	0	f	f	ey	¢) F	Ç	je	ote	chnics	-	Excava	ation No	No. TP13
Clie Prin Proj Tesi	ent: ncipal: ject: et pit lo pment	oca:	tion:	TAT RIVI REF	ERS ER	RSAL IDE I TO F Backho	L SU EST, IGU	JRVE ATE I RE 1	PROJECT APPLICATION, TEA GAR	DENS		arted: omplete d by: ed by: R.	eted: 4.4.2007 CW
	avation cavati			rmation	1.5m	long	0.4m w mat		Northing: m ubstance			da	datum: AHD
method	c benetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 pocket 200 pocket 300 ponetro- meter	
			▼ 04-04-07 11:51am	D	2.0	0. <u>5</u> - 1.0 1.5 - 2.0		SM	thick). SIIty SAND: dark brown-dark red, fine to medium grained, with cemented sand nodules to 0.16mm dia. Becoming brown-pale brown cemented nodules of sand still present. Becoming dark brown-brown weakly cemented nodules present. Test pit TP13 terminated at 2m	W	VD		Bucket scraping on hard layer.
m N X B B R E	r e t t	existi backi bulldo ipper	ng ex noe bi ozer b	posure cavation ucket lade	S pe 1	ing f	a anging to efusal evel evel eshowr)	U _{so} undisturbed sample 50mm diameter soil des U _{so} undisturbed sample 63mm diameter based o D disturbed sample system V vane shear (kPa) moistur Bs bulk sample moistur E environmental sample D d R refusal W w	cription n unified	mbols an classifical		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

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E	ng	jir	1e	erinç	j L	.og	- E	Exc	avation				Sheet Projecl	No:	1	of 1 GEOTSGTE20248
Clie	ent:			ΤΑΤ	TEF	RSAL	LSU	IRVE	YORS PTY LTD				Date st	tarted:		4.4.2007
Prir	псіра	1:											Date c	•	ted:	4.4.2007
	ject:								PROJECT APPLIC	CATION, TEA	A GARE			-		CW MAA
	st pit l					TO F Backho		RE 1	Pit Orientation;	Eastir	ng: m	(Checke	•	21 5	urface: 2.760
	avatio				1.5m l		0.4m w	ide	T x Onentation.	North	•				latum:	
exc		tion	info	rmation	1		mat		ubstance							
method	benetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	m: soil type: plasticity o colour, secondary a	aterial r particle characteri and minor compone	stics,	moisture condition	consistency/ density index	100 A pocket 200 A pocket 300 b penetro		structure and additional observations
BH		N			_2.5	0.5		СН	TOPSOIL: Silty CLAY, me brown with some rootlets CLAY: high plasticity, bro	approximately 400	es, mm.		VSt			OPSOIL
				D	_2.0	1.0									×	
				D	_1.5	_ _ 1. <u>5</u> _			Becoming dark grey-blac	k with some mottle	d orange.			×.	×	
					_0.5	2. <u>0</u> - - 2.5			Test pit TP14 terminated	at 1.8m						
Sł	ketch]														
meth N BH B R E		exisl back bullo rippe	ing ex hoe b ozer b		S s		o resistar anging to efusal evel e shown			lle 50mm diameter Ile 63mm diameter nple	W we Wp pla	ription unified of	classificat			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

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CO		ey	4935°	ى ك					-	Excava	ition N	lo.	TP15
Engi Client: Principal: Project: Test pit loc		TAT RIVI	TER	SAL	L SL	IRVE	YORS PTY LTD PROJECT APPLICATION, TEA	GARL	ו נו DENS	Sheet Project Date st Date co Logged Checke	arted: omplei i by:		of 1 <u>GEOTSGTE20248AA</u> 4.4.2007 4.4.2007 CW f///
equipment ty			4WD E	Backho	e		Pit Orientation: Eastin	g: m		· · · ·	 R	R.L. SI	urface: 2.355
excavation di			1.5m k	ong ().4m w mat		Northin ubstance	ng: m			d	atum:	AHD
method 5 5 penetration	support water	notes samples, tests, etc	RL r	depth netres	graphic log	classification symbol	material soil lype: plasticity or particle characteris colour, secondary and minor compone		moisture condition	consistency/ density index	100 × pocket 200 × penetro- 300 vd penetro-		structure and additional observations
Ξ	N	D	_1.0	- 0. <u>5</u> - 1.0 - 1.5		SP	TOPSOL: Silty (Clayey) SAND, fine to media grained, dark grey-black, with some roots 10 rootlets to approximately 400mm. SAND: fine to coarse grained, pale grey-brow small percent of fines <20%. Becoming pale grey mottled black and white.	mm and 	M	DAVD		Pr	t collapsing no groundwater served.
Sketch			_0.5	2.0	<u> </u>		Pit collapsing. Test pit TP15 terminated at 1.7m						
X exis BH bac B bull R ripp	khoe bi Idozer b	cavation ucket	Ss pen 12 ₩1 wat	ra s re	o resistar anging to afusat evel e shown aflow	nil	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	W we Wp pla	ription a unified of y oist	dassificati			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

С	:O	f	f	ey		Ç	geo	ote	chnics				Excava	ation No.	TP16	
									avation			:	Sheet		1 of 1	75000404
Clie	+			-		-			YORS PTY LTD				Project	t No: tarted:	GE01SG 4.4.2007	TE20248A)
	cipal:			1.7.1		UAL		// (¥ L						ompletec		
Proj				PIV		יחבי	FOT	ATE	PROJECT APPLICA		CAP			•	CW	
	pit lo	t	ioni			TO F			NOULCI AITEICA	10N, 1LF				-	MM	
						Backho			Pit Orientation:	Eastin	ng: m		Check	-	Surface: 2,68	2
• •	vation				1.5m		0.4m w	ride	r it offentation.	Northi	-			datu		
exc		on i	info	rmation	_		·		ubstance							
	penetration			notes			ß	ition	materi	al			loy/	pocket penetro- meter		
method	beneti	support	Ŀ	samples, tests, etc			graphic log	classification symbol				moisture condition	consistency/ density index	d d E kPa	structu additional ol	
met	123	dns	water		RL	depth metres	gral	clas	soil type: plasticity or par colour, secondary and r			con	gen	6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
BH		Ν				-	{ }}		TOPSOIL: Silty SAND, fine to grey-black mottled white, with	medium graine some rootlets.	ed, dark	D			TOPSOIL	
					_2.5	-	$\left \left \right \right $									
								SP	SAND: fine to medium graine	d, pale grey-bro	own.	M	D			
						0.5										_
				D	-	- 1										
					2.0											
													VD			
						1.0										-
			_ ا	D	1.5	_						M/W				
			12:54pm	2		-										
			04-04-07			1. <u>5</u>										-
			8		1.0	-										
		1	-	D	[SP	SAND: fine to medium grained cemented sand nodules, coffe	J, dark grey-bla	ack,	W			INDURATED SAN	D
						-			Pit collapsing, Test pit TP16 terminated at 1.			1				
						2.0			rest pictr to temanated at 1.	ын						-
					_0.5											
						-										
						2.5										
Sk	etch					12.0			L			1	1	<u>L.I.I.i ! </u>		
meth	od				61	pport			notes, samples, tests	T	classifi	ation syr	nhole an	i h	consistency/dens	ity infor
N X	n			osure cavation		shoring	N	nil	U ₅₀ undisturbed sample 50		soil des	cription n unified o		1	VS ve	ry soft
8H	b	ackh	ce bu	ucket	pe 1	netratior 2 3 4	ı		D disturbed sample	non vianeter	based o system	n uninea (ларынса		F fi rr	n
8 R	'n	pper	zer b	Idue			io resista anging to		V vane shear (kPa) Bs bulk sample	ľ	moistur					ry stiff
ε	e	xcav	ator		wa	ater	efusal		E environmental sample R refusal			ioist		[able
					⊻	water le on date	evel e shown				Wp pi	et Iastic limit			L loc	ry loose ase
						water in	nflow				WL lie	quid limit				edium dense nse
					ł	water o	utflow									ry dense

4	~~	.4	.	~~~			nor	- h	chnics							
	こ)		еy	C. S.	Ľ,	100					Excava	tion No	D.	TP17	
E	Eng	ir	e	ering	j L	.og	- E	Exc	avation			Sheet Project	No:	1 (of 1 GEOTSGTE20248	AA
C	ient:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD		I	Date st	arted:		4.4.2007	
	incipal	:											mplete	ed:	4.4.2007	
	oject:								PROJECT APPLICATION, TE	I GAR			•		CW	
	est pit l					TO F		RE 1				Checke			////	
	upment cavation					Backho long (e 0.4m w	ride	Pit Orientation: Easti North	•	m			L. Sur itum:	face: 2.635 AHD	
_	xcavat			rmation	.,				ubstance							
method	5 penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle character colour, secondary and minor compon		moisture condition	consistency/ density index	200 X pocket 300 V penetro- 400 meter		structure and additional observations	
HB		N			_2.5	0.5	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey-black mottled white, low fines, with some rootlets.	m plasticity	D				PSOIL	-
				D	2.0	1. <u>0</u>		SC SC	Sitty Clayey SAND: fine to medium grained brown / red, low to medium plasticity fines, v cemented nodules of SAND. Clayey SAND: fine to medium grained, brow brown, low plasticity fines, with weakly ceme nodules of sand.	/ith /n-pale	M	VD			- 	
			4-07 10:53am	D	1.5	- - 1. <u>5</u>		SP	SAND: fine to coarse grained, pale grey-pal	∍ brown.	-					_
			€05-04-07	D		2.0			Becoming grey-brown. Pit collapsing.		W				bid inflow of groundwater bei n depth.	wc
	979971 PT 197 197 197 197 197 197 197 197 197 197				_0.5	2.5			Test pit TP17 terminated at 2m							
ę	Sketch															
m N X B B R E	e I I I r	existi backi	ng exi noe bu ozer b		S pe 1	ter water le	o resistar anging to afusal evel esvel shown		notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil de: based o system moistu D o M r W v Wp p				V S F V F V L N	firm St stiff St very stiff b friable fL very loose L loose MD medium dense	
						water ir water o	flow							N C	AD mediu	im dense

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coff	ev		È (geo	ote	chnics			
	-						Exca	avation No.	TP18
Engine	ering	j L	.og	- E	Exc	avation	She	et ect No:	1 of 1 GEOTSGTE20248AA
Client:			·			YORS PTY LTD		e started:	5.4.2007
Principal:							Date	e completed	5.4.2007
Project:	RIV	ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TEA GARDEN	VS Logg	ged by:	CW
Test pit location	REF	ER	TO F	IGUI	RE 1		Che	cked by:	1111
equipment type and	d model:	4WD I	Backho	e		Pit Orientation; Easting: m		R.L.	Surface; 2.302
excavation dimensi		1.5m l	long (0.4m w mat		ubstance Northing: m		datu	m: AHD
		Τ					y/	rtetex €	
thod penetration port ter	notes samples			graphic log	classification symbol	material g	condition consistency/	ity index pocket penetro- meter	structure and additional observations
method 5 pene support water	tests, etc	RL	depth metres	grap	class	soil type: plasticity or particle characteristics, colour, secondary and minor components.	cond	kPa ₿₿₿₽ ₽	
Ha N			_	<u> </u>		TOPSOIL: Sandy CLAY, low to medium plasticity, M dark brown-black, sand fine to medium grained, with			TOPSOIL -
		2.0				some rootlets to 100mm.			-
		L2.0			~			<u>,</u> *	
			0. <u>5</u>		CI	CLAY: medium plasticity, dark grey mottled orange, with minor sand component approximately 10%.	VS	ы ¹	-
	D	-			SC	Clayey SAND: fine to medium grained, grey, low plasticity fines.	C		-
		_1.5	-	<u>/</u>	SP	SAND: fine to coarse grained, pale grey-white.			-
			1.0			Becoming grey / brown.	V		-
	D	-							-
		1.0							-
10:35am			1.5						-
07 10									-
05-04-07		0.5	-			Sand becoming indurated and dark brown / red.	/		
	D		2.0	·		Pit collapsing due to inflow of groundwater, collapsing			
			2.0			from sides. Test pit TP18 terminated at 1.9m			
			-					A. (A. 47)	-
		_0.0							-
			2.5						
Sketch									
method			pport			notes, samples, tests classification		s and	consistency/density index
N natural exp X existing ex	cavation		shoring		nil	U _{so} undisturbed sample 50mm diameter soil descriptio U _{so} undisturbed sample 63mm diameter based on unifie		fication	VS very soft S soft
BH backhoe b B buildozer t R ripper		per 1 2	netration 234 n	io resista	nce	D disturbed sample system V vane shear (kPa) Bs bulk sample moisture			F firm St stiff VSt verv.stiff
R rìpper E excavator		wa		anging to efusal		Bs bulk sample moisture E environmental sample D dry R refusal M moist			VSt very stiff H hard Fb friable
			water le	evel e shown		W nost W wet Wp plastic ii	imit		VL very loose L loose
			water in water o			W _L liquid lin			MD medium dense D dense VD vervidense

		.4	.	~~ /			יסר	-tc	chnice				
(こ	וו		ey	A.	5	10	JIE	chnics	Ē	Excava	tion No.	TP19
	nc ent:	jir	le						avation YORS PTY LTD	ł	Sheet Project Date st	No:	of 1 GEOTSGTE20248AA 4.4.2007
Pri	ncipa	al:								Γ	Date co	ompleted:	4.4.2007
Pro	oject:								PROJECT APPLICATION, TEA GARE	DENS	_oggeo	i by:	CW
	st pit					TO F		RE 1			Checke		
	ipmer avatio				400 1.5m	Backho Iona	ie 0.4m w	ide	Pit Orientation: Easting: m Northing: m			R.L. S datum	Surface: 2.261
ex		tion	info	rmation			mat		ubstance	1	1		
method	<pre>L benetration</pre>	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 ¢ penetro- 400 meter	structure and additional observations
BH		N			_2.0			СН	TOPSOIL: Clayey SAND, fine to medium grained, dark brown-black, low plasticity fines with some rootlets.	Ď			OPSOIL
				D	_1.5	0. <u>5</u>			brown-black, sand fine to coarse grained.				-
			07 2:31pm	Ď	_1.0	1. <u>0</u>		SP	Becoming dark grey-grey. SAND: fine to coarse grained, pale grey-white.	W	VD		- - - -
			T 04-04-07	D	_0.5	1. <u>5</u> –			Becoming pale brown / grey.				
					_0.0	2.0			Pit collapsing due to groundwater. Test pit TP19 terminated at 1.8m				- - - - -
	ketcl	1 1				2.5							
me N B H B R E	thod	exist back build rippe	ng ex hoe b ozer b	oosure cavation ucket alade	s pe 1 wa V	iter water k	n no resista anging to refusal evel e shown nflow	2	W we Wp pla	ription n unified of y oist	classificat		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD madium dense D dense VD very dense

coffey	o contra	chnice			
coney	geole			Excavation No.	TP20
EngineeringClient:TATPrincipal:Froject:Project:RIVETest pit location:REF	J LOG - EXC	avation	I I A GARDENS	Project No: Date started: Date completed: Logged by: Checked by:	of 1 <u>GEOTSGTE20248AA</u> 4.4.2007 4.4.2007 CW M Surface: 2.255
	1.5m long 0,4m wide	North	-	datum	
excavation information Contraction Dot Dot	depth RL metres	material soil type: plasticity or particle character	stics, condition	consistency/ density index 100 m pocket 200 m penetro- aoo meter	structure and additional observations
E 123 36 36 H N D H D D U D D U D D U D D U D D U D D U D D U D D Sketch Sketch D	RL metres 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 6 7 <th7< th=""> 7 <th7< th=""> <th7< t<="" td=""><td>colour, secondary and minor component TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey-black mottled white, with rootlets. Sandy CLAY: low plasticity, dark brown-red, fine to medium grained, trace of rootlets and commented sand nodules. Sandy CLAY: low to medium plasticity, pale grey-pale brown mottled orange, sand fine t grained. Becoming pale brown / grey. Pit collapsing due to groundwater. Test pit TP20 terminated at 1.7m</td><td>n D some M</td><td></td><td>OPSOIL</td></th7<></th7<></th7<>	colour, secondary and minor component TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey-black mottled white, with rootlets. Sandy CLAY: low plasticity, dark brown-red, fine to medium grained, trace of rootlets and commented sand nodules. Sandy CLAY: low to medium plasticity, pale grey-pale brown mottled orange, sand fine t grained. Becoming pale brown / grey. Pit collapsing due to groundwater. Test pit TP20 terminated at 1.7m	n D some M		OPSOIL
method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nii penetration 1 2 3 4 ranging to ranging to refusal water water level on date shown water inflow water outflow	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification syn soil description based on unified of system D dry M moist W wet Wp plastic limit W _L liquid limit	classification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very losse L loose MD medium dense D dense VD very dense

Form GEO 5.2 Issue 3 Rev.2

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													Excava Sheet	non h		TP21 1 of 1
E	ng	gi	ne	96	ering	g L	_og	- E	EXC	avation			Sneet Project	No:		GEOTSGTE20248A
Clie	ent:				TA	TTE	RSAL	LSU	JRVE	YORS PTY LTD		I	Date st	arted:		4.4.2007
^{>} rir	ncipa	al:										1	Date c	omple	ted:	4.4.2007
^{>} ro	oject	:			RIV	'ERS	SIDE	EST	ATE I	PROJECT APPLICATION, TEA	GARI	DENS	_ogged	d by:		CW
	st pit						TO F		RE 1			(Checke			111
	ipme avatio				model:		Backho long		/ide	Pit Orientation: Easting Northing					R.L. : Iatur	Surface: 2.675 n: AHD
	cava	atio			mation				erial s	ubstance		1	· · ····			
method	penetration		support	L.	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle characteristi	.	moisture condition	consistency/ density index	pocket bocket penetro-		structure and additional observations
	12	3		wale		RL,	metres	gra	syn	colour, secondary and minor component	.5, S.		con der	30 <u>3</u> 0	400	
ВН			N			_2.5	0.5		SC	TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey, low plasticity fines with son rootlets and some thick roots to 300mm. Clayey SAND: fine to medium grained, orange brown, low plasticity fines with some cemented	-pale		VD			Topsoil
		a a su de la construction e a construction a conservation de la conservation de la construction de la conserva			D	2.0			SP	sand nodules. SAND: fine to medium grained, pale grey-white	<u>+</u> . ── ──					
					D	1.5	1. <u>0</u> 									
		tabla ka aka mata ina manana na manana manana per penan				_1.0	1. <u>5</u>			Becoming pale brown-pale grey.					halifada Mandanan an in fuananana lakananan kan	
			V 04 07				2.0			Test pit TP21 terminated at 2m		W				Rapid groundwater inflow below 1.7m depth.
					D	0.5	2.5									
- Si	ketc	:h												<u> </u>		
net 1 1 1 1 1 1 1	thod	ex ba	tural e sting ckhoe	exca bud	avation :ket	S P	upport shoring enetration 2 3 4	1	nil	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa)	soil des	cation sys scription in unified d				consistency/density index VS very soft S soft F firm St stiff
2		qin	per cavat				ater water le	shown	5	Bs bulk sample E environmental sample R refusal	M m W w Wp pl	re Iry noist vet Iastic limit quid limit				VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

TESTPIT 20

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	U		C	y	1997 1997	2	,		echnics	E	Excava	ition No		TP22
Eng	gi	ne	er						avation		Sheet Project	No:	1	of 1 GEOTSGTE20248AA
lient:				ΤΑΤ	TER	RSAL	L SL	IRVE	YORS PTY LTD		Date st			4.4.2007
rincip					-00	ine	-07					omplete	d:	4.4.2007 CW
rojec est pi		eatio				TO F			PROJECT APPLICATION, TEA GARDE		.oggeo Checke	-		
quipme						Backho			Pit Orientation: Easting; m		HECKE		Su	///// rface: 2.332
xcavat					1.5m l	ong (0.4m w		Northing: m			dat	tum:	AHD
excav		n in	orma	tion	<u> </u>		mat		ubstance		- ×		<u> </u>	
L pepetration		support water	sar	otes nples, ts, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 × pocket 200 × penetro- 400 meter		structure and additional observations
		N			_2.0	0.5			TOPSOIL: Sandy CLAY, low to medium plasticity, dark brown-black, sand fine to medium grained, with some rootlets.	D			тс	PSOIL
				D	_1.5	-		Ci SM	CLAY: medium plasticity, dark brown-black, with some sand component approximately 30%.	M	D			
				D		1. <u>0</u>			brown, with some cemented sand nodules.		VD			-
					_1.0	- 1. <u>5</u>		SP	SAND: fine to medium grained, pale grey-white.	M/W				
		2:50bm		D	_0.5	- - 2. <u>0</u>			Pit collapsing due to groundwtaer inflow.					
		04-04-07 2			_0.0				Test pit TP22 terminated at 1.9m					
						2.5								
Sket														
nethod \ \ }H } \ \ \	na ex ba bu rip	isting ickhoe	xposure excavati bucket blade r		S : per		n o resista anging to efusal evel		notes, samples, tests classification Uso undisturbed sample 50mm diameter soil descrip Uso undisturbed sample 63mm diameter based on un D disturbed sample system V vane shear (RPa) moisture Bs bulk sample moisture E environmental sample D dry R refusal W wet Wp plastii W juastii	otion hified cl			-	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense

TESTPIT 20248A

	U	/		⊂y	and the				chnics		E	Excava	tion No	Э.	TP23
Ξr	ıg	in	e	ering	j L	.og	- E	Exc	avation			Sheet Project	No:	1	of 1 GEOTSGTE20248A
lien	nt:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD			Date st			5.4.2007
rinc	ipal:										0	Date co	omplete	ed:	5.4.2007
roje	ect:			RIV	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, TEA GA	ARDI	ENS	oggeo	l by:		CW
est	pit lo	ocat	tion:	REF	ER	TO F	IGUI	RE 1			C	Checke	ed by:		M
						Backho			Pit Orientation: Easting:	m					uface: 2.090
	ation avati			ns: rmation	1.5m	ong (ubstance Northing:	m			da	atum:	AHD
												lex lex	tet etro-		
	penetration	support	water	notes samples, tests, etc	ы	depth	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.		moisture condition	consistency/ density index	o y pocket b d penetro- meter		structure and additional observations
	23	N	~		2.0	metres	<u>}</u>]]}	50	TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black, low plasticity fines, with		D	00	200		DPSOIL
						-	3		some rootlets to 300mm.						
						0.5		SC	Clayey SAND: fine to medium grained, dark grey-black, low to medium plasticity fines.						
				D	_1.5	1		CL	Sandy CLAY: low to medium plasticity, pale browr orange, sand fine to medium grained.	n/	М				
			ved			-		SC SP	Clayey SAND: fine to medium grained, pale grey / pale brown, low plasticity fines.	7-		VD			
			Observed			1.0		58	SAND: fine to coarse grained, pale grey-white.						
			None	D	1.0	_									
						_	•••••								
						1.5									
					_0.5	1. <u>0</u>									
									Becoming grey / brown,	-	w				visible water, but pit collapsing
					-									De	elow 1.7m depth.
				D	_0.0	2.0			Test pit TP23 terminated at 2m						<u> </u>
	etch					2.5]					
netho 3 3 H 3 2	r e t t	natural exposure existing excavation backhoe bucket buildozer blade ripper excavator water			shoring netration 2 3 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	n to resista anging to elusal evel evel e shown	•	Use undisturbed sample 50mm diameter so Use undisturbed sample 63mm diameter ba D disturbed sample sys V vane shear (kPa)	oil descri ased on u rstem oisture dry moi wet (wet (p plas	iption unified o	nbols an		_	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb fitable VL very loose L loose MD medium dense D dense	

