La Vie Developments Pty Ltd

Geotechnical Investigation:
Lot 22 DP 607750 and Lot 4 DP 258024, Corner Avondale Road and Huntley Road, Huntley, NSW

P0802279JR03_v3
May 2009

Limitations Statement

The sole purpose of this report and the associated services performed by Martens & Associates Pty Ltd is to provide a geotechnical investigation in accordance with the scope of services set out in the contract / quotation between Martens & Associates Pty Ltd and La Vie Developments Pty Ltd (hereafter known as the Client). That scope of works and services were defined by the requests of the Client and by the time and budgetary constraints imposed by the Client.

Martens & Associates Pty Ltd derived the data in this report primarily from a number of sources including site inspections, correspondence regarding the proposal, examination of records in the public domain, interviews with individuals with information about the site or the project, and field explorations conducted on the dates indicated. The passage of time, manifestation of latent conditions or impacts of future events may require further examination / exploration of the site and subsequent data analyses, together with a re-evaluation of the findings, observations and conclusions expressed in this report.

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Overview

1.1 Background

The purpose of this report is to provide a preliminary geotechnical investigation to support a development application (DA) for a proposed private hospital and health care campus at Lot 22 DP 607750 and Lot 4 DP 258024, corner Avondale Road and Huntley Road, Huntley, NSW. The assessment determines geotechnical parameters for structural design and geotechnical risk management for the proposed development based on observed site, soil and environmental conditions. The assessment also involves a review of groundwater conditions at the site.

1.2 Proposed Development

We understand that the proposed 'Illawarra International Health Precinct' is to involve staged development over the next 10 – 12 years matching growth in the adjacent West Dapto release area. Development stages are outlined below whilst a full description of each development stage is provided in Attachment G. Refer to Attachment A (sheets 1 and 2) for plans of the proposed development.

Table 1: Proposed development stages.

Stage	Proposed Development
1	Illawarra International Specialist and Surgicentre
2	24hr Radiology and 24hr Pathology
3	Illawarra International Hospital Casualty/Medical Centre
4	Illawarra International Hospital Obstetric Unit (stand alone)
5a	Illawarra International Hospital 352 Bed Tertiary Referral
5b	Shops
5c	Commercial Laundry, Dry Cleaner and Car Washing Facility
6	Nurses, Medical Students Resident Medical Officers Registrar Accommodation
7	Huntley Further Education Facility
8a	Illawarra International Aged and Disability Centre
8b	Seniors Independent Living

With respect to bulk earthworks for the proposed development, proposed rock excavation in accordance with the Cardno Forbes Rigby rock excavation plan (Attachment A – sheet 6) is to maximum depths of approximately 10.7 m below the existing rock level. When assessed in light of soil cover (Attachment A – sheet 4) the total maximum excavation depth is approximately 11.5 m below ground level. In accordance with the Cardno Forbes soil cut and fill plan (Attachment A – sheet 5), filling is proposed to a maximum depth of 6.1 m.

1.3 Scope of Work

Site investigations were undertaken in accordance with the agreed scope of works as follows:

- Drilling of 15 boreholes via a 4wd mounted hydraulic auger to refusal on bedrock.
- Completion of Dynamic Cone Penetrometer (DCP) penetration testing at 5 locations to allow for preliminary characterisation of underlying soil strata strength and bedrock depth.
- Risk assessment of the proposed works in accordance with the Australian Geomechanics Society (March 2007), *Landslide Risk Management* and Wollongong City Council's Geotechnical Development Control Plan (2006).

1.4 Relevant Guidelines/Standards

The assessment has been prepared in accordance with the following guidelines/standards:

- Australian Geomechanics Society (March 2007), *Landslide Risk Management*.
- Australian Standard 1796 (1993).
- Australian Standard 2870 (1996).

2 Site Description

2.1 Field Investigations

A site inspection was undertaken in accordance with the agreed scope of works on the 3rd December 2008. DCP and borehole locations can be found on the site plan in Attachment A. Borehole logs are provided in Attachment B.

2.2 Location and Existing Land-use

The subject site (Lot 22 DP 607750 and Lot 4 DP 258024) is located at the corner of Avondale Road and Huntley Road, Huntley, NSW and is within the Wollongong City Council Local Government Area. It is bordered by Huntley Road to the south, Avondale Road to the west and north, and Goolagong Street to the east.

The site is currently pasture and has an area of approximately 10.5 ha. Refer to Attachment A for a site plan. Surrounding land use is generally medium density residential to the east and rural pastures west of the site.

2.3 Topography and Drainage

Site topography is characterised by a knoll (RL 49 m) near the middle of the site with grades of up to approximately 15% to the east and west and shallower grades on the northern and southern hillsides. Elevation ranges between RL 49 m and RL 27 m. No surface drainage lines were observed on the site, nor were there any indications of springs or seepage at the time of inspection. Runoff drains from the centre of the site towards the boundaries as sheet flow, following natural contours.

An unnamed drainage line is situated approximately 50 m north west of the site which has its confluence with Mullet Creek approximately 400 m north of the site. Mullet Creek generally flows in a north easterly direction before its confluence with Dapto Creek which later confluences with Forest Creek, Robins Creek and Reed Creek before discharging into Lake Illawarra approximately 5 km north-east of the site.

2.4 Geology and Soil Profile

The Kiama 1:100,000 Soil Landscape Sheet (Hazelton, 1992) identifies the site as having soils of the Shellharbour soil landscape group. The Shellharbour soil landscape group consists of deep Prairie soils on crests and upper slopes, Brown krasnozems on midslopes, and Red podzolic soils and Prairie soils on lower slopes and drainage plains.

Geological mapping (Wollongong 1:250,000, NSW Dept. Mines, 1966) indicates that the site is near the boundary of two geological groups. The first geological group is comprised of Quaternary aged alluvium, gravel, swamp deposits and sand dunes. The second geological group is comprised of undifferentiated Permian aged siltstone, shale and sandstone from the Berry Formation.

On-site sub-surface investigations confirmed that the site was underlain by the Berry Formation geological group and indicated that the site is predominantly covered by silt topsoils underlain by clay with siltstone and shale bedrock. Soil depth was found to range between 0.15 m and 2.2 m.

3 Groundwater Assessment

3.1 Site Observations

Site sub-surface investigations to a maximum depth of 3.0 mBGL (into bedrock) did not encounter groundwater. Two monitoring piezometers were installed to a maximum depth of 2 mBGL (25.6 mAHD) to determine the presence of shallow groundwater. Groundwater was not observed in either of the piezometers.

3.2 Public Record Bore Construction Logs

Review of local groundwater conditions based on public record bore construction logs as available in public domain records (NSW Government Natural Resource Atlas – www.nratlas.nsw.gov.au) indicates that four licensed bores with available data exist within approximately 0.6 km of the site (Figure 1). These bores have standing water levels between 9.8 and 13.6 mAHD (Table 2). This is well below the site levels and below any expected excavation depths.

3.3 Ground Water Level

Based on site topography, borehole/piezometer observations and review public domain records (NSW Government Natural Resource Atlas – www.nratlas.nsw.gov.au), we estimate the permanent groundwater table could exist within the bedrock at a level of approximately 14 to 16 mAHD. Ephemeral groundwater is likely to collect at the soil / rock interface after periods of substantial or prolonged rainfall. However, due to the limited catchment area at any point on the site, the extent of ephemeral or any permanent groundwater is likely to be minor.

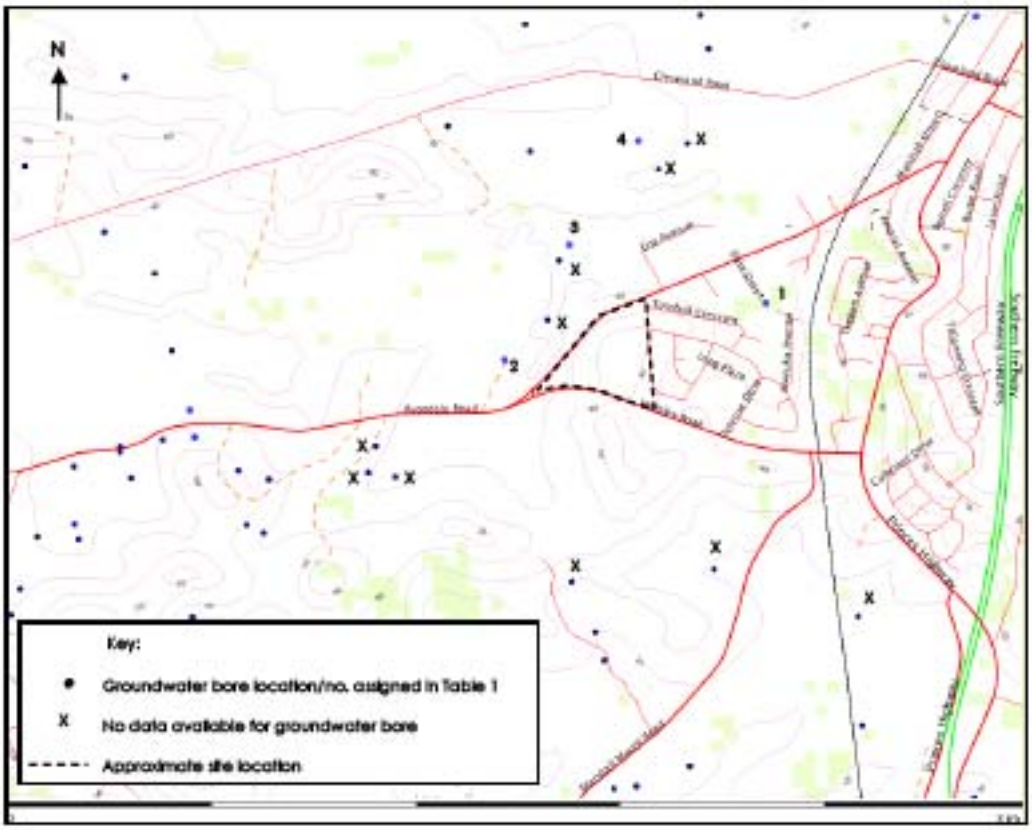


Figure 1: Summary of local bores included in data analysis.

Table 2: Summary of local bore data within an approximate 1.7 km radius of the site.

Groundwater Bore No. on Figure 1	Groundwater Number	Yield (L/S)	Salinity (mg/L)	Location (easting, northing)	Distance from subject site (km)	Bore depth (m)	Bore surface level (mAHD)	Standing water level/Water bearing zone (mBGL)	Standing water level/Water bearing zone (mAHD)
1	GW033541	NA	NA	296185, 6178953	0.45	6.10	19.0	5.40	13.6
2	GW062030	NA	NA	295247, 6178686	0.2	6.10	23.0	NA	NA
3	GW037283	Variable (>0.32)	NA	295469, 6179191	0.3	32.90	19.5	9.70	9.8
4	GW011918	0	NA	295710, 6179652	0.6	17.30	21.5	NA	NA

3.4 Likelihood of Permanent Groundwater Contact

Based on the likely groundwater level of approximately 14 – 16 mAHD (Section 3) and the lowest level of excavations (approximately 27.5 mAHD), it is unlikely that excavation works will come into contact with permanent groundwater.

