

**SUPPLEMENTARY GEOTECHNICAL
INVESTIGATION
ROYAL NORTH SHORE HOSPITAL
REDEVELOPMENT, ST LEONARDS**

Thiess Pty Ltd

GEOTLCOV23589AA-AH
23 September 2008

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Thiess Pty Ltd
Level 5, 26 College Street
SYDNEY NSW 2000

Attention: Mark Foster

Dear Mark

RE: SUPPLEMENTARY GEOTECHNICAL INVESTIGATION
ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT, ST LEONARDS

Coffey Geotechnics Pty Ltd is pleased to present the results of our supplementary geotechnical investigation for the Royal North Shore Redevelopment Project. If you require further information please contact the undersigned on 9911 1000.

For and on behalf of Coffey Geotechnics Pty Ltd



Peter Waddell

Principal

Distribution: Original held by Coffey Geotechnics Pty Ltd
1 copy held by Coffey Geotechnics Pty Ltd
2 hard copies and 1 electronic copy to Thiess Pty Ltd

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1 INTRODUCTION

This report presents the results of a supplementary geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for the proposed redevelopment of the Royal North Shore Hospital site at St Leonards. The investigation was commissioned by Thiess Pty Ltd (Thiess) and carried out under consultancy contract No.: 740036N2140-01.

We understand that the proposed redevelopment is to consist of the demolition and reconstruction of various sections of the existing hospital, the excavation of basements and the construction of multi storey reinforced concrete frame buildings. A new acute care hospital is to be nine storeys with basement excavations extending to depths ranging from approximately 2.5m to 14m below existing site grade. A new community health building is to be constructed on the Herbert Street boundary is to be eight storeys with excavations to depths ranging from approximately 4m to 9m. A 2m high unsupported cut is shown adjacent to the community health building.

Coffey previously carried out investigations for the project under commission of NSW Health and produced a number of geotechnical reports. The most relevant reports from a geotechnical perspective are as follows:

- ENVILCOV 00298AA-GA, dated 20 December 2006 "Geotechnical Investigation Proposed New Hospital, Royal North Shore Hospital, St Leonards".
- ENVILCOV 00298AA-GB, dated 20 December 2006 "Geotechnical Investigation Divestment Site, Royal North Shore Hospital, St Leonards".

The objectives of the supplementary investigation were to improve site coverage and to obtain information from deeper boreholes to assist the structural designers with the design of footings.

2 SCOPE OF WORK

2.1 Fieldwork

The fieldwork for the investigation was carried out between 25 August 2008 and 4 September 2008 and comprised the drilling of seven boreholes (BH201 to BH207) at locations and to depths nominated by Thiess. An additional three boreholes were planned to provide information to the west of Reserve Road, however, access was not available at the time of the current fieldwork.

The boreholes were drilled using a truck mounted drilling rig to depths of between 8m and 30.18m. Prior to mobilising the drilling rig a vacuum excavation unit was used to excavate to a depth up to about 2m to check for buried services. The drilling rig was used to advance the borehole using a tungsten carbide bit in soils and weathered rock. A triple tube core barrel was used to core the rock to the nominated termination depth.

On completion the boreholes were backfilled with cuttings and a plug of concrete was placed to the ground surface.

Ground levels at the borehole locations were assessed based on spot levels shown on a plan provided by Thiess.

2.2 Laboratory Testing

Rock core was taken to our laboratory and colour photographed. Point load strength index tests were carried out on the rock cores. The results of the point load tests are presented on the engineering logs.

Uniaxial Compressive Strength (UCS) tests were carried out on nine samples of rock core. The results are presented in Appendix C

3 RESULTS OF INVESTIGATION

3.1 Subsurface Conditions and Geotechnical Models

The locations of the supplementary boreholes and boreholes from previous investigations are shown on Figure 1. Engineering logs of the supplementary boreholes are presented in Appendix A with sheets explaining the symbols and abbreviations used in the preparation of the logs.

The supplementary boreholes revealed conditions similar to those encountered in previous investigations. We have used the available geotechnical information to prepare interpreted sections presented in Figures 2, 3, and 4. For the logs of boreholes from previous investigations refer to reports ENVILCOV 00298AA-GA and ENVILCOV 00298AA-GB, both reports dated 20 December 2006.

Across the investigation area there are relatively shallow and variable thicknesses of topsoil and fill, overlying residual soil, overlying bedrock. The bedrock comprises shales and sandstone of variable strength and weathering characteristics.

Ashfield Shale was encountered in all boreholes. The Ashfield Shale overlies laminite and sandstone inferred to be Mittagong Formation grading into Hawkesbury Sandstone. The boundaries between the various units can be gradational and the boundary between the Mittagong Formation and Hawkesbury Sandstone can be difficult to differentiate.

The depths and thicknesses of various units presented are based on information at the borehole locations and variations outside of the ranges of depth and thickness could occur between borehole locations.

We have developed geotechnical models for two areas of the site:

- The new acute hospital characterised by the sections in Figures 2 and 3; and
- The community health building adjacent to Herbert Street characterised by the section in Figure 4.

The geotechnical models are summarised in the following tables.

Table 1: Geotechnical Model – New Acute Hospital Building

Unit	General Description	Approximate Depth to Top of Unit	Approximate Thickness of Unit
1. Pavement, Topsoil and Fill	Silty Clay and Clayey Silt, some Gravelly Clay	0	< 1m
2. Residual Soil	Silty Clay: Medium and high plasticity, very stiff and hard	<1m	1m to 3m
3A. Ashfield Shale	Shale: <ul style="list-style-type: none"> • Extremely weathered to highly weathered; • Very low to high strength; • Class V and Class IV Shale ⁽¹⁾ 	1m to 4m	1m to 13m
3B. Ashfield Shale	Shale: <ul style="list-style-type: none"> • Highly weathered to slightly weathered; • low to high strength; • Class III and Class II Shale 	4m to 15m	1m to 9m
4. Mittagong Formation and Hawkesbury Sandstone	Interbedded Sandstone, Laminite and Shale (Mittagong Formation), becoming less laminated with increasing depth until predominantly Sandstone (Hawkesbury Sandstone): <ul style="list-style-type: none"> • Moderately and slightly weathered; • Fine and medium grained Sandstone; • Generally medium and High strength; • Variable Class III to Class I Shale, Class IV and III Sandstone in upper stratum (Mittagong Formation) • Class II Sandstone where sandstone predominates Mittagong Formation and Hawkesbury Sandstone 	8m to 20m	Not penetrated

Notes: (1) Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl. Dec 1998.