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U)		ЗY	1997 1	ي د	jci			E	Excava	tion No.	TP24
Er	ng	in	e	ering	j L	og	- E	Exc	avation		Sheet Project		of 1 GEOTSGTE20248A
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Prin	cipal	:										ompleted:	
-	ect:								PROJECT APPLICATION, TEA GARD				CW MA
	t pit l					TO F		RE 1	Pit Orientation: Easting: m		Checke		
. ,	vatior				1.5m).4m w	ide	Northing: m			datum	
exc	-	ion	info	rmation			mat		ubstance		v	4	
method	benetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	200 × pocket 200 d penetro- 400 meter	structure and additional observations
HBH	123	N			_2.0	_			TOPSOIL: Sandy CLAY, low to medium plasticity, sand fine to medium grained, with some rootlets to 100mm.	M			OPSOIL
000000000000000000000000000000000000000				D	-	0. <u>5</u>		CL	Sandy CLAY: low to medium plasticity, orange, sand fine to coarse grained.				·
					1.5			SP	SAND: fine to medium grained, pale grey-white mottled orange.		D		
				D	_1.0	-							
			11:44am		0.5	1. <u>5</u>							
			05-04-07 11:44am	D		2.0			Lenses of colour change to pale grey / brown, with	w			
					_0.0			;	Pit collapsing from groundwater table. Test pit TP24 terminated at 2m				
						2.5							
	(etch												
metr N X 8H B R E	existing excavation backhoe bucket bulldozer blade ripper excavator water			shoring netration 2 3 4 1 7 r	n io resista anging tr efusal evel e showr	5		ription unified o	classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense		

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TESTPIT 20

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COII	ey	s í	Jeore	echnics		Excavation No.	TP25
Engine	ering	j Log	J - Exc	avation		Sheet Project No:	1 of 1 GEOTSGTE20248AA
Client:	ΤΑΤ	TERSAL	LL SURVI	YORS PTY LTD	l	Date started:	5.4.2007
Principal:						Date completed	
Project:				PROJECT APPLICATION, TEA			CW MAR
Test pit locatio		4WD Backho	FIGURE 1	Pit Orientation: Eastin		Checked by: R.L.	Surface: 2.611
excavation dimen			0.4m wide	Northi	•	datu	
excavation in	formation	1		substance			
method 5 7 penetration support	notes samples, tests, etc	depth RL metres		material soil type: plasticity or particle characteris colour, secondary and minor compone	nts. ĒŠ	consistency/ density index ¹⁰⁰ × pocket ²⁰⁰ v pocket ²⁰⁰ meter	structure and additional observations
T N		_2.5		TOPSOIL: Silty SAND, fine to medium graine grey mottled white with some rootlets and roo (10mm) to 150mm. Silty SAND: fine to medium grained, dark gre	ots	D	TOPSOIL
	D	2.0		cemented nodules of SAND.		VD	
11.0 fam.		1.5		100mm band of pale grey-pale brown and th becoming grey-brown weakly cemented san nodules.			- - - -
	D			Becoming dark brown / red weakly sand nod Test pit TP25 terminated at 2m	ules.		- Rapid inflow of groundwater below _ 1.9m depth. -
Sketch		2.5					
		support		notes samples tests	classification	mbols and	consistency/density index
X existing		water water on da	-	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification sy soli description based on unified system D dry M moist W wet Wp plastic limit W _L liquid limit	classification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

	acoto	obnico				
coffey	geole	CHHICS	-	Excaval	tion No.	
Principal: Project: RIVI Test pit location: REF	TERSALL SURVE ERSIDE ESTATE I ER TO FIGURE 1	YORS PTY LTD PROJECT APPLICATION, TEA (GARDENS		No: arted: mpleted by: d by:	cw M/
	4WD Backhoe 1.5m long 0.4m wide	Pit Orientation: Easting: Northing	m : m		R.L. datu	Surface: 1.709 m: AHD
excavation information	material s				·····	
po true true true true true true true true	debth symbol symbol	material soil type: plasticity or particle characteristic colour, secondary and minor components	o sture moisture condition	consistency/ density index	100 × pocket 200 × penetro- 400 meter	structure and additional observations
	_1.5	TOPSOIL: Silty Sandy CLAY, medium plasticity dark grey-black, sand fine to medium grained, v some rootlets to 100mm. SAND: fine to coarse grained, pale grey-white. Becoming pale brown / grey. Pit collapsing due to groundwater. Test pit TP26 terminated at 1.5m	, M	D		TOPSOIL
Sketch method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R nipper E excavator	support S shoring N nil penetration 1 2 3 4 ranging to ranging to refusal water water level on date shown water inflow water outflow	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification sy soil description based on unified system moisture D dry M moist W wet Wp plastic limi W_ liquid limit	classificati		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

Form GEO 5.2 Issue 3 Rev.2

	J		ey	6 57	ر د	JC	JIC	chnics		Ē	Excava	tion No.	TP27
Ξnę	gi	ne	ering	g L	og	- E	Exc	avation			Sheet Project	No:	1 of 1 GEOTSGTE20248A
lient:			TAT	TER	RSAL	LSL	IRVE	YORS PTY LTD		۵	Date st	arted:	4.4.2007
rincip	al:											ompleted	
roject	:							PROJECT APPLICATION, TEA GA	ARDE				CW MAA
est pit					TO F Backho		RE 1	Pit Orientation: Easting:	m	(Checke		Surface: 1.536
xcavati	-		id model: sions:	1.5m l		e 0.4m w	ide	Northing:	m			datu	
1	- 1	on in	ormation	1		mat		ubstance					
Trieurod 7 penetration		support	notes samples, tests, etc		depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.		moisture condition	consistency/ density index	100 × pocket 200 v penetro- 400 meter	structure and additional observations
	3	N			0.5			TOPSOIL: Silty (Clayey) SAND, fine to medium grained, dark grey-black, with some rootlets to 200mm.		D			TOPSOIL
			D	1.0	-	BB	ŚM	Silty SAND: fine to medium grained, dark brown,		M	VD		
				0.5	- - 1. <u>0</u>		SP	with some cemented sand nodules. SAND: fine to coarse grained, brown / grey, with small percent of fines approximately 20-30% poss clay lenses or nodules.	sibly				
			D	-	-								
		T 04-04-07 3:46m		0.0	- - 1. <u>5</u> -			Becoming pale grey-white. Becoming pale grey / brown.		M/W			
				0.5	2. <u>0</u> -			Pit collapsing due to groundwater inflow. Test pit TP27 terminated at 1.8m			-		
Sketo					2.5								
nethod N K BH B R E	na ex ba bi rig	xisting ackhoe	exposure excavation bucket r blade or	S pe 1	ater water	n no resista ranging t refusal level e showr	5	U _{so} undisturbed sample 50mm diameter so U _{so} undisturbed sample 63mm diameter ba D disturbed sample sy: V vane shear (kPa)	il descr ised on i stem oisture dry moi wet p plas	iption unified	nbois ar classifica		consistency/density index VS very soft S soft F firm St stiif VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

	J		Ξy	w.	9			chnics			Excav	ation No.	TP28
Eng	ji	ne	ering	J Lo	bg	- E	Exc	avation			Sheet Projec		1 of 1 GEOTSGTE20248A
lient:			ΤΑΤ	TERS	ALI	LSU	IRVE	YORS PTY LTD			Date s	started:	4.4.2007
rincipa	al:										Date o	completed	i: 4.4.2007
roject:								PROJECT APPLICATION, T	EA GA	RDEN	S Logge	d by:	CW
est pit l							RE 1	Photostation 5			Check		Surface: 2.012
uipmen cavatior	-	-		4WD Ba 1.5m lon		e 1.4m w	ide		sting: rthing:	ភា ភា		R.L.	
xcava			rmation	1	_		erial s	ubstance			-		
5 penetration	3	support water	notes samples, tests, etc	d RL me	epth etres	graphic log	classification symbol	material soil type: plasticity or particle charac colour, secondary and minor comp		moisture	consistency/ consistency/ density index	100 A pocket 200 A penetro- 400 meter	structure and additional observations
5	-	N						TOP\$OIL: Silty SAND, fine to medium gr grey-black, with some rootlets.	ained, da	ark D			TOPSOIL
			D	_1.5	0. <u>5</u>	} } }	SM	Silty SAND: fine to medium grained, dart brown-black / red, cemented sand nodul		<u>-</u> M	D		
		ε	D	_1.0			SP	SAND: fine to coarse grained, pale brow			_		
		-07 3:31pm		0.5	- - 1.5		эг	SAND, fille to coarse grained, pale brown	7 grey.				
		▼ 04-04-07		0.5	-			Becoming brown / grey mottled orange.					
			D	_0.0	2.0	<u></u>		Test pit TP28 terminated at 1.8m					
					-								
					-					ŀ			
					2.5								
Sketch	ri								·				
nethod V SH 3 R E	ex ba bu rip	itural ex isting e ackhoe t illdozer oper icavator	kcavation bucket blade	1 2 wate	tration	n o resista anging to efusal evel	د ا	notes, samples, tests Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	r so r ba		n ed classific		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose

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CO		ey	1	y	ec	າຍ	chnics		E	Excava	tion No.	TP29
Engi	nee	ering	J Lo	g.	- E	хс	avation			Sheet Project		1 of 1 GEOTSGTE20248AA
Client:		ΤΑΤ	TERSA	LL	SU,	RVE	YORS PTY LTD		[Date st	arted:	5.4.2007
Principal:											mpleted	5.4.2007
Project:							PROJECT APPLICATION, TEA	GARD				CW Mai
Test pit loc			ER TO		SUR	2E 1	Pit Orientation: Easting	E m		Checke		
excavation di	•		1.5m long		lm wi	ie	Northin				datu	
excavatio	n info	rmation					ibstance					
method 5 5 penetration	support water	notes samples, tests, etc	dep RL metr	oth	graphic log	classification symbol	material soil type: plasticity or particle characteris colour, secondary and minor componer		moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 meter 400 meter	structure and additional observations
	N Contraction		2.0	- }			TOPSOIL: Silty SAND, fine to medium grained brown-black, with some rootlets.	1, dark	D			TOPSOIL
		D	_1.5	<u>5 }</u> 		SC	Silty SAND: fine to medium grianed, pale gre brown. Clayey SAND: fine to medium grained, pale b low plasticity fines.		M	D		
		D	_1.									-
		D	_0.5	5		SP	SAND: fine to medium grained, pale grey-whi	ie,	w			_
	05-04-07 3:12pm		_0.0	- - - -			Pit collapsing. Test pit TP29 terminated at 1.7m					-
Sketch	:		2.	5								
GNOLOI												·
X exi BH ba B bu R nip	tural exp isting ex ckhoe b Ildozer b per cavator	cavation ucket	l <u> </u>	ng 4 nor rang ser refu date s er infle	resistar ging to usal el shown ow	nil	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	W we Wp pla	ription unified y oist	classifica		consistency/density Index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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)		сy	469	2	,		chnics		-	Excava	ition I	No.	TP30
E	nç	ji	ne	ering	j L	.og	- E	Exc	avation	·		Sheet Project	No:		1 of 1 GEOTSGTE20248A
Cli	ent:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD			Date st			5.4.2007
	ncipa									~		Date co	'	eted:	
	oject:								PROJECT APPLICATION, TEA	GARL			-		CW MI
	st pit					TO F Backho			Pit Orientation: Easting:	m	(Checke			Surface: 1,159
	avatio				1.5m		-).4m w	ide	Northing					datur	
ex		tio	1 info	ormation	1		mat		ubstance		T		6		
method	Denetration	3	water	notes samples, tests, etc		depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristic colour, secondary and minor components	CS, S.	moisture condition	consistency/ density index	100 pocket	a	structure and additional observations
ВН		ľ	1		_1.0	-			TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plas fines, some rootlets 300mm and roots to 300m	sticity m.	D				TOPSOIL
			05-04-07			0.5)) 	SP	SAND: fine to coarse grained, pale grey-white.		W	MD			Some inflow of groundwater to pit at 0.3m, 8:05am, pit slowly
				D	0.5				Becoming pale brown-grey.			D			collapsing from sides, organic odour.
				D		1. <u>0</u>									
					_0.0										
				D		1. <u>5</u> _			Becoming dark brown-red, with some cemente nodules.	d sand					
						2.0			Pit collapsing. Test pit TP30 terminated at 1.7m						
					1.0	-									
	ketcl	h				2.5									
me N X BH B R E	thod	exi bac bul ripp	sting ex khoe t dozer		S pe 1	iter water i	n no resista anging to efusal	•	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil des based or system moistur D dr M m W w Wp pl	n unified	classifica			consistency/density index VS very soft S soft F firm St stiff VSt very sliff H hard Fb friable VL very loose L loose MD medium dense

				⊂ y		Ċ) -		chnics		E	Excava	tion	No.	TP31
									avation			Sheet Project	No:		1 of 1 GEOTSGTE20248A
lier	nt:			ΤΑΤ	TER	SAL	L SL	IRVE	YORS PTY LTD		I	Date st	arted	l;	5.4.2007
rinc	cipal										ſ	Date co	mple	eted	: 5.4.2007
roje	ect:			RIVE	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, TEA G	SARD)ENS	ogged	l by:		CW
	pit lo			REF		-		RE 1			(Checke			
• •	ment ation	• •				Backho	e).4m w	ido	Pit Orientation: Easting: Northing:	m				R.L. datu	Surface: 0.732
				mation	1.5m l	ong t			ubstance	m				ualu	
	penetration	support	water	notes samples, tests, etc	RL	depth	graphic log	classification symbol	material soil type: plasticity or particle characteristic: colour, secondary and minor components		moisture condition	consistency/ density index	100 pocket	a	structure and additional observations
	123	N	_				BIB		TOPSOIL: Silty Clayey SAND, fine to medium		D		58¥	54	TOPSOIL (swampy area) organic
					_0.5	0.5		SC	grained, dark grey-black mottled white, low to m plasticity fines, with layer of mulch and rootlets to 100mm. Clayey SAND: fine to medium grained, pale gre pale brown, low plasticity fines.	> /	M	MD D	a sector de la deste del calder de la consector de las consector de la dela consector de la defensa		odour
				D	_0.0	- 1. <u>0</u>			Becoming grey / brown.		W	-	a de la constante de la consta Ante de la constante de la cons Ante de la constante de la const		Very slow inflow of groundwater.
			05-04-07 8:29am		0.5	- - 1. <u>5</u>		SP	SAND: fine to medium grained, dark brown-red, indurated cemented sand nodules.				t de rest de la fertil de la ferencia de la fertil de la composition de la ferencia de la ferencia de la compo Este de la composition de la ferencia de la fertil de la composition de la fertil de la fertil de la compositio		Rapid inflow of groundwater.
				D	1.0	-			Silty Gravelly SAND: fine to coarse grained, day grey-black, gravel fine to medium grained, rounded-subrounded.	rk					
					15	2. <u>0</u> _			Pit collapsing due to inflow of groundwater. Test pit TP31 terminated at 1.8m				and the second secon		
					1.5										
						2.5									
<u>L</u>	etch					2.5									
eth H		existi backl	ng exe noe bu ozer b		S			nii nce	U _{so} undisturbed sample 50mm diameter U _{ss} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample	soil desc based or system moisture D dr	cription n unified	mbols an Classifical			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb fnable

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C	U		ey		, r	30		echnics		-	Excava	ation No	D.	TP32		·
Clien Princi Proje	t: ipal: ct:		TA1 RIV	TEI	RSAL	.L SI	JRVE ATE I	YORS PTY LTD	EA GARI	DENS	Date co Loggeo	tarted: omplete 1 by:	ed:	f 1 GEOTSG 5.4.2007 5.4.2007 CW	<u>FE20248</u>	BAA
Test p					TO F Backho		RE 1	Pit Orientation: Eas	sting; m		Checke		1			- 1
	ation dir			1.5m		0.4m w	vide		rthing: m				L. Surf itum:	ace: 0.994 AHD		
		n info	rmation	1		mat	1	ubstance		1						
8	 benetration support 	water	notes samples, tests, etc	RL	depth metres		classification symbol	material soil type: plasticity or particle character colour, secondary and minor compo		moisture condition	consistency/ density index	100 X pocket 200 X penetro- 300 e meter		structur additional ob		
BH	N							TOPSOIL: Silty Clayey SAND, fine to med grained, dark grey-black mottled white, lov fines, with some rootlets and roots (10mm	v plasticity	D			TOF	'SOIL (swampy	area)	
				_0.5	0. <u>5</u>		SC	Clayey SAND: fine to coarse grained, pale brown, low plasticity fines maybe low perce fines approximately 30-40%.	s grey-pale entage of	M	D		Som	e inflow of wate		
		-07 8:47am	D	_0.0	- - 1. <u>0</u>			Becoming grey-brown, some presence of sand nodules.	cemented	W			Mod 8:47	erate inflow of g am.	proundwater	-
		05-04-07		0.5	- - 1. <u>5</u>											-
			D	1.0	-			Becoming grey mottled brown / orange and of subrounded to rounded gravel (fine to m grained) less than 10mm size. Pit continually collapsed due to water table Test pit TP32 terminated at 1.7m	nedium							
Sket		J			oport			notes, samples, tests	classific	ation syn	bols and		60	nsistency/densit	y Index many	
N X BH B R E	natur existi back	hoe bu ozer bi r	avalion Icket	s: per 1 ₩ wa ₩	shoring	o resistan inging to ifusal ivel shown	nìl	Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil desc based on system D dry M mo W we Wp pla	ription nunified cl			C0 VS S F St VS F D VL L D V U	; very soft firm stiff hard friab very loos 0 med dens	soft stiff le loose e tum dense	

Form GEO 5.2 Issue 3 Rev.2

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Ε	ng	ji	ne	ering	g L	.og	- E	Exc	avation		Sheet [⊃] rojecl	t No:	1	of 1 GEOTSGTE20248A
Cli	ent:			TAT	TEF	RSAL	L SL	IRVE	YORS PTY LTD	ſ	Date st	tarted:		5.4.2007
Pri	ncipa	al:									Date c	•	ted:	
	oject:								PROJECT APPLICATION, TEA GARL					CW MA
	st pit			d model:		TO F Backho		RE 1	Pit Orientation: Easting: m		Check	-	21 9	Surface: 0.923
	avatio				1.5m		e 0.4m w	íde	Northing: m				iatun	
ex	1	tio	n inf	ormation			mat		ubstance	1	1	1		
method	5 penetration		water	notes samples, tests, etc		depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 A pocket 200 A pocket 300 a penetro-	1	structure and additional observations
H8	12.	<u> </u>	1						TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticity fines, with some rootlets to 250mm.	D/M		- ~ ~		FOPSOIL (swampy area)
					0.5	0.5		SC	Clayey SAND: fine to coarse grained, pale grey-pale brown.	M	D			
			8:56am	D	0.0				Becoming grey / brown.	w				/ery slow inflow of groundwater :56am, organic odour.
			05-04-07	D		-								
					0.5	1. <u>5</u>							and the fact that the second of the factor fact that the fact that that the fact that the fact that the fact that	-
				D	1.0	2.0		SP	SAND: fine to medium grained, dark brown-black, some cemented nodules of sand. Pit collapsing due to water table.					
					1.5	2.5			Test pit TP33 terminated at 2m				an bi shekara shekara shekara ta sa	
S	Sketch	h				<u> </u>				,	ſ			
me N B B R E	ethod	exi ba bul rip	sting e :khoe Idozer	xposure xxcavation bucket blade f	S pe 1	ater	n no resista ranging to refusal	nil nce	U _{so} undisturbed sample 50mm diameter soil des U _{es} undisturbed sample based o D disturbed sample system V vane shear (kPa) moistur Bs bulk sample moistur E environmental sample D d R refusal M m	cation syn scription on unified re re hy noist				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose
					1.	water l on dat water i water o	e shown nflow	I	Wp p	vet Aastic limit quid limit	t			VL very loose L loose MD medium dense D dense VD very dense

TESTPIT

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C	J		ey	will be	Ĺ	jet	JIE	chnics		Ē	Excava	tion No	D. TP34
Eng	gin	e	ering	j L	.og	- E	Exc	avation			Sheet Project	No:	1 of 1 GEOTSGTE20248AA
Client:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD		[Date st	arted:	5.4.2007
Principa	al:									٤	Date co	omplete	ed: 5.4.2007
Project	:		RIVI	ERS	IDE I	ESTA	ATE /	PROJECT APPLICATION, TE	A GARI	DENS	oggeo	l by:	CW
Test pit	loca	ion:	REF	ER	TO F	IGUI	RE 1			(Checke	ed by:	
equipme					Backho			Pit Orientation: East	•				L. Surface: 0.893
excavation excavation			ons: rmation	1.5m	long	0.4m w mat		Norti	hing: m			da	etum: AHD
method 5 5 5 5 5 6 6 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	support	water	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle characte		moisture condition	consistency/ density index	a pocket a d penetro- meter	
는 12 표	3 0 N	3			metres		00	colour, secondary and minor compor TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey-black mottled white, low	ım	M	90	200 200 300 400	TOPSOIL
				_0.5	0.5		SC	plasticity fines. Clayey SAND: fine to coarse grained, pale grey-white, low plasticity fines. Becoming pale grey-pale brown.			D		
		-07 9:13am	D	0.0	-		SP	SAND: with some clayey lenses, fine to me grained, low plasticity fines.	dium —				Very slow inflow of water, 9:13am - -
		05-04-07	D	0.0	1.0		SC	Clayey SAND: fine to coarse grained, grey low to medium plasticity fines. Pit slowly collapsing due to water table.	/ brown,	Ŵ	MD		
				0.5	1.5						MD		-
				1.0	_		SM	Silty SAND: fine to medium grained, dark t	rown /				_
					-			Pit collapsing due to groundwater. Test pit TP34 terminated at 2m					-
				1.5	2.5								-
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IE Form GEO 5.2 Issue 3 Rev.2

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BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

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BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

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BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23,10.07

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	diam				100 m				Easting: Northing	slope: bearing					Surfac ium:	e: 2.303 AHD	
dril	lling	inf	orma	tion		;	mat	-	ubstance		-	1	1				
וופתוסם	5 penetration	suport	water	notes samples, tests, etc		depth	graphic log	classification symbol		material ty or particle character ary and minor compone		moisture condition	consistency/ density index	200 A pocket 300 B penetro- 400 meter	4	structur Idditional ob	
		c						CL	TOPSOIL: Clayey SA	ND, fine grained, dark	grey,	M			TOPS	OIL	
				SPT 2,2,3 N*=5	_2	- - -				n to high plasticity, gre	J y, sand	>Wp					
					1	-		CL	Sandy CLAY: low to sand fine grained.	nedium plasticity, dark	brown,						
000000000000000000000000000000000000000			Y			-											
000000000000000000000000000000000000000				SPT	-	2						W					
10010000				4,5,5 N*=10	۵_			SW	SAND: fine to mediur	n grained, grey.			D	1			
100000					1	-		•									
						3	· · · ·										
0000000					1	-]									
00000000				SPT	-	_			Becoming black.								
0.00000				12,18,23 N*=41		4											
0000000					2	_											
0.00010					Γ	-											
0.0000								-									
00000000				SPT	1_	5											
0000000				4,8,11 N*=19	3	-		•									
00000000																	
1000000						6							MD	$\left\{ \left \left \left \right \right \right\}$			
1000000000			1		4	-											
200100000000			1	SPT	-	-											
000000		_	ļ	4,8,8 N*=16		7											
					5	-			Borehole BH38 termi	nated at 7m							
						_											
						8											
Lineth SDR V TIA DT S	iod hown	a r v t t t t	uger o oller/tr vashbo able to and a liatube lank b / bit 'C bit	ore ool uger o	M C Pe 1 Wa	pport mud casing netratio 2 3 4 2 3 4 1 1 10/1/9	no resist ranging t refusal 8 water ie show	level	U ₆₃ undisturbed D disturbed sa	netration test (SPT) e recovered d cone kPa) er	soil des based o system D di M m W w Wp pl	n unified	classifica		Cor VS F St VSI H Fb VL L D	sofi firm stift ver har fria ver loo:	y soft t f y stiff d ble y loose