3.5 Groundwater Impacts

Considering that a permanent groundwater table is unlikely to be contacted during excavation works, impacts associated with Groundwater Dependent Ecosystems (GDE's), changes to groundwater levels and flow directions are therefore not likely to occur as a result of the proposed development.

4 Geotechnical Assessment

4.1 Geotechnical Risk Management Guidelines

The geotechnical risk assessment for the proposed development (construction of a new dwelling, garage and driveway) has been conducted in accordance with the principles outlined in AGS (2007) The assessment employs the qualitative risk assessment matrices in Appendix C of the AGS (2007) guidelines to determine the level of risk to life and property posed by the proposed development.

The objectives of the AGS (2007) guidelines relevant to the proposed development include assurances of the following:

- That geotechnical and related structural matters are adequately investigated and documented by applicants or proponents of activities prior to the lodgement of any development application;
- Establishment of whether or not the proposed development activity is appropriate to be carried out, and the conditions that should be applied if it is to be carried out, having regard to the results of the geotechnical and related structural investigations;
- That, in the event that a proposed development activity is only appropriate to be carried out subject to geotechnical and related structural engineering conditions, those conditions are able to be met and are identified by the applicants prior to the lodgement of the development application including all appropriate constraints and remedial maintenance actions required prior to, during and after the carrying out of the development;
- To ensure that effective controls exist to guarantee that a development is carried out in accordance with the policy; and
- That developments are only carried out if geotechnical and related structural engineering risks, and, where appropriate, coastal process risks, are identified and can be effectively addressed and managed for the life of the development.

4.2 Slope Stability Risk Assessment

Risk assessment for the site is made in accordance with AGS (2007) (Table 3). Instability risk has been determined for post-development conditions with assessment made based on the condition that the

geotechnical recommendations of this report have been implemented.

Table 3: Summary of slope instability risk assessment following proposed development, based on AGS (2007).

Risk	Description	Treatment Measure(s)	Likelihood[1]	Risk to Life[1]		Risk to Property[1]	
				Established Probability	Risk	Consequence	Risk
A	Soil creep	Maintain vegetation where possible. Ensure appropriate foundations and footings design.	Likely	1.00×10^{-7}	Acceptable	Insignificant	Low
B	Deep seated slide	Good hillslope engineering practice. Maintain or enhance vegetation where possible. Appropriate fill and cut batters.	Rare	5.00×10^{-7}	Acceptable	Minor	Very Low
C	Shallow rotational slide	Adequate shoring and retention structures for all excavations. Good site drainage. Appropriate fill and cut batters.	Rare	5.00×10^{-7}	Acceptable	Minor	Very Low

NOTES: [1] Based on 'treated' site conditions as per recommendations of this report.

The proposed development is considered to constitute an acceptable risk to life and a low to very low risk to property provided that our recommendations made in this report are adhered to. Refer to Attachment D for landslide hazard evaluation calculations and assumptions.

4.3 Preliminary Soil and Rock Strength

Preliminary soil and rock strength properties for the site have been estimated using *in-situ* DCP testing and borehole investigations. Results are summarised in Table 3 and DCP/borehole locations are shown on the site plan (Attachment A). It is noted that the soil parameters

outlined within Table 3 are indicative only and subject to further investigation at the detailed design stage.

Table 4: Preliminary typical estimates of soil strength properties.

Indicative Depth[1] (m)	Soil Description	d_d[2] (kN/m³)	C_u[3] (kPa)	ϕ[4]	ABC[5] (kPa)	ASF[6] (kPa)
0.0-0.3	Silt (MH), brown, dry, stiff.	16	35	-	70	35
0.70-1.00	Clay (CL), brown to grey/orange, dry, stiff.	17	75	-	120	35
1.00-1.20	Extremely Weathered Siltstone – light brown to yellow.	18	185	-	150	40
>1.20	Moderately Weathered Siltstone – light brown to yellow.	19	125	-	250	50

Notes: [1] Profile depth varies and depth of layers varies (see borelogs). [2] Dry Unit Weight. [3] Undrained shear strength. [4] Internal Angle of Friction. [5] Allowable Bearing Capacity. [6] Allowable Skin Friction.

Strength testing of bedrock was not undertaken. However, based on DCP "n" counts and review of available literature, we consider that the strength of siltstone/shale bedrock beneath the site would generally increase with depth from extremely – highly weathered shale to moderately weathered shale, or from Class IV/V to Class III shale (Bertuzzi & Pels *et al*, 2002). Rock coring would be required to provide further details on rock strength properties and confirm the nominated allowable bearing pressures in Table 4.

4.4 Preliminary Site Classification

Based on the depth of clay at the site, the site's soil is classified in accordance with AS 2870 (1996) for each borehole (Table 5). This analysis indicates that the majority of the site is classed as M. Areas of the site with shallow soil (boreholes 3, 7, 8, 13 and 14) are classed as S. Further testing at detailed design stage will be required.

Table 5: Site soil classification in accordance with AS 2870 (1996) per borehole based on depth of clay.

Borehole No.	AS 2870 (1996) Soil Classification
1	M
2	M
3	S
4	M
5	M
6	M
7	S
8	S
9	M
10	M
11	M
12	M
13	S
14	S
15	M

4.5 Geotechnical Laboratory Testing

Four soil samples were tested for linear shrinkage, Atterberg Limits and Emerson Aggregate Type. Emerson Aggregate classes were variable and indicative of variable soil dispersability. Linear shrinkage results ranged from 11.5 to 22.5 % and are assigned an expansive rating of non-critical and very critical respectively (Hazelton and Murphy, 2007). Plasticity index ranged from 20 to 69% and is classed as ranging from a medium to high rating (Hazelton and Murphy, 2007). Liquid limit ranged from 43 to 101% and is classed as ranging from a low to very high rating (Hazelton and Murphy, 2007). Refer to Attachment F for the laboratory report and Table 6 for a summary of laboratory results.

Table 6: Summary of laboratory results.

	Analysis			
		Atterberg Limits		
Sample I.D	Linear Shrinkage (%)	Plasticity Index (%)	Liquid Limit (%)	Emerson Aggregate classes
5/0.5	22.5	69	101	4
5/1.0	22.0	61	91	2(s)
15/0.5	12.5	22	46	2(m)
15/1.0	11.5	20	43	1

4.6 Preliminary Geotechnical Model

A preliminary geotechnical model has been developed for the site. The model shows the depth to extremely weathered rock from ground level and is based on interpolation between boreholes and DCP tests. The geotechnical model indicates that the soil profile at the site is shallow with moderate soil depth occurring in isolated portions of the site (south western and south eastern corners) (refer to Attachment A – sheet 2).

4.7 Recommendations

Geotechnical recommendations for the development site are provided below in Table 7.

Table 7: Geotechnical recommendations.

Recommendation	Description
Further Testing	We recommend that further soil penetration testing is completed at the detailed design stage. We also recommend that rock coring is completed to a level below the deepest excavation level and that rock strength testing is completed at detailed design stage. This will also allow groundwater levels to be confirmed (if the water table is contacted during drilling/coring).
Footings	All footings, particularly those in soil materials, should be excavated, inspected and poured with minimal delay. All footings should be free from all loose or softened materials prior to pouring. If water ponds in the base of the footings, they should be pumped dry and then re-excavated to remove all loose and softened materials. If a delay in pouring is anticipated, we recommend that a blinding layer of at least 50 mm concrete be placed to protect the base of the footing excavation.
Sediment and Erosion Control	Appropriate design and construction methods shall be required during site works to minimise erosion and provide sediment control. In particular, any stockpiled soil will require erosion control measures.
Soil Excavation	Any excavations resulting in a permanent batter slope exceeding 0.75 m in height should be supported by suitably designed and installed retaining or shoring structures. Alternatively, soil overburden may be excavated without structural supports but with a batter slope of 1 (vertical): 2 (horizontal).
Fill Placement	All fill exceeding 0.75 m in height should be supported by suitably designed and installed retaining or shoring structures or designed with a maximum batter slope of 1 (vertical): 2 (horizontal). Engineered fill is to be free from organic materials, other contaminants and deleterious substances and have a maximum particle size not exceeding 40 mm. Engineered fill should be placed in layers of a maximum of 150-200 mm loose thickness and compacted (as specified herein). For sandy materials, a minimum ID of 75 % should be achieved, which can be reduced to 70 % in landscaped areas. For clayey soils (eg. including weathered sandstone), engineered fill should be compacted to at least 98 % SMDD, which can be reduced to 95 % SMDD in landscaped areas.
Rock Excavation	Based on the Cardno Forbes Rigby rock excavation plan (Attachment A – sheet 5), maximum rock excavation is approximately 10.7 m below the existing rock level and is required for the Illawarra International Hospital located in the south west of the site. Excavations into fresh bedrock (if necessary) may be made near vertical (8V:1H). We expect based on local geology that rock strength will increase with depth.

	For excavation into the first say 1 m of rock, it is considered that this material is likely to be rippable. Excavation below this level is likely to require the attachment of a rock hammer. Further testing will be required to confirm these estimates.
Retaining Structures	Any retaining structures to be constructed as part of site works are to be backfilled with suitable free-draining materials and include suitable drainage measures, such as a geotextile enclosed 100 mm agricultural pipe, to redirect water that may collect behind the retaining walls.
Vibrations	Vibrations created during excavation works are to be minimised to reduce potential impacts on the neighbouring properties. Recommended maximum levels of ground vibration (as per AS 2187.2, 1993, Appendix J) are 10 mm/s PPV (peak particle velocity) at the site boundary or at closer retained site structures.
Groundwater	Given that permanent groundwater is estimated to exist within the siltstone rock at a level of approximately 14-16 mAHD and maximum excavation is to approximately 28 mAHD, it is unlikely that excavation works will come into contact with groundwater. Ephemeral groundwater flows may be encountered and should be dealt with as prescribed in the stormwater section of this table. If permanent groundwater is encountered then site works are to cease immediately and a geotechnical engineer is to inspect/document groundwater conditions and determine the need for further management.
Stormwater	A potential exists for stormwater flows to enter excavation areas during site works. All surface runoff should be diverted away from excavation areas where possible. Stormwater is unlikely to be contaminated and therefore any water required to be pumped out of excavation areas may be discharged through a coarse filter cloth fence then allowed to flow across and off the site.

4.8 Monitoring Program

To ensure site stability, prevent any adverse geotechnical impacts and reduce the risk of sediment transport off-site due to erosion during site works, we recommend the following be monitored regularly (daily or otherwise):

- Seepage rates from any excavated soil/ rock interface;
- Sedimentation downslope of excavated areas during and after rainfall events; and
- All sediment erosion control structures – for functioning condition and removal of built-up spoil.

4.9 Contingency Plan

In the event that the proposed development works cause an adverse impact on overall site stability or on neighbouring properties, 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.

4.10 Inspection Schedule

We suggest the following minimum inspections in relation to Stage 1 be undertaken (where relevant) by a qualified geotechnical engineer:

- At 4 m rock excavation depth increments (where required) and at completion of bulk earthworks for each building to determine if nominated allowable bearing pressures are present.
- Footings and foundations prior to placement of concrete.
- At completion of fill compaction (where relevant) for each building footprint.