Table 2: Geotechnical Model – Community Health Building

Unit	General Description	Approximate Depth to Top of Unit	Approximate Thickness of Unit
1. Pavement, Topsoil and Fill	Silty Clay and Clayey Silt, some Gravelly Clay	0	0.4m to 1.6m
2. Residual Soil	Silty Clay: Medium and high plasticity, very stiff and hard	0.4m to 1.6m	0.5m to 3m
3A. Ashfield Shale	Shale: <ul style="list-style-type: none"> • Extremely weathered to highly weathered; • Very low to high strength; • Class V to Class III Shale ⁽¹⁾ 	2m to 4m	1m to 5m
3B. Ashfield Shale	Shale: <ul style="list-style-type: none"> • Highly weathered to slightly weathered; • low to high strength; • Class III and Class II Shale 	5m to 8m	1m to 3m
4. Mittagong Formation and Hawkesbury Sandstone	Interbedded Sandstone, Laminite and Shale (Mittagong Formation), becoming less laminated with increasing depth until predominantly Sandstone (Hawkesbury Sandstone): <ul style="list-style-type: none"> • Moderately and slightly weathered; • Fine and medium grained Sandstone; • Generally medium and High strength; • Variable Class III to Class I Shale, Class IV and III Sandstone in upper stratum (Mittagong Formation) • Class II Sandstone where sandstone predominates Mittagong Formation and Hawkesbury Sandstone 	6m to 10m	Not penetrated

Notes: (1) Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl. Dec 1998.

3.2 Groundwater

Groundwater was generally not encountered in the augered sections of the boreholes (soil and extremely weathered rock). Water was used as a drilling fluid in the cored sections of the boreholes, hence groundwater was not monitored during the core drilling. In an open standpipe piezometer that was installed in BH5 of an investigation carried out in 2004 a groundwater depth 9.1m (about RL+86.9m AHD) was monitored in 2006.

Groundwater levels in geological conditions such as those present at this site are often associated with infiltration through fissured soils into the fractured rock mass and may vary seasonally. Perched groundwater is often encountered at the soil bedrock interface and within joints and bedding partings within the bedrock.

4 DISCUSSION AND RECOMMENDATIONS

4.1 Excavation Conditions

Based on the geotechnical models interpreted from Figures 2, 3 and 4:

- The proposed Acute Hospital Unit excavation will encounter relatively thin layers of Units 1 Fill and Unit 2 Residual Soil and then predominantly Unit 3a Shale to bulk excavation level.
- The proposed Community Health Building will encounter roughly equal thicknesses of Unit 1 and Unit 2, Unit 3A and Unit 3B Shale. At the proposed bulk excavation level Unit 4 Mittagong Formation may be exposed.

Excavations in Unit 1 and Unit 2 should be able to be carried out using excavators and tracked loaders. In Unit 3a a Class 200C dozer (CAT D8 or equivalent) fitted with rippers is likely to be required. In Unit 3b a Class 300C dozer (CAT D9 or equivalent) is likely to be required.

Although bulk excavation are not expected to extend into Unit 4, if detailed excavations are required to penetrate into Unit 4 productivity may be low in confined spaces and rock saws and impact hammers required to excavated the higher strength rock in this unit.

Excavation contractors should be required to assess the core logs and core photographs to make their own assessment of the suitability of specific plant and likely production rates.

Groundwater seepage is likely to occur within the fill and natural soils and from joints and bedding partings within the bedrock. We would anticipate that seepage should be able to be controlled by pumping from sumps.

4.2 Unsupported Cuts

4.2.1 General Recommendations for Cuts

Recommendations for unsupported cuts batters are presented in the following table:

Table 3: Cut Batter Recommendations

Geotechnical Unit	Temporary Cuts (Horizontal to Vertical Ratio)	Permanent Cuts (Horizontal to Vertical Ratio)
Unit 1	2H:1V	2.5H:1V
Unit 2	1.5H:1V	2H:1V
Unit 3A	1.5H:1V	2H:1V
Unit 3B	1H:1V	1.5H:1V

The recommendations in Table 3 assume that:

- excavations in soil are above the groundwater table;
- the ground surface at the crest of the excavation is horizontal;
- surcharge loads are kept clear of the crest of the excavation for a distance equal to the depth of the excavation;
- all cuts are protected from erosion.

Batters should be reassessed if the above criteria are not met.

In Ashfield Shale there is a risk that relatively shallow dipping joints or shear zones (typically 30° to 40° from the horizontal) daylight in the excavation face forming unstable wedges. There have also been cases where failures have occurred in shale where joints dipping at 70° that were continuous over depths of 20m have intersected relatively low angle bedding planes (5°) to form large wedges.

Such joints or shear zones are known to occur within the Ashfield Shale and rarely in the Mittagong Formation and Hawkesbury Sandstone. Jointing in the Mittagong Formation and Hawkesbury Sandstone is typically steeper (>70°) and tend not to be as continuous with depth and hence are less likely to form large wedges. Therefore, it may be necessary to install relatively heavy support such as shoring walls for deep vertical excavations in Ashfield Shale.

4.2.2 Community Health Building

The cut adjacent to the community health building is shown on the bulk excavation plan as being 2m high. BH105 shows Unit 1 to 0.6m depth overlying Unit 2. The cuts in Table 3 could be adopted for an unsupported cut of 2m height as proposed. Protection from erosion would be required such as drainage strips and a protective facing of shotcrete. From landscaping and long term maintenance perspectives some form of retention system may be preferable to shotcrete. Vegetated benches retained by gabions or similar gravity retaining walls may be a suitable alternative, with the overall cut slope complying with the recommendations in Table 3.

4.3 Vertical Excavations in Rock

Provisions for the installation of support will be required where vertical excavations are made in rock. Specific rock support requirements in the un-shored sections of excavations can only be assessed during excavation. An experienced geotechnical engineer/engineering geologist should carry out regular inspections as excavation progresses (at least every 2m depth of excavation). For preliminary design purposes the support guidelines presented in the following table are recommended:

Table 4: Vertical Excavation Face Support Requirements

Geotechnical Unit	Material/Rock Class	Support
Unit 1, Unit 2 and Unit 3A	Fill, Residual Soil, Class V and Class IV Shale	<ul style="list-style-type: none"> Shoring wall
Unit 3b	Class III or better Shale	<ul style="list-style-type: none"> Shoring wall; or Anchors, mesh supported by 0.5m long dowels and shotcrete (minimum 75 mm thick) or fibre reinforced shotcrete of fractured zones below shoring walls.
Unit 4	Class III or better Sandstone *	<ul style="list-style-type: none"> Localised pattern rock bolting, particularly in Mittagong Formation, mesh supported by 0.5m long dowels and shotcrete (minimum 75 mm thick) or fibre reinforced shotcrete of fractured zones Generally only isolated rock bolting in Hawkesbury Sandstone to support potentially unstable wedges.

Note: * If shale is encountered in Mittagong Formation use support requirements for Unit 3B.

Where long-term support is required below the site retention system, anchors and rock bolts must be provided with a high level of corrosion protection if they cannot be maintained (i.e. inspected and replaced, if necessary). Multiple layers of corrosion protection such as encapsulating bolts in both grout and PVC sheaths may be required.

For the preliminary design of rock anchors the allowable bond stresses in Table 5 can be adopted. The capacity of anchors should be based on a performance specification with anchors proof loaded.

Table 5: Preliminary Recommendations for Rock Anchor Design

Geotechnical Unit/Rock Class	Allowable Bond Stress (kPa)
Unit 3A Class V and IV Shale	75 to 100kPa
Unit 3B Class III or better Shale	300
Unit 4 Class III or better Sandstone	600

Anchor designs should be based on allowing effective bonding to be developed behind an ‘active zone’ determined by drawing a line at 45° from the base of the soldier pile to intersect the ground surface behind the excavated face. Retaining structures should be designed against hydrostatic water pressures, unless effective drainage is provided or the ground dewatered behind the retaining structures. Applicable surcharge loads should be added to lateral earth pressures.