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

coffey	nente	chnics			
coney	• yeur	,CH111C5	-	Excavation No.	TP39
Engineerin	g Log - Exc	avation		Sheet Project No:	1 of 1 GEOTSGTE20248AA
Client: TA	TTERSALL SURVE	YORS PTY LTD		Date started:	1.6.2007
Principal:				Date completed:	
		PROJECT APPLICATION, TE			RJP Mu
Test pit location: RE equipment type and model:	FER TO FIGURE 1	Pit Orientation: East		Checked by:	Surface: 2,77
excavation dimensions:	2m long 0.45m wide	Nort	-	datur	
excavation information		ubstance		- X 6	
notes sample: tests, et 1 2 3		material soil type: plasticity or particle characte colour, secondary and minor compor		consistency/ density index ¹⁰⁰ A pocket ²⁰⁰ A pocket ⁴⁰⁰ Meter	structure and additional observations
HØ		TOPSOIL: Sandy Silty CLAY, medium plas dark grey, sand fine to medium grained.	icity, M		TOPSOIL Root affected.
	CH	CLAY: high plasticity, grey-brown and oran mottled, some sand. CLAY: high plasticity, grey-grey-brown, son	ne	St	-
	1.5	orange motiled with a trace of sand fine to grained. SAND: fine to medium grained, while / light grey-brown.			- Pit collapsing below 1.4m, organic odour
		Moderate groundwater inflow below 1.4m, Test pit TP39 terminated at 1.7m			
method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nil penetration 1 2 3 4 ranging to ranging to water water reusal water level on date shown water inflow	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification sy soil description based on unified system moisture D dry M moist W wet Wp plastic limit W, liquid limit	classification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense

TESTPIT 20

		obnios			
coffey	geole	CHINGS	-	Excavation No.	TP40
Engineering	g Log - Exc	avation		Sheet Project No:	1 of 1 GEOTSGTE20248AA
Client: TA	TTERSALL SURVE	YORS PTY LTD		Date started:	1.6.2007
Principal:				Date completed	d: 1.6.2007
Project: RIV	ERSIDE ESTATE I	PROJECT APPLICATION, TEA	GARDENS	Logged by:	RJP
	FER TO FIGURE 1			Checked by:	
equipment type and model: excavation dimensions:	4WD Backhoe 2m long 0.45m wide	Pit Orientation: Easting Northing			. Surface: 2.59 um: AHD
excavation information	material s		j: m	dau	
De la construction de la constr	depth a depth	material soil type: plasticity or particle characterist		consistency/ density index 100 pocket 200 d penetro- 400 meter	structure and additional observations
123 ° ≶ <u>⊥</u> N	RL metres 5 5 6	colour, secondary and minor componen TOPSOIL: Silty Sandy CLAY, medium plasticit			TOPSOIL Root affected.
		dark grey, sand fine to medium grained.		St	
		Sandy CLAY: medium plasticity, grey-brown a orange mottled, sand fine to medium grained.	na	51	-
	2.0 0.5	Becoming grey-brown and sand content increa Sandy CLAY / Clayey SAND.	asing to	X	- - -
	1.5				- - -
	SP 	SAND: fine to medium grained, grey-brown wil some clay.			-
	1.5 SP	SAND: fine to medium grained, light grey-brow	m.		Rapid groundwater inflow below 1.4m. Organic odour. –
	2.0	Pit collapsing below 1.1m. Test pit TP40 terminated at 1.7m			-
					-
	2.5				_
Sketch					
method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nil penetration 1 2 3 4 ranging to ranging to returnal water water level on date shown water inflow water outflow	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification sy soil description based on unified system D dry M moist W wet Wp plastic lim W _L liquid limit	dassification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD verv dense

Form GEO 5.2 issue 3 Rev.2

U		/		ΞY	***		<i>,</i>		chnics		{	Excava	ation No.	TP41
Eı	ng	in	e	ering	g L	.og	- E	Exc	avation			Sheet Project	t No:	1 of 1 GEOTSGTE20248
Clie	nt:			TAT	TEF	RSAL	L SU	JRVE	YORS PTY LTD		Γ	Date s	tarted:	1.6.2007
² rin	cipal	:											ompleted	
	ect:								PROJECT APPLICATION, TEA C	GARD				RJP Mu
	t pit lo			model:		TO F Backho		RE 1	Pit Orientation: Easting:	m	(Check		. Surface: 3.63
• •	vation				2m lo		45m wi	de	Northing:				datu	
exc		ion	info	rmation			mat		ubstance	-				
method	penetration	support	water	notes samples, tests, etc	:	depth metres		classification symbol	material soil type: plasticity or particle characteristic colour, secondary and minor components		moisture condition	consistency/ density index	100 A pocket 200 A penetro 300 b meter	structure and additional observations
H B B B B B B B B B B B B B B B B B B B	123	N	_	-	3.5			0	TOPSOIL: Sandy CLAY, medium plasticity, grey-brown, sand fine to medium grained.		M		20230	TOPSOIL Root affected.
00000000						-			are, wronn, oand nne to modum gramou.					
0.000000						-		CI	Sandy CLAY: medium plasticity, light grey-brow and orange mottled, sand fine to medium graine		>Wp	St		
000000				D	-	0.5							X	
					3.0	-			Becoming light grey-light grey-brown and orange	e				
						-			mottled.				-X	
				D	-	1.0_			Sand content increasing light grey-brown and or	range				
020000					2.5				mottled.					
0000000						-								
				D	_	1. <u>5</u>		SP	SAND: fine to medium grained, light grey-brown		M			
					2.0	-			some orange mottled, cemented.					
						-								
						2.0								
					_1.5	-								
						-		SP	SAND: fine to medium grained, white-light grey-brown.		W			Slow groundwater inflow below 2.2m. Organic odour.
00000				D		2.5								
Sk	etch								Test pit TP41 terminated at 2.5m					
neth	bor	natur	alexn	osure		pport shoring	N	nil		classifica soil desc		nbols ar	nd	consistency/density index VS very soft
(BH	í I	existi backl	ng ex noe bi	cavation ucket	pe	netratio			U ₆₃ undisturbed sample 63mm diameter I D disturbed sample s	based on system	•	classifica	tion	S soft F firm
3 2	ſ	ippe		lade		<u>234</u>	no resista ranging to	псе		moisture				St stiff VSt very stiff
		exca	/ator		wa	ater water i	etusal evel		R refusal	D dry M mo W we	ist			H hard Fb friable VL very loose
						• on dat	e shown			Wp pia	, istic limit uid limit			L loose MD medium dense
						 water i water i 								D dense VD very dense

C	0	I	[(эу		Q	je	υτε	chnics			Excava	ation No).	TP42	
									avation			Sheet		1	of 1	
Client:						-			YORS PTY LTD			Project Date st	t No: tarted:		GEOTSGTE 1.6.2007	20248A
Princip	oal:										I	Date c	omplete	ed:	1.6.2007	
Project	t:			RIV	'ERS	IDE	EST.	ATE I	PROJECT APPLICATION, TE	A GARI	DENS	_ogged	d by:		RJP	
Test pi	it lo	cati	on:	REI	FER	TO F	IGU	RE 1			(Check	ed by:		MA	
equipme						Backho			Pit Orientation: Easti	0					nface: 2.82	
excavati excavati				ms: mation	2m lo	ng 0.	45m w mat		ubstance North	iing: m			da	tum:	AHD	
method 1 5 penetration	helieriariori	support	water	notes samples tests, etc		depth		classification symbol	material soil type: plasticity or particle character		moisture condition	consistency/ density index	ady pocket benetro- meter		structure additional obse	
E 12 범행		ิ N	3		RL	metres	्र जि	ට්ගි	colour, secondary and minor compon TOPSOIL: Silty Sandy CLAY, low to mediur	n	E X M	రశా	5 8 8 6 8 8 8 9		PSOIL Root affect	ed.
В						-			plasticity, sand fine to medium grained, darl grey-brown.	K						
					_2.5	-		CI	Sandy CLAY: medium plasticity, grey-brow		>Wp	Şt				
				D	-	0.5			orange mottled, sand fine to medium graine	u.			×			
						-										
					_2.0	-		СІ	Sandy CLAY: medium plasticity, grey-grey-	brown						
			ļ		_	1.0			some orange mottled, sand fine to medium sand content increasing.	grained,			×			
		•	►	D		-		SP	SAND: fine to medium grained, white.		W			Ve	ery slow water inflow	v below 1.1m
					_1.5	_		-	Becoming grey-grey-brown, with a trace to	some clav.						
						1. <u>5</u>		•		, .						
			+	D	_	-										
					1.0	<u> </u>		1	Test pit TP42 terminated at 1.7m					•		
						2.0										
						-										
					_0.5	-										
						2.5										
Sketo	 ch	l.				2.0		1	I			1		1		
					- F											
method N X BH B R E	na ex ba bu rig	distîn ackho	g exc be bu zer bl	osure cavation icket iade	S pe 1	ेळ्या ।		ince	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{ss} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil des based o system moistur D di M m	n unified e ry noist				consistency/density VS very s S soft F firm St stiff VSt very s H hard Fb friable	soft stiff
					_		e showr	1		Wp pl	et lastic limit quid limit					ım dense
						 water i water o 									D dense	

	ונ		чy		ſ	100	JIC	chnics	-	Excava	ation No.	TP43
Enc	nir	1e	erind	χL	oa	- E	Exc	avation		Sheet		1 of 1
Client:	,			-	-			YORS PTY LTD		Project Date st		GEOTSGTE20248A 1.6.2007
Principa	al:										ompleted	
Project:			RIV	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, TEA GAR	DENS		•	RJP
Test pit	loca	ation			TO F					Checke		111
equipmer	nt typ	e and	I model:	4WD I	Backho	e		Pit Orientation: Easting: m	1		R.L.	Surface: 4,75
excavatio			ons: rmation	2m lor	ng 0.4	45m wi		Northing: m ubstance	1		datu	im: AHD
							-			ex /	r tro-	
method penetration	support	water	notes samples, tests, etc	PI	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	o A pocket benetro- meter	structure and additional observations
	3 0. N					.	SP	SAND: fine to medium grained, grey-brown.	M		400 300 400	AEOLIAN Root affected to 0.15m
				4.5								
					-			Becoming light grey-brown.				
			D	-	0. <u>5</u>							
				-	-							
				_4.0	-	•••••	SP					
				-	1.0		อก	SAND: fine to medium grained, grey-brown and orange mottled, trace to some clay.				
			D		-							
				_3.5		· · · · ·						
					1. <u>5</u>							
							SP	SAND: fine to medium grained, light grey-brown, some weakly cemented nodules, grey-brown.				
			D	3.0	-				w	1		Very slow water inflow below 1.7n
					2.0			Test pit TP43 terminated at 1.85m				
					_							
				_2.5	-							
					2							
Sketcl	<u></u> h	I			2.5							
0.1010												
				i —				· · · · ·			<u> </u>	
method N X			cavation		pport shoring	N	nil	U _{so} undisturbed sample 50mm diameter soll des	scription	mbols an classifica		consistency/density index VS very soft S soft
х BH B	bac	ting ex khoe b dozer b	ucket	per 1	netration 2 <u>34</u>			U ₆₀ undisturbed sample 63mm diameter based o D disturbed sample system V vane shear (kPa)	AT UTIMED	Classifica	uuri	S soft F firm St stiff
R	ripp					io resista anging to efusal	nce	Bs bulk sample moistur E environmental sample D d	lry			VSt very stiff H hard
				wa	water i			W w	noist vet	•	ł	Fb friable VL very toose
					on date water i	e shown nflow			ilastic lim quid limit			L loose MD medium dense D dense
					water d						1	VD very dense

L)()	T(ey		^{μω} Ω	jeo	ote	chnics			Ē	Excava	tion No.	TP44
									avation			S	Sheet		1 of 1
	ent:	<u>, , , , , , , , , , , , , , , , , , , </u>							YORS PTY LTD				Project Date st		GEOTSGTE20248A 1.6.2007
	ent: ncipa	al·		IAI		(SAL	L 30	KVE	TORSFITLID					ompleted	
	oject:			RIV	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION	I. TEA G	ARD			•	RJP
	st pit		tion:			TO F				,			Checke		A.M.
qui	ipmer	nt typ	e and	l model:	4WD	Backho	е		Pit Orientation:	Easting:	m			R.L.	, Surface: 4.46
	avatio			ons: rmation	2m lor	1g 0.4	45m wi		ubstance	Northing:	m			datu	um: AHD
		_						· · · · ·					ex /	r tro-	
mernoa	penetration	Ĩ	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle c colour, secondary and minor (moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 meter	structure and additional observations
	12	3 N						SP	SAND: fine to medium grained, darl	,		M		19	AEOLIAN Root affected to 0.3m.
						-									
						-			Becoming light grey-brown.						
				D	4.0	0. <u>5</u>									
			rved		1		· · · · ·	SP	SAND: fine to medium grained, darl	brown, some					INDURATED SAND
			Observed			-	· · · · ·		silt / Silty SAND.						
			None		3.5	1. <u>0</u>	· · · · · ·								
				D	-	-									
						-									
					_3.0	1. <u>5</u>									
				D		-			Becoming cleaner and less cement	ed, brown.					
						-									
Ì					2.5				Test pit TP44 terminated at 1.8m						
		a ad a laborator to				2. <u>0</u>					1				
						_									
						-									
					_2.0	2.5									
net H	thod	exis bac bull ripp	ting ex khoe b dozer t		S pe 1	iter	n no resista ranging to refusal	l nil ance o	notes, samples, tests U ₅₀ undisturbed sample 50mm di U ₅₃ undisturbed sample 63mm di D disturbed sample V vane shear (kPa) Bs buik sample E environmental sample R refusal	ameter so ameter ba sy	oil desc ased on stem oisture dry mo	ription unified	nbols ar dassifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose
					-	vater l on dat	evei e showr	1		w w	/p pla	stic limit ıid limit			L loose MD medium dense
						- water i	nflow			I "					D dense

coffey	geotechnics
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<u></u>	
Client:	

TATTERSALL SURVEYORS PTY LTD

' LTD

Principal: Project:

RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENSLogged by:

Borehole Location: REFER TO FIGURE 1

drili mode					101			Easting: slope	:: -90°		JIECK		_	
hole diam			<i>a</i> -	mm				Northing beari						um; AHD
drilling			ation			mat	erial s	Ibstance					uui	
method 5 penetration		support water	notes sample tests, é	s,	depth metre	graphic log	classification symbol	material soil type: plasticity or particle characte colour, secondary and minor compo	eristics, nents.	maisture condition	consistency/ density index	100 pocket		structure and additional observations
<u>н</u>				3			SP	SAND: fine to medium grained, grey-brow	1.	M	D		Π	AEOLIAN SAND
			SPT 2,5,7 N*=12		1 - - - 2			Becoming light grey-brown.						
		_	, 5,6,8 N*=12		3			Becoming dark grey-brown.		W				
			SPT 3,15,2 N*=36	1	4		SP	SAND: fine to coarse grained, dark brown, gravel fine grained and silt.	trace of		VD			
			SPT 9,21,2 N*=41	2	- - - - - - - -			Wilh a trace fine grained gravel.						20 blows for 100mm penetration
			SPT 8,18,2 N*=39	4	- - - - -			Becoming fine to medium grained, light bro brown.	wn and					21 blows for 100mm penetration
method AS AD RR W W CT HA DT B B V T "bit shown I e.g.	by s	auger roller/ washt cable hand diatut blank blank V bit TC bit	tool auger e		ater 10/1/9	n no resista ranging to refusal 8 water I e shown inflow) level	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample 63mm diameter N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal	soil desi based or system D dr M m W w Wp pt	n unified c				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

 Sheet
 1 of 2

 Project No:
 GEOTSGTE20248AA

 Date started:
 5.6.2007

BH45

Borehole No.

Checked by:

Date completed: 5.6.2007

y: **RJP**

1M

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

(20	of	f	ev		<u>م</u>	aec	ote	chnics			_				
				⊂ y								E	Boreho	le No	-	BH45
E	-nainaarina Laa Karahala															2 of 2 GEOTSGTE20248AA
Cli	ient:			TAT	TER	?SAL	LSU	IRVE	YORS PTY LTD			Ľ	Date st	arted:		5.6.2007
Pri	incipal:	:										C	Date co	mple	ted:	5.6.2007
Pr	oject:			RIVE	ERS	IDE I	ESTA	ATË F	PROJECT APPLICATIO	N, TEA G	ARDE	ENS	.ogged	by:		RJP
Во	rehole	Lo	catio	on: REF	ER	TO F	IGUI	RE 1				C	hecke	d by:		M
dil	modei	and	mou	inting:					Easting:	slope:	-90°			F	₹.L. Su	rface: 3.20
	e diame				mm				Northing	bearing:				c	latum:	AHD
dı	rilling i	nfo	rma	ition			mate	erial su	ubstance							
method	5 penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle of colour, secondary and minor	components.	Į	moisture condition	consistency/ density index	100 A pocket 200 A penetro- 300 b benetro-		structure and additional observations
н		С			5			SP	SAND: fine to coarse grained, dark gravel fine grained and silt. (continu		of	W	D			

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

SPT 5,13,17 N*=30 9 -6 ٢ 10 SPT _-7 1,6,15 N*≂21 Borehole BH45 terminated at 10.45m 1<u>1</u> -8 Collapsed back to 2.3m 12_ _-9 1<u>3</u> -10 1<u>4</u> -11 1<u>5</u> _-12 16 method notes, samples, tests classification symbols and consistency/density index support AS auger screwing* M mud N nil U₅₀ undisturbed sample 50mm diameter soil description vs very soft AS auger AD auger RR roller/tu W washb CT cable t HA hand a DT diatube B blank t V V bit T TC bit *bit shown by suffix e.g. ADT auger drilling* roller/tricone undisturbed sample 63mm diameter disturbed sample C casing based on unified classification S F U₆₃ D N N* soft system penetration GEO 5.3 Issue 3 Rev.2 firm St VSt washbore standard penetration test (SPT) stiff no resistance ranging to
 refusal SPT - sample recovered SPT with solid cone vane shear (kPa) cable tool moisture very stiff H Fb VL hand auger diatube Nc V D M W dry hard moist friable water blank bit Ρ pressuremeter wet very loose 10/1/98 water level on date shown V. , Bs E R L MD D bulk sample Wp plastic limit loose environmental sample refusal $W_{\rm L}$ liquid limit medium dense water inflow Form (dense ADT _ water outflow VD very dense e.g

(CC)f	f	ey		Ś	geo	ote	chnics		Boreho	ole No.		BH46	
									rehole		Sheet Project	t No:		1 of 1 GEOTSGTE20248	BA/
Cli	ent:			ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD		Date s	tarted:	• • •	6.6.2007	
Pri	incipa	:									Date c	omplet	ed:	6.6.2007	
	oject:			RIVI	FRS	IDE	EST		PROJECT APPLICATION, TE			•		RJP	
Во	rehole			on: REF							Check	-		M	
dril	l modei	and	mou	nting:					Easting: slope	e: -90°		R	.L. Su	rface: 1.07	
	e diam rilling				mm		1		Northing bear ubstance	ing:		da	atum:	AHD	
						1	man	i			. ×	. 6			
method	penetration	support	water	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle character	eristics,	condition consistency/ density index	a pocket Benetrc		structure and additional observations	
	123	° C	\$		RL	metres	> ∑∏ ∑]	00	colour, secondary and minor compo		0 00 N	ទន្តន្តទ		PSOIL	
ЧH						-			plasticity, dark grey, sand fine to medium a some sitt.						
						-		SP	SAND: fine to medium grained, grey-brow	n	MD]	[]		
			⊻			1				7	N				
				SPT 3,2,2	1_0	_			Becoming light grey-brown.						-
				N*=4		_									
						-									
						2					i.				
					-1	-									-
		SPT - SF 7,12,14						SP	SAND: fine to medium grained, dark brow	n, trace	VD				
		7,12,14 N*=26							silt.						
															-
						-									
						-									
						-									
					-3	4									_
				SPT 5,16,23	F	_		SP	SAND: fine to medium grained, some clay and dark brown, trace fine grained gravel.	, brown					
				N*=39											
						5									
					-4]								-
			ł]									
			ŀ	SPT				SP	SAND: fine to medium grained, light brown						
				2,9,18 N*=27											
			ŀ		5	6									
			╞	007	6	7			Becoming fine to coarse grained, trace fin	arained					_
				SPT 3,10,18	[gravel, light grey-brown.	e graineu					
			-	N*=28		\vdash			Borehole BH46 terminated at 7.45m						
						8									
met AS	hod	au	ger so	rewing*		pport mud	N	nil	notes, samples, tests U _{so} undisturbed sample 50mm diameter	classification soil descript	-	d		consistency/density index VS very soft	
AD RR		au		illing*	С	casing			U _{sa} undisturbed sample 63mm diameter D disturbed sample	based on uni		tion		S soft	
W		wa	shbor	e	per 1 : Sourt	netration	n 10 resista	nce	N standard penetration test (SPT)	system				St stiff	
CT HA			ole too nd au			in la construction de la constru	anging to efusal		N* SPT - sample recovered Nc SPT with solid cone	moisture D dry				VSt very stiff H hard	
рт В		dia	lube nk bit		wa	ter 10/1/99	R water !	ovel	V vane shear (kPa) P pressuremeter	M moist W wet			1	Fb friable VL very loose	
v		V	bit		┸		8 water l e shown		Bs bulk sample	Wp plastic			1	L loose	
₹ *bit	shown b	iy sufi			· ·	water i			E environmental sample R refusal	W _L liquid li	imit			MD medium dense D dense	
e.g.		A	Ţ			water o	outflow						\ \	VD very dense	

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23,10,07

													Borehol	e No.	BH 21
E	nai	ine	er	ring L	. 0 0	-	Pi	ezo	me	ter			Sheet	ob 61	BH 21 ^{1 of 1} <u>E12752/03</u> 30.4.2004 d: 30.4.2004 KML
Clie				CAF			- •						Office Jo Date sta		E12752/03 30.4.2004
Prii	ncipa	d:		CRI	GHT	ON	I PF	ROPE	ERTI	ES			Date co		d: 30.4.2004
Pro	ject:			MYA		QU	AY	S ES	TAT	Έ			Logged	by:	KML
Boi	ehol	e Lo	catio	on: See	Figu	ıre	5						Checked	d by:	Ew.
drill	mode	l & m	ounti	ng:Gemco	Traile	r			Eas	sting:	slope:	-90°		R.L	Surface: 1.026
	e diam illing		rma	tion						thing: Iterial :	bearin substance	g:		dati	um: AHD
method	benetration	upport		notes samples, tests, etc	we	 	RL	depth metres	aphic log	classification symbol	material soil type: plasticity or particle colour, secondary and minc	characteristics,	moisture condition	consistency/ density index	structure and additional observatio
ADV		N			4.4	4	_		3 }		TOPSOIL: dark grey-brown, sand	with organics.	M		TOPSOIL
								_		SP	SAND: fine to medium grained, da organic odour.	ark grey, strong			ALLUVIUM
								-		•					
			Ŧ	D		7	0.5	0. <u>5</u>					w	-	
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AS AD RR W	thod	a n w	uger o		C per	ppori casi netra 2 3	ng tion 4 1 no 1	<u>4.0</u> N n		notes, s U ₅₀ D N N* Nc	amples, tests undisturbed sample 50mm diameter disturbed sample standard penetration test (SPT) SPT - sample recovered SPT with solid cone	soll descript	n symbols and lion lfied classificati		consistency/density index VS very soft S soft F firm St stiff VSt very stiff
HA DT B V T	shown	ի d b V T nbysu	and a iatube lank b bit C bit	uger e	wa L	ter 10/ on wat	iran Si≖refi 1/98 v	ging to usat vater lev uhown ow		V P Bs R E PID WS	vane shear (kPa) pressure meter bulk sample refusai environmental sample PID measurement water sample	Moisture D dry M moist W wet Wp plastic W _L liquid			VSt very stiff H hard Fb friable VL very loose L loose MD medium den D dense

		y v	яe	05	cience	s P	ty	Ltd	ACN	056 33	5 516			Borehol	e No.	BH 22
=r	nu	in	P	٥r	ing L	ഹ	1 - ľ	Pi	070	me	tor			Sheet		BH 22 1 of 1 <u>E12752/03</u> 30.4.2004 d: 30.4.2004 KML <i>Tulo (</i>
	nt:	111			CAR				620		ICI			Office J		E12752/03 30.4.2004
	cipa	al:						N PI	ROPL	ERTI	ES			Date ste		d: 30.4.2004
	ect:								'S ES					Logged	-	KML
-			.oc	atio	n: See									Checke		En.
		_			ng: Gemco					Ea	sting:	slope:	-90°			Surface: 1.095
	dian			ma	tion						thing:	bearing substance	r		dat	um: AHD
	penetration	_	support	water	notes samples, tests, etc		/ell tails	RL	depth	raphic log	classification symbol	material soil type: plasticity or particle o colour, secondary and minor	characteristics,	moisture condition	consistency/ density index	structure and additional observations
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t	hod						uppo		4.0	<u> </u>	notes. s	amples, tests	classification	n symbols an	d	consistency/density index
S auger screwing* C casing D auger drilling* R roller/thcone penetration v washbore 1 2 3 4						vater	sing ration 4 no rate rate 0/1/98 n date ater int	water lev shown flow	e	U _{so} D N N [*] NC V P Bs R E PID WS	undisturbed sample 50mm diameter disturbed sample standard penetration test (SPT) SPT - sample recovered SPT with solid cone vane shear (kPa) pressure meter bulk sample refusal environmental sample PID measurement water sample	soil descript	lon fied classifical		VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense	