4.11 Suggested Works Prior to Issue of Construction Certificate

Further geotechnical testing is suggested at detailed design stage prior to final detailed structural design.

All designs of proposed foundations, supports, retaining walls, and drainage measures should be referred to a suitably qualified geotechnical engineer for review and certification that proposed structures have been designed in accordance with the recommendations given in this report or any subsequent geotechnical report.

4.12 Investigation Limitations

Occasionally sub-surface soil conditions during proposed works may be found to be different from those detailed in this report due to investigation limitations. This can also occur with groundwater conditions, especially following different weather conditions. 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 assessed by Martens & Associates to determine geotechnical implications before recommencement.

5 References

Australian Geomechanics Society, Sub-Committee on Landslide Risk Management (March 2007) *Practice note guidelines for landslide risk management.*, Australian Geomechanics 42 (1), March 2007.

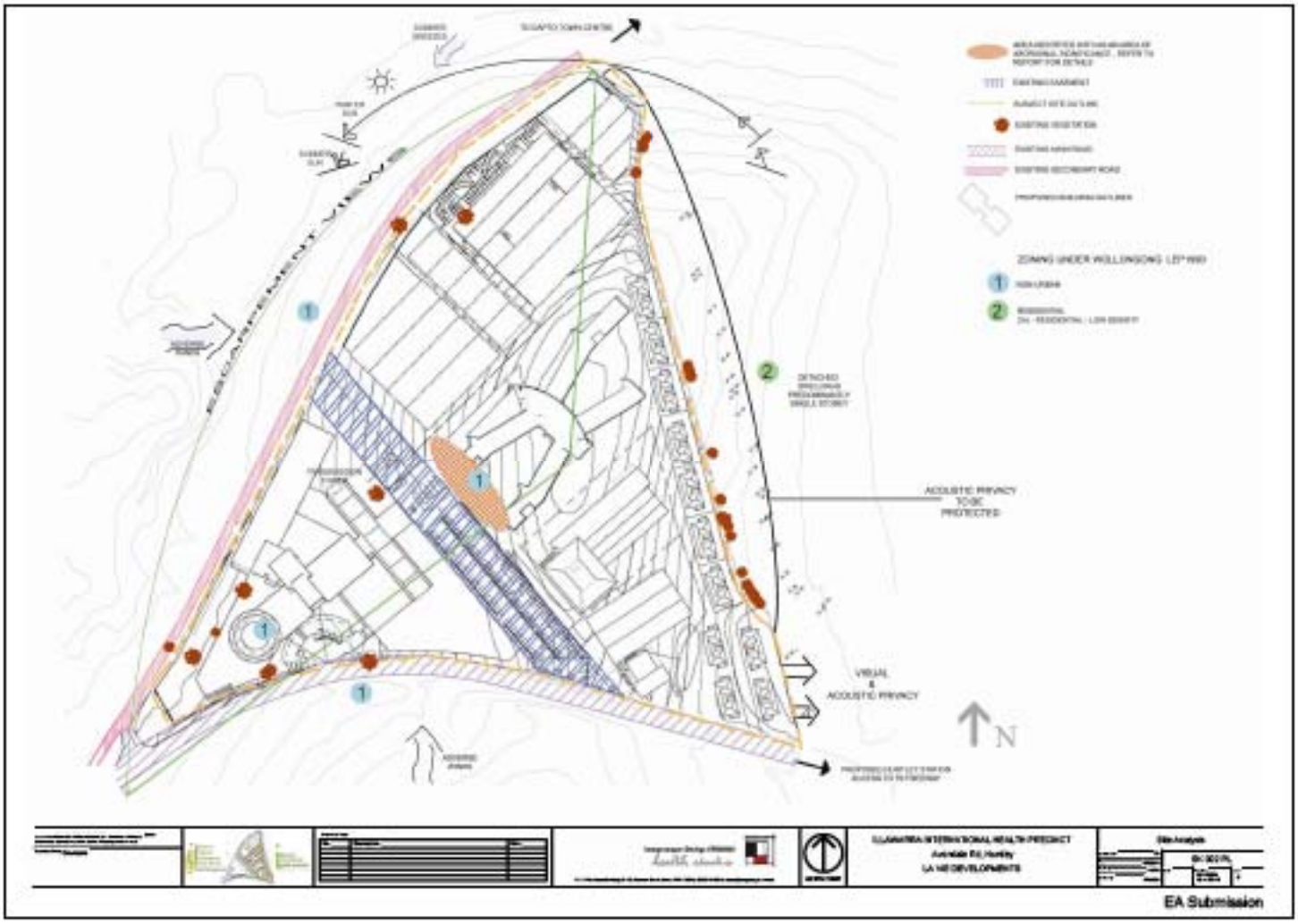
Australian Standard 1289.6.3.2 (1997) *Determination of the Penetration Resistance of a Soil using the 9 kg Dynamic Cone Penetrometer*

Australian Standard 2187.2 (1993) *Explosives – Storage, transport and use – Use of explosives.*

Australian Standard 2870 (1996) *Residential Slabs and Footings*

Geological Survey of NSW (1966) Wollongong 1:250,000 Geological Series Sheet SI 56-9.

6 Attachment A – Site Plans, Bulk Earthworks Plans & Geotechnical Model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VISUAL & ACOUSTIC PRIVACY
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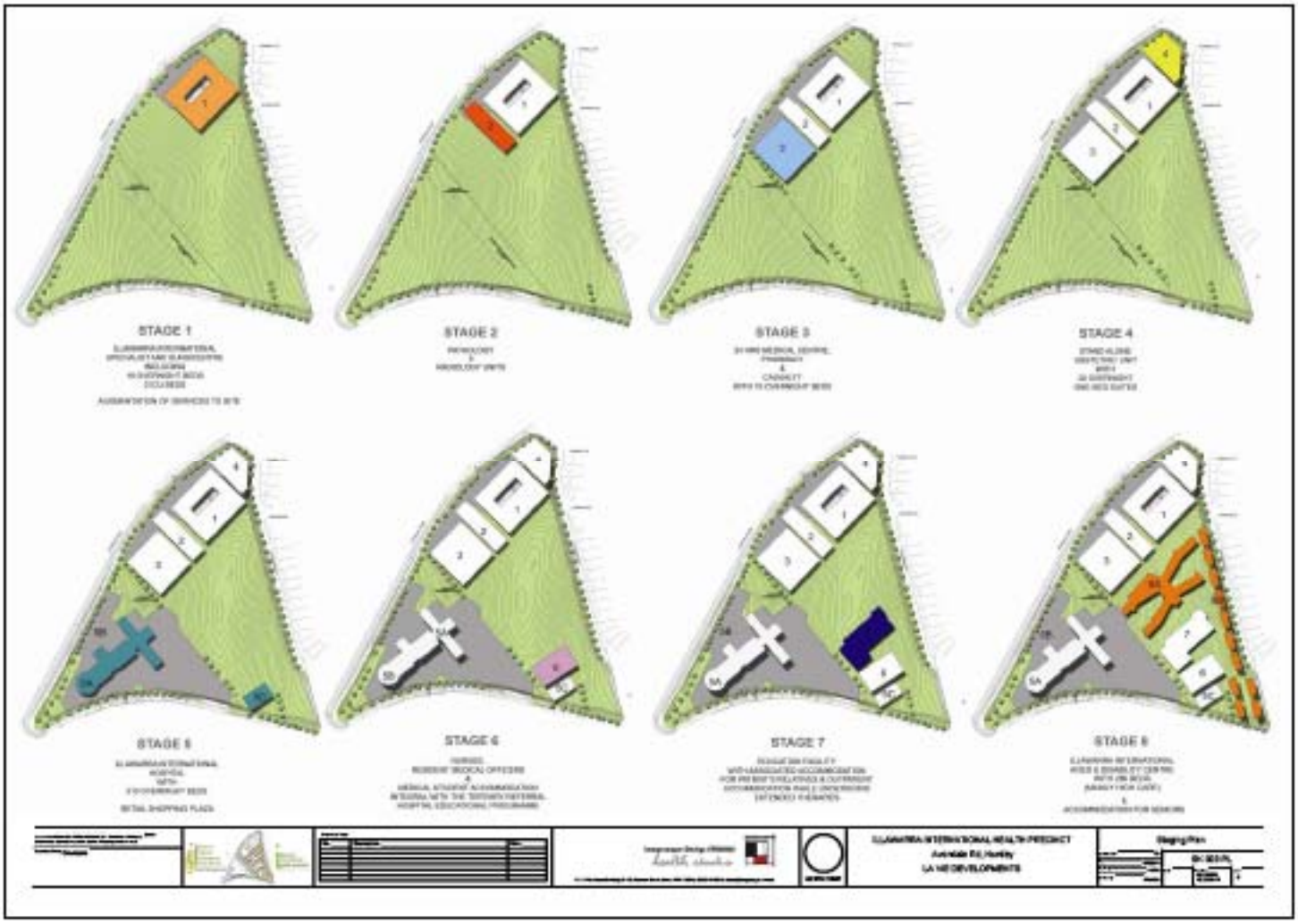
EA Submission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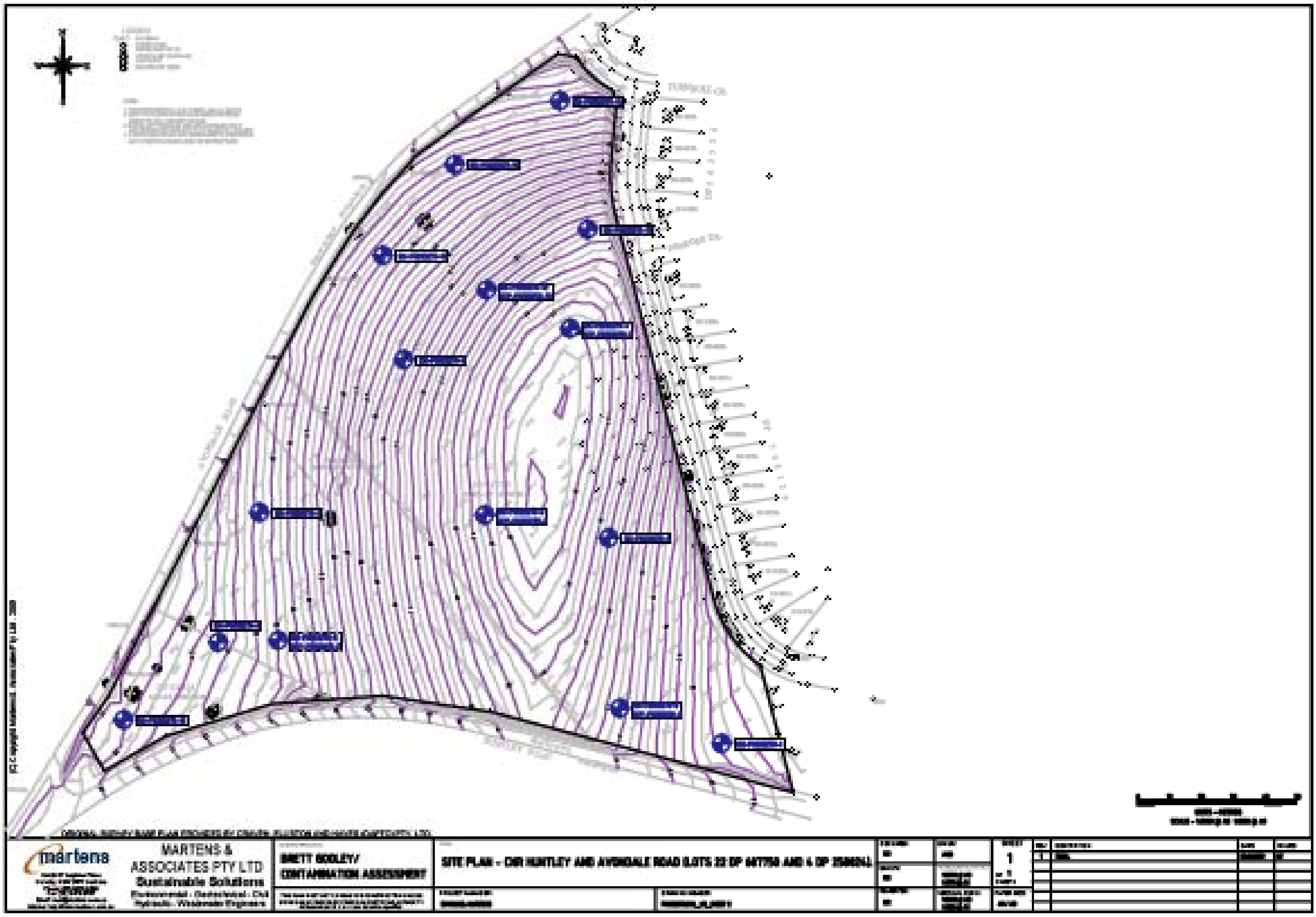