4.4 Retaining Walls

Conventional shoring such as contiguous bored pile walls or anchored soldier piles with walers and timber panels, or shotcrete infill panels should be suitable. Ideally, the pile toes should be founded below the bulk excavation level, or support measures such as the installation of toe anchors or bolts installed to prevent the kick-out of the pile toe.

Drilling contractors tendering for the soldier pile drilling should be required to inspect the rock core, engineering logs and photograph and to make their own judgement as to likely drilling productivity and drilling rig requirements.

Cantilever walls are generally limited to a retained height of about 3m. Therefore, temporary anchors or internal props will be required where more than one basement level is planned.

The following table provides parameters for retaining wall design for the following cases:

- Case 1 = temporary retention, no adjacent sensitive structures or services.
- Case 2 = permanent retention, sensitive structures or service.
- Case 3 = adjacent to sensitive structures or service and hence need to limit movement.

Table 6: Earth Pressure Coefficients

Geotechnical Unit	Value of Lateral Earth Pressure Coefficient, K ⁽¹⁾			Passive Earth Pressure Coefficient, K _p ^(1,2)	Bulk Density (kN/m ³)
	Case 1	Case 2	Case 3		
Unit 1 and Unit 2	0.3	0.35	0.5	2.5	20
Unit 3A and Unit 3B	0.25	0.3	0.4	2.8	22
Unit 4	-	-	-	3	24

Note:

1. These values are only applicable for a horizontal ground surface.
2. Passive earth pressure coefficients for rock have been reduced to allow for potential defects in rock mass

Design of cantilevered retaining walls should be based on a triangular pressure distribution adopting the earth pressure coefficients recommended in Table 6. Design of shoring and permanent retaining walls, which are anchored or strutted at several levels, can be based on a trapezoidal earth pressure distribution as presented in Table 7. A trapezoidal earth pressure distribution may be appropriate for a one-material layer (layer thickness H) requiring retention. Where retention of a multi-layered material profile is required, modification of the distribution (including the definition of H) will be necessary.

Table 7: Trapezoidal Pressure Distribution

Depth (m)	Horizontal Pressure (kPa)
0	$K \cdot p_s$
0.25 H	$K (0.8 \cdot \gamma \cdot H + p_s)$
0.75 H	$K (0.8 \cdot \gamma \cdot H + p_s)$
H	$K \cdot p_s$

Where:

K = earth pressure coefficient which depends upon material type; whether movement needs to be limited; whether temporary or permanent

p_s = design surcharge pressure (kPa)

H = thickness of layer being retained (m), assume maximum depth would typically be to the base of Class IV Shale or Class V Sandstone.

γ = density calculated based on the bulk density presented in Table 6.

4.5 Foundations

Fill is unlikely to have been placed in a controlled manner and should be considered to be unsuitable as a bearing stratum for footings. Strip and pad footings or bored piles are feasible footing options on the other geotechnical units. Open bored piles should be feasible, however, seepage could occur and provision for measures such as temporary liners, dewatering and cleaning of open bored piers will be required. Alternatively, continuous flight auger (CFA) piles could be adopted, which do not require cleaning and dewatering.

Tables 8 and 9 present parameters for the preliminary design of footings. During construction rock quality will need to be assessed to confirm that the adopted assumed design parameters are appropriate.

It is important that the designer understands that the design bearing pressure of footings on rock is often governed by serviceability considerations (ie.settlement). The recommended allowable end bearing pressures should result in settlement of <1% of minimum footing dimension.

Higher load capacities may be able to be assessed if a limit state approach is adopted for footings taken into rock and where settlements calculated using the higher end pressures and shaft adhesion values are found to be acceptable. The end bearing pressures that are calculated using the ultimate end bearing pressures in Table 9 may need to be downgraded in an iterative approach based on the results of settlement calculations.

Table 8: Allowable Footing Design Parameters

Geotechnical Unit	Rock Class	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Unit 2: Residual Very Stiff and Hard Clay	-	175	Nil
Unit 3A	Class V Shale	700	50
	Class IV Shale	1,000	75
Unit 3B	Class III or better Shale	3,000	200
Unit 4	Class IV Sandstone	3,000	250
	Class III Sandstone	5,000	400
	Class II Sandstone	7,500	600

Table 9: Limit State Footing Design Parameters

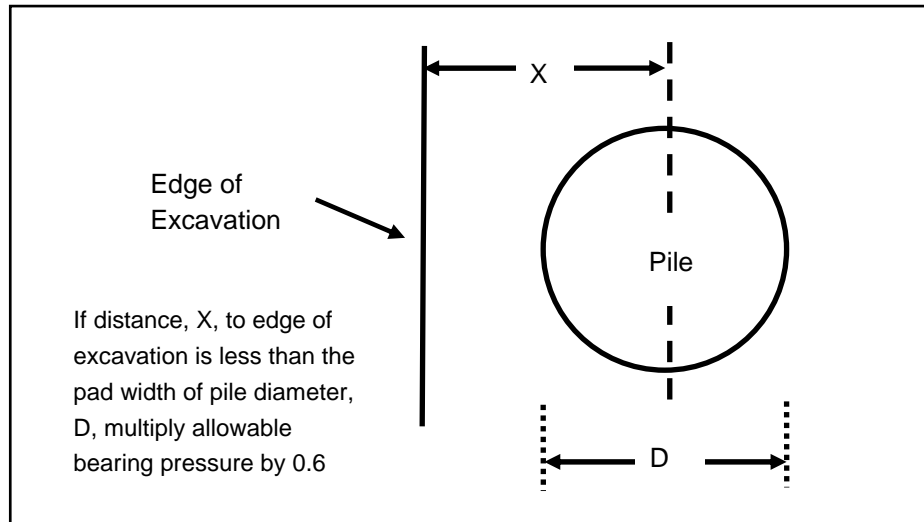
Geotechnical Unit	Rock Class	Ultimate End Bearing Pressure (kPa) ⁽¹⁾	Ultimate Shaft Adhesion (kPa) ⁽²⁾	Elastic Modulus (MPa)
Unit 3A	Class V Shale	2,000	100	75
	Class IV Shale	3,000	150	100
Unit 3B	Class III or better Shale	7,000	500	300
Unit 4	Class IV Sandstone	7,000	500	300
	Class III Sandstone	20,000	800	400
	Class II Sandstone	40,000	1,500	900

The bearing pressures in Tables 8 and 9 assume a minimum embedment of 0.3m into the relevant material. The shaft adhesion values assume a clean socket roughness category R2 or better. Shaft adhesion should only be assigned where the socket length is at least 3 pile diameters. The socket should be cleaned and roughened by a suitable scraper or tooth, orientated perpendicular to the auger shaft. In shorter sockets the majority of the load will be carried in the pile base.