											Borehole	e No.	BH 23
Eng	jin	ee	ring L	og ·	- Pi	ezo	me	ter			Sheet Office Jo		BH 23 ^{1 of 1} <u>E12752/03</u> 30.4.2004 : 30.4.2004 KML
Client:				DNO				-			Date star		30.4.2004
Princip	oal:		CRIC	GHTC	ON P	ROPI	ERTI	ES			Date con	npleted	:: 30.4.2004
Project	t:		МҮА	LL G	UA	'S ES	TAT	Έ			Logged b	oy:	KML
Boreho	ole L	.ocati	on: See	Figu	re 5						Checked	l by:	Ew.
drill mod	del &	moun	ting: Gemco	Trailer			Eas	sting:	slope:	-90°		R.L.	Surface: 0.895
hole dia d rillin			ation				1	rthing:	bearing substance	r:		datu	im: AHD
	penetration	support water	notes samples, tests, etc	well		depth	hic log	classification symbol	soil type: plasticity or particle i colour, secondary and minor	characteristics,	moisture condition	consistency/ density index	structure and additional observations
P P		N		4.4.4	<u>a:</u>	_	R		TOPSOIL: dark grey-brown, sand t grained, with organics.	fine to medium	м		TOPSOIL
						-	RIR	SP	SAND: light brown, fine to medium	grained.			ALLUVIUM
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						-		SP	SAND: dark grey-brown, fine to me		w	$\left \right $	
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				ЬĤ	>2	3. <u>0</u>	1						
		+		<u>e H</u>	2	-	<u> </u>	<u>.</u>	Borehole terminated at 3.1m		_		*****
						-	1						
					2.5	3. <u>5</u>	1						
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						-	-						
					3.0	-	1						
method				supp	port	4.0	<u> </u>	notes. s	amples, tests	classification	symbols and		consistency/density index
AS AD RR W CT HA DT B V T			oore tool auger e bit	C c pena 1 2 Wate	etration 3 4 ra ra ra ra	v resistance nging to fusat water lev shown	e	U ₅₀ D N N C N C V P B S R E P D S S	undisturbed sample 50mm diameter disturbed sample standard penetration test (SPT) SPT - sample recovered SPT with solid cone vane shear (kPa) pressure meter bulk sample refusal environmental sample PID measurement water sample	soli descriptio based on unifie system D dry M moist W wet Wp plastic li WL liquid lim	n ed classificatio		VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

	ne	. y •	u¢.	05	cience	S P	ty I	Ltd	ACN (056 33	5 516			Borehol	e No.	BH 24	
Ξr	าต	in	e	er	ing L	00	1 -	Pie	270	me	ter			Sheet		1 of 1	coffev ##
	nt:			•	CAF									Office Jo Date sta		E12752/03 30.4.2004	1
	icipi	al:			CRI	GH	τοι	V PF	ROPE	RTI	ES			Date co			Ľ
, voj	ject				MYA	۱LL	QL	IAY	S ES	ΤΑΤ	Έ			Logged	-	KML	Ģ
lor	eho	le I	-oc	atio	n: See	Fig	ure	95						Checke		En.	U
rill I	mod	el &	mo	untir	ıg:Gemco	Trail	er			Eas	sting:	slope:	-90°		R.L	Surface: 1.198	
	diar Itin (mat	ion						thing: torial (bearing]:		datı	um: AHD	
nethod	penetration		support		notes samples, tests, etc					graphic log	classification symbol	material		moisture condition	consistency/ density index	structure additional obse	
	12	3		water		de	rell tails	RL	depth metres	<u> dra</u>	syn	soil type: plasticity or particle colour, secondary and mino	r components.		den		
AUV			Ζ		D	0000			0.5 1.0 1.5 1.5 2.0 2.5 -		SP	TOPSOIL: dark grey-brown, sand grained, with organics. SAND: fine to medium grained, da notable organic odour.				ALLUVIUM	
						4			20		•						
	83					0	<u> </u>	1	3. <u>0</u>	• • • •		Borehole terminated at 3m					
								2.0	-						1		
									- 								
									3. <u>5</u>								
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method support AS auger screwing* C casing N AD auger drilling* RR roller/tricone penetration W washbore 1 2 3 4						vater	ing ation 4 ran ran 23 ran 1/1/98 v 1/1/98 v 1/1/98 v 1/1/98 v	isel vater lev hown ow	1	I notes, s U ₅₀ D N N V P Bs R E PID WS	amples, tests undisturbed sample 50mm diameter disturbed sample standard penetration test (SPT) SPT - sample recovered SPT with solid cone vane shear (kPa) pressure meter bulk sample refusal environmental sample PID measurement water sample	classification soll descripti based on unif system D dry M moist W wet Wp plastic W ₄ liquid li	on ied classificat		L. loose	soft stiff loose e um dense	

С	LIEN	П	С	righton	Proper	ties Pty	Ltd		COMMENCED	24.10.11		COMPLETE	D 24.1	0.11		REF	GN	IB1A
	ROJ	ЕСТ	_			ssessmei			LOGGED	BR		CHECKED	GT/	DM		Sheet 1		
-	ITE		N	RD, Tea	-	ens, NSW			GEOLOGY	Marine Sands		VEGETATI	_			PROJECT N	O. P090	2346
-			DIME	ISIONS	Auger	(5.5m depth			EASTING NORTHING	219893.60 1385661.38		RL SURFA	E 2.52	2mAHD		SLOPE	<2%	
F				ION DA				MA	TERIAL D						SAMPLI	NG & TEST		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STF nottling, colour, p anics, secondary ontamination, odo	lasticity, rocks, oxidat and minor componer	tion, hts,	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	WATER W		Lockable stand up monument
	/ Nil	N 1.04 - -					SM	SILTY	' SAND - Bro	wn.							e backfill wi	Concrete
	X BH E	latural Existin	expos g exca e buck	ure Si vation Si et R	UPPORT H Shoring C Shoicrei B Rock BG	te X Not olts ∏7 Wat		rved D Dry L Lo red M Moist M M	TRATION CO w VS oderate S gh F	ISISTENCY DENS Very Soft VL Soft L Firm MD	Very Loos Loose Medium De	e AA BB ense UU	uger sam ulk sampl	e d sample	pp Pocket S Standar VS Vane sl		SYM	
	HA F PT P A A TC T	land a ush tul luger	uger be			- d Wat	er inflo	low WI Liquid limit	VSt H F	Very Stiff VD V Hard Friable	Dense Very Dense	e M M Ux Ti	bisture co be samp	ontent le (x mm)	FD Field de WS Water s	ometer Insity	Y N	Agricultural
	(rte Martens & As	ns			Pł	MARTENS & 6/37 Hornsby, none: (02) 9476	ASSOCIATES PT Leighton Place NSW 2077 Austra 9999 Fax: (02) S WEB: http://www	TY LTD alia 9476 8767	7			ngine	ering oreho	-	g -

С	IEN	т	Cı	righton	Proper	ties Pty I	_td		COMMENCED 24.10.11			COMPLET	ED 24.	10.11		REF	GMB2	2A			
PROJECT			-			ssessmer			LOGGED	BR		CHECKED	GT	/DM			Sheet 1 of 1				
SITE EQUIPMENT			M	RD, Tea	1	ens, NSW	l		GEOLOGY	Marine San		VEGETAT		ass		PROJECT N	PROJECT NO. P0902346				
				ISIONS	Auger Ø90mm X 7.0m depth				EASTING 220359.156 NORTHING 1385847.319					79mAHD		SLOPE	NA				
-															LING & TEST						
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION R RESISTANCE		CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org	IPTION OF STRATA motiling, colour, plasticity, rocks, oxidation, ganics, secondary and minor components, ontamination, odour.			CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	WATER V	WATER WELL DETAILS				
~	Nil	N M 10 10					AND - Dark I	brown.							e backfill with material.	bgl - - - - - - - - - - - - - - - -					
				- - - - - - - - - - - - - - - - - - -				Borehole termin	nated at 7.0m	ı in silty sa	nd.										
N Natural exposure SH Shoring N None observed D Dry L Low									ow VS oderate S gh F efusal St VSt H	ISISTENCY Very Soft Soft Firm Stiff Very Stiff Hard Friable	DENSITY VL Very Loos L Loose MD Medium I D Dense VD Very Dens	ose AA BE Dense UL DE se MN	luger san Bulk samp Indisturbe Disturbed foisture c	le ed sample sample	pp Poc S Star VS Van DCP D pe) FD Fiel	ket penetrometer idard penetration tes ne shear ynamic cone netrometer d density ter sample	CLASSIFICA SYMBOLS A SOIL DESCR Y USCS N Agricul	ND RIPTION			
						EXCAVATION	ON LC	OG TO BE READ IN CONJU	JNCTION WITI	H ACCOMP	ANYING REP	ORT NOTE	S AND	ABBRE	VIATIONS						
				rte Martens & Ass	NS sociates Pty. I	Ltd . 2011				Leighton P NSW 2077 9999 Fax:	lace Australia (02) 9476 876			E	_	neering Boreho	-				

СГ	IEN	т	Cı	righton	Proper	rties Pty I	∟td		COMMENCED 24.10.11			COMPLETED		24.10.11			REF	G	MB25		
PROJECT			-			ssessmer			LOGGED BR			CHECKED	G	GT/DM			Sheet 1 of 1				
SITE			Μ	RD, Tea	1	ens, NSW	!		GEOLOGY Marine Sands					Grass			PROJECT	10. PC	902346		
-				ISIONS	Auger Ø90mm X 5.5m depth				EASTING 220407.133 NORTHING 1385267.804			RL SURFACE		.798mAHD ast?		SLOPE <2%					
		•									J4	AGILOT		dotr	SA		G & TES				
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRII Soil type, texture, structure, n particle characteristics, org:	IPTION OF STRATA mottling, colour, plasticity, rocks, oxidation, janics, secondary and minor components, oritamination, odour.			CONSISTENCY	DENSITY INDEX	TYPE DEPTH(M)			WATER WELL DETAILS				
v	Nil	N M Image: state						(SAND - Bro	wn.							Note: Bo natura	re backfil		1.0 - - - - - - - - - - - - -		
H E F A T	N Na GEBHBA E EX HAHA PTPU A AI	atural (xisting ackhoe (cavate and au ush tub uger ngsten	exposi g excav e bucké or iger	ure SH vation SC et RE Nil	JPPORT H Shoring C Shotret B Rock Bo I No supp	te X Noti olts ∏ Wat	e obse measu er leve er outfl	rrved D Dry L Lo red M Moist M Mu I W Wet H Hig Wp Plastic limit R Re Iow WI Liquid limit	TRATION CON w VS oderate S gh F fusal St VSt H	ISISTENCY Very Soft Soft Firm Very Stiff Hard Friable	DENSITY VL Very Loo L Loose MD Medium I D Dense VD Very Dens	ose A B Dense U D I se M	Auger sa Bulk sam Jndistur Disturbe Aoisture		pp S VS DC	Pocket p Standard Standard S Vane sha CP Dynam penetrc J Field der S Water sa	ic cone meter isity	SI	-		
			_			EXCAVATIO	ON LC	OG TO BE READ IN CONJU	JNCTION WIT	H ACCOMF	ANYING REP	ORT NOT	ES ANI	D ABBRE	VIATIO	ONS					
1.04.15)						MARTENS & 6/37	ASSOCIAT Leighton P				F	no	iine	erin	al	oa -		
ano fu		M	a	rte	ns				Hornsby, none: (02) 9476	NSW 2077 3 9999 Fax	Australia (02) 9476 876			-			oreh	-	- 3		
	-	(C) Cop	pyright	Martens & Ass	sociates Pty.	Ltd . 2011			artens.com.au							D	леп	JIE			

CLIENT			С	righton	Proper	ties Pty	Ltd		COMMENCED 25.09.12			COMPLET	ED 25	25.09.12			REF BH201			
PROJECT		H	ydrogeo	ological	Investig	jatio	n	LOGGED NF			CHECKED		GT/DM			Sheet 1 of 1				
SITE			M	RD, Tea	1	ens, NSW	1		GEOLOGY Marine Sands			VEGETAT	-	Sedges and Grasses			PROJECT NO. P0902346			
EQUIPMENT EXCAVATION D				SIONS	Hydraulic Auger 100mmØ X 5.5m depth				EASTING NA NORTHING NA			RL SURFA	CE -	-		SLOPE <5%				
										ASILUI	-		SAN	SLOPE <5%						
												ζ	EX						DETAILS	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M PENETRATION H R R R	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxid and minor compon	lation, ents,	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)		0.69m agl		Well Cov	'er
V	Nil	N	м	-0.25		× × × ×	OL	ORGANIC SILT - D				VS- S	_	D		2346/201	۶.		Concrete	
v	Nil	N	м	- - - - 1.0			CL	SANDY CLAY - Me grey, with some fine minor organic Sand content	ledium plasticity, grey brown to ne to medium grained sand and c matter present (rootlets). nt decreasing with depth, g high plasticity >0.7m.			St VSt St		D	0.6	2346/201 2346/201 2346/201	/ 0.6	•	Bentonite So 	- 1
v	Nil	N	м	E			SP	\sim	ent increasing		/	/			H	2346/201 lydrogen	sulfide			_
		_	\vdash	<u>1.3</u>				SAND - Medium grai			^			+ -	1.4	odour pre 2346/201	/ 1.4		&	
v	Nil	N	M	1.6 2.0 - - - - - - - - - - - - -			SC	dark brown, with s ORGANIC CLAYEY black to dark grey, wit	ome <u>m</u> edium	grained sand	<u>I</u>	St					<u>4.0m bgl</u>		UPVC Sci	reen
	Borehole terminated at 5.5m in organic clayey sand.																			
				- - - - - - - - - - - - - - - - - - -																
N Natural exposure SH Shoring N None observed D Dry L LO X Existing excavation SC Shotcrete X Not measured M Moist M Moist BH Backhoe bucket RB Rock Bolis									w VS oderate S gh F efusal St VSt H	Very Soft VL Soft L Firm MD Stiff D	NSITY Very Loo Loose Medium I Dense Very Dens	ose A A B B Dense U L D D se M M Ux T	uger sa ulk sam ndisturt isturbeo oisture ube sar		pp F S S VS DCP		ic cone meter sity	S	-	ION
V V-Bit 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 mail@martens.com.au WEB: http://www.martens.com.au																				

C	LIE	NT		Cri	ghton	Proper	ties Pty	Ltd		COMMENCED	25.09.12	COMPLETE	25.09	9.12			REF	В	H202	
-	RO	IEC	-				l Investig		on	LOGGED	NF	CHECKED	GT/E				Sheet 1			
-			_	MR		Hydraulic	ens, NSW			GEOLOGY EASTING	Marine Sands	VEGETATIO RL SURFAC	_	ses and	Ferns		PROJECT	NO. P090	2346	
-				ENS		-	X 7.0m depth			NORTHING	NA	ASPECT	-				SLOPE	<5%		
	E	xc	AVA	TIC	ON DAT				MA	TERIAL D	ATA				SA	MPLIN	G & TES	TING		
	SUPPORT		WAIEK	MUISIUKE	DEPTH (M)	L M FENETRATION R R R R	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org		asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)		WATER		ETAILS Well Cover	
	Ni	<u> </u>		2 0	.1			SP	LOAMY SAND -					D	0.0	2346/202	2/0.0		Concrete _	
,	Ni				0.85			SP	SAND - Medium grair	prganic matte ned, pale grey c matter pres	to grey, with some		L MD- D	D D	0.3	2346/202 2346/202	2/0.7	•	Back fill	
,	'Ni	1	ч I	и I I I I I I I I I I I I I I I I I I I	<u>.0</u>			SP	SAND - Medium gra very minor s					D	1.0	2346/202 Hard pana coffee 2346/202	tration/ rock.		Bentonite Seal	1.0
,	' Ni	.	- - N I	и 2	. <u>8</u> .0 .3			SP	SAND - Mediur dark orange brov roots and		l occasional			+			·		1.8m bgl	2 <u>.0</u> -
,	' Ni				.0 .0 .0			sc		nell fragments	s present.			D	3.5	2346/202	2/3.5 5.4m bgl		2.4m bgl	
	N X	Natur Exist	NT / I ral exp ing ex	AETH osure cava	e SH tion SC	PPORT Shoring Shotcrete Rock Bo	e X Not	e obse measu	erved D Dry L Lo ired M Moist M Mo	TRATION CON W VS dotrate S	SISTENCY DENSITY Very Soft VL Very Loos Firm MD Medium ID	se A Au B Bul	LING & T jer sample k sample	le	pp S	Pocket p Standard S Vane sh	enetrometer penetration tr ar	SYN	SSIFICATION ABOLS AND L DESCRIPTIO	80
	E HA PT A TC T	Exca Hand Push Auge	vator auger tube r		Nil	No supp	→ Wat	er out er inflo	Wp Plastic limit R Re low WI Liquid limit	fusal St VSt H F	Stiff D Dense Very Stiff VD Very Dens Hard Friable	D Dis M Mo Ux Tut E Env	turbed sa isture con be sample ironment	ample ntent e (x mm) al sample	DC FD e W	CP Dynam penetro O Field der S Water sa	nic cone ometer hsity	Y	USCS Agricultural	
		n	72	a r	te			JN L		MARTENS & 6/37 Hornsby, none: (02) 9476	ACCOMPANYING REP ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WEB: http://www.martens	57				jine	ering	-	og -	

С	LIEN	IT	C	righton	Proper	ties Pty	Ltd		COMMENCED	25.09.12	COMPLET	E D 2	5.09.12			REF	E	3H203	
_		ECT	-		-	Investig		on	LOGGED	NF	CHECKED		ST/DM			Sheet 1			
-			N	IRD, Tea	A Garde	ens, NSW	/		GEOLOGY EASTING	Marine Sands	VEGETATI	-	Grasses and	Ferns		PROJECT	NO. PO	902346	
			DIME	SIONS		X 7.0m depth			NORTHING	NA	ASPECT	-				SLOPE	<5%	6	
	E	(CA	VAT	ION DA				MA	TERIAL D	ATA	•			SA	MPLIN	IG & TE	STING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION H RESISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)		WATER		DETAILS	r
V	Nil	N	D	0.2			SP	LOAMY SAND - Medi				VL- L	D	0.0	2346/20	3/ 0.0		Concrete	_
V	Nil	N	м	0.9			sc	CLAYEY SAND - N grading to low pla	ledium grain	ed, dark brown,		L- MD	D	0.3	2346/20	 3/ 0.3	÷ •	Bentonite Sea UPVC Pipe 0.9m bgl	
V	Nil	N	м	1.0			CL	SANDY CLAY - grey brown to da			<u>+ +</u>		Ď	1.0	2346/20	3/ 1.0		U.SITI Dgi	1.0
 	Nil	Y	w	1.2 - 1.7 2.0 - 2.25 - - 2.25 - -			SP	SAND - Medium orange brown and	m grained sa grained, dark	nd present / grey, mottled vn, with some			D	1.3 1.8	2346/20			Sand Pac Sand Pac 1.5m bgl	 2 <u>.0</u>
	Nil	Y	w				SP	SAND - Medium with some sh	nell fragment:	s present.						<u>4.5m bgl</u>		UPVC Scre 5 5 6 7 7 7 7 7 7 7 7 7 7 7 7 7	een
					JPPORT	WATER				SISTENCY DENSITY			& TESTIN					LASSIFICATION	
	N I BH E E E HA H PT F A / TC T	latural Existin ackho xcava land a ush tu uger	expos g exca e buck itor uger be	sure SH vation S(set RE	H Shoring C Shotcrete B Rock Bol I No suppo	e X Non Its <u>Ψ</u> Wat ort Ψ Wat - Wat	e obse measu er leve er out	nrved D Dry L Lo red M Moist M Mu I W Wet H Hig Wp Plastic limit R Re Iow 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 Stiff D Dense Very Stiff VD Very Den Hard Friable	ose A A B B Dense U U D D Ise M M Ux T E Er	uger sa ulk sam indistur isturbe oisture ube sam nvironm	ample hple bed sample content mple (x mm hental samp	PI S D D) FI ile W	Standard S Vane sh CP Dynam penetro D Field dei /S Water si	nic cone ometer nsity	test S	YMBOLS AND OIL DESCRIPTI Y USCS N Agricultural	
((m	a	rte				Pr	MARTENS & 6/37 Hornsby, none: (02) 9476	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: http://www.marten	67				gine	erin oreh		og -	

СГ	IEN	Г	C	righton	Proper	ties Pty	Ltd		COMMENCED	25.09.12	0	COMPLETED	25.0	9.12			REF	BH204
PF	OJE	СТ	H	/drogec	ological	Investig	gatio	on	LOGGED	NF	C	CHECKED	GT/I	DM			Sheet 1 o	
Sľ	ГΕ		м	RD, Tea	Garde	ns, NSW	/		GEOLOGY	Marine Sands	1	VEGETATIO	Gras	sses and	Ferns		PROJECT NO.	P0902346
EQ	JIPMEI	T			Hydraulic A	luger			EASTING	NA	F	RL SURFACE	-					
EX				SIONS		1.0m depth			NORTHING	NA	ŀ	ASPECT	-				SLOPE	<5%
	EX	CAV		ON DA				MA	TERIAL D	ATA				_	SA	MPLIN	G & TEST	NG
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M M H R E SISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR nottling, colour, pl anics, secondary i ontamination, odor	asticity, rocks, oxidatio and minor components	on, 5,	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	А		TS AND DBSERVATIONS
v	Nil	Ν	м	- - - 0.3			SP	ORGANIC LOAM dark brown, black and		organic matter				D	0.1	2346/204	/ 0.1	- - -
v	Nil	N	M	- - 0.5			SP					+		D	0.4	2346/204	/ 0.4	
v	Nil	N Y	W	 0.65 			SP							D	0.6	2346/204	/0.6	- - - -
v	Nil	N	м	- - 1.0			sc	CLAYEY SAND - M with minor sh	ledium grain nell fragments	ed, pale brown, present.				D	0.9	2346/204	/0.9	 - - 1.0
								Borehole terminat	ted at 1.0m ir	clayey sand.								
V NI N															SYMBOLS AND SOIL DESCRIPTION			
E F F A	H Ba Ex IA Ha T Pu	ckhoe cavato nd aug sh tub ger gsten	bucke or ger e	et RE Nil	Rock Bol No suppo	ts <u>▼</u> Wat ort	er leve er outf er inflo	il W Wet H Hig Wp Plastic limit R Re low WI Liquid limit w	gh F vfusal St VSt H F	Firm MD M Stiff D D. Very Stiff VD Ve Hard Friable	ledium Der ense ery Dense	nse U Uno D Dis M Moi Ux Tub E Envi	listurbed surbed s sture co e sampl ronmen	d sample ample intent le (x mm) tal sample	VS DO FE e W	S Vane she CP Dynam penetro D Field den S Water sa	ear ic cone meter sity	Y USCS N Agricultural
					E	XCAVATI	ON LO	OG TO BE READ IN CONJU				RT NOTES	AND A	ABBRE	VIATIO	ONS		
				rte		td 2012			6/37 Hornsby, none: (02) 9476	ASSOCIATES PTY Leighton Place NSW 2077 Austral 9999 Fax: (02) 94 WEB: http://www.n	ia 176 8767			E	ng		ering rehol	Log - le