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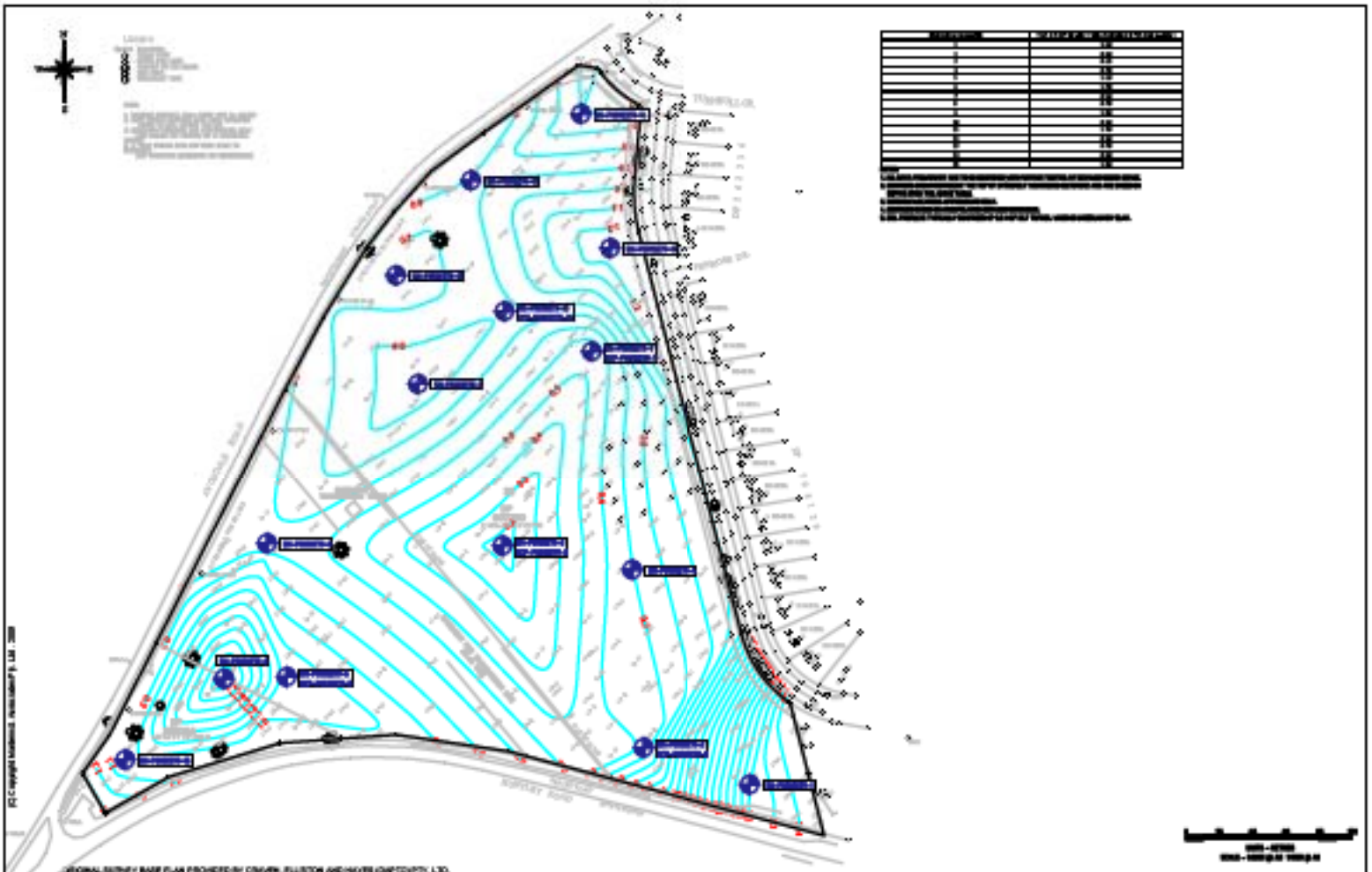
Sustainable Solutions
BRETT BODLEY/
CONTAMINATION ASSESSMENT
SITE PLAN - CNR HUNTLEY AND AVONDALE ROAD (LOTS 22 DP 607750 AND 4 DP 250624)



martens

MARTENS & ASSOCIATES PTY LTD

Sustainable Solutions

Environmental - Geotechnical - Civil

Hydraulic - Wastewater Engineers

BRETT BOSLEY/
GEOTECHNICAL ASSESSMENT

GEOTECHNICAL MODEL – CNR HUNTLEY AND AVONDALE ROAD (LOTS 22 DP 607758 AND 4 DP 250624), PRELIMINARY ROCK LEVEL CONTOURS.

SHEET 1

Levels Table					
No.	Min. Depth	Max. Depth	Colour	Range Volume	
1	-1.599	-1.000		802.97m³	CUT
2	-1.000	0.000		39167.68m³	
3	0.000	1.000		63719.41m³	FILL
4	1.000	2.000		32942.28m³	
5	2.000	3.000		1640.81m³	
6	3.000	4.000		715.81m³	
7	4.000	5.000		211.68m³	
8	5.000	6.100		56.76m³	

NOTE:

REV	DATE	BY	APP.	DETAILS

DRAWING STATUS: INFORMATION

SCALE (at A1 Original): 1:1000

HEIGHT DATUM: AHD

Cardno Forbes Rigby
279 KEIRA STREET, WOLLONGONG, NSW 2500

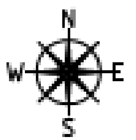
PROJECT TITLE: ILLAWARRA INTERNATIONAL HEALTH PRECINCT for LA VIE DEVELOPMENTS

DRAWING TITLE: SOIL CUT AND FILL DEPTH PLAN

Project No.	Doc No.	Drawing No.	REV
108121	2	2002	R0

Levels Table

No.	Min. Depth	Max. Depth	Colour	Range Volume
1	-10.450	-10.000	Red	15.90m³
2	-10.000	-8.000	Orange	946.68m³
3	-8.000	-6.000	Green	5698.26m³
4	-6.000	-4.000	Cyan	15364.50m³
5	-4.000	-2.000	Blue	30565.80m³
6	-2.000	0.000	Purple	53714.69m³



SCALE 1:1000

NOTE:

REV	DATE	BY	APP.	DETAILS

DRAWING STATUS: **INFORMATION**

SCALE (at A1 Original): 1:1000

HEIGHT DATUM: AHD

Cardno Forbes Rigby

278 KEIRA STREET, WOLLONGONG, NSW 2500

PROJECT TITLE: ILLAWARRA INTERNATIONAL HEALTH PRECINCT for LA VIE DEVELOPMENTS

DRAWING TITLE: ROCK CUT DEPTH PLAN

Project No.	Class No.	Drawing No.	REV
108121	2	2001	R0

7 Attachment B – Borehole Logs

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH1
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Sillstone	VEGETATION	Grass	PROJECT NO.	P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	37m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 2250mm depth	NORTHING	NA	ASPECT	East	SLOPE	5-10 %

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.3			MH	SILT - Brown.	-				
A	Nil	N	D	1.0			CL	CLAY - Brown to grey with orange.	-		B	0.5	2279/U 0.5 1.0
A	Nil	N	M	2.0 2.2			CH	CLAY - Brown, high plasticity.	-		B	1.5	2279/U 1.5 2.0
A	Nil	N	D	2.25			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				3.0 4.0 4.5				Borehole refused at 2.25m on moderately weathered siltstone.					3.0 4.0 4.5

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; Fr Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

Drafts/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF BH2
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRISL	CHECKED	DMM	Sheet 1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO. P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	42.5m AHD	
EXCAVATION DIMENSIONS	Ø 90mm X 900mm depth	NORTHING	NA	ASPECT	East	SLOPE 10 %

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.3			MH	SILT - Brown.	-				
A	Nil	N	D	0.6			CL	CLAY - Brown to grey with orange.	-		B	0.5	2279/2/0.5 (X2)
A	Nil	N	D	0.9			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.			B	0.85	2279/2/0.85
				1.0				Borehole refused at 0.9m on moderately weathered siltstone.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH3
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRISL	CHECKED	DMM	Sheet 1 of 1	
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	46.5m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 500mm depth	NORTHING	NA	ASPECT	West	SLOPE	30 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.15			MH	SILT - Brown.	-				
A	Nil	N	D	0.5			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				1.0 2.0 3.0 4.0 4.5				Borehole refused at 0.5m on moderately weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH4
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	45m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1000mm depth	NORTHING	NA	ASPECT	East	SLOPE	25 %

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.1			MH	SILT - Brown.	-				
A	Nil	N	D	0.7			CL	CLAY - Brown to grey with orange.	-		B	0.5	227SAM 0.5 (X2)
A	Nil	N	D	1.0			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					1.0
				2.0				Borehole refused at 1.0m on moderately weathered siltstone.					2.0
				3.0									3.0
				4.0									4.0
				4.5									4.5

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; Fr Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Code/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH5
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	34m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1200mm depth	NORTHING	NA	ASPECT	West	SLOPE	15 %

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE L M H X	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	1.0 1.1			CL	CLAY - Brown.	-				1.0
A	Nil	N	D	1.2			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
								Borehole refused at 1.2m on moderately weathered siltstone.					
				2.0									2.0
				3.0									3.0
				4.0									4.0
				4.5									4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
Fr Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

Code/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH6
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	29.5m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 2700mm depth	NORTHING	NA	ASPECT	West	SLOPE	10 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H VH)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	0.8			CL	CLAY - Brown.	-		B	0.5	227SW 0.5
A	Nil	N	M	1.0 1.7			CH	CLAY - Grey to brown, high plasticity.			B	1.5	227SW 1.5
A	Nil	N	D	2.0 2.7			EW	RESIDUAL SOIL GRADING TO EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				3.0 4.0 4.5				Borehole terminated at 2.7m on moderately weathered siltstone.					