A geotechnical strength reduction factor, Φ_g , of 0.75 should be adopted for vertical compressive loads provided suitable rock quality assessment is carried out by spoon testing or coring. For uplift loads Φ_g of 0.6 should be adopted, and shaft adhesion values presented in the above tables should be multiplied by 0.6.

The allowable bearing pressure of pads or piles founded near the edge of an excavation, such as retention system piles, should be downgraded. Pads or piles where the distance from the centre of the

footing to the edge of an excavation lies closer than the footing width perpendicular to the line of the excavation or the pile diameter (see sketch below) should have design bearing pressures downgraded by multiplying the allowable bearing pressure by 0.6.



Prior to concreting, all footings should be inspected by a geotechnical engineer or engineering geologist to assess the exposed rock. Where the required allowable bearing pressure is greater than 1,000 kPa for Shale and 2000 kPa for Sandstone, footing assessment should also include spoon testing (or cored boreholes) to assess whether defects below the base of the footing are within tolerable limits for the respective rock class.

5 LIMITATIONS

The geotechnical models presented in this report are based on relatively widely spaced boreholes. The engineering logs describe subsurface conditions only at the specific borehole locations and inferred boundaries between geotechnical units may vary from those shown on the interpreted sections.

Ground conditions can vary over relatively short distances and a geotechnical engineer should be engaged to review subsurface conditions during construction stages and to confirm that subsurface conditions are consistent with design assumptions.

Boreholes have not been drilled on the western edge of the proposed development area. We recommend that an additional three boreholes be drilled on the western edge to extend borehole coverage.

The attached document entitled "Important Information About Your Coffey Report" presents additional information on the uses and limitations of this report.

For and on behalf of Coffey Geotechnics Pty Ltd

Peter Waddell

Principal

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. 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. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal 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. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary 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 cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is 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 Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey 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.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

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 our reports 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 logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.

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 Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

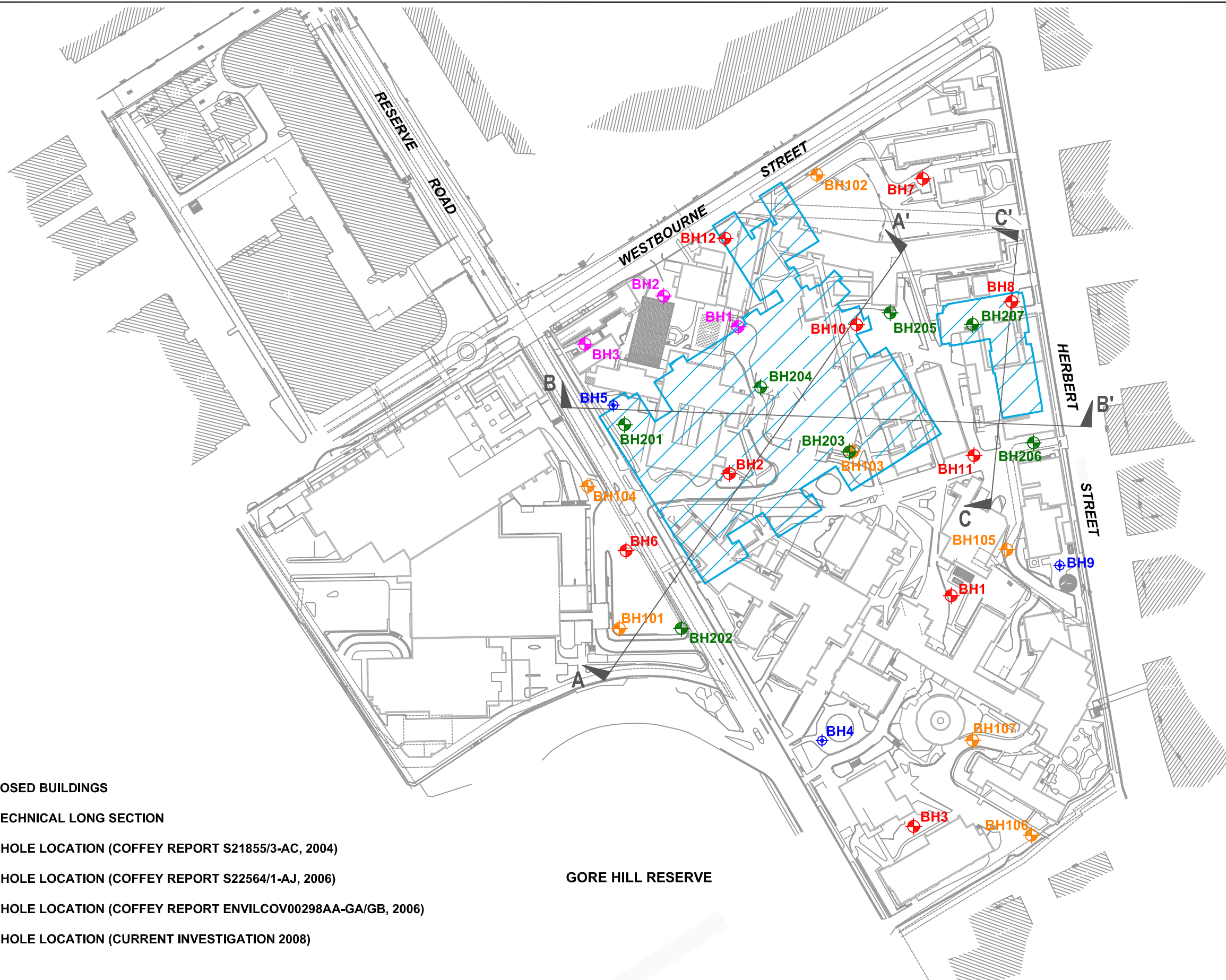
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is 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 Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures



LEGEND

PROPOSED BUILDINGS

GEOTECHNICAL LONG SECTION

BOREHOLE LOCATION (COFFEY REPORT S21855/3-AC, 2004)

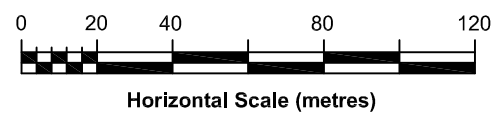
BOREHOLE LOCATION (COFFEY REPORT S22564/1-AJ, 2006)

BOREHOLE LOCATION (COFFEY REPORT ENVILCOV00298AA-GA/GB, 2006)

BOREHOLE LOCATION (CURRENT INVESTIGATION 2008)