CL	IEN	Г	С	righton	Prope	rties Pty	Ltd		COMMENCED	25.09.12	COMPLETE	D	25.09.12			REF	BH205	
PR	OJE	СТ	H	ydrogeo	ologica	I Investig	gatio	on	LOGGED	NF	CHECKED		GT/DM			Sheet 1 d		
SI			Μ	RD, Tea	T	ens, NSV	/		GEOLOGY	Marine Sands	VEGETATI	-	Grasses an	d Ferns		PROJECT NO	. P0902346	
_				SIONS	Hydraulic	Auger X 1.0m depth			EASTING NORTHING	NA	RL SURFAC	E	-			SLOPE	<5%	
				ION DA		X 1.0m depth		MA			ASILOI		-	S		IG & TEST	1	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	TYPE	(RESU	TS AND OBSERVATIONS	
v	Nil	N	м	- - 0.2			SP	ORGANIC LOAM dark grey, with sc					D	0.0	2346/20	5/ 0.0		-
v	Nil	N	м	- - 0.5 - 0.6			SP	SAND - Med	lium grained,	pale grey.			D	0.3	2346/20	5/ 0.3		- - - 0 <u>.5</u>
v	Nil	N Y Y	M W	 1.0			SP	SAND - Medium gr orange brown wi shell fragme		some minor			D	0.7	2346/20	5/ 0.7		- - - - - - - - 1.0
				- - - - - - - - - - - - - - - - - - -				Borehole term										
N E E F A T	H Ba Ex IA Ha T Pu	atural e xisting ckhoe cavate nd au sh tub iger igsten	expos exca buck or ger e	ure SH vation SC et RE Nil	JPPORT 1 Shoring 2 Shotcrei 3 Rock Bo 1 No supp	te X Not olts ∏7 Wat	e obse measu er leve er out	erved D Dry L Lo Ired M Moist M M el W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit	ow VS oderate S gh F efusal St VSt H	SISTENCY DENSITY Very Soft VL Very L Soft L Loose Firm MD Mediu Stiff D Dense Very Stiff VD Very D Hard Friable	Loose A A B B m Dense U U D D ense M M Ux Tu	uger s ulk sa ndistu isturb oistur ube s	3 & TESTIN sample unple urbed sample re content ample (x mr imental sam	p S V D n) F	p Pocket p Standard S Vane sh ICP Dynam penetro D Field der /S Water sa	nic cone ometer nsity	CLASSIFICATIO SYMBOLS AND SOIL DESCRIPT Y USCS N Agricultural	ION
				rte	ns		ON L		MARTENS & . 6/37 Hornsby, none: (02) 9476	ACCOMPANYING RI ASSOCIATES PTY LT Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 8 WEB: http://www.martr	D 3767	S AN			gine	ering oreho	ı Log - le	

С	IEN	Т	С	righton	Prope	rties Pty	Ltd		COMMENCED	25.09.12	COMPLETE	ED 3	25.09.12	2			REF	BH20)6
PF	roj	ЕСТ	Н	ydrogeo	ologica	al Investig	gatio	on	LOGGED	NF	CHECKED		GT/DM				Sheet 1		
_	TE		M	RD, Tea	7	ens, NSV	1		GEOLOGY	Marine Sands	VEGETATI	-	Grasses				PROJECT NO	D. P0902346	
				SIONS	Hydraulic	X 1.0m depth			EASTING NORTHING	NA	RL SURFA	CE					SLOPE	<5%	
F				ION DA				MA							SA		G & TEST		
METHOD	_	WATER	MOISTURE	DEPTH (M)	H PENETRATION	GRAPHIC LOG	CLASSIFICATION	DESCRI Soil type, texture, structure, r particle characteristics, org	PTION OF STR	ATA asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX			DEPTH(M)		RESU	LTS AND OBSERVATIO	ONS
v	Nil	N	м	- - 0.25			SP	ORGANIC LOAM dark brown, with so	IY SAND - Mo me fines and	edium grained, organic present.				D	0.1	2346/206	/ 0.1		- - -
v	Nil	N	м	- - 0.5 - 0.6			SP	ORGANIC LOAMY SAI	ND - Medium with some or					D	0.3	2346/206	/0.3		
v	Nil	N Y	M W	 0.7 0.8			SP	SAND - Med with r	ium grained, minor organio					D	0.7	2346/206	/ 0.7		- - -
v	Nil	Y	w	- - 1.0			SP	LOAMY SAND parcia	- Medium gra ally cemented						1	Hard pana coffee r			- - 1.0
				- - - - - - - - - - - - - - - - - - -	IPPORT	WATER		MOISTURE PENE		n in sand.	SAM	PLING	- & TES	IFING				CLASSIFIC	- - - - - - - - - - - - - - - - - - -
	N N BH B E E HA H PT P A A	atural Existing ackhoe xcavat and au ush tub uger ingster	expos g exca e buck or iger ie	ure SH vation SC et RE Nil	Schoring Schotcre Rock Bi No supp	te X Non olts ∇ Wat	e obs measi er lev er out	erved D Dry L Lo Ired M Moist M Mi el W Wet H Hit Wp Plastic limit R Re flow WI Liquid limit	ow VS oderate S gh F efusal St VSt H	Very Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Dens Hard Friable	ise A A B B Dense U U D D se M M Ux Ti	uger s ulk sa ndistu isturb oistur ube sa	ample	mple ile it mm)	S VS DC FD	Pocket pe Standard Vane she P Dynam penetro Field den S Water sa	ic cone meter sity	t SYMBOLS SOIL DESC	AND RIPTION
		m	a	rte	ns	EXCAVATI	ON L		MARTENS & 6/37 Hornsby, none: (02) 9476	ACCOMPANYING REP ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 876 WFB: http://www.martens	67	S AN				ine	ering reho	r Log le	-

С	IEN	т	С	righton	Prope	rties Pty	Ltd		COMMENCED	25.09.12		COMPLET	ED	25.09.12			REF	BH207
-	SOl	СТ	H	ydrogeo	ologica	I Investi	gatio	on	LOGGED	NF		CHECKED)	GT/DM			Sheet 1 d	
_		NT	M	RD, Tea	Hydraulic	ens, NSV	V		GEOLOGY	Marine San	ds		-	Grasses			PROJECT NO	P0902346
			DIMEN	SIONS	-	X 0.7m depth	1		EASTING NORTHING	NA		RL SURFA	UCE .	-			SLOPE	<5%
	EX	CA	VAT	ION DA				MA	L ATERIAL D	ATA					S	AMPLIN	IG & TEST	ING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STI nottling, colour, p anics, secondary ontamination, odd	lasticity, rocks and minor cor	i, oxidation, nponents,	CONSISTENCY	DENSITY INDEX	-	B		DDITIONAL (LTS AND OBSERVATIONS
v	Nil	N	D	_ _ 			SP	ORGANIC LOAM dark grey, with sc							0.0	2346/20		- -
v	Nil	N N Y	D	- - - 0.5 - 0.6 - 0.7			SP	SAND - Mec	lium grained	, pale grey				D	0.3	2346/20	7/0.3	- - - - - - - - - - - - -
	X E BH B: E E HA H: PT PU A A TC TU	atural xisting ackhoe kcavat and au ish tub uger ngster	expos g exca e buck tor uger be	ure SH vation SC et RE Nil	JPPORT I Shoring Shorkre No supp	te X Not olts <u>▼</u> Wat	e obse measu ter leve ter out	erved D Dry L Lo Ired M Moist M M el W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit	TRATION COM w VS oderate S gh F fusal St VSt	NSISTENCY Very Soft Soft Firm Suff	DENSITY VL VeryLoos L Loose MD Medium 1 D Dense VD Very Den	ose A B I Dense U D se M M Ux	Auger : Bulk sa Undistu Disturb Moistu Fube s	3 & TESTI sample imple sample sample re content ample (x m imental sam	p S ble V D m) F		nic cone ometer nsity	1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6
E	V V-	סונ				EXCAVATI	ON L	OG TO BE READ IN CONJU				ORT NOT	ES AN	ND ABBR	EVIAT	IONS		
				rte		l td. 2012				7 Leighton P NSW 2077 6 9999 Fax:	lace Australia (02) 9476 870			Ł	Enę		ering oreho	ı Log - le

CL	IEN	Т	С	righton	Prope	rties Pty	Ltd		COMMENCED	25.09.12	COMPLET	ED	25.09.12			REF	BH208
PR	OJE	СТ	H	ydroged	ologica	al Investi	gatio	on	LOGGED	NF	CHECKED	(GT/DM				of 1
SIT	Е		м	RD, Tea	Gard	ens, NSV	v		GEOLOGY	Marine Sands	VEGETATI	ON	Grasses			PROJECT NO	D. P0902346
	IPME				Hydraulio				EASTING	NA	RL SURFA	CE					
EXC				SIONS	1	X 1.0m depth	۱		NORTHING	NA	ASPECT	-				SLOPE	<5%
⊢	EX	CAV		ION DAT			7	M/A	ATERIAL D					5/	AMPLIN	IG & TEST	ING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		RAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR mottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX		DE		DDITIONAL	LTS AND OBSERVATIONS
v	Nil	N	D	- - 0.2			SP	ORGANIC LOAM dark grey, with so							2346/200	3/ 0.0 	- -
v	Nil	N Y	M W					SAND - Mec	lium grained,	pale grey.			D	0.4	2346/200	3/0.4	- - - - - - - - - - - - - - - - - - -
				1.0		- 28,285 	-							_			1.0
				-				Borehole term	inated at 1.0	n in sand.							-
				-													-
				-													-
				-													-
				-													-
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				-													-
				-													-
				1.5													1.5
				-													-
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1																	_
L		- - - 2.25															2.25
E N		atural e	exposi	ure SH	IPPORT			erved D Dry L Lo	w VS	SISTENCY DENSITY Very Soft VL Very La			& TESTI ample	NG r	p Pocket n	enetrometer	CLASSIFICATION SYMBOLS AND
Х В	E: H Ba	xisting Ickhoe	excav bucke	vation SC et RB	Shotcre Rock B	ete X Not olts ∏ Wa		ured M Moist M M el W Wet H Hi	oderate S gh F	Soft L Loose Firm MD Medium	Dense U U	ulk saı Indistu	mple Irbed sam	le \	S Standard /S Vane sh	l penetration test ear	t SOIL DESCRIPTION
	A Ha		ger	Nil	No sup	port ≛ ⊣ Wa		Wp Plastic limit R Re	VSt	Stiff D Dense Very Stiff VD Very De	nse M M	isturbe loistur	ed sample e content	[CP Dynam	ometer	Y USCS
A	Au	sh tub Iger		do Dit		⊳ Wa	iter inflo	DW .		Hard Friable			ample (x m mental sar		D Field der VS Water sa		N Agricultural
V	C Tur V-E	igsten Bit	Jarbi	ue Bit													
\vdash		-	~			EXCAVAT	ION L	OG TO BE READ IN CONJU				S AN			_		
	/.	~	2	rt-	n ~				6/37	ASSOCIATES PTY LTD Leighton Place	,			Eng	gine	erin <u>q</u>	ı Log -
				rte Martens & Ass					none: (02) 9476	NSW 2077 Australia 9999 Fax: (02) 9476 87 WEB: <u>http://www.marte</u> i					-	oreho	-

12 Attachment E – Laboratory Test Reports





CLIENT:	Coffey Geosciences						SAM	PLER:	JJT						• • • •							
	/ OFFICE: Sandgate						1	ILE: 042		913									ALS			
	MANAGER (PM): Andrew F	ulton	·				PHO								•				Australian Laboratory Service	es Pty Ltd		
	ID: Myall Quays						1		ORT TO); andre	ew fulto	on@cof	ey.com.a	u								
SITE:			F	.0. NO.:				L INVO														
RESULTS	REQUIRED (Date): standard				D.:		1						S (note - s	suite c	odes mus	be listed	d to att	act suite	prices)		1	
ORLABO	RATORY USE ONLY SEAL (circle appropriate)	COMI			LING / STORAGE O	R DIPOSAL:		Sulphate	Hardness	TKN									<u>Notes</u> : e.g. Highly contaminated e.g. "High PAHs expected".	l samples		
ntaot: SAMPLE 1	EMPERATURE 3 94							Chloride,	', Total Ha	Ammonia,	sur								Extra volume for QC or trace L0)Rs etc.		
HILLED	Yes No							L X	alinity	Nitrate	bhqs	TDS							****Please see note be	ow****		
ALS ID	SAMPLE INFORMATION (note	<u>S = Soil.</u> MATRIX	DATE	Time	CONTAINER INF	ORMATION Total bottles	8 Metals	Ca,Mg, Na,	Total Alk	Nitrite, Ni	Total Phosphorus	pH, Ec, T	100	BOD								
	22	H20	29/03/2007	14110	Type Toolde	Total Dottics	×		x	×		x x					-					
<u>))))))))))))))))))) </u>	21		29/03/2007				, .		l.			~									1	
X	24						Â	Ê	Ê	Ê	Ê	Ê	<u>^</u>				+	E	nvironmental Division		-	
ਛੋ†			29/03/2007				×	×	IX.	×	×	×	XXX				+		Sydney			
¥+	23		29/03/2007				x	×	×	×	×	×	x X			_	+		Work Order			
2	4A		29/03/2007				x	×	×	×	×	×	x X	· .		_	+				-	
إن€	8		29/03/2007				x	×	×	×	×	×	x x	:			\downarrow		ES0704246			
OL	DUP1		29/03/2007				x	×	x	×	x	×	x X				⊥,	i t (1) i n	88 2 8 8 98 188 18			
	10	100					Samp	le not re	iceived													
	. 11.						Samp	ie not re	ceived													
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	Split	•	30/03/2007	L			x	×	x	x		×	×						Send to SGS	HUN	wledsed	
		RELINC	UISHED BY:									RE	CEIVED B	<u>BY</u>					METHOD OF SHIPMEN	п		
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AUSTRALIAN LABORATORY SERVICES P/L

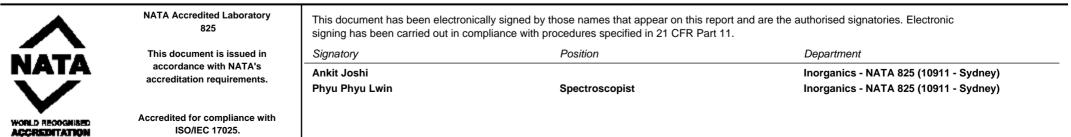


ALS Environmental

CERTIFICATE OF ANALYSIS

Client		Laboratory	Environmental Division Sydney	Page	∴ 1 of 7
Contact	MR ANDREW FULTON	Contact	Victor Kedicioglu	Work Order	⁻ ES0704246
Address	: 13 MANGROVE ROAD SANDGATE NSW AUSTRALIA 2304	Address	277-289 Woodpark Road Smithfield NSW Australia 2164		200704240
E-mail	∑ andrew_fulton@coffey.com.au	E-mail	: Victor.Kedicioglu@alsenviro.com		
Telephone	÷ 49676377	Telephone	£ 61-2-8784 8555		
Facsimile	£ 49675402	Facsimile	∑ 61-2-8784 8500		
Project	: MYALL QUAYS	Quote number	EN/007/07	Date received	2 Apr 2007
Order number	: - Not provided -			Date issued	∶ 12 Apr 2007
C-O-C number	- Not provided -			No. of samples	- Received : 10
Site	ິ - Not provided -				Analysed : 10

ALSE - Excellence in Analytical Testing



Page Number	2 of 7
Client	COFFEY GEOTECHNICS
Work Order	ES0704246



Comments

This report for the ALSE reference ES0704246 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- 1 Analytical Results for Samples Submitted
- 1 Surrogate Recovery Data

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order ES0704246

It has been noted that RP is greater than TP (sample ID D2), however this difference is within the limits of experimental variation. TDS by method EA-015 may bias high on various sample due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper. EK059G: It has been noted that Nitrite is greater than NOx on sample ID (22), however this difference is within the limits of experimental variation.

Page Number	2 3 of 7
Client	COFFEY GEOTECHNICS
Work Order	ES0704246



Work Order : ES0704246								ALS Environmenta
Analytical Results	Sampl	e Matrix ⊺ Sa	Client Sample ID : Type / Description : mple Date / Time :	22 WATER 29 Mar 2007 15:00	21 WATER 29 Mar 2007 15:00	24 WATER 29 Mar 2007 15:00	23 WATER 29 Mar 2007 15:00	4A WATER 29 Mar 2007 15:00
		Labo	oratory Sample ID :					
Analyte	CAS number	LOR	Units	ES0704246-001	ES0704246-002	ES0704246-003	ES0704246-004	ES0704246-005
EA005: pH								
pH Value		0.01	pH Unit	6.05	5.62	5.46	5.60	5.32
EA010P: Conductivity by PC Titrator			·				•	·
Electrical Conductivity @ 25°C		1	µS/cm	1610	15500	2730	234	202
EA015: Total Dissolved Solids					1	•	1	1
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1350	11500	2250	212	155
EA065: Total Hardness as CaCO3							1	
Total Hardness as CaCO3		1	mg/L	123	2040	300	39	23
ED037P: Alkalinity by PC Titrator							I	
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	102	92	26	28	14
Total Alkalinity as CaCO3		1	mg/L	102	92	26	28	14
ED040F: Dissolved Major Anions							1	
Sulphate as SO4 2-	14808-79-8	1	mg/L	39	702	344	6	10
ED045G: Chloride Discrete analyser			Ŭ I		<u>I</u>	L		
Chloride	16887-00-6	1.0	mg/L	430	5300	800	58.7	50.4
ED093F: Dissolved Major Cations			0			I	I	
Calcium	7440-70-2	1	mg/L	11	126	31	3	2
Magnesium	7439-95-4	1	mg/L	23	420	54	7	4
Sodium	7440-23-5	1	mg/L	283	2650	551	31	29
Potassium	7440-09-7	1	mg/L	7	65	24	1	<1
EG020F: Dissolved Metals by ICP-MS	•		.					
Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.006	<0.001	<0.001
Cadmium	7440-43-9	0.000		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3		mg/L	0.007	0.002	0.005	<0.001	<0.001
Copper	7440-50-8		mg/L	<0.001	0.001	0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.003	<0.001	<0.001
Zinc	7440-66-6	0.005	i mg/L	<0.005	<0.005	0.016	0.008	0.085
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.000	1 mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete	Analyser							
Ammonia as N	7664-41-7	0.010) mg/L	0.655	0.934	0.893	0.179	0.212
EK057G: Nitrite as N by Discrete Ana	alyser				•	•		
Nitrite as N	-	0.010	mg/L	0.087	<0.010	0.013	<0.010	<0.010
			-					

Page Number Client	ິ 4 of 7 ິ COFFEY GEOT	ECHNICS							ALS
Work Order	ES0704246	Lonnioo							ALS Environmental
Analytical F	Results	Samp	ole Matrix Ty Sam	ent Sample ID : be / Description : ple Date / Time : htory Sample ID :	29 Mar 2007 15:00	21 WATER 29 Mar 2007 15:00	24 WATER 29 Mar 2007 15:00	23 WATER 29 Mar 2007 15:00	4A WATER 29 Mar 2007 15:00
Analyte		CAS number	LOR	Units	ES0704246-001	ES0704246-002	ES0704246-003	ES0704246-004	ES0704246-005
EK058G: Nitrate	as N by Discrete An	alyser				•	<u>!</u>	•	
Nitrate as N		14797-55-8	0.010 ו	ng/L	<0.010	0.027	0.013	0.013	0.034
EK059G: NOX as	N by Discrete Anal	yser					•		
Nitrite + Nitrate as I	N		0.010 ו	ng/L	0.037	0.027	0.026	0.013	0.034
EK061: Total Kjel	dahl Nitrogen (TKN)								
Total Kjeldahl Nitro	gen as N		0.1 ו	ng/L	7.2	12.1	9.3	2.5	0.9
EK067G: Total Pl	nosphorous-As P by	Discrete Analyse	er						
Total Phosphorus a	is P		0.01 ו	ng/L	0.79	1.38	1.12	0.32	0.14
EK071G: Reactive	e Phosphorous as P	by discrete analy	yser						
Reactive Phosphor	us as P		0.010 ו	ng/L	0.095	0.035	0.062		0.017
EP005: Total Org	anic Carbon (TOC)								
Total Organic Carb	on		1 1	ng/L	189	109	94	56	16
EP030: Biochemi	cal Oxygen Demand	I (BOD)							
Biochemical Oxyge	n Demand		2 1	ng/L	<2	<2	<2	9	9

Page Number	∴ 5 of 7
Client	COFFEY GEOTECHNICS
Work Order	ES0704246



Work Order : ES0704246								ALS Environmental
Analytical Results			ent Sample ID :	8	DUP1	?1	D2	POND
	Sample	21	be / Description :	WATER	WATER	WATER	WATER	WATER
		Sam	ple Date / Time :	29 Mar 2007 15:00	29 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00	30 Mar 2007 15:00
		Labora	tory Sample ID :	13.00	13.00	13.00	13.00	10.00
Analyte	CAS number	LOR	Units	ES0704246-006	ES0704246-007	ES0704246-008	ES0704246-009	ES0704246-010
EA005: pH								
pH Value		0.01 p	H Unit	5.02	5.53	3.99	3.86	5.83
EA010P: Conductivity by PC Titrator						·		
Electrical Conductivity @ 25°C		1 μ	IS/cm	268	15500	2730	169	182
EA015: Total Dissolved Solids			•		1			
Total Dissolved Solids @180°C	GIS-210-010	1 n	ng/L	1210	9700	200	195	129
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3		1 n	ng/L	29	2070	14	13	33
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1 n	ng/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1 n	ng/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1 n	ng/L	6	96	26	<1	23
Total Alkalinity as CaCO3		1 n	ng/L	6	96	26	<1	23
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1 n	ng/L	22	701	13	10	12
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0 n	ng/L	64.6	5180	34.4	33.7	37.4
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1 n	ng/L	2	127	<1	<1	8
Magnesium	7439-95-4	1 n	ng/L	6	427	3	3	3
Sodium	7440-23-5		ng/L	39	2670	15	14	22
Potassium	7440-09-7	1 n	ng/L	4	66	4	4	2
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001 n		<0.001	0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001 n		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001 n		<0.001	0.002	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001 n	-	<0.001	0.001	<0.001	0.001	0.005
Lead	7439-92-1	0.001 n	-	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001 n	0	<0.001	<0.001	<0.001	<0.001	0.001
Zinc	7440-66-6	0.005 n	ng/L	0.009	<0.005	0.017	0.032	0.029
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001 n	ng/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete A								
Ammonia as N	7664-41-7	0.010 n	ng/L	0.303	1.14	0.545	0.541	<0.010
EK057G: Nitrite as N by Discrete Anal	lyser							
Nitrite as N		0.010 n	ng/L	0.027	<0.010	0.028	0.027	<0.010

Page Number Client	∴ 6 of 7 ∴ COFFEY GEOT	ECHNICS							ALS
Work Order	É ES0704246								ALS Environment
Applytical	Poculte		Clie	nt Sample ID :	8	DUP1	?1	D2	POND
Analytical Results		Samp		e / Description : e Date / Time :	WATER 29 Mar 2007 15:00	WATER 29 Mar 2007 15:00	WATER 30 Mar 2007 15:00	WATER 30 Mar 2007 15:00	WATER 30 Mar 2007 15:00
			Laborate	ory Sample ID :					
Analyte		CAS number	LOR	Units	ES0704246-006	ES0704246-007	ES0704246-008	ES0704246-009	ES0704246-010
EK058G: Nitrate	as N by Discrete A	nalyser							
Nitrate as N		14797-55-8	0.010 m	g/L	0.039	0.011	<0.010	0.013	0.020
EK059G: NOX a	s N by Discrete Ana	lyser							
Nitrite + Nitrate as	Ν		0.010 m	g/L	0.066	0.011	0.034	0.040	0.020
EK061: Total Kje	Idahl Nitrogen (TKN	I)							
Total Kjeldahl Nitro	ogen as N		0.1 m	g/L	3.0	11.2	2.5	3.8	0.7
EK067G: Total P	hosphorous-As P b	y Discrete Analyse	ər						
Total Phosphorus a	as P		0.01 m	g/L	0.76	1.33	1.00	1.10	0.08
EK071G: Reactiv	e Phosphorous as	P by discrete anal	yser						
Reactive Phosphor	rus as P		0.010 m	g/L	0.036	0.016	0.799	1.12	<0.010
EP005: Total Orç	ganic Carbon (TOC)								
Total Organic Carb	oon		1 m	g/L	22	110			
EP030: Biochem	ical Oxygen Deman	d (BOD)							
Biochemical Oxyge	en Demand		2 m	g/L	<2	<2		6	5



Page Number: 7 of 7Client: COFFEY GEOTECHNICSWork Order: ES0704246



Surrogate Control Limits

l No surrogates present on this report.