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; Fr Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

Coals Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF BH7
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRISL	CHECKED	DMM	Sheet 1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO. P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	46m AHD	
EXCAVATION DIMENSIONS	Ø 90mm X 1000mm depth	NORTHING	NA	ASPECT	North	SLOPE 10 %

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA (Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.)	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.15			MH	SILT - Brown.	-				
A	Nil	N	D	0.5			CL	CLAY - Brown to grey with orange.	-				
A	Nil	N	D	1.0			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				2.0 / 3.0 / 4.0 / 4.5				Borehole terminated at 1.0m on Shale grey.					

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; F Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH8
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	31.25m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 750mm depth	NORTHING	NA	ASPECT	West	SLOPE	20 %

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.3			MH	SILT - Brown.	-				
A	Nil	N	D	0.7	L		CL	CLAY - Brown.	-		B	0.5	227kN/M 0.5 (X2)
A	Nil	N	D	0.75	R		EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				1.0				Borehole refused at 0.75m on moderately weathered siltstone.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
Fr Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

Code/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF BH9
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRISL	CHECKED	DMM	Sheet 1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO. P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	39.5m AHD	
EXCAVATION DIMENSIONS	Ø 90mm X 3000mm depth	NORTHING	NA	ASPECT	West	SLOPE 25 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.3			MH	SILT - Brown.	-				
A	Nil	N	D	1.0			CL	CLAY - Brown.	-		B	0.5	2279/9/ 0.5
A	Nil	N	D	2.0 3.0			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.			B	2.3	2279/9/ 2.3
				4.0 4.5				Borehole terminated at 3.0m on extremely weathered siltstone.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH10
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	42.5m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1100mm depth	NORTHING	NA	ASPECT	North West	SLOPE	25 %

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	0.9			CL	CLAY - Brown to grey with orange.	-		B	0.5	2279/H2/ 0.5
A	Nil	N	D	1.0 1.1			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					1.0
				2.0				Borehole terminated at 1.1m on moderately weathered siltstone.					2.0
				3.0									3.0
				4.0									4.0
				4.5									4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
Fr Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH11
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	43m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1550mm depth	NORTHING	NA	ASPECT	North	SLOPE	25 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H VH E)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	1.0 1.3			CL	CLAY - Brown to yellow, appreciable silt content.	-		B	0.5	2279/11/0.5
A	Nil	N	D	1.55			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				2.0 3.0 4.0 4.5				Borehole refused at 1.55m on moderately weathered siltstone.					

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; Fr Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

Code/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH12
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	33.5m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1350mm depth	NORTHING	NA	ASPECT	North West	SLOPE	20 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	0.9			CL	CLAY - Brown to grey with orange.	-		B	0.5	2279/12/0.5 (X 2)
A	Nil	N	D	1.0 1.35			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.			B	1.0	2279/12/ 1.0 (X 2)
				2.0 3.0 4.0 4.5				Borehole terminated at 1.35m on moderately weathered siltstone.					

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; F Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

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CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH13
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	34.5m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1400mm depth	NORTHING	NA	ASPECT	North West	SLOPE	20 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.2			MH	SILT - Brown.	-				
A	Nil	N	D	0.7			CL	CLAY - Brown.	-		B	0.5	2279/13/0.5
A	Nil	N	D	1.0 1.4			SW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
				2.0 3.0 4.0 4.5				Borehole terminated at 1.4m on moderately weathered siltstone.					

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; Fr Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

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Engineering Log - Borehole

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CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH14
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRSL	CHECKED	DMM	Sheet	1 of 1
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0602279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	31m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 1700mm depth	NORTHING	NA	ASPECT	North West	SLOPE	20 %

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE L M H R	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS GROUND WATER WELL
A	Nil	N	D	0.2			MH	SILT - Brown.	-				Push mounted Well cover, Ground Level, Concrete, PVC Casing, Bentonite back fill, 0.5m
A	Nil	N	D	0.6			CL	CLAY - Brown.	-		B	0.5	2279/H14/0.5, Coarse sand back fill, Slotted Screen, 1m
A	Nil	N	D	1.0 1.7			EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					1.0
				2.0 3.0 4.0 4.5				Borehole terminated at 1.7m on moderately weathered rock.					2.0 3.0 4.0 4.5

EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; Water level; Water outflow; Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; F Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

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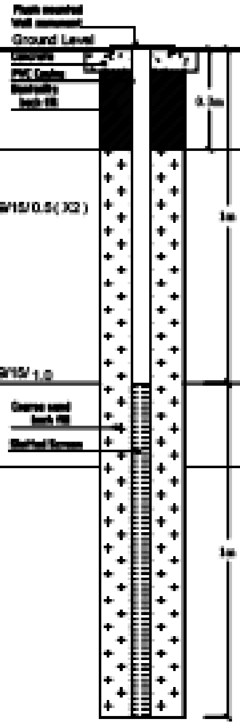
Engineering Log - Borehole

Cards/Sheet No. 4

CLIENT	Brett Gooley	COMMENCED	03.12.08	COMPLETED	03.12.08	REF	BH15
PROJECT	Geotechnical/Contamination Assessment	LOGGED	BRISL	CHECKED	DMM	Sheet 1 of 1	
SITE	CNR Huntley and Avondale Road, Dapto	GEOLOGY	Siltstone	VEGETATION	Grass	PROJECT NO.	P0802279
EQUIPMENT	Hydraulic Auger	EASTING	NA	RL SURFACE	27.6m AHD		
EXCAVATION DIMENSIONS	Ø 90mm X 2600mm depth	NORTHING	NA	ASPECT	North West	SLOPE	20 %

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	CLASSIFICATION	DESCRIPTION OF STRATA (Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.)	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS GROUND WATER WELL
A	Nil	N	D	0.3	MH	SILT - Brown.	-				
A	Nil	N	D	1.0	CL	CLAY - Brown.	-		B	0.5	2279/15/0.5 (X2)
									B	1.0	2279/15/ 1.0
A	Nil	N	D	1.25	EW	EXTREMELY WEATHERED SILTSTONE – Light brown to yellow.					
A	Nil	N	D	2.6	EW	MODERATELY WEATHERED SILTSTONE – Brown.					
						Borehole refused at 2.6m on moderately weathered siltstone.					



EQUIPMENT / METHOD	SUPPORT	WATER	MOISTURE	PENETRATION	CONSISTENCY	DENSITY	SAMPLING & TESTING		CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
N Natural exposure	SH Shoring	N None observed	D Dry	L Low	VS Very Soft	VL Very Loose	A Auger sample	pp Pocket penetrometer	Y USCS
X Existing excavation	SC Shotcrete	X Not measured	M Moist	M Moderate	S Soft	L Loose	B Bulk sample	S Standard penetration test	N Agricultural
BH Backhoe bucket	RB Rock Bolts	Water level	W Wet	H High	F Firm	MD Medium Dense	U Undisturbed sample	VS Vane shear	
E Excavator	Nil No support	Water outflow	Wp Plastic limit	R Refusal	St Stiff	D Dense	D Disturbed sample	DCP Dynamic cone penetrometer	
HA Hand auger		Water inflow	Wl Liquid limit		VSt Very Stiff	VD Very Dense	M Moisture content	FD Field density	
S Hand spade					H Hard		Ux Tube sample (x mm)	WS Water sample	
PT Push tube					F Friable				
A Auger									
CC Concrete Corer									

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

8 Attachment C – Risk Assessment Reports

Landslide Hazard Evaluation - Risk to Life Assessment

Method based on Walker et al. in AGS Vol 42 No. 1 March 2007

Method 3104 Revised 20.02.08

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PROJECT DETAILS

Project	GEOTECHNICAL ASSESSMENT - Cnr Huntley Rd and Avondale Rd			Ref. No.	P0802279JR06_V1
Author	MR B. Rose	Reviewed	DR D. Martens	Created	12.02.2009

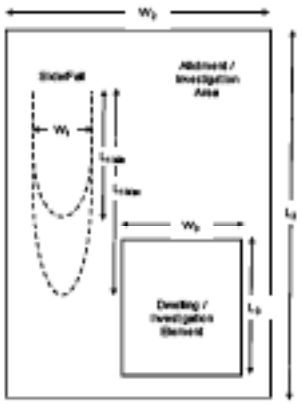
STEP 1 - ENTER SITE AND DESIGN DATA

Hazard Type	Soil creep

$P_{(H)}$ Annual probability of landslide: **0.01**

INDICATIVE VALUE	RECURRENCE INTERVAL	DESCRIPTION	DESCRIPTOR	LEVEL
10^{-1}	10 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	100 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	1000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	10,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	100,000 years	The event is conceivable but only under exceptional circumstances over the design life	RARE	E
10^{-6}	1,000,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

$P_{(S:H)}$ Probability of spatial impact impeding building location taking into account lateral distance and travel direction: **1.00**



FACTOR	DESCRIPTION	UNITS	VALUE
W_1	Likely slide/fall width	m	84
W_2	Width of allotment / investigation area	m	84
W_3	Width of dwelling / investigation element	m	84
L_{Hmin}	Minimum run-out length	m	70
L_{Hmax}	Maximum run-out length	m	80
L_2	Length of allotment / investigation area	m	80
L_3	Length of dwelling / investigation element	m	80
I_{Hmin}	Probability of runout being 0 - 70 m long	(0 - 1)	0.40
I_{Hmax}	Probability of runout being 0 - 80 m long	(0 - 1)	0.60
WI	Likelihood of across slope strike on risk element	(0 - 1)	1.00
L/I_{Hmin}	Likelihood of downslope strike on risk element for minimum run-out distance	(0 - 1)	1.00
L/I_{Hmax}	Likelihood of downslope strike on risk element for maximum run-out distance	(0 - 1)	1.00
L/I_{Design}	Likelihood of downslope strike (integrated) on risk element run-out distance	(0 - 1)	1.00

$P_{(T:S)}$ Temporal spatial probability given the spatial impact: **1.00**

FACTOR	DESCRIPTION	UNITS	VALUE
T_1	Percentage of time person(s) are on site	in	100%
T_2	Percentage of dwelling / element that person(s) occupy	in	100%

$V_{(V:D)}$ Vulnerability of the individual (ie. probability of loss of life given the impact): **0.00001**

CASE	DESCRIPTION	RANGE IN DATA	RECOMMENDED VALUE	COMMENTS
Person in open space	If struck by a rockfall	0.1 - 0.7	0.50	May be injured but unlikely to cause death
	If buried by debris	0.9 - 1.0	1.00	Death by asphyxia almost certain
	If not buried	0.1 - 0.5	0.10	High chance of survival
Person in a vehicle	If vehicle is buried / crushed	0.9 - 1.0	1.00	Death is almost certain
	If the vehicle is damaged only	0.0 - 0.3	0.30	High chance of survival
Persons in building	If the building collapses	0.9 - 1.0	1.00	Death is almost certain
	If the building is inundated with debris and the person is buried	0.9 - 1.0	1.00	Death is highly likely
	If the debris strikes the building only	0.0 - 0.1	0.05	Very high chance of survival

STEP 2 - RISK EVALUATION

$R_{(LI)}$ Risk (annual probability of loss of life of an individual): **1.00E-07**

Risk Assessment: Acceptable risk for loss of life for the person(s). Risk level suitable for new developments.