GORE HILL RESERVE

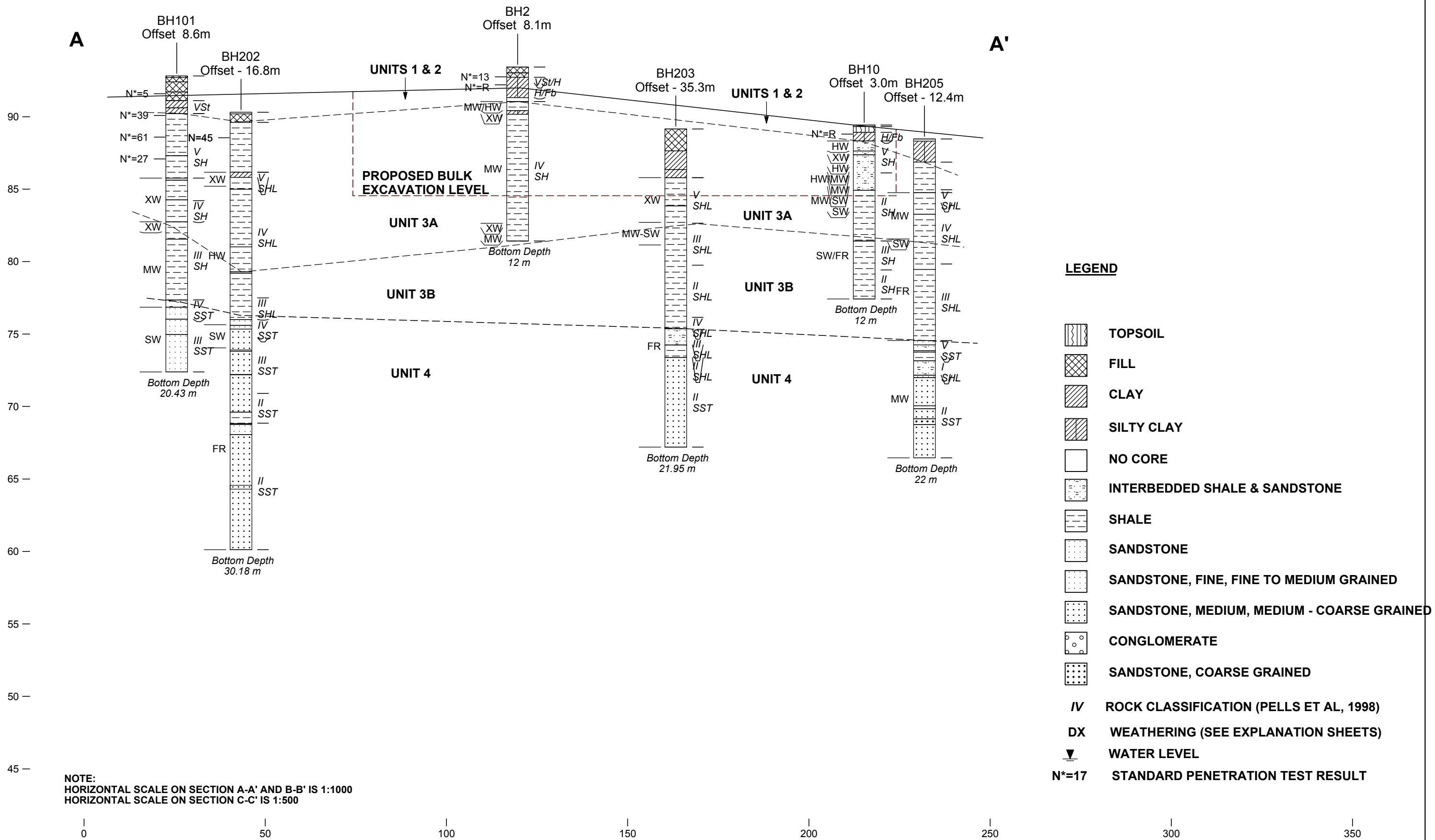
revision	description	drawn	approved	date



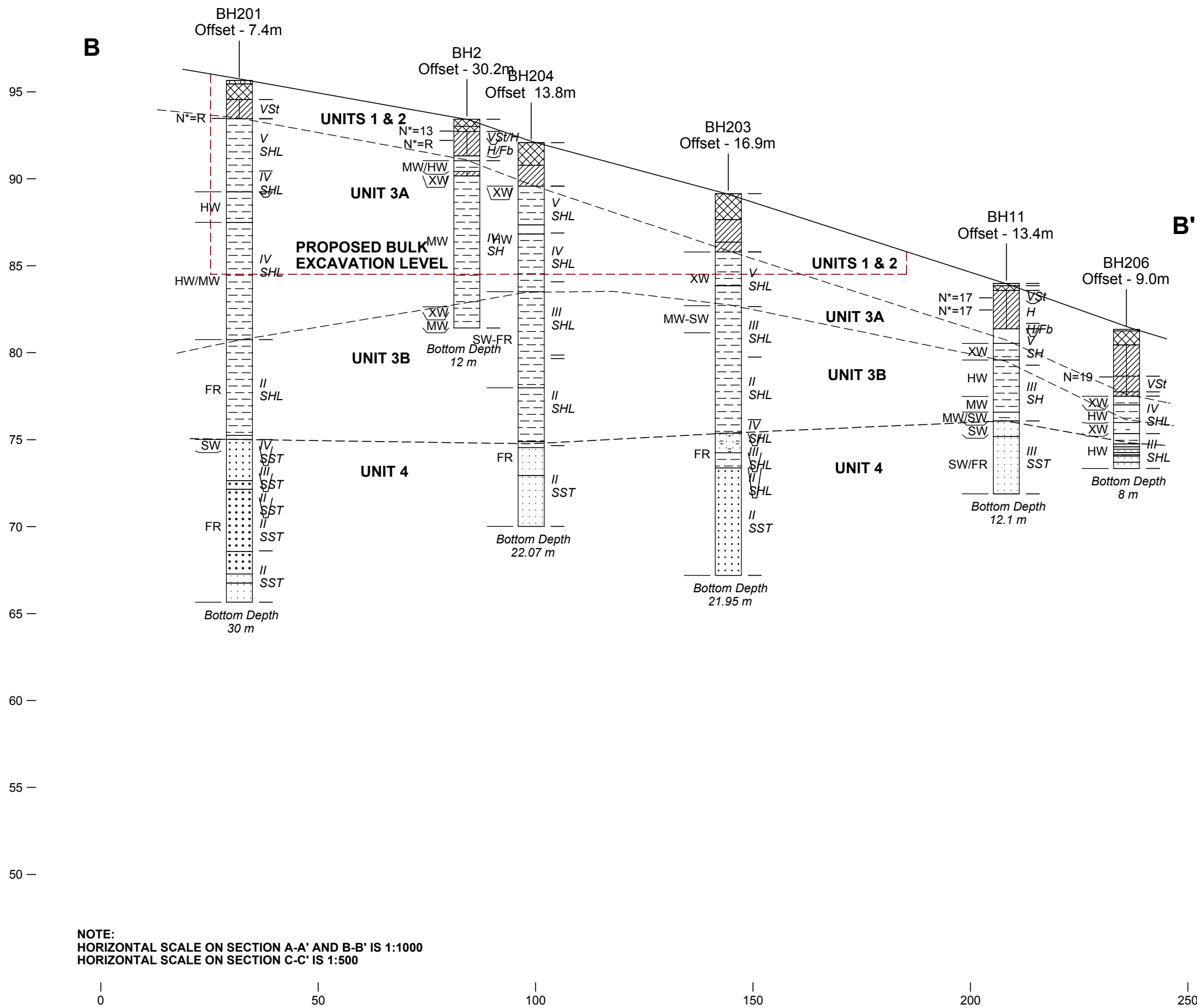
drawn	DS/AW
approved	PJW
date	11/9/08
scale	1:2 000
original size	A3



client:	THIESS PTY LTD	
project:	REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL ST LEONARDS, NSW	
title:	SITE PLAN	
project no:	GEOTLCOV23589AA	figure no: FIGURE 1



revision	description	drawn	approved	date	 Horizontal Scale (metres) Vertical Scale (metres)	drawn	PJW/LT	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	THIESS PTY LTD		
						approved	PJW		project:	REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL ST LEONARDS, NSW		
						date	23/9/08		title:	GEOTECHNICAL CROSS SECTION A-A'		
						scale	AS SHOWN		project no:	GEOTLCOV23589AA	figure no:	FIGURE 2
						original size	A3					