ALS Environmental

QUALITY CONTROL REPORT

Client	:	COFFEY GEOTECHNICS	Laboratory	: Environmental Division Sydney	Page	:	1 of 11
Contact	:	MR ANDREW FULTON	Contact	: Victor Kedicioglu			
Address	:	13 MANGROVE ROAD SANDGATE NSW AUSTRALIA 2304	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164	Work order	:	ES0704246
					Amendment No.	:	
Project	:	MYALL QUAYS	Quote number	: EN/007/07	Date received	:	2 Apr 2007
Order number	:	- Not provided -			Date issued	:	12 Apr 2007
C-O-C number	:	- Not provided -					
Site	:	- Not provided -					
E-mail	:	andrew_fulton@coffey.com.au	E-mail	: Victor.Kedicioglu@alsenviro.com	No. of samples		
Telephone	:	49676377	Telephone	: 61-2-8784 8555	Received	:	10
Facsimile	:	49675402	Facsimile	: 61-2-8784 8500	Analysed	:	10

This final report for the ALSE work order reference ES0704246 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

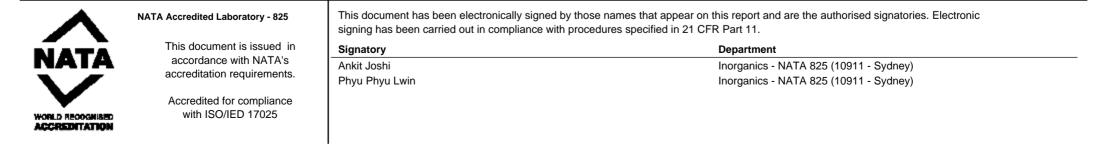
This report contains the following information:

- 1 Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- 1 Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- 1 Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

TDS by method EA-015 may bias high on various sample due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper. EK059G: It has been noted that Nitrite is greater than NOx on sample ID (22), however this difference is within the limits of experimental variation. It has been noted that RP is greater than TP (sample ID D2), however this difference is within the limits of experimental variation.

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Client	:	COFFEY GEOTECHNICS	Work Order	:	ES0704246	Page Number	:	2 of 11	(ALS)
Project	:	MYALL QUAYS	ALS Quote Reference	:	EN/007/07	Issue Date	:	12 Apr 2007	ALS Environmental

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* **LOR** = *Limit* of *Reporting*, **RPD** = *Relative Percent Difference*. * Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: WATER

Laboratory Duplicates (DUP) Report
Original Result
Duplicate Result
RPD

					I	
Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EA005: pH				1		
EA005: pH - (QC Lot: 38	5626)			pH Unit	pH Unit	%
ES0704246-001	22	pH Value	0.01 pH Unit	6.05	6.05	0.0
ES0704246-010	POND	pH Value	0.01 pH Unit	5.83	5.86	0.5
EA010P: Conductivity by	PC Titrator				•	•
EA010P: Conductivity by	/ PC Titrator - (QC Lot: 385345)			µS/cm	μS/cm	%
ES0704246-001	22	Electrical Conductivity @ 25°C	1 µS/cm	1610	1580	2.0
ES0704252-001	Anonymous	Electrical Conductivity @ 25°C	1 µS/cm	22400	22300	0.4
EA015: Total Dissolved So	olids		I	•		
EA015: Total Dissolved S	Solids - (QC Lot: 385565)			mg/L	mg/L	%
ES0704217-001	Anonymous	Total Dissolved Solids @180°C	1 mg/L	7890	7720	2.2
ES0704229-006	Anonymous	Total Dissolved Solids @180°C	1 mg/L	500	508	1.6
ED037P: Alkalinity by PC	Titrator			•		•
ED037P: Alkalinity by PC	C Titrator - (QC Lot: 385344)			mg/L	mg/L	%
ES0704246-001	22	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	102	102	0.0
		Total Alkalinity as CaCO3	1 mg/L	102	102	0.0
ES0704252-001	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Total Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
ED040F: Dissolved Major	Anions			•	•	•
ED040F: Dissolved Majo	r Anions - (QC Lot: 386020)			mg/L	mg/L	%
ES0704246-001	22	Sulphate as SO4 2-	1 mg/L	39	40	0.0
ED045G: Chloride Discret	e analyser		1	•		
ED045G: Chloride Discre	ete analyser - (QC Lot: 386094)			mg/L	mg/L	%
	1	I				A Comphall Brothors Limited Com



ALS
LS Environmental

	EY GEOTECHNICS L QUAYS	Work Order : ES07 ALS Quote Reference : EN/00	04246 7/07	Page Number: 3 ofIssue Date: 12 /		(ALS) Environmen
atrix Type: WATER						Duplicates (DUP) Re
Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
D045G: Chloride Discre	ete analyser - continued					
ED045G: Chloride Disc	rete analyser - (QC Lot: 386094) - continued	I		mg/L	mg/L	%
ES0704246-001	22	Chloride	1.0 mg/L	430	436	1.4
ES0704246-008	?1	Chloride	1.0 mg/L	34.4	33.9	1.5
D093F: Dissolved Majo	or Cations			•		
ED093F: Dissolved Maj	or Cations - (QC Lot: 386021)			mg/L	mg/L	%
ES0704246-001	22	Calcium	1 mg/L	11	11	0.0
		Magnesium	1 mg/L	23	24	0.0
		Sodium	1 mg/L	283	285	0.6
		Potassium	1 mg/L	7	7	0.0
ES0704314-001	Anonymous	Calcium	1 mg/L	3	3	0.0
		Magnesium	1 mg/L	62	63	2.3
		Sodium	1 mg/L	779	746	4.3
		Potassium	1 mg/L	<1	<1	0.0
G020F: Dissolved Meta	Is by ICP-MS					
EG020F: Dissolved Met	tals by ICP-MS - (QC Lot: 385229)			mg/L	mg/L	%
ES0704242-001	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Cadmium	0.0001 mg/L	<0.0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Zinc	0.005 mg/L	0.014	0.014	0.0
ES0704246-002	21	Arsenic	0.001 mg/L	0.002	<0.001	0.0
		Cadmium	0.0001 mg/L	<0.0001	<0.0001	0.0
		Chromium	0.001 mg/L	0.002	0.002	0.0
		Copper	0.001 mg/L	0.001	0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Lead				
		Nickel	0.001 mg/L	<0.001	<0.001	0.0

(ALS)	
LS Environmental	

latrix Type: WATER	Client Sample ID	Anglyta name	LOR	Original Result	Duplicate Result	Duplicates (DUP) Repo
Laboratory Sample ID	· ·	Analyte name	LUR	Original Result	Duplicate Result	RPD
G035F: Dissolved Mercur	y by FIMS - continued iry by FIMS - (QC Lot: 385598)			mg/L	mg/L	%
ES0704246-001		Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
ES0704289-004	Anonymous	Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
		Intercury	0.0001 Hig/L	<0.0001	<0.0001	0.0
K055G: Ammonia as N by	•					
	y Discrete Analyser - (QC Lot: 386879)			mg/L	mg/L	%
ES0704246-001	22	Ammonia as N	0.010 mg/L	0.655	0.670	2.3
ES0704246-010	POND	Ammonia as N	0.010 mg/L	<0.010	<0.010	0.0
EK057G: Nitrite as N by Di	screte Analyser			1		
EK057G: Nitrite as N by D	Discrete Analyser - (QC Lot: 385367)			mg/L	mg/L	%
ES0704246-002	21	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
ES0704246-010	POND	Nitrite as N	0.010 mg/L	<0.010	<0.010	0.0
K059G: NOX as N by Dis	crete Analyser			•	• •	
EK059G: NOX as N by Di	screte Analyser - (QC Lot: 386091)			mg/L	mg/L	%
ES0704246-001	22	Nitrite + Nitrate as N	0.010 mg/L	0.037	0.036	2.7
ES0704246-010	POND	Nitrite + Nitrate as N	0.010 mg/L	0.020	0.019	5.1
EK061: Total Kjeldahl Nitro	ogen (TKN)			I		
EK061: Total Kjeldahl Nitr	ogen (TKN) - (QC Lot: 387458)			mg/L	mg/L	%
ES0704246-001	22	Total Kjeldahl Nitrogen as N	0.1 mg/L	7.2	6.4	11.7
ES0704246-010	POND	Total Kjeldahl Nitrogen as N	0.1 mg/L	0.7	0.7	0.0
K067G: Total Phosphorou	us-As P by Discrete Analyser				1	
	ous-As P by Discrete Analyser - (QC Lot: 387459)			mg/L	mg/L	%
ES0704246-001	22	Total Phosphorus as P	0.01 mg/L	0.79	0.76	3.9
ES0704246-010	POND	Total Phosphorus as P	0.01 mg/L	0.08	0.03	85.7
	prous as P by discrete analyser	• • • • • • • • • • • • • • • • • • • •				
•	norous as P by discrete analyser - (QC Lot: 385204)			mg/L	mg/L	%
ES0704246-001	22	Reactive Phosphorus as P	0.010 mg/L	0.095	0.111	15.5
P005: Total Organic Carb			, _			
				mg/L	mg/L	%
EP005: Total Organic Car	hon (TOC) - (OC of: 3855/5)					
EP005: Total Organic Car ES0704203-004	bon (TOC) - (QC Lot: 385545) Anonymous	Total Organic Carbon	1 mg/L	20	20	0.0

ALS
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Client : COFFEY Project : MYALL QU	GEOTECHNICS IAYS	Work Order:ES0704246ALS Quote Reference:EN/007/07		Page Number: 5 ofIssue Date: 12 A		(ALS) <u>S Environmental</u>			
Natrix Type: WATER									
Laboratory Sample ID	Client Sample ID	Analyte name LOR		Original Result	Duplicate Result	RPD			
EP030: Biochemical Oxygen	EP030: Biochemical Oxygen Demand (BOD)								
EP030: Biochemical Oxyger	n Demand (BOD) - (QC Lot: 385733)		mg/L	mg/L	%				
EB0703652-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	6	6	0.0			
EB0703660-015	Anonymous	Biochemical Oxygen Demand	2 mg/L	23	19	19.0			
EP030: Biochemical Oxyger	n Demand (BOD) - (QC Lot: 385734)		•	mg/L	mg/L	%			
EB0703640-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	3850	3640	5.5			
ES0704278-001	Anonymous	Biochemical Oxygen Demand	2 mg/L	1740	1840	5.8			

Project	:	MYALL QUAYS	ALS Quote Reference	:	EN/007/07	Issue Date	:	12 Apr 2007	ALS Environment
Client	:	COFFEY GEOTECHNICS	Work Order	:	ES0704246	Page Number	:	6 of 11	(ALS)

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The guality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: WATER

					(
		Method blank	Actual	Results	Recov	ery Limits		
		result	Spike concentration	Spike Recovery	Dynamic Re	ecovery Limits		
Analyte name	LOR			LCS	Low	High		
EA010P: Conductivity by PC Titrator				_				
EA010P: Conductivity by PC Titrator - (QC Lot: 385345)		μS/cm	µS/cm	%	%	%		
Electrical Conductivity @ 25°C	1 μS/cm		2000	101	86.3	112		
	1 µS/cm	<1						
EA015: Total Dissolved Solids			-					
EA015: Total Dissolved Solids - (QC Lot: 385565)		mg/L	mg/L	%	%	%		
Total Dissolved Solids @180°C	1 mg/L		293	107	77.9	122		
	1 mg/L	<1						
ED037P: Alkalinity by PC Titrator				-				
ED037P: Alkalinity by PC Titrator - (QC Lot: 385344)		mg/L	mg/L	%	%	%		
Total Alkalinity as CaCO3	1 mg/L		200	91.6	80.2	108		
ED040F: Dissolved Major Anions								
ED040F: Dissolved Major Anions - (QC Lot: 386020)		mg/L	mg/L	%	%	%		
Sulphate as SO4 2-	1 mg/L	<1	1					
	1 mg/L		150	93.4	82.9	114		
ED045G: Chloride Discrete analyser								
ED045G: Chloride Discrete analyser - (QC Lot: 386094)		mg/L	mg/L	%	%	%		
Chloride	1 mg/L		50	104	83.7	124		
	1 mg/L		250	96.0	83.7	124		
	1.0 mg/L	<1.0						
ED093F: Dissolved Major Cations				•	-	-		
ED093F: Dissolved Major Cations - (QC Lot: 386021)		mg/L	mg/L	%	%	%		
Calcium	1 mg/L	<1						
	1 mg/L		50	92.9	82.9	121		



Method Blank (MB) and Laboratory Control Samples (LCS) Report

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Client : COFFEY GEOTECHNICS	Work Order	: ES0704246		Page Number : 7 of	11	(ALS)
Project : MYALL QUAYS	ALS Quote Reference	: EN/007/07		Issue Date : 12 A	Apr 2007 📃 🛝	S Environmenta
Matrix Type: WATER				Method Blank	(MB) and Laboratory Con	trol Samples (LCS) Repor
		Method blank	Actual	Results	Recovery Limits	
		result	Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
ED093F: Dissolved Major Cations - continued			•		•	-
ED093F: Dissolved Major Cations - (QC Lot: 386021) - continued		mg/L	mg/L	%	%	%
Magnesium	1 mg/L		50	96.1	82.7	114
	1 mg/L	<1				
Potassium	1 mg/L		50	94.5	84.3	118
	1 mg/L	<1				
Sodium	1 mg/L	<1				
	1 mg/L		50	92.1	77.4	113
EG020F: Dissolved Metals by ICP-MS			_		_	
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 385229)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	<0.001				
	0.001 mg/L		0.1	94.6	70	130
Cadmium	0.0001 mg/L		0.1	92.3	70	130
	0.0001 mg/L	<0.0001				
Chromium	0.001 mg/L		0.1	96.4	70	130
	0.001 mg/L	<0.001				
Copper	0.001 mg/L		0.1	91.7	70	130
	0.001 mg/L	<0.001				
Lead	0.001 mg/L	<0.001				
	0.001 mg/L		0.1	94.3	70	130
Nickel	0.001 mg/L		0.1	91.9	70	130
	0.001 mg/L	<0.001				
Zinc	0.005 mg/L		0.1	101	70	130
	0.005 mg/L	<0.005				
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 385598)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	<0.0001				
	0.0001 mg/L		0.010	115	80.5	117
EK055G: Ammonia as N by Discrete Analyser						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879)		mg/L	mg/L	%	%	%

Slient : COFFEY GEOTECHNICS Project : MYALL QUAYS	Work Order ALS Quote Reference	: ES0704246 : EN/007/07		Page Number : 8 of 1 Issue Date : 12 Ap		S Environmen
latrix Type: WATER		1 210,001,01			MB) and Laboratory Con	
	Г	Method	Actual			ery Limits
		blank result	Spike concentration	Spike Recovery		ecovery Limits
Analyte name	LOR	looun		LCS	Low	High
EK055G: Ammonia as N by Discrete Analyser - continued						
EK055G: Ammonia as N by Discrete Analyser - (QC Lot: 386879) - continued		mg/L	mg/L	%	%	%
Ammonia as N	0.01 mg/L		1.00	105	75.6	128
	0.010 mg/L	<0.010				
K057G: Nitrite as N by Discrete Analyser						
EK057G: Nitrite as N by Discrete Analyser - (QC Lot: 385367)		mg/L	mg/L	%	%	%
Nitrite as N	0.010 mg/L	<0.010				
	0.01 mg/L		0.96	102	66.6	131
EK059G: NOX as N by Discrete Analyser						
EK059G: NOX as N by Discrete Analyser - (QC Lot: 386091)		mg/L	mg/L	%	%	%
Nitrite + Nitrate as N	0.010 mg/L	<0.010				
	0.01 mg/L		0.96	94.3	76.9	122
EK061: Total Kjeldahl Nitrogen (TKN)						
EK061: Total Kjeldahl Nitrogen (TKN) - (QC Lot: 387458)		mg/L	mg/L	%	%	%
Total Kjeldahl Nitrogen as N	0.1 mg/L		10	98.2	62.4	140
	0.1 mg/L	<0.1				
K067G: Total Phosphorous-As P by Discrete Analyser						
EK067G: Total Phosphorous-As P by Discrete Analyser - (QC Lot: 387459)		mg/L	mg/L	%	%	%
Total Phosphorus as P	0.01 mg/L	<0.01				
	0.01 mg/L		4.42	90.3	64.3	120
K071G: Reactive Phosphorous as P by discrete analyser						
EK071G: Reactive Phosphorous as P by discrete analyser - (QC Lot: 385204)		mg/L	mg/L	%	%	%
Reactive Phosphorus as P	0.010 mg/L	<0.010				
	0.01 mg/L		0.50	102	83.8	122
P005: Total Organic Carbon (TOC)						
EP005: Total Organic Carbon (TOC) - (QC Lot: 385545)		mg/L	mg/L	%	%	%
Total Organic Carbon	1 mg/L		10	92.2	86.9	125
	1 mg/L	<1				



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Client Project	:	COFFEY GEOTECHNICS MYALL QUAYS	Work Order ALS Quote Reference	:	ES0704246 EN/007/07		Page Number:9 ofIssue Date:12 A		(ALS) S Environmental
Matrix Ty	Matrix Type: WATER Method Blank (MB) and Laboratory Control Samples (LC								trol Samples (LCS) Report
					Method blank	Actual	Results	Recove	ery Limits
·					result	Spike concentration	Spike Recovery	Dynamic Re	covery Limits
Analyte	e name		LOR				LCS	Low	High
EP030: B	Biochen	nical Oxygen Demand (BOD) - continued					-		
EP030:	Bioche	mical Oxygen Demand (BOD) - (QC Lot: 385733)			mg/L	mg/L	%	%	%
Bioche	mical C	Dxygen Demand	2 mg/L		<2				
			2 mg/L			200	99.5	66.8	112
EP030:	Bioche	mical Oxygen Demand (BOD) - (QC Lot: 385734)			mg/L	mg/L	%	%	%
Bioche	mical C	Dxygen Demand	2 mg/L		<2				
			2 mg/L			200	96.0	66.8	112

Client	:	COFFEY GEOTECHNICS	Work Order	:	ES0704246	Page Number	:	10 of 11	(ALS)
Project	:	MYALL QUAYS	ALS Quote Reference	:	EN/007/07	Issue Date	:	12 Apr 2007	ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: LOR = Limit of Reporting, RPD = Relative Percent Difference.* * Indicates failed QC

Matrix Type: WATER

Matrix Type: WATER			_			Matrix Spike (MS) Report			
					Actual	Results	Recov	ery Limits	
					Sample Result	Spike Recovery		c Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High	
ED045G: Chloride Discre	te analyser					·		i	
ED045G: Chloride Discr	ete analyser - (QC Lot: 386094)			mg/L	mg/L	%	%	%	
Chloride	ES0704246-001	22	1 mg/L	250	430	125	70	130	
EG020F: Dissolved Metal	Is by ICP-MS								
EG020F: Dissolved Meta	als by ICP-MS - (QC Lot: 385229)		mg/L	mg/L	%	%	%	
Arsenic	ES0704242-001	Anonymous	0.001 mg/L	0.2	<0.001	98.1	70	130	
Cadmium			0.0001 mg/L	0.05	<0.0001	98.4	70	130	
Chromium			0.001 mg/L	0.2	<0.001	94.9	70	130	
Copper			0.001 mg/L	0.2	0.001	95.4	70	130	
Lead			0.001 mg/L	0.2	<0.001	100	70	130	
Nickel			0.001 mg/L	0.2	<0.001	96.8	70	130	
Zinc			0.005 mg/L	0.2	0.014	104	70	130	
EG035F: Dissolved Merci	ury by FIMS								
EG035F: Dissolved Merc	cury by FIMS - (QC Lot: 385598)			mg/L	mg/L	%	%	%	
Mercury	ES0704246-001	22	0.0001 mg/L	0.0100	<0.0001	116	70	130	
EK055G: Ammonia as N I	by Discrete Analyser								
EK055G: Ammonia as N	l by Discrete Analyser - (QC Lot	386879)		mg/L	mg/L	%	%	%	
Ammonia as N	ES0704246-001	22	0.01 mg/L	1.00	0.655	93.3	70	130	
EK057G: Nitrite as N by	Discrete Analyser		·					•	
EK057G: Nitrite as N by	v Discrete Analyser - (QC Lot: 38	5367)		mg/L	mg/L	%	%	%	
Nitrite as N	ES0704246-002	21	0.01 mg/L	0.60	<0.010	102	70	130	
EK059G: NOX as N by Di	iscrete Analyser								
EK059G: NOX as N by I	Discrete Analyser - (QC Lot: 386	091)		mg/L	mg/L	%	%	%	
Nitrite + Nitrate as N	ES0704246-001	22	0.01 mg/L	0.60	0.037	92.3	70	130	
EK061: Total Kjeldahl Nit	rogen (TKN)								