Landslide Hazard Evaluation - Risk to Life Assessment

Method based on Walker et al. in AGS Vol 42 No. 1 March 2007

Method 3104 Revised 20.02.08

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PROJECT DETAILS

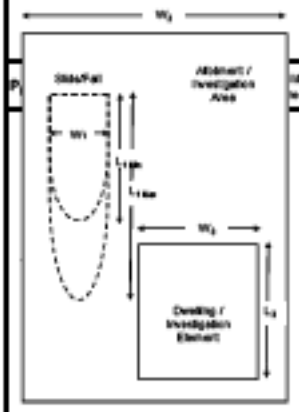
Project	GEOTECHNICAL ASSESSMENT - Cnr Huntley Rd and Avondale Rd			Ref. No.	P0802279JS05_V1
Author	Dr D. MARTENS	Reviewed	Dr D. MARTENS	Created	12.02.2009

STEP 1 - ENTER SITE AND DESIGN DATA

Hazard Type	Deep seated rotational slide

$P_{(H)}$ Annual probability of landslide: **0.00001**

INDICATIVE VALUE	RECURRENCE INTERVAL	DESCRIPTION	DESCRIPTOR	LEVEL
10^{-1}	10 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	100 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	1000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	10,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	100,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}	1,000,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F



$P_{(S:H)}$ Spatial location taking into account: **1.00**

FACTOR	DESCRIPTION	UNITS	VALUE
W_1	Likely slide/fall width	m	10
W_2	Width of allotment / investigation area	m	84
W_3	Width of dwelling / investigation element	m	84
L_{Min}	Minimum run-out length	m	3
L_{Max}	Maximum run-out length	m	5
L_2	Length of allotment / investigation area	m	60
L_3	Length of dwelling / investigation element	m	60
L_{Prob}	Probability of run-out being 0 - 3 m long	(0 - 1)	0.10
L_{Prob}	Probability of run-out being 0 - 5 m long	(0 - 1)	0.00
W	Likelihood of across slope strike on risk element	(0 - 1)	1.00
L_{Fmin}	Likelihood of downslope strike on risk element for minimum run-out distance	(0 - 1)	1.00
L_{Fmax}	Likelihood of downslope strike on risk element for maximum run-out distance	(0 - 1)	1.00
$L_{FDebris}$	Likelihood of downslope strike (integrated) on risk element run-out distance	(0 - 1)	1.00

$P_{(T:S)}$ Temporal spatial probability given the spatial impact: **1.00**

FACTOR	DESCRIPTION	UNITS	VALUE
T_1	Percentage of time person(s) are on site	%	100%
T_2	Percentage of dwelling / element that person(s) occupy	%	100%

$V_{(V:D)}$ Vulnerability of the individual (ie. probability of loss of life given the impact): **0.05**

CASE	DESCRIPTION	RANGE IN DATA	RECOMMENDED VALUE	COMMENTS
Person in open space	If struck by a rockfall	0.1 - 0.7	0.50	May be injured but unlikely to cause death
	If buried by debris	0.9 - 1.0	1.00	Death by asphyxia almost certain
	If not buried	0.1 - 0.5	0.10	High chance of survival
Person in a vehicle	If vehicle is buried / crushed	0.9 - 1.0	1.00	Death is almost certain
	If the vehicle is damaged only	0.0 - 0.3	0.30	High chance of survival
Persons in building	If the building collapses	0.9 - 1.0	1.00	Death is almost certain
	If the building is inundated with debris and the person is buried	0.9 - 1.0	1.00	Death is highly likely
	If the debris strikes the building only	0.0 - 0.1	0.05	Very high chance of survival

STEP 2 - RISK EVALUATION

$R_{(D,T)}$ Risk (annual probability of loss of life of an individual): **5.00E-07**

Risk Assessment: Acceptable risk for loss of life for the person(s). Risk level suitable for new developments.

Landslide Hazard Evaluation - Risk to Life Assessment

Method based on Walker et al. in AGS Vol 42 No. 1 March 2007

Method 3104 Revised 20.02.08

637 Leighton Place, Hornsby, NSW 2077, Ph: (02) 9476 6777 Fax: (02) 9476 6999, mail@martens.com.au, www.martens.com.au

PROJECT DETAILS

Project	GEOTECHNICAL ASSESSMENT - Cnr Huntley Rd and Avondale Rd			Ref. No.	P0902279JS05_V1
Author	Dr D. MARTENS	Reviewed	Dr D. MARTENS	Created	12.02.2009

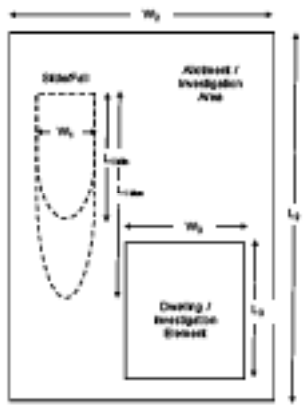
STEP 1 - ENTER SITE AND DESIGN DATA

Hazard Type	Shallow rotational slide

$P_{(H)}$ Annual probability of landslide: **0.00001**

INDICATIVE VALUE	RECURRENCE INTERVAL	DESCRIPTION	DESCRIPTOR	LEVEL
10^{-1}	10 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	100 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	1000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	10,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	100,000 years	The event is conceivable but only under exceptional circumstances over the design life	RARE	E
10^{-6}	1,000,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

$P_{(S:H)}$ Probability of spatial impact impeding building location taking into account travel distance and travel direction: **1.00**



FACTOR	DESCRIPTION	UNITS	VALUE
W_s	Likely slide/fall width	m	5
W_a	Width of allotment / investigation area	m	64
W_b	Width of dwelling / investigation element	m	64
L_{Smin}	Minimum run-out length	m	3
L_{Smax}	Maximum run-out length	m	5
L_a	Length of allotment / investigation area	m	60
L_b	Length of dwelling / investigation element	m	60
I_{Pmin}	Probability of run-out being 0 - 3 m long	(0 - 1)	0.10
I_{Pmax}	Probability of run-out being 0 - 5 m long	(0 - 1)	0.00
WI	Likelihood of across slope strike on risk element	(0 - 1)	1.00
LI$_{Pmin}$	Likelihood of downslope strike on risk element for minimum run-out distance	(0 - 1)	1.00
LI$_{Pmax}$	Likelihood of downslope strike on risk element for maximum run-out distance	(0 - 1)	1.00
LI$_{Design}$	Likelihood of downslope strike [integrated] on risk element run-out distance	(0 - 1)	1.00

$P_{(T:S)}$ Temporal spatial probability given the spatial impact: **1.00**

FACTOR	DESCRIPTION	UNITS	VALUE
T_1	Percentage of time person(s) are on site	in	100%
T_2	Percentage of dwelling / element that person(s) occupy	in	100%

$V_{(V:D)}$ Vulnerability of the individual (ie. probability of loss of life given the impact): **0.05**

CASE	DESCRIPTION	RANGE IN DATA	RECOMMENDED VALUE	COMMENTS
Person in open space	If struck by a rockfall	0.1 - 0.7	0.50	May be injured but unlikely to cause death
	If buried by debris	0.9 - 1.0	1.00	Death by asphyxia almost certain
	If not buried	0.1 - 0.5	0.10	High chance of survival
Person in a vehicle	If vehicle is buried / crushed	0.9 - 1.0	1.00	Death is almost certain
	If the vehicle is damaged only	0.0 - 0.3	0.30	High chance of survival
Persons in building	If the building collapses	0.9 - 1.0	1.00	Death is almost certain
	If the building is inundated with debris and the person is buried	0.9 - 1.0	1.00	Death is highly likely
	If the debris strikes the building only	0.0 - 0.1	0.05	Very high chance of survival

STEP 2 - RISK EVALUATION

$V_{(D:T)}$ Risk (annual probability of loss of life of an individual): **5.00E-07**

Risk Assessment: Acceptable risk for loss of life for the person(s). Risk level suitable for new developments.

9 Attachment D – DCP 'N Counts'

Dynamic Cone Penetrometer Test Log Summary

martens
consulting engineers since 1980

6 / 37 Leighton Place, Hornsby, NSW 2158. Ph: (02) 9476 9999 Fax: (02) 9476 8767. mail@martens.com.au www.martens.com.au

Site	Cnr Huntley and Avondale Rd's, Huntley	DCP Group Reference	1 of 1
Client	La Vie Developments PTY LTD	Log Date	12/02/2009
Logged by	SL		
Checked by	DMM		
Comments			

TEST DATA

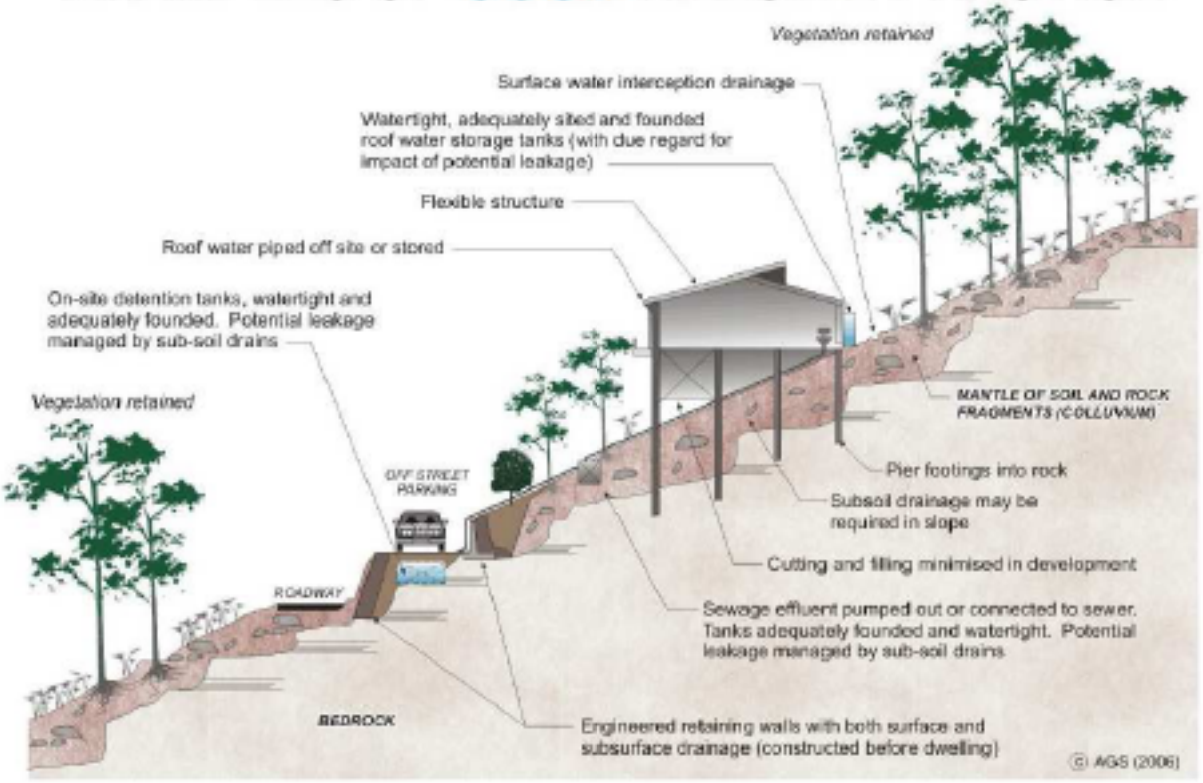
Depth Interval (m)	DCP 2	DCP 3	DCP 5	DCP 7	DCP 10			Geomean
0.15	8	7	4	5	5			6
0.30	11	10	9	10	10			10
0.45	7	19	8	15	25			13
0.60	7	20	5	50	50			18
0.75	7	15	8	refusal @ 0.6	25			12
0.90	refusal @ 0.75	refusal @ 0.75	12		21			16
1.05			40		20			28
			5/50mm		refusal @ 1.05			
			refusal @ 1.1					