LEGEND

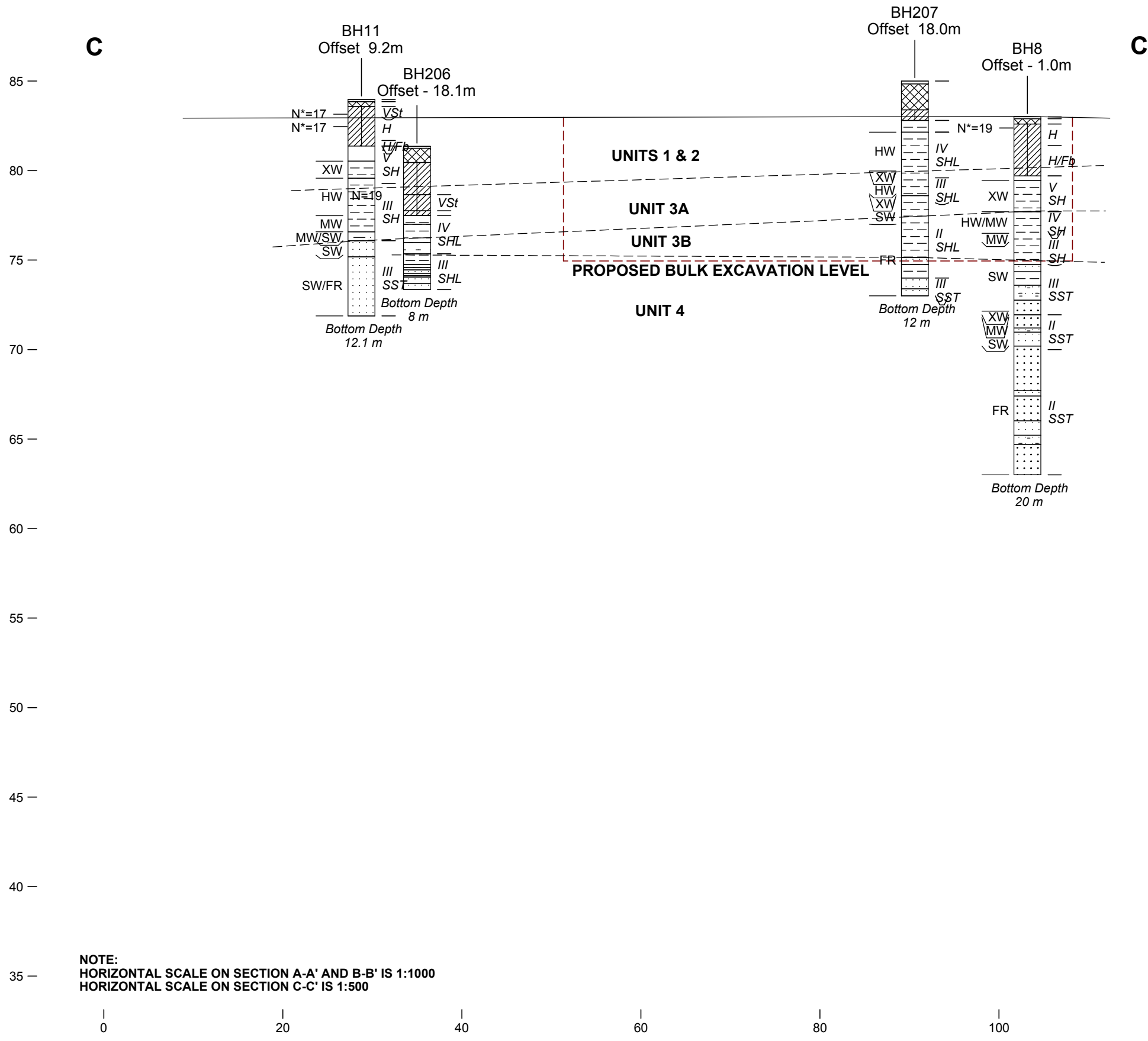
- CONCRETE**
- TOPSOIL**
- FILL**
- CLAY**
- SILTY CLAY**
- NO CORE**
- SHALE**
- SILTSTONE**
- SANDSTONE**
- MUDSTONE**
- SANDSTONE, MEDIUM, MEDIUM - COARSE GRAINED**
- SANDSTONE, COARSE GRAINED**
- SANDSTONE, FINE, FINE TO MEDIUM GRAINED**
- INTERBEDDED SHALE & SANDSTONE**
- IV** **ROCK CLASSIFICATION (PELLS ET AL, 1998)**
- DX** **WEATHERING (SEE EXPLANATION SHEETS)**
- WATER LEVEL**
- N*=17** **STANDARD PENETRATION TEST RESULT**

NOTE:
 HORIZONTAL SCALE ON SECTION A-A' AND B-B' IS 1:1000
 HORIZONTAL SCALE ON SECTION C-C' IS 1:500



A3LANDSCAPE GEOTLCOV23589AA.GPJ COFFEY.GDT 11.9.08

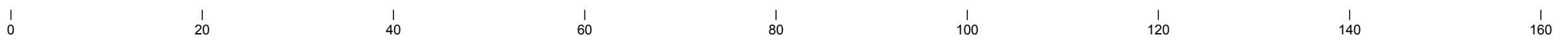
revision	description	drawn	approved	date	 Horizontal Scale (metres) Vertical Scale (metres)	drawn	P JW/LT	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	THIESS PTY LTD		
						approved	P JW		project:	REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL ST LEONARDS, NSW		
						date	23/9/08		title:	GEOTECHNICAL CROSS SECTION B-B'		
						scale	AS SHOWN		project no:	GEOTLCOV23589AA	figure no:	FIGURE 3
						original size	A3					



NOTE:
 HORIZONTAL SCALE ON SECTION A-A' AND B-B' IS 1:1000
 HORIZONTAL SCALE ON SECTION C-C' IS 1:500

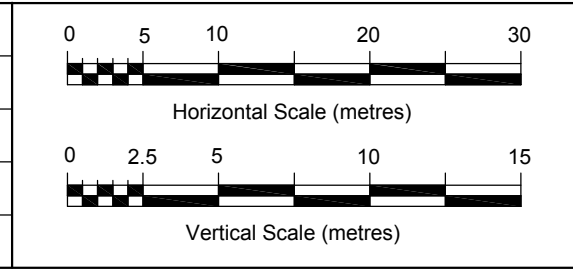
LEGEND

- CONCRETE
- FILL
- SILTY CLAY
- NO CORE
- SHALE
- SILTSTONE
- SANDSTONE
- MUDSTONE
- SANDSTONE, MEDIUM, MEDIUM - COARSE GRAINED
- SANDSTONE, FINE, FINE TO MEDIUM GRAINED
- SANDSTONE, COARSE GRAINED
- INTERBEDDED SHALE & SANDSTONE
- IV** ROCK CLASSIFICATION (PELLS ET AL, 1998)
- DX** WEATHERING (SEE EXPLANATION SHEETS)
- WATER LEVEL
- N*=17** STANDARD PENETRATION TEST RESULT