Matrix Spike (MS) Report

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S	ALS Quote Reference	: EN/007/07		Issue Date	: 12 Apr 2007	O7 ALS Environmental		
						Ма	trix Spike (MS) Repor	
				Actual	Results	Recove	ery Limits	
		1		Sample Result	Spike Recovery	Static	Limits	
Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High	
TKN) - continued								
(TKN) - (QC Lot: 387458			mg/L	mg/L	%	%	%	
ES0704246-001	22	0.1 mg/L	25	7.2	100	70	130	
P by Discrete Analyser								
s P by Discrete Analyser -	(QC Lot: 387459)		mg/L	mg/L	%	%	%	
ES0704246-001	22	0.01 mg/L	5	0.79	75.3	70	130	
as P by discrete analyse					_			
s as P by discrete analyse	er - (QC Lot: 385204)		mg/L	mg/L	%	%	%	
ES0704246-001	22	0.01 mg/L	0.50	0.095	101	70	130	
OC)								
TOC) - (QC Lot: 385545)			mg/L	mg/L	%	%	%	
ES0704203-004	Anonymous	1 mg/L	100	20	94.9	70	130	
	TKN) - continued (TKN) - (QC Lot: 387458) ES0704246-001 P by Discrete Analyser s P by Discrete Analyser ES0704246-001 as P by discrete analyser s as P by discrete analyser ES0704246-001 ES0704246-001 OC) TOC) - (QC Lot: 385545)	Laboratory Sample ID Client Sample ID TKN) - continued TKN) - (QC Lot: 387458) (TKN) - (QC Lot: 387458) 22 P by Discrete Analyser 22 P by Discrete Analyser - (QC Lot: 387459) 22 ES0704246-001 22 as P by Discrete analyser - (QC Lot: 387459) 22 ES0704246-001 22 B Sorrotzete analyser - (QC Lot: 385204) 22 ES0704246-001 22 OC) TOC) - (QC Lot: 385545)	Laboratory Sample ID Client Sample ID LOR TKN) - continued	Laboratory Sample ID Client Sample ID LOR Spike Concentration TKN) - continued TKN) - (QC Lot: 387458) mg/L [ES0704246-001] 22 0.1 mg/L 25 P by Discrete Analyser mg/L 25 s P by Discrete Analyser - (QC Lot: 387459) mg/L 5 is as P by discrete analyser 0.01 mg/L 5 is as P by discrete analyser - (QC Lot: 385204) mg/L 0.01 mg/L [ES0704246-001] 22 0.01 mg/L 5 is as P by discrete analyser - (QC Lot: 385204) mg/L 0.50 [ES0704246-001] 22 0.01 mg/L 0.50 OC) CIENTIFICIAL SESSER mg/L 0.50	Laboratory Sample ID Client Sample ID Client Sample ID LOR Spike Concentration TKN) - continued mg/L mg/L mg/L [ES0704246-001 22 0.1 mg/L 25 7.2 P by Discrete Analyser QC Lot: 387459) mg/L mg/L ES0704246-001 22 0.1 mg/L 25 7.2 P by Discrete Analyser QC Lot: 387459) mg/L mg/L ES0704246-001 22 0.01 mg/L 5 0.79 as P by discrete analyser - (QC Lot: 387459) mg/L mg/L mg/L ES0704246-001 22 0.01 mg/L 5 0.79 as P by discrete analyser - (QC Lot: 385204) mg/L mg/L mg/L ES0704246-001 22 0.01 mg/L 0.50 0.095 OC) Z 0.01 mg/L 0.50 0.095	Actual Results Laboratory Sample ID Client Sample ID LOR Spike Concentration Sample Result Spike Recovery TKN) - continued MS MS MS TKN) - CQC Lot: 387458 > mg/L Mg/L % ES0704246-001 22 0.1 mg/L 25 7.2 100 P by Discrete Analyser Mg/L % % ES0704246-001 22 0.01 mg/L 25 7.2 100 P by Discrete Analyser - (QC Lot: 387459) mg/L Mg/L % ES0704246-001 22 0.01 mg/L 5 0.79 75.3 ras P by discrete analyser - (QC Lot: 385204) mg/L Mg/L % ES0704246-001 22 0.01 mg/L 0.50 0.095 101 ras P by discrete analyser - (QC Lot: 385204) mg/L Mg/L % ES0704246-001 22 0.01 mg/L 0.50 0.095 101 CO- ras P by discrete analyser - (QC Lot: 385204) mg/L Mg/L % <td>Ma Actual Results Recove Sample Result Actual Results Recove Sample Result Actual Recover Sample Result Sample Colspan="2"Sample Result</td>	Ma Actual Results Recove Sample Result Actual Results Recove Sample Result Actual Recover Sample Result Sample Colspan="2"Sample Result	

: ES0704246

Work Order

Client

: COFFEY GEOTECHNICS



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 30674

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

Attention: Ben Rose

Sample log in details:

Your Reference:	P0902346
No. of samples:	6 Waters
Date samples received:	08/07/09
Date completed instructions received:	08/07/09

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: 15/07/09 Date of Preliminary Report: Not issued Issue Date: 15/07/09 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:

Jacinta/Hurst

Jacinta/Hurst Operations Manager

Envirolab Reference: Revision No:

30674 R 00



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Client Reference: P0902346

Ion Balance						
Our Reference:	UNITS	30674-1	30674-2	30674-3	30674-4	30674-5
Your Reference		2346/1A/GW	2346/2A/GW	2346/9/GW	2346/23/GW	2346/25/GW
Date Sampled		6/07/2009	6/07/2009	6/07/2009	6/07/2009	6/07/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Date analysed	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Calcium - Dissolved	mg/L	5.6	1.2	0.30	3.6	3.6
Potassium - Dissolved	mg/L	19	8.9	4.5	2.1	2.0
Sodium - Dissolved	mg/L	27	22	16	35	34
Magnesium - Dissolved	mg/L	8.2	3.4	2.9	7.8	4.4
Hydroxide Alkalinity (OH ⁻) as CaCO ₃	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as CaCO3	mg/L	140	18	<0.1	25	45
Carbonate Alkalinity as CaCO3	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity as CaCO3	mg/L	140	18	<0.1	25	45
Sulphate, SO4	mg/L	39	<5	<5	<5	5
Chloride (titration) - water	mg/L	30	50	37	65	25
Ionic Balance	%	-26	-7.4	1.1	1.5	9.6

Ion Balance		
Our Reference:	UNITS	30674-6
Your Reference		2346/26/GW
Date Sampled		6/07/2009
Type of sample		Water
Date prepared	-	9/07/2009
Date analysed	-	9/07/2009
Calcium - Dissolved	mg/L	110
Potassium - Dissolved	mg/L	130
Sodium - Dissolved	mg/L	3,820
Magnesium - Dissolved	mg/L	360
Hydroxide Alkalinity (OH ⁻) as CaCO ₃	mg/L	<0.1
Bicarbonate Alkalinity as CaCO3	mg/L	50
Carbonate Alkalinity as CaCO3	mg/L	<0.1
Total Alkalinity as CaCO3	mg/L	50
Sulphate, SO4	mg/L	850
Chloride (titration) - water	mg/L	5,800
Ionic Balance	%	5.8



Client Reference: PO

P0902346

HM in water - dissolved						
Our Reference:	UNITS	30674-1	30674-2	30674-3	30674-4	30674-5
Your Reference		2346/1A/GW	2346/2A/GW	2346/9/GW	2346/23/GW	2346/25/GW
Date Sampled		6/07/2009	6/07/2009	6/07/2009	6/07/2009	6/07/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	13/07/2009	13/07/2009	13/07/2009	13/07/2009	13/07/2009
Date analysed	-	13/07/2009	13/07/2009	13/07/2009	13/07/2009	13/07/2009
Arsenic-Dissolved	µg/L	2.0	3.0	<1.0	<1.0	8.0
Cadmium-Dissolved	µg/L	<0.10	<0.10	0.10	<0.10	<0.10
Chromium-Dissolved	µg/L	2.0	1.0	<1.0	<1.0	3.0
Copper-Dissolved	µg/L	3.0	2.0	1.0	<1.0	<1.0
Lead-Dissolved	µg/L	<1.0	<1.0	2.0	<1.0	<1.0
Mercury-Dissolved	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel-Dissolved	µg/L	2.0	3.0	3.0	2.0	2.0
Zinc-Dissolved	µg/L	<1.0	9.0	31	3.0	2.0

HM in water - dissolved		
Our Reference:	UNITS	30674-6
Your Reference		2346/26/GW
Date Sampled		6/07/2009
Type of sample		Water
Date prepared	-	13/07/2009
Date analysed	-	13/07/2009
Arsenic-Dissolved	µg/L	2.0
Cadmium-Dissolved	µg/L	<0.10
Chromium-Dissolved	µg/L	<1.0
Copper-Dissolved	µg/L	<1.0
Lead-Dissolved	µg/L	<1.0
Mercury-Dissolved	µg/L	<0.50
Nickel-Dissolved	µg/L	<1.0
Zinc-Dissolved	µg/L	<1.0

Client Reference: P

P0902346

Miscellaneous Inorganics						
Our Reference:	UNITS	30674-1	30674-2	30674-3	30674-4	30674-5
Your Reference		2346/1A/GW	2346/2A/GW	2346/9/GW	2346/23/GW	2346/25/GW
Date Sampled		6/07/2009	6/07/2009	6/07/2009	6/07/2009	6/07/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
Date analysed	-	9/07/2009	9/07/2009	9/07/2009	9/07/2009	9/07/2009
рН	pH Units	6.2	5.1	4.3	5.7	5.6
Electrical Conductivity	μS/cm	280	200	160	280	260
Total Dissolved Solids (grav)	mg/L	170	120	96	180	160
Ammonia as N in water	mg/L	<1.0	<1.0	<0.5	<0.1	0.6
NOx as N in water	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0
TKN in water	mg/L	7.1	3.8	1	<0.5	30
Total Nitrogen in water	mg/L	7.1	3.8	1	<0.6	30
Phosphorus - Total	mg/L	6.1	2.8	1.9	<0.050	1.2

Miscellaneous Inorganics		
Our Reference:	UNITS	30674-6
Your Reference		2346/26/GW
Date Sampled		6/07/2009
Type of sample		Water
Date prepared	-	9/07/2009
Date analysed	-	9/07/2009
рН	pH Units	6.3
Electrical Conductivity	μS/cm	14,000
Total Dissolved Solids (grav)	mg/L	11,000
Ammonia as N in water	mg/L	<0.1
NOx as N in water	mg/L	<1.0
TKN in water	mg/L	<0.5
Total Nitrogen in water	mg/L	<0.6
Phosphorus - Total	mg/L	<0.050



Client Reference: P0902346

Method ID	Methodology Summary
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.9	Sulphate determined turbidimetrically.
LAB.11	Chloride determined by argentometric titration.
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.
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.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.57	Ammonia water extractable - determined colourimetrically based on EPA350.1
LAB.55	Nitrate water extractable - determined colourimetrically based on EPA114A.
LAB.62	TKN - determined colourimetrically based on EPA110A.
LAB.66	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.



Client Reference: P0

P0902346

		•			002040			
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Ion Balance						Base II Duplicate II %RPD		
Date prepared	-			9/7/09	30674-5	9/07/2009 9/07/2009	LCS-W2	9/7/09
Date analysed	-			9/7/09	30674-5	9/07/2009 9/07/2009	LCS-W2	9/7/09
Calcium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	3.6 4.1 RPD: 13	LCS-W2	90%
Potassium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	2.0 2.1 RPD: 5	LCS-W2	105%
Sodium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	34 35 RPD: 3	LCS-W2	110%
Magnesium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	30674-5	4.4 5.0 RPD: 13	LCS-W2	100%
Bicarbonate Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	30674-5	45 <0.1	LCS-W2	100%
Carbonate Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	30674-5	<0.1 <0.1	[NR]	[NR]
Total Alkalinity as CaCO3	mg/L	0.1	LAB.6	<0.1	30674-5	45 <0.1	LCS-W2	100%
Sulphate, SO4	mg/L	5	LAB.9	<5	30674-5	5 [N/T]	LCS-W2	103%
Chloride (titration) - water	mg/L	20	LAB.11	<20	30674-5	25 [N/T]	LCS-W2	104%
Ionic Balance	%		LAB.41	[NT]	30674-5	9.6 [N/T]	[NR]	[NR]
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike %
HM in water - dissolved						Base II Duplicate II %RPD		Recovery
Date prepared	-			13/07/2	30674-5	13/07/2009 13/07/2009	LCS-W3	13/07/2009
Date analysed	-			009 13/07/2	30674-5	13/07/2009 13/07/2009	LCS-W3	13/07/2009
Arsenic-Dissolved	µg/L	1	Metals.22	009 <1.0	30674-5	8.0 8.0 RPD: 0	LCS-W3	102%
Cadmium-Dissolved	µg/L	0.1	ICP-MS Metals.22 ICP-MS	<0.10	30674-5	<0.10 <0.10	LCS-W3	110%
Chromium-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	3.0 4.0 RPD: 29	LCS-W3	104%
Copper-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	<1.0 <1.0	LCS-W3	99%
Lead-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	<1.0 <1.0	LCS-W3	106%
Mercury-Dissolved	µg/L	0.5	Metals.21 CV-AAS	<0.50	30674-5	<0.50 <0.50	LCS-W3	94%
Nickel-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	2.0 2.0 RPD: 0	LCS-W3	94%
Zinc-Dissolved	µg/L	1	Metals.22 ICP-MS	<1.0	30674-5	2.0 2.0 RPD: 0	LCS-W3	93%



Client Reference:

P0902346

QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Miscellaneous Inorganics						Base II Duplicate II %RPD		
Date prepared	-			9/7/09	30674-5	9/07/2009 9/07/2009	LCS-W2	9/7/09
Date analysed	-			9/7/09	30674-5	9/07/2009 9/07/2009	LCS-W2	9/7/09
рН	pH Units		LAB.1	[NT]	30674-5	5.6 [N/T]	LCS-W2	66%
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	30674-5	260 [N/T]	LCS-W2	100%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	30674-5	160 [N/T]	LCS-W2	92%
Ammonia as N in water	mg/L	0.1	LAB.57	<0.1	30674-5	0.6 [N/T]	LCS-W2	90%
NOx as N in water	mg/L	0.1	LAB.55	<0.1	30674-5	<1.0 [N/T]	LCS-W2	101%
TKN in water	mg/L	0.5	LAB.62	<0.5	30674-5	30 [N/T]	LCS-W2	92%
Total Nitrogen in water	mg/L	0.6	LAB.66	<0.6	30674-5	30 [N/T]	[NR]	[NR]
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.050	30674-5	1.2 1.4 RPD: 15	LCS-W2	98%
QUALITY CONTROL	UNITS	S	Dup. Sm#		Duplicate			
Ion Balance				Base + I	Duplicate + %RPD)		
Date prepared	-		30674-1	9/07/2	009 9/07/2009			
Date analysed	-		30674-1	9/07/2	009 9/07/2009			
Calcium - Dissolved	mg/L		30674-1	4	5.6 [N/T]			
Potassium - Dissolved	mg/L		30674-1		19 [N/T]			
Sodium - Dissolved	mg/L		30674-1		27 [N/T]			
Magnesium - Dissolved	mg/L		30674-1	:	3.2 [N/T]			
Bicarbonate Alkalinity as CaCO3	mg/L		30674-1	140	140 RPD: 0			
Carbonate Alkalinity as CaCO3	mg/L		30674-1		<0.1 <0.1			
Total Alkalinity as CaCO ₃	mg/L		30674-1	140	140 RPD: 0			
Sulphate, SO4	mg/L		30674-1		39 [N/T]			
Chloride (titration) - water	mg/L		30674-1		30 [N/T]			
Ionic Balance	%		30674-1		26 [N/T]			

Envirolab Reference: 30 Revision No: R



		Client Reference	e: P0902346
QUALITY CONTROL	UNITS	Dup. Sm#	Duplicate
Miscellaneous Inorganics			Base + Duplicate + %RPD
Date prepared	-	30674-1	9/07/2009 9/07/2009
Date analysed	-	30674-1	9/07/2009 9/07/2009
рН	pH Units	30674-1	6.2 6.2 RPD: 0
Electrical Conductivity	µS/cm	30674-1	280 280 RPD: 0
Total Dissolved Solids (grav)	mg/L	30674-1	170 170 RPD: 0
Ammonia as N in water	mg/L	30674-1	<1.0 <1.0
NOx as N in water	mg/L	30674-1	<1.0 <1.0
TKN in water	mg/L	30674-1	7.1 [N/T]
Total Nitrogen in water	mg/L	30674-1	7.1 [N/T]
Phosphorus - Total	mg/L	30674-1	6.1 [N/T]

Report Comments:

Nitrate and Ammonia: detection limits have been raised due to matrix interferences.

Asbestos was analysed by Approved Identifier: Not applicable for this job

INS: Insufficient sample for this testNT: Not testedPQL: Practical Quantitation Limit<: Less than</th>>: Greater thanRPD: Relative Percent DifferenceNA: Test not requiredLCS: Laboratory Control SampleNR: Not requested

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 batches of 20. The duplicate sample RPD and matrix spike recoveries for the sample batch were within 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. Surrogates: 60-140% is acceptable for general organics and 10-140% for SVOC and speciated phenols.

Envirolab Reference: 306 Revision No: R 0





Nome	P0902346									
Martens Contact Officer	Ben Rose				Contact Email	brose@mart	ens.com.a	J		
	Sample Date	Sample Date 06.07.2009 Dispatch Date				Turnaround Time standar		standard	ard	
Sampling and Shipping	Our Reference	P	0902346		Shipping Method (X)	Hand	Post	Courler	x	
	On Ice (X)	r franciska	X No Ice (X)	Other (X)						
				Laboratory						
Name	EnviroLab									
Sample Delivery Address	12 Ashley Stre	et, Chats	wood, NSW, 2067							
			an that we should be a strength		STAND N. GA	ACCOUNTS (CONTRACTOR)				
Delivery Contact	Name Ailee	en Hie	Phone	(02) 9910 6200		Email				

Jacinta,

The following groundwater samples are enclosed in the esky:

- 1 2346/1A/GW
- 2 2346/2A/GW
- 3 2346/9/GW
- 4 2346/23/GW
- C 2346/25/GW
- 6 2346/26/GW

e,

Envirolab Services 12 Ashley St Chatswood NSW 2067 Ph: 9910 6200 JOB NO: 3067 Date received: 8/7/9 Time received: Sacelved by: SS Samp: Cool/Amblent Sooling: Childepack

Sequrity: Inteo/Broken/None

Please test all samples for the following:

Head Office Unit 6 / 37 Leighton Place Hornsby NSW 2077, Australia Ph 02 9476 9999 Fax 02 9476 8767

> mail@martens.com.au > www.martens.com.au MARTENS & ASSOCIATES P/L ABN 85 070 240 890 ACN 070 240 890



SOIL ANALYSIS CHAIN OF CUSTODY

- o pH
- o EC
- o Total Dissolved Solids
- o Major cations and anions
- o Metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury)
- o Ammonia
- o Nox
- o TKN
- o TN
- o TP

If you require any further information, please do not hesitate to contact the writer.

For and on behalf of

MARTENS & ASSOCIATES PTY LTD

Benlove

BEN ROSE BEnvMgt Environmental Scientist



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

78418

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

NSW 2077

Attention: Ben Rose

Sample log in details:

Your Reference:	P0902346JC1	1V01, Rivers	side
No. of samples:	9 waters		
Date samples received / completed instructions received	05/09/12	/ 05/09/	12

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: / Issue Date:
 12/09/12
 /
 12/09/12

 Date of Preliminary Report:
 not issued

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

 Accredited for compliance with ISO/IEC 17025.

 Tests not covered by NATA are denoted with *.

Results Approved By:

Rhian Morgan Reporting Supervisor

Nick Sarlamis

Nick Sarlamis Inorganics Supervisor



Client Reference: P0902346JC11V01, Riverside

Miscellaneous Inorganics						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference		2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled		04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012	05/09/2012
Date analysed	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012	05/09/2012
рН	pH Units	6.7	6.2	6.3	6.4	5.8
Total Dissolved Solids (grav)	mg/L	7,300	120	200	3,500	200
Chloride, Cl	mg/L	5,500	75	49	1,700	62
Sulphate, SO4	mg/L	760	4	10	210	20
Electrical Conductivity	µS/cm	18,000	320	260	6,400	310
Total Nitrogen in water	mg/L	2.2	1.9	1.9	0.9	1.9

Miscellaneous Inorganics					
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9
Your Reference		2346/GW9	2346/GW11	2346/GW25	2346/GW26
Date Sampled		04/09/2012	03/09/2012	04/09/2012	04/09/2012
Type of sample		Water	Water	Water	Water
Date prepared	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012
Date analysed	-	05/09/2012	05/09/2012	05/09/2012	05/09/2012
рН	pH Units	4.0	6.1	6.3	7.3
Total Dissolved Solids (grav)	mg/L	160	2,800	130	10,000
Chloride, Cl	mg/L	27	1,300	36	4,900
Sulphate, SO4	mg/L	<1	170	1	600
Electrical Conductivity	μS/cm	170	4,700	240	16,000
Total Nitrogen in water	mg/L	2.8	0.7	5.3	0.9

Client Reference:

-

-

mg/L

P0902346JC11V01, Riverside

03/09/2012

Water

06/09/2012

06/09/2012

0.5

04/09/2012

Water

06/09/2012

06/09/2012

0.2

04/09/2012

Water

06/09/2012

06/09/2012

<0.05

Metals in Waters - Acid extractable						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference		2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled		04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Phosphorus - Total	mg/L	<0.05	<0.05	0.09	<0.05	0.1
Metals in Waters - Acid extractable						
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9	
Your Reference		2346/GW9	2346/GW11	2346/GW25	2346/GW26	

04/09/2012

Water

06/09/2012

06/09/2012

1.3

Date Sampled

Type of sample

Date prepared

Date analysed

Phosphorus - Total

Client Reference:

P0902346JC11V01, Riverside

Metals in Water - Dissolved						
Our Reference:	UNITS	78418-1	78418-2	78418-3	78418-4	78418-5
Your Reference		2346/GW3	2346/GW4	2346/GW5	2346/GW6	2346/GW8
Date Sampled		04/09/2012	04/09/2012	03/09/2012	04/09/2012	03/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Calcium - Dissolved	mg/L	110	2.4	0.9	49	2.8
Magnesium - Dissolved	mg/L	370	6.1	2.1	130	4.8

Metals in Water - Dissolved					
Our Reference:	UNITS	78418-6	78418-7	78418-8	78418-9
Your Reference		2346/GW9	2346/GW11	2346/GW25	2346/GW26
Date Sampled		04/09/2012	03/09/2012	04/09/2012	04/09/2012
Type of sample		Water	Water	Water	Water
Date digested	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Date analysed	-	06/09/2012	06/09/2012	06/09/2012	06/09/2012
Calcium - Dissolved	mg/L	0.5	18	4.2	97
Magnesium - Dissolved	mg/L	3.1	77	4.2	300

Client Reference: P0902346JC11V01, Riverside

MethodID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-5oC.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Metals-020 ICP- AES	Determination of various metals by ICP-AES.

Client Reference:

P0902346JC11V01, Riverside

		Clie	ent Referenc	e: P	0902346JC11	V01, Riverside		
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Miscellaneous Inorganics						Base II Duplicate II %RPD		
Date prepared	-			05/09/2 012	78418-1	05/09/2012 05/09/2012	LCS-W1	05/09/2012
Date analysed	-			05/09/2 012	78418-1	05/09/2012 05/09/2012	LCS-W1	05/09/2012
pН	pH Units		Inorg-001	[NT]	78418-1	6.7 [N/T]	LCS-W1	101%
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	ব্য	78418-1	7300 [N/T]	LCS-W1	92%
Chloride, Cl	mg/L	1	Inorg-081	<1	78418-1	5500 5500 RPD:0	LCS-W1	94%
Sulphate, SO4	mg/L	1	Inorg-081	<1	78418-1	760 760 RPD:0	LCS-W1	101%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	78418-1	18000 [N/T]	LCS-W1	110%
Total Nitrogen in water	mg/L	0.1	Inorg- 055/062	<0.1	78418-1	2.2 2.3 RPD:4	LCS-W1	93%
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Metals in Waters - Acid extractable						Base II Duplicate II %RPD		,
Date prepared	-			06/09/2 012	78418-1	06/09/2012 06/09/2012	LCS-W1	06/09/2012
Date analysed	-			06/09/2 012	78418-1	06/09/2012 06/09/2012	LCS-W1	06/09/2012
Phosphorus - Total	mg/L	0.05	Metals-020 ICP-AES	<0.05	78418-1	<0.05 <0.05	LCS-W1	95%
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate	Duplicate results	Spike Sm#	Spike %
Metals in Water - Dissolved					Sm#	Base II Duplicate II % RPD		Recovery
Date digested	-			06/09/2 012	78418-6	06/09/2012 06/09/2012	LCS-W1	06/09/2012
Date analysed	-			06/09/2 012	78418-6	06/09/2012 06/09/2012	LCS-W1	06/09/2012
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	78418-6	0.5 0.5 RPD:0	LCS-W1	95%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	78418-6	3.1 3.1 RPD:0	LCS-W1	95%
QUALITY CONTROL Miscellaneous Inorganics	UNITS	6	Dup.Sm#		Duplicate Duplicate + %RP	Spike Sm# D	Spike % Reco	overy
Date prepared	_		78418-2	05/09/2	2012 05/09/201	2 78418-2	05/09/201	2
Date analysed	_		78418-2		2012 05/09/201		05/09/201	
Total Dissolved Solids (grav)	mg/L		78418-2		120 RPD:0	[NR]	[NR]	-
Total Nitrogen in water	mg/L		78418-2		1.9 [N/T]	78418-2	99%	
QUALITYCONTROL	UNITS		Dup.Sm#		Duplicate	Spike Sm#	Spike % Reco	overv
Metals in Waters - Acid extractable				Base+I	Duplicate + %RP			
extractable				1				
Date prepared	-		[NT]		[NT]	78418-2	06/09/201	2
	-		[NT] [NT]		[NT] [NT]	78418-2 78418-2	06/09/201 06/09/201	

Report Comments:

Sample #6: TDS\Conductivity ratio outside acceptance limits due to presence of organics

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent 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

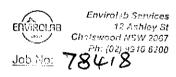
Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance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



				A	dditional	Testing	al y a sage					
Name	P0902346	0902346 – Riversīde										
Martens Contact Officer	Ben Rose	n Rose					Conto	ect Email	brose@mart	rens.com.au		
	Sample Date		3/9/12 + 4/9/	12	Dispatch	Date	5/9/1:	2	Turnaround	Time s	tandard	
Sampling and Shipping	Our Refe	rence	P0902346JC1	6JC11V01			Shipp	ing Method (X)	Hond	Post	Courier	x
	On Ice ()	K)	X No Ice	• (X)		Other (X)						
				uran Gr	Labora	lory						
Name	EnviroLo	d¢										
Sample Delivery Address	12 Ashle	ey Street, Ch	atswood									
Delivery Contact	Name	Aileen	P	hone	9910 6200		Fax		Email			
'Please Send Report By (X)	Post			moli X		Reporting Er			Imartens@mar		and s@martens.cor	<u>n.au</u>

ſ	Sample ID	рH	TDS	Chloride	Sulphate	Magnesium	Calcium	EC	TN	TP
r [2346/GW3/04.09.12	x	x	x	x	x	x	x	x	x
2 [2346/GW4/04.09.12	x	x	x	X	x	x	x	X	x
3 [2346/GW5/03.09.12	x	х	x	X	x	х	x	x	x
4	2346/GW6/04.09.12	x	x	x	x	x	x	x	X	x
ζΪ	2346/GW8/03.09.12	x	x	X	x	x	x	X	x	x
6	2346/GW9/04.09.12	x	x	x	x	X	x	X	x	x
7	2346/GW11/03.09.12	x	x	x	x	x	x	X	X	X
ġĮ	2346/GW25/04.09.12	x	x	x	x	x	x	x	x	×
91	2346/GW26/04.09.12	x	x	x	x	x	x	x	x	x



Date Reneived: 5.9.12. Time Received: 14.10 Received by: Jacker Temp: Containing methods Cooling Methods Security: machoroken None

Received By: Sia Low/ Ers.