10 Attachment E - Hillslope Construction Guidelines

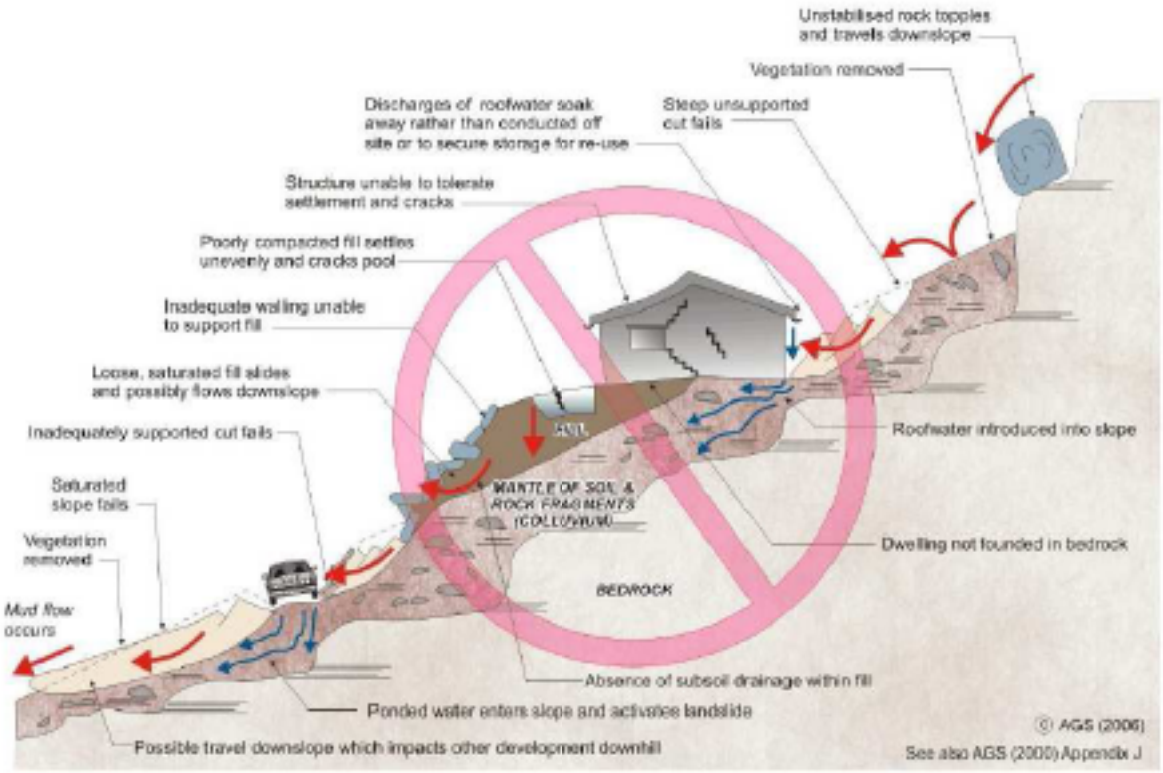
APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE



11 Attachment F – Laboratory Report

GHD GEOTECHNICS
Sydney Laboratory
57 Herbert St
Artarmon NSW 2064
Locked Bag 2727 St Leonards 1590
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

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GHD GEOTECHNICS

Material Test Report

Report No: SYD081716
Issue No: 1

Client: Martens Consulting Engineers
Unit 6 / 37 Leighton Place
Hornsby NSW 2077

Project: 2116124 PO802278JC02

NATA Accredited Laboratory Number: 679

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO IEC 17025
Laboratory Accreditation No. 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 19/12/2008

Material Details

Source:
Description:
Specification:
Sampled From:
Location:
Sample Method:

Sample Details

Sample ID:	SYD08-3073	SYD08-3074	SYD08-3075	SYD08-3076
Field Sample ID:	5 / 0.5	5 / 1.0	15 / 0.5	15 / 1.0
Date Sampled:	3/12/2008	3/12/2008	3/12/2008	3/12/2008

Other Test Results

Description	Method	Results				Limits
Sample History	AS 1289.3.1.1, AS 1289.3.2.1, AS 1289.3.3.1	Oven-dried	Oven-dried	Oven-dried	Oven-dried	
Preparation		Dry Sieved	Dry Sieved	Dry Sieved	Dry Sieved	
Linear Shrinkage (%)		22.5	22.0	12.5	11.5	
Mould Length (mm)		125	125	125	127	
Crumbling		No	No	No	No	
Curling		Yes	Yes	No	No	
Liquid Limit (%)		101	91	46	43	
Method		Four Point	Four Point	Four Point	Four Point	
Plastic Limit (%)		32	30	24	23	
Plasticity Index (%)		69	61	22	20	
Emerson Class Number	AS 1289.3.8.1	4	2 (s)	2 (m)	1	
Soil Description		CLAY	CLAY	CLAY	CLAY	
Type of Water		distilled	distilled	distilled	distilled	
Temperature of Water (°C)		21	21	21	21	

Comments

12 Attachment G – Development Staging Details

ILLAWARRA INTERNATIONAL HEALTH PRECINCT

STAGING DETAILS

1. ILLAWARRA INTERNATIONAL SPECIALIST & SURGICENTRE

Construction :

- Two Storey/Concrete/Glass
- 2 Levels @ 6,000 m²/Level

Basement Car Park

- 231 Car Spaces
- Including 90 Lockup Garages

External Car Park

- 28 Car Spaces

Gross Floor Area

- 12,000 m² in Total, excluding Car Parking

Consisting of :

Specialist Consultation Suites

- Catering for 92 Specialists

Day Surgery

- 6 x Theatres
- 5 x High Dependency
- 4 x ICU Beds
- 21 x Recovery Beds
- 2 x Recovery Cots
- 40 x 'Stage 2' Chairs
- 10 x Overnight Hospital Beds(Ensuited)

Training Rooms

- 6 Briefing Rooms

Shops

- Pharmacy
- Coffee/Sandwich Shop

Licensed Procedures :

1) Surgical – General
   - Gynaecological Surgery
   - ENT Surgery
   - Ophthalmic Surgery
   - Orthopaedic Surgery
   - Neurosurgery
   - Plastic & Microsurgery
2) Endoscopic
3) Dialysis
4) Cytotoxic
5) Cardiac Catherisation
6) Family Care
7) Paediatric Surgery

Anaesthesia:

- General
- Spinal/Epidural
- IV Sedation/Nerve Block

Staging Dates/Timing: Construction works start mid 2009 thru to 2011, completion & opening late 2011

2. 24 HR RADIOLOGY (Ground Floor)
24 HR PATHOLOGY (First Floor)

Construction :

- Two Storey/Concrete/Glass
- 2 Levels @ 2,000 m²/Level

Basement Car Park
- 90 Car Spaces

External Car Park
- 10 Car Spaces

Gross Floor Area
- 4,000 m² in Total, excluding Car Parking

Consisting of :

Radiology
- Simple Radiology, Ultra sound, CT Scan & MRI

Pathology
- NATA Accredited Category '1' Laboratory
  Sonic Health Care Ltd Trading as
  Douglass Hanly Moir Pathology

Staging Dates/Timing: Construction works start early 2010 through to 2012, completion and opening late 2012.

3. ILLAWARRA INTERNATIONAL HOSPITAL CASUALTY/MEDICAL CENTRE

Construction :

- Two Storey/Concrete/Glass
- 2 Levels @ 6,000 m²/Level

Basement Car Park

- 230 Car Spaces
- Including 50 Lockup Garages

External Car Park

- 20 Car Spaces

Gross Floor Area

- 9,000 m² in Total, excluding Car Parking

Consisting of:

- 1 Trauma Dedicated Theatre
- 3 Minor Operative Procedure Theatre's
- 30 Treatment Bays
- School of General Practice
- 24 Hour Medical Centre
- 24 Hour Pharmacy
- 24 Hour Casualty
- Dental Practitioner
- Allied Health Professionals
- Administration & Staff Education
- Training Rooms

Anaesthesia:

- General
- Spinal/Epidural
- IV Sedation/Nerve block

Shops:

- Pharmacy
- Florist
- Newsagent
- Hairdresser
- Café/Food Court

Staging Dates/Timing: Construction works start early 2013 through to 2015, completion and opening late 2015.

4. ILLAWARRA INTERNATIONAL HOSPITAL

OBSTETRIC UNIT (Stand Alone)

Construction :

Construction
- Two Storey/Concrete/Glass
- 2 Levels @ 1,500 m²/Level

Basement Car Park
- 50 Car Spaces
- Including 10 Lockup Garages

External Car Park
- 10 Car Spaces

Gross Floor Area
- 3,000 m² in Total, excluding Car Parking

Consisting of:

Ground Floor
- 6 x Delivery Suites
- 1 x Birthing Centre
- Dedicated Caesarean Section Theatre
- Private Suites for on-site Obstetricians, Paediatricians and Intensivists

Anaesthesia:
- General
- Spinal/Epidural
- IV Sedation/Nerve block, Pudenal,
- Local

First Floor:
- 20 x 1 bedroom Patient Accommodation with en-suite
- Well Baby Nursery
- Stage 2 Critical Care Nursery
- 2 x Training Rooms

Staging Dates/Timing: Construction works start early 2015 through to 2017, completion and opening late 2017.

5a. ILLAWARRA INTERNATIONAL HOSPITAL
352 BED TERTIARY REFERRAL

303 Beds in Hospital Proper
+ 19 Beds in Surgicentre
+ 10 Beds in Casualty
+ 20 Beds in Obstetrics

Construction
- Eight Storey with rooftop plant
Concrete/Glass

Basement Car Park
- 906 Car Spaces

Podium
- 3 Levels

Tower
- 5 Levels @ 4,200 m^2/Level
- 21,000 m^2 in Total

Shopping Plaza
- 2 levels with roof top restaurant
- 12,690 m^2 in total

Gross Floor Area
- 54,310 m^2 in Total, excluding Car Parking

Consisting of:
- 10 Operating Theatres
- Radiotherapy Unit
- Oncology Unit
- Nuclear Medicine
- 8 Training Rooms
- Mortuary

Licensed Procedures:
- General
- All previously Delivered Procedures In Stages 1,3,4,
- Internal Medicine
- Surgical
- Psychiatric
- Rehabilitation
- Intensive care
- Neonatal Intensive Care & Special
- Open Heart
- Neonatal Special Care

Anaesthesia:
- General
- Spinal/Epidural
- IV Sedation/Nerve block

5b. SHOPS
- Mini Mart
- Florist
- Newsagent
- Bottle Shop
- Bank
- Real-estate
- Café
- Restaurant
- Hairdresser
- Beauty Salon
- Café/Food Court
- Commercial Office Space
- Laundromat/Dry Cleaner
- Pharmacy

Parking:
- Basement 100
- External 40

Staging Dates/Timing: Construction works start early 2018 through to 2019, completion and opening late 2019

5c. COMMERCIAL LAUNDRY
DRY CLEANER
CAR WASHING FACILITY

Construction

- Three Storey/Concrete/Glass
- 2 Levels @ 1,200 m²/Level (under revision)
- 1 Level @ 120m²/Level

Basement Car Park
- 30 Car Spaces

External Car Park
- 5 Car Spaces, including Drive Through Area

Gross Floor Area
- 2,500 m² in Total, excluding Car Parking

Consisting of:

Ground Floor
- 2 x Continuous Batch Washers
- Barrier Area
- 2 Dirty Storage Areas
- 6 x High Duty Dryers
- 3 x High Duty Ironers
- Ozone System
- Onsite Water Recycling
- Plant Room
- Workshop and Maintenance
- Power Generation
- Drive Thru & Pickup

First Floor
- Administration
- Amenity Areas
- Toilets
- Clean Storage
- Stock Storage
- Dry Cleaning Area
- Garment Marking

Staging Dates/Timing; Construction works start when required.

6. NURSES, MEDICAL STUDENTS RESIDENT MEDICAL OFFICERS REGISTRAR ACCOMMODATION

Construction

- Two Storey/Concrete/Glass
- 2 Levels @ 2,000 m^2/Level

Basement Car Park

- 40 Car Spaces

External Car Park

- 10 Car Spaces

Gross Floor Area

- 4,000 m^2 in Total, excluding Car Parking

Consisting of:

- 30 x 1 Bedroom Serviced Apartments
- 20 x 2 Bedroom Serviced Apartments
- 4 x Meeting Rooms
- 1 x Training Rooms

Note: Integral with Tertiary Referral Hospital Status and Education Programs
Affiliated with TAFE Wollongong and University.

Staging Dates/Timing: Construction works start early 2020 through to 2021, completion and opening late 2021

7. HUNTLEY FURTHER EDUCATION FACILITY

Construction :

Construction
- Two Storey/Concrete/Glass
- 2 Levels @ 750 m²/Level
- 5 Levels @ 1,500m²/Level

Basement Car Park
- 100 Car Spaces

External Car Park
- 10 Car Spaces

Gross Floor Area
- 12,540 m² in Total, excluding Car Parking

Consisting of :

- 80 x 1 Bedroom Serviced Apartments
- 4 x Meeting Rooms
- 2 x Conference Rooms

Accommodation:

- Patient Carer/Relative Accommodation for visiting International and Interstate patients
- Outpatient accommodation while undergoing extended therapies, including radiotherapy and chemotherapy.

Staging Dates/Timing: Construction works start early 2021 through to 2022, completion and opening late 2022

8a. ILLAWARRA INTERNATIONAL AGED & DISABILITY CENTRE

Construction :

- Two Storey/Concrete/Glass
- 2 x 2 Levels @ 460 m²/Level
- 1 x 3 Levels @ 460 m²/Level
- 1 x 4 Levels @ 460 m²/Level

External Car Park

- 110 Car Spaces

Gross Floor Area

- 4,750 m² in Total, excluding Car Parking

Consisting of:

4 Wings
- Dedicated Ethnic/Cultural Wings
- Ethnic Kitchen
- Dedicated to Youth in Nursing Home
- Aged Guardian with Handicapped Dependent
- Dementia Wing

Rehabilitation Centre
- Gymnasium, Pool & Spa
- Hydrotherapy
- Accessible to Day Care Providers
- Accessible to Rehabilitation Providers
- Training Exercise Physiologists
- Nutrition Education
- Caring for Aged Education
- Dementia Walk
- Gardening
- Craft and Men's Shed

Note: Integrally designed to allow wings to be constructed to meet a graded development, demand, and/or opening.

Staging Dates/Timing: Construction works/opening dependant on Commonwealth Bed Rounds

8b. SENIORS INDEPENDENT LIVING

Construction :

- Two Storey/Brick Veneer
- 2 Levels @ 40 m²/Level

Garaged Car Spaces

- 46 Motor Vehicles

Gross Floor Area

- 2,940 m² in Total, excluding Car Parking

Consisting of :

46 x Independent Living Houses with Emergency Call to the Nursing Home.

Staging Dates/Timing: Construction works on a needs basis

13 Attachment H – Notes Relating to this Report

Information

Important Information About Your Report

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

Engineering Reports - Limitations

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

Engineering Reports – Project Specific Criteria

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

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

Engineering Reports – Recommendations

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

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

Engineering Reports – Use For Tendering Purposes

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

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

Engineering Reports – Data

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

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

Engineering Reports – Other Projects

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

Subsurface Conditions - General

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

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

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and

policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

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

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

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

Subsurface Conditions - Changes

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

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

Subsurface Conditions - Site Anomalies

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

Report Use By Other Design Professionals

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

Subsurface Conditions - Geoenvironmental Issues

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

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

Responsibility

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

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

Site Inspections

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

Soil Data

Explanation of Terms (1 of 3)

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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.

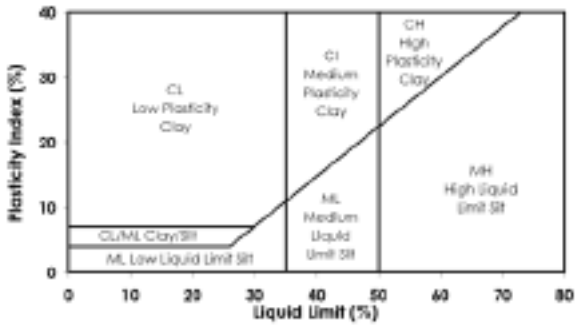
Particle Size

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
GRAVEL	Coarse	20 to 60 mm
	Medium	6 to 20 mm
	Fine	2 to 6 mm
SAND	Coarse	0.6 to 2.0 mm
	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	C_u (kPa)	Approx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail.
Friable	-		Crumbles or powders when scraped by thumbnail

Density of Granular Soils

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

Relative Density	%	SPT 'N' Value (blows/300mm)	CPT Cone Value (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:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5 % Fine grained soils: < 15 %
With some	Presence easily detectable by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 – 12 % Fine grained soils: 15 – 30 %

Soil Data

Explanation of Terms (2 of 3)

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Soil Agricultural Classification Scheme

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

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL*	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
LfSy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	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
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Soil Data

Explanation of Terms (3 of 3)

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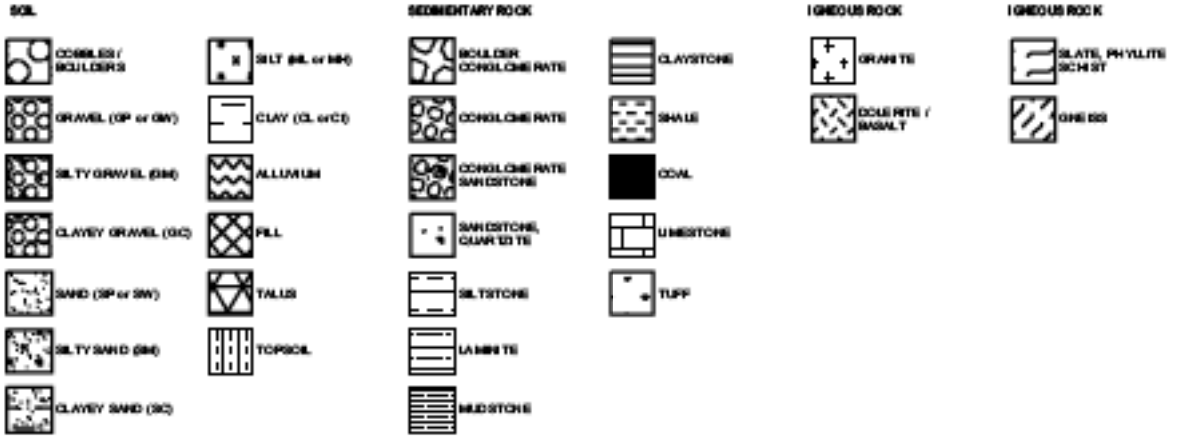
Symbols for Soil and Rock



Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Gravel
				Predominantly one size or a range of sizes with more intermediate sizes missing	GP	Gravel
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty Gravel
				Plastic fines (for identification procedures see CL below)	GC	Clayey Gravel
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of intermediate sizes missing.	SW	Sand
				Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Sand
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty Sand
				Plastic fines (for identification procedures see CL below)	SC	Clayey Sand

FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
	Medium to High	None	Medium	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	CL	Clay
	Low to Medium	Slow to Very Slow	Low	Organic silts and organic silty clays of low plasticity	OL	Organic Silt
	Low to Medium	Slow to Very Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	Silt
	High	None	High	Inorganic clays of high plasticity, fat clays	CH	Clay
	Medium to High	None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				PT	Peat

Low Plasticity – Liquid Limit W_L < 35 % Medium Plasticity – Liquid limit W_L 35 to 60 % High Plasticity - Liquid limit W_L > 60 %

Rock Data

Explanation of Terms (1 of 2)

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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 occuring 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	Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering

Rock Strength

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

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

Rock Data

Explanation of Terms (2 of 2)

martens consulting engineers

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.

Test Methods

Explanation of Terms (1 of 2)

martens consulting engineers

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 thin-walled 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.

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

Hand Auger - 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.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ 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.

Continuous Sample Drilling - 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.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ 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.

Rotary Mud Drilling - 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).

Continuous Core Drilling - 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 non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in AS 1289 Methods of Testing Soils for Engineering Purposes - Test F3.1.

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

The test results are reported in the following form:

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

as 4, 6, 7
N = 13

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

as 15, 30/40 mm.

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

CONE PENETROMETER TESTING AND INTERPRETATION

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

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

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

Test Methods

Explanation of Terms (2 of 2)

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

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

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

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

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

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

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

q_c = (12 to 18) c_u

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

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

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

Perth sand penetrometer - a 16 mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS 1289 - Test F 3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
Cone penetrometer (sometimes known as the Scala Penetrometer) - a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289 - Test F 3.2). The test was developed initially for pavement sub-grade investigations, with correlations of the test results with California bearing ratio published by various Road Authorities.

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

TEST PIT / BORE LOGS
The test pit / bore log(s) presented herein are an engineering and/or geological interpretation of the sub-surface 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.