Head Office Unit 6 / 37 Leighton Place Hornsby NSW 2077, Australia Ph 02 9476 9999 Fax 02 9476 8767

> mail@martens.com.au > www.martens.com.au MARTENS & ASSOCIATES P/L ABN 85 070 240 890 ACN 070 240 890





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

79518

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

Attention: Ben Rose

Sample log in details:

Your Reference:P0902346JC14V01, RiversideNo. of samples:10 watersDate samples received / completed instructions received27/09/12/27/09/12/

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: / Issue Date:
 5/10/12
 / 5/10/12

 Date of Preliminary Report:
 Not issued

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 Accredited for compliance with ISO/IEC 17025.

 Tests not covered by NATA are denoted with *.

Results Approved By:

Rhian Morgan Reporting Supervisor

Nick Sarlamis Inorganics Supervisor

Alex MacLean Chemist



Envirolab Reference: Revision No:

ce: 79518 R 00

Client Reference: P0902346JC14V01, Riverside

Miscellaneous Inorganics						
Our Reference:	UNITS	79518-1	79518-2	79518-3	79518-4	79518-5
Your Reference		2346/GW5	2346/GW6	2346/GW7	2346/GW8	2346/GW9
Date Sampled		25/09/2012	25/09/2012	25/09/2012	25/09/2012	25/09/2012
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
Date analysed	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
pН	pHUnits	5.8	5.7	5.5	5.2	4.1
Total Dissolved Solids (grav)	mg/L	180	4,900	120	160	150
Total Suspended Solids @ 103- 105 ⁰ C	mg/L	36	48	230	140	9
Chloride, Cl	mg/L	44	2,900	38	71	29
Sulphate, SO4	mg/L	10	360	7	24	<1
Electrical Conductivity	µS/cm	230	8,400	200	320	170
Total Nitrogen in water	mg/L	1.1	1.2	3.0	1.6	1.9
Miscellaneous Inorganics						
Our Reference:	UNITS	79518-6	79518-7	79518-8	79518-9	79518-10
Your Reference		2346/GW10	2346/GW11	2346/GW202	2346/GW201	2346/GW20
Date Sampled		25/09/2012	25/09/2012	26/09/2012	26/09/2012	26/09/201
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
Date analysed	-	27/09/2012	27/09/2012	27/09/2012	27/09/2012	27/09/2012
pН	pH Units	6.0	5.6	5.4	5.3	5.3
Total Dissolved Solids (grav)	mg/L	160	2,700	65	1,200	110
	1	1	1	1	1	1

190

53

3

300

1.6

Total Suspended Solids @ 103-

105⁰C Chloride, Cl

Sulphate, SO4

Electrical Conductivity

Total Nitrogen in water

mg/L

mg/L

mg/L

µS/cm

mg/L

2,100

43

5

190

4.1

1,000

18

5

110

3.3

120

1,400

180

4,600

0.7

9,800

640

26

2,000

9.9

Client Reference:

P0902346JC14V01, Riverside

Metals in Waters - Acid extractable Our Reference: Your Reference Date Sampled Type of sample	UNITS	79518-1 2346/GW5 25/09/2012 Water	79518-2 2346/GW6 25/09/2012 Water	79518-3 2346/GW7 25/09/2012 Water	79518-4 2346/GW8 25/09/2012 Water	79518-5 2346/GW9 25/09/2012 Water
Date prepared	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	02/10/2012	02/10/2012	02/10/2012	02/10/2012	02/10/2012
Phosphorus - Total	mg/L	<0.05	<0.05	0.2	0.3	1.3
Metals in Waters - Acid extractable Our Reference: Your Reference Date Sampled Type of sample	UNITS	79518-6 2346/GW10 25/09/2012 Water	79518-7 2346/GW11 25/09/2012 Water	79518-8 2346/GW202 26/09/2012 Water	79518-9 2346/GW201 26/09/2012 Water	79518-10 2346/GW203 26/09/2012 Water
Date prepared Date analysed	-	28/09/2012 02/10/2012	28/09/2012 02/10/2012	28/09/2012 02/10/2012	28/09/2012 02/10/2012	28/09/2012 02/10/2012
Phosphorus - Total	mg/L	0.1	0.07	0.3	1.2	0.6

Client Reference:

P0902346JC14V01, Riverside

Metals in Water - Dissolved						
Our Reference:	UNITS	79518-1	79518-2	79518-3	79518-4	79518-5
Your Reference		2346/GW5	2346/GW6	2346/GW7	2346/GW8	2346/GW9
Date Sampled		25/09/2012	25/09/2012	25/09/2012	25/09/2012	25/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Calcium - Dissolved	mg/L	0.6	67	3.6	3.1	<0.5
Magnesium - Dissolved	mg/L	1.5	170	3.7	5.0	3.1
Metals in Water - Dissolved						
Our Reference:	UNITS	79518-6	79518-7	79518-8	79518-9	79518-10
Your Reference		2346/GW10	2346/GW11	2346/GW202	2346/GW201	2346/GW203
Date Sampled		25/09/2012	25/09/2012	26/09/2012	26/09/2012	26/09/2012
Type of sample		Water	Water	Water	Water	Water
Date digested	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Date analysed	-	28/09/2012	28/09/2012	28/09/2012	28/09/2012	28/09/2012
Calcium - Dissolved	mg/L	6.2	21	1.7	13	1.1
Magnesium - Dissolved	mg/L	10	87	1.9	42	4.0

Client Reference: P0902346JC14V01, Riverside

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-5oC.
Inorg-019	Suspended Solids - determined gravimetrcially by filtration of the sample, in accordance with APHA 22nd ED, 2540-D.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Metals-020ICP- AES	Determination of various metals by ICP-AES.

Client Reference:

P0902346JC14V01, Riverside

		Clie	nt Referenc	e: P()902346JC14	V01, Riverside		
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Miscellaneous Inorganics						Base II Duplicate II % RPD		
Date prepared	-			27/09/2 012	79518-1	27/09/2012 27/09/2012	LCS-W1	27/09/2012
Date analysed	-			27/09/2 012	79518-1	27/09/2012 27/09/2012	LCS-W1	27/09/2012
рН	pH Units		Inorg-001	[NT]	79518-1	5.8 5.7 RPD:2	LCS-W1	102%
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	4 5	79518-1	180 [N/T]	LCS-W1	93%
Total Suspended Solids @ 103-105 ⁰ C	mg/L	5	Inorg-019	ব্য	79518-1	36 [N/T]	LCS-W1	91%
Chloride, Cl	mg/L	1	Inorg-081	<1	79518-1	44 44 RPD:0	LCS-W1	104%
Sulphate, SO4	mg/L	1	Inorg-081	<1	79518-1	10 10 RPD:0	LCS-W1	107%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	79518-1	230 230 RPD:0	LCS-W1	108%
Total Nitrogen in water	mg/L	0.1	Inorg- 055/062	<0.1	79518-1	1.1 1.1 RPD:0	LCS-W1	106%
QUALITYCONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Metals in Waters - Acid extractable						Base II Duplicate II % RPD		
Date prepared	-			28/09/2 012	79518-1	28/09/2012 28/09/2012	LCS-W1	28/09/2012
Date analysed	-			28/09/2 012	79518-1	02/10/2012 02/10/2012	LCS-W1	28/09/2012
Phosphorus - Total	mg/L	0.05	Metals-020 ICP-AES	<0.05	79518-1	<0.05 <0.05	LCS-W1	100%
QUALITY CONTROL	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results	Spike Sm#	Spike % Recovery
Metals in Water - Dissolved						Base II Duplicate II %RPD		
Date digested	-			28/09/2 012	79518-3	28/09/2012 28/09/2012	LCS-W1	28/09/2012
Date analysed	-			28/09/2 012	79518-3	28/09/2012 28/09/2012	LCS-W1	28/09/2012
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	79518-3	3.6 3.6 RPD:0	LCS-W1	104%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	79518-3	3.7 3.7 RPD:0	LCS-W1	100%
QUALITYCONTROL	UNITS	3 [Dup. Sm#		Duplicate	Spike Sm#	Spike % Reco	overy
Miscellaneous Inorganics				Base + I	Duplicate + %RP	טי 		
Date prepared	-		79518-2	27/09/2	012 27/09/201	2 79518-2	27/09/201	2
Date analysed	-		79518-2	27/09/2	012 27/09/201	2 79518-2	27/09/201	2
Total Dissolved Solids (grav)	mg/L		79518-2	4900	4900 RPD:0	[NR]	[NR]	
Total Suspended Solids @ 103-105 ⁰ C	e mg/L		79518-2	48	51 RPD:6	[NR]	[NR]	
Chloride, Cl	mg/L	.	79518-2	2	900 [N/T]	79518-2	#	
Sulphate, SO4	mg/L		79518-2		360 [N/T]	79518-2	#	
Total Nitrogen in water	mg/L		79518-2		1.2 [N/T]	79518-2	121%	
		1			11.11.11		,3	

		Client Referenc	e: P0902346JC14V01	, Riverside	
QUALITYCONTROL Metals in Waters - Acid extractable	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared Date analysed	-	[NT] [NT]	[NT] [NT]	79518-2 79518-2	28/09/2012 28/09/2012
Phosphorus - Total	mg/L	[NT]	[NT]	79518-2	104%
QUALITYCONTROL Metals in Water - Dissolved	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date digested	-	[NT]	[NT]	79518-4	28/09/2012
Date analysed	-	[NT]	[NT]	79518-4	28/09/2012
Calcium - Dissolved	mg/L	[NT]	[NT]	79518-4	95%
Magnesium - Dissolved	mg/L	[NT]	[NT]	79518-4	85%

Report Comments:

Chloride\Sulphate:# Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Samples 8, 9 and 10: TDS reported are derived by calculation of Conductivity. Due to large amount of colloids in sample TDS results by gravimetric analysis is overexagerrated

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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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.

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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.



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		. :	· . · ·			Addition	al Testing		_				
Name		P0902346	– Riverside										·
Martens Contact Office	great to as Cast of as	Grant Har	low					Conte	act Email	e ja se	gharlow@ma	rtens.com	1.au
		Sample D	cte	25/9/12	+ 26/9/12	Dispa	ch Date	27/9/	12		Turnaround T	mē	standard
					46JC14V01			Shipr	ing Meth	od (X)	Hand	Post	Courler
Sampling and Shipping)	Our Refer	<u> </u>									<u>l</u>	<u> </u>
	· · · ·	On Ice (X) na Braideach Anns Braideach	X	No Ice (X)	х. <u>.</u>	Other (X						
						Labo	ratory						
Name		EnviroLa	0										
	n i i i Iaite nati		y Street, Ct										
Sample Delivery Addr	755							Errer			Email		· · · · · · · · · · · · · · · · · · ·
Delivery Contact		Name	Aileen		Phone	9910 6	200	Fax					
									Ĭ		rtens.com.au		
Please Send Report By	(X)	Post		fax	Email	X	Reporting	mail Addr	ess plea	ise cc <u>d</u>	martens@marte	ens.com.a d mkovelis	<u>u</u> and <u>@martens.com.au</u>
	1571								Dros	e <u>@mone</u>	ens.com.du		
Sample ID	рH	TDS	TSS	Chloride	Sulphate	Magnesium	Calcium	EC	TN	TP			
	X	x	x	×	×	x	x	x	x	×			
2346/GW5/25.09.12 2346/GW6/25.09.12		+ <u>^</u>	x	x	x	x	x	x	x	x			
2346/GW7/26.09.12	<u>x</u>	x	x	x	x	x	x	x	x	X		ENVIROLPE	Envirolab Service 12 Asking S
2346/GW8/25.09.12	X	x		x	x	X	x	x	x	x			Chotswood NSW 200 Ph: (02) 9910 820
2346/GW9/25.09.12	×	x	x	x	X	X	x	x	x	X		Job No:	79518
2346/GW10/25.09.12	x	x	x	x	x	x	×	x	<u>x</u>	X			
2346/GW11/25.09.12	X	x	x	×	x	X	x	x	X	×	_	Date Rece	alved: 27/9/12 alved: 14:30
2346/GW202/26.09.12	x	×	X	X	X	x	x	X	<u>×</u>	<u> </u>		Received	by: A→t√
2346/GW201/26.09.12	х	×	X	x	x	X	X	x	<u>×</u>	× ×	<u> </u>	Temp:	Amblent
2010/011201/2011									x				

Head Office Unit 6 / 37 Leighton Place Hornsby NSW 2077, Australia Ph 02 9476 9999 Fax 02 9476 8767



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13 Attachment F – CSIRO – BTF 18-2011

Foundation Maintenance and Footing Performance: A Homeowner's Guid



Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTF 18-2011 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a boglike suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

	GENERAL DEFINITIONS OF SITE CLASSES									
Class	Foundation									
A	Most sand and rock sites with little or no ground movement from moisture changes									
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes									
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes									
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes									
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes									
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes									

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.

3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/ below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

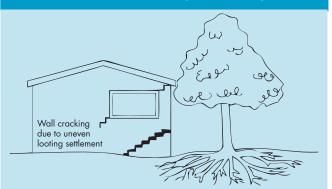
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the

Trees can cause shrinkage and damage



external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred. The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

• Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS								
Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category						
Hairline cracks	<0.1 mm	0						
Fine cracks which do not need repair	<1 mm	1						
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2						
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3						
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4						

Gardens for a reactive site Shrubs Clump of trees; height selected for distance from house lawn Drained pathway Carport Path Garden bed \$ 0 \$ covered with **;;;**} Driveway mulch Medium height tree

extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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14 Attachment G – Pavement Thickness Design Summary (Coffey, 2008)



Geotechnical Assessment: Riverside Estate, Tea Gardens, NSW P1404136JR03V01 – September 2015 Page 170



13 Mangrove Road, Sandgate, NSW, 2304 Ph: (02) 4967 6377 Fax (02) 4967 5402

pavement thickness design summary client : TATTERSALL SURVEYORS PTY LTD job no : GEOTSGTE20248AA principal : CRIGHTON PROPERTIES PTY LTD NEWCASTLE laboratory : project : PROPOSED SUBDIVISION report date : May 09, 2007 location : RIVERSIDE ESTATE, PROJECT APPLICATION, TEA GARDENS test report no .: MAY09-03/1 council : GREAT LAKES COUNCIL designed by : RJP checked by : Form Number L2.10R1 Version 6.0 road name or type : LOCAL ACCESS LOCAL ACCESS COLLECTOR COLLECTOR chainage interval : (m) Clay Subgrade Sand Subgrade Clay Subgrade Sand Subgrade design traffic loading: (ESA 5 x 10⁵ 5 x 10⁵ 1 x 10[°] 1 x 10⁶ wearing course thickness : (mm)40 40 40 40 150 150 150* 150* (mm) basecourse thickness: 150 150* 150' sub-base thickness: 150 (mm) 500 -500 select thickness: (mm)340 340 840 840 total thickness : (mm) CBR used for design : (%) 2 10 2 10 design traffic loading : Design traffic loading is the number of equivalent standard axles (E.S.A.) in the design lane during the design period. For definitions, refer Appendix 1.1 "Pavement Design" AUSTROADS. Refer covering letter/report. Material Quality wearing course : RTA QA Specification R116 Conforming to ARRB Special Report No 41, * RTA QA Specification 3051 basecourse : Conforming to ARRB Special Report No 41, * RTA QA Specification 3051 sub-base: select : Well graded granular material, maximum particle size 100mm, minimum CBR 15%. Recommended material types may vary from those of job specification or statutory authority. Refer covering letter/report. Note : **Compaction Requirements** wearing course : RTA QA Specification R116 **Modified:** Minimum required dry density ratio, AS1289 5.4.1-1993, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent, and the maximum dry density obtained using AS1289 5.2.1-2003 or equivalent. 98% MODIFIED basecourse : equivalent. Standard: As above, but maximum dry density obtained using AS1289 5.1.1-2003 or sub-base : 95% MODIFIED using equivalent. **Density Index:** Minimum required Density Index AS1289 5.6.1-1998, calculated using field dry density determined by AS1289 5.3.1-2004 or equivalent, and laboratory values of maximum and minimum density obtained by AS1289 5.5.1-1998 or equivalent. select : 80% DI, 100% STD subgrade : 80% DI, 100% STD fill below : 70% DI, 95% STD Recommendations for compaction may vary from those of job specification or statutory authority. Refer covering letter/report Note: Drainage: The design assumes the provision of adequate surface and subsurface drainage of the pavement and adjacent areas. Refer covering letter/report.

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15 Attachment H – Notes Relating to this Report



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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.

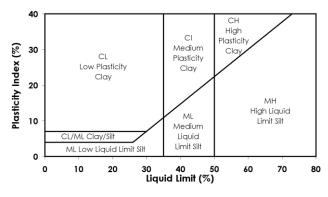
Particle Size

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	Cu (kPa)	Apprx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort. Sample extrudes between fingers when squeezed in fist.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth. Easily moulded in fingers.
Firm	25 - 50	4 - 8	The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong pressure in the figures.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail. Brittle. Tends to break into fragments.
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 (q _c 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:
	Presence just detectable by feel or eye, but soil properties	Coarse grained soils: < 5 %
Trace of	little or no different to general properties of primary component.	Fine grained soils: < 15 %
With some	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 %

Soil Data Explanation of Terms (2 of 3)

Soil Agricultural Classification Scheme

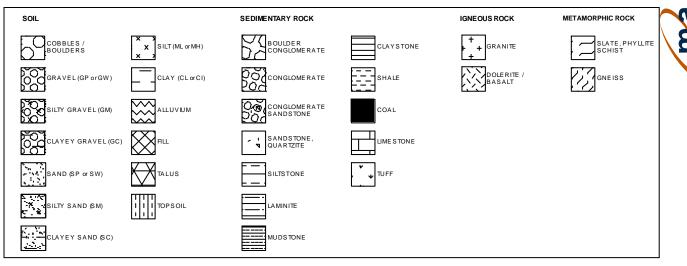
In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions 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
SCI-	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

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Soil Data Explanation of Terms (3 of 3)

Symbols for Soil and Rock



Unified Soil Classification Scheme (USCS)

	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)						Primary Name
0.075		action is	AN VELS or no ss)	Wide range in grain si	ize and substantial amounts of all intermediate particle sizes.	GW	Gravel
ger than		GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Predominantly one	e size or a range of sizes with more intermediate sizes missing	GP	Gravel
DILS mm is lar	e)	GRA an half of larger tha	GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fin	es (for identification procedures see ML below)	GM	Silty Gravel
COARSE GRAINED SOILS material less than 63 mm mm	aked 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 n	iction is	AN IDS or no ss)	Wide range in grai	n sizes and substantial amounts of intermediate sizes missing.	SW	Sand
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	le visible	SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Predominantly one	Predominantly one size or a range of sizes with some intermediate sizes missing		Sand
han 50 %	est partic	SANDS an half of coa smaller than 2.	s WITH ES ciable unt of ss)	Non-plastic fin	es (for identification procedures see ML below)	SM	Silty Sand
More t	ie smalle	More th	SANDS WITH FINES (Appreciable amount of fines)	Plastic fines (for identification procedures see CL below)		SC	Clayey Sand
	ot th			IDENTIFICATIO	ON PROCEDURES ON FRACTIONS < 0.2 MM	•	
FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	DRY STRENG (Crushing Characteristi	DILATANC	Y TOUGHNESS	DESCRIPTION	USCS	Primary Name
ILS s than 6 mm		None to Lo	w Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
IED SOI arial les: 0.075 r		Medium t High	o None	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL	Clay
FINE GRAINED SOILS 50 % of material less thc smaller than 0.075 mm		Low to Medium	Slow to Ve Slow	ry Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
FINF an 50 % smal		Low to Medium	Slow to Ve Slow	ry Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	мн	Silt
ore th		High	None	High	Inorganic clays of high plasticity, fat clays	СН	Clay
		Medium t High	o None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANI SOILS		Rec	adily identified by	colour, odour, spon	gy feel and frequently by fibrous texture	Pt	Peat
Low Plastic	$Low Plasticity - Liquid Limit W_L < 35\% Medium Plasticity - Liquid limit W_L 35 to 60\% High Plasticity - Liquid limit W_L > 60\%$						

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Rock Data Explanation of Terms (1 of 2)



Definitions

Descriptive terms used for 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.			
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	ck substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be noulded and can be classified according to the Unified Classification System, but the texture of the original ck is still evident.			
Highly weathered	НW	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 low	≤0.03	<0.03 Easily remoulded by hand to a material with soil properties.	
Very low	>0.03 ≤0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	
Low	>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.		L
Medium	>0.3 ≤1.0	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	
High	>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.	
Very high	>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.	
Extremely high	>10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	

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.

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.

Rock Core Recovery

TCR = Total Core Recovery

SCR = Solid Core Recovery

 $= \frac{\sum \text{Length of cylindrical core recovered}}{\times 100\%}$

Lengthofcorerun

RQD = Rock Quality Designation

 $=\frac{\sum \text{Axiallengths of core} > 100 \text{ mm long}}{\times 100\%}$

Lengthofcorerun

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= Length of core recovered $\times 100\%$ Lengthofcorerun

Rock Strength Tests

- Point load strength Index (Is50) axial test (MPa)
- Point load strength Index (Is50) diametrall test (MPa)
- Unconfined compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)		Coating	Coating or Filling		ess
BP	Bedding plane parting	Cn	Clean	Ро	Polished
х	Foliation	Sn	Stain	Ro	Rough
L	Cleavage	Ct	Coating	SI	Slickensided
TL	Joint	Fe	Iron Oxide	Sm	Smooth
F	Fracture			Vr	Very rough
SZ	Sheared zone (Fault)	Planarity		Inclination	
CS	Crushed seam	Cu	Curved	The inclination of defects are measured from	
DS	Decomposed seam	lr	Irregular	perpend	dicular to the core axis.
IS	Infilled seam	PI	Planar		
V	Vein	St	Stepped		
		Un	Undulating		

Test Methods Explanation of Terms (1 of 2)

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. consulting en

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<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_{υ}

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.