A3LANDSCAPE GEOTLCOV23589AA.GPJ COFFEY.GDT 11.9.08

revision	description	drawn	approved	date



drawn	PJW/LT
approved	PJW
date	23/9/08
scale	AS SHOWN
original size	A3



client:	THIESS PTY LTD	
project:	REDEVELOPMENT OF ROYAL NORTH SHORE HOSPITAL ST LEONARDS, NSW	
title:	GEOTECHNICAL CROSS SECTION C-C'	
project no:	GEOTLCOV23589AA	figure no: FIGURE 4

Appendix A

Engineering Logs, Core Photographs and Explanation Sheets

Soil Description Explanation Sheet (1 of 2)

DEFINITION:

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 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.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

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 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

TERM	UNDRAINED STRENGTH S_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	-	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	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 detected 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 STRUCTURE

ZONING	CEMENTING
Layers Continuous across exposure or sample.	Weakly cemented Easily broken up by hand in air or water.
Lenses Discontinuous layers of lenticular shape.	Moderately cemented Effort is required to break up the soil by hand in air or water.
Pockets Irregular inclusions of different material.	

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material Structure and fabric of parent rock visible.

Residual soil Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil Deposited by wind.

Alluvial soil Deposited by streams and rivers.

Colluvial soil Deposited on slopes (transported downslope by gravity).

Fill Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil Deposited by lakes.









Marine soil Deposited in ocean basins, bays, beaches and estuaries.

Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)				USC	PRIMARY NAME		
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	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		
		GRAVELS WITH FINES (Appreciable amount of fines)	Predominantly one size or a range of sizes with more intermediate sizes missing.	GP	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 all intermediate sizes missing	SW	SAND	
			SANDS WITH FINES (Appreciable amount of fines)	Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	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.					
		SILTS & CLAYS Liquid limit less than 50	DRY STRENGTH	DILATANCY	TOUGHNESS		
			None to Low	Quick to slow	None	ML	SILT
			Medium to High	None	Medium	CL	CLAY
SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low	OL	ORGANIC SILT		
	High	None	High	MH	SILT		
	Medium to High	None	Low to medium	CH	CLAY		
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.	Pt	PEAT		
<ul style="list-style-type: none"> • Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%. 							

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM	TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.		SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.		TUBE	Tabular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.		TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.		INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.

Defect Discontinuity or break in the continuity of a substance or substances.

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.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME Simple rock names are used rather than precise geological classification.

PARTICLE SIZE Grain size terms for sandstone are:
 Coarse grained Mainly 0.6mm to 2mm
 Medium grained Mainly 0.2mm to 0.6mm
 Fine grained Mainly 0.06mm (just visible) to 0.2mm

FABRIC Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:

Massive No layering or penetrative fabric.

Indistinct Layering or fabric just visible. Little effect on properties.

Distinct Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbreviation	Point Load Index, I_{s50} (MPa)	Field Guide
Very Low	VL	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.

Low	L	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
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Medium	M	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
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High	H	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
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Very High	VH	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
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Extremely High	EH	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.
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CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	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 Material	XW	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	HW	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	MW	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	SW	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	FR	Rock substance unaffected by weathering.






















Notes on Weathering:

- AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
- Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

Notes on Rock Substance Strength:

- In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
- The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
- The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (I_{s50}). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES		Diagram	Map Symbol	Graphic Log (Note 1)	DEFECT SHAPE	TERMS
Term	Definition				Planar	The defect does not vary in orientation
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.				Curved	The defect has a gradual change in orientation
Joint	A surface or crack across which the rock has little or no tensile strength, but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.				Undulating	The defect has a wavy surface
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.				Stepped	The defect has one or more well defined steps
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.				Irregular	The defect has many sharp changes of orientation
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.				Note: The assessment of defect shape is partly influenced by the scale of the observation.	
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.				ROUGHNESS TERMS	
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in place.				Slickensided	Grooved or striated surface, usually polished
					Polished	Shiny smooth surface
					Smooth	Smooth to touch. Few or no surface irregularities
					Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
					Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.
					COATING TERMS	
					Clean	No visible coating
					Stained	No visible coating but surfaces are discoloured
					Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
					Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.
					BLOCK SHAPE TERMS	
					Blocky	Approximately equidimensional
					Tabular	Thickness much less than length or width
					Columnar	Height much greater than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

Engineering Log - Borehole

 Client: **THIESS PTY LTD**

 Date started: **28.8.2008**

Principal:

 Date completed: **29.8.2008**

 Project: **ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT**

 Logged by: **AVS**

 Borehole Location: **ST LEONARDS (SEE SITE PLAN)**

 Checked by: **PJW**

drill model and mounting: Pioneer Mole P160 Truck	Easting: 332568.533	slope: -90°	R.L. Surface: 95.65
hole diameter: 100 mm	Northing 6256204.268	bearing:	datum: AHD

drilling information				material substance									
method	penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material	moisture condition	consistency/density index	pocket penetrometer kPa	structure and additional observations
	1 2 3								soil type: plasticity or particle characteristics, colour, secondary and minor components.			100 200 300 400	
Poaholed		C		None observed while augering	95	1		CH	TOPSOIL: SILTY CLAY: Low plasticity, black, some roots. FILL: SILTY CLAY: High plasticity, red, grey with some fine to coarse gravels.	M			TOPSOIL FILL
				SPT 2,15,10/50 N*=R	94	2			SILTY CLAY: High plasticity, red, pale grey.		VSt		RESIDUAL SOIL
ADT					93	3			SHALE: Extremely weathered, very low strength, pale grey, some iron staining.				BEDROCK
					92	4			Becoming reddish brown in colour.				
					91	5			Becoming highly weathered, dark brown, grey in colour.				
					90	6							
					89	7			Borehole BH201 continued as cored hole				
					88	8							

method AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube B blank bit V V bit T TC bit *bit shown by suffix e.g. ADT	support M mud N nil C casing penetration 1 2 3 4 no resistance ranging to refusal water 10/1/98 water level on date shown water inflow water outflow	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal	classification symbols and soil description based on unified classification system moisture D dry M moist W wet Wp plastic limit W _L liquid limit	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense
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Engineering Log - Cored Borehole

 Client: **THIESS PTY LTD**

 Date started: **28.8.2008**

Principal:

 Date completed: **29.8.2008**



 Project: **ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT**










 Logged by: **AVS**

 Borehole Location: **ST LEONARDS (SEE SITE PLAN)**

 Checked by: **PJW**

drill model & mounting: Pioneer Mole P160 Truck	Easting: 332568.533	slope: -90°	R.L. Surface: 95.65
hole diameter: 100 mm	Drilling fluid: Water	Northing: 6256204.268	bearing: datum: AHD

drilling information				material substance					rock mass defects				
method	core-lift	water	RL	depth metres	graphic log core recovery	material	weathering alteration	estimated strength	IS ₍₅₀₎ MPa	D- diam- etral A- axial	RQD %	defect spacing mm	defect description
						rock type; grain characteristics, colour, structure, minor components		VL L M H VH EH			30 100 300 1000 3000		type, inclination, planarity, roughness, coating, thickness
		None observed while augering	95	1									
			94	2									
			93	3									
			92	4									
			91	5									
			90	6									
						Continued from non-cored borehole							
NMLC	Not monitored while coring		89	7		SHALE WITH SANDSTONE LAMINATIONS: Pale grey and dark grey, thinly laminated at 0-10°, about 70% Shale, 30% Sandstone, with siderite bands.	HW		D 0.03 A 0.03				JT, 30-90°, IR, Closed
			88	8					D 0.07 A 0	45			PT, 5°, PL - IR, iron infilled

method DT diatube AS auger screwing AD auger drilling RR roller/tricone CB claw or blade bit NMLC NMLC core NQ, HQ, PQ wireline core	core-lift  casing used  barrel withdrawn graphic log/core recovery  core recovered - graphic symbols indicate material  no core recovered	water  10/1/98 water level on date shown  water inflow  partial drill fluid loss  complete drill fluid loss  water pressure test result (lugeons) for depth interval shown	weathering FR fresh SW slightly weathered MW moderately weathered HW highly weathered XW extremely weathered DW distinctly weathered (covers MW and HW) strength VL very low L low M medium H high VH very high EH extremely high	defect type JT joint PT parting SM seam SZ sheared zone SS sheared surface CS crushed seam planarity PL planar CU curved UN undulating ST stepped IR irregular roughness VR very rough RO rough SO smooth SL slickensided coating CN clean SN stained VN veneer CO coating
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Engineering Log - Cored Borehole

 Client: **THIESS PTY LTD**

 Date started: **28.8.2008**

Principal:

 Date completed: **29.8.2008**

 Project: **ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT**

 Logged by: **AVS**

 Borehole Location: **ST LEONARDS (SEE SITE PLAN)**

 Checked by: **PJW**

drill model & mounting: Pioneer Mole P160 Truck	Easting: 332568.533	slope: -90°	R.L. Surface: 95.65
hole diameter: 100 mm	Drilling fluid: Water	Northing: 6256204.268	bearing: datum: AHD

drilling information				material substance				rock mass defects						
method	core-lift	water	RL	depth metres	graphic log core recovery	material	weathering alteration	estimated strength	Is ₍₅₀₎ MPa	D- diam- E- axial	A- axial	defect spacing mm	defect description	
						rock type; grain characteristics, colour, structure, minor components								
NMLC				87		SHALE WITH SANDSTONE LAMINATION: Dark grey, pale grey, thinly laminated at 0-10°, about 20% Sandstone, 80% Shale.	HW/MW						PT, IR, RO	
				9										CS, gravelly laminites 70mm
				86										
				10										
				85										
				11										
				84										
				12										
				83										
				13										
				82										
				14										
				81										
				15		SHALE: Dark grey/black thinly laminated at 0-5°.	FR							
				80										
				16										

Defects are PT, 0-20°, PL, SO, CN or SN unless otherwise noted

method DT diatube AS auger screwing AD auger drilling RR roller/tricone CB claw or blade bit NMLC NMLC core NQ, HQ, PQ wireline core	core-lift casing used barrel withdrawn graphic log/core recovery core recovered - graphic symbols indicate material no core recovered	water 10/1/98 water level on date shown water inflow partial drill fluid loss complete drill fluid loss water pressure test result (lugeons) for depth interval shown	weathering FR fresh SW slightly weathered MW moderately weathered HW highly weathered XW extremely weathered DW distinctly weathered (covers MW and HW) strength VL very low L low M medium H high VH very high EH extremely high	defect type JT joint PT parting SM seam SZ sheared zone SS sheared surface CS crushed seam planarity PL planar CU curved UN undulating ST stepped IR irregular roughness VR very rough RO rough SO smooth SL slickensided coating CN clean SN stained VN veneer CO coating
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CORED BOREHOLE GEOTLCOV23589AA.GPJ COFFEY.GDT 12.9.08

Engineering Log - Cored Borehole

 Client: **THIESS PTY LTD**

 Date started: **28.8.2008**

Principal:

 Date completed: **29.8.2008**

 Project: **ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT**

 Logged by: **AVS**

 Borehole Location: **ST LEONARDS (SEE SITE PLAN)**

 Checked by: **PJW**

drill model & mounting: Pioneer Mole P160 Truck	Easting: 332568.533	slope: -90°	R.L. Surface: 95.65
hole diameter: 100 mm	Drilling fluid: Water	Northing: 6256204.268	bearing: datum: AHD

drilling information				material substance				rock mass defects					
method	core-lift	water	RL	depth metres	graphic log core recovery	material rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength				defect spacing mm	defect description type, inclination, planarity, roughness, coating, thickness
								VL	L	M	H		
NMLC				79		SHALE: Dark grey/black thinly laminated at 0-5°. (continued)	FR					60	JT, 30-40°, PL, SO, CN
				17									CS, 30-40°, shale gravels, 30mm
				78									JT, 45-60°, PL, SO, CN
				18									JT, 50-70°, PL, SO, CN
													Fractured Rock, JT, 90°, PL, CN, SO
				77									JT, 50-90°, PL, SO, CN
				19									JT, 20-30°, PL, SO, CN
													JT, 40-60°, PL, SO, CN
				76									JT, 40-60°, PL, SO, CN
				20									JT, 20-40°, PL, SO, CN
				75		MUDSTONE: Grey, massive.							JT, 30-40°, PL, SO-RO, CN
				21		SANDSTONE: Medium grained, pale grey, clay laminae, cross bedded 15-25°.	SW						Jt, 30-40°, CN, SO
				74			FR						Shale SM, 5-6mm
				22									Shale SM, 0-5°, 3mm
				73		22.3 - 22.43m: 130mm seam of black shale interlaminated with sandstone, trace coal lentils.							CS, Sandstone, 13mm
				23		22.86 - 23m: Interlaminated shale and sandstone.							CS, clay, 2mm
				72		SANDSTONE: Coarse grained, pale grey, cross bedded at 20°.							SM, clay, 10mm
				24		SANDSTONE: Coarse grained, pale grey, cross bedded at 20°, some fine carbonaceous particles and laminae present, 10-20mm thick bedding.							CS, clay 30mm 0°

Defects are PT, 0-20°, PL, SO, CN or SN unless otherwise noted

method DT diatube AS auger screwing AD auger drilling RR roller/tricone CB claw or blade bit NMLC NMLC core NQ, HQ, PQ wireline core	core-lift casing used barrel withdrawn graphic log/core recovery core recovered indicate material no core recovered	water 10/1/98 water level on date shown water inflow partial drill fluid loss complete drill fluid loss water pressure test result (lugeons) for depth interval shown	weathering FR fresh SW slightly weathered MW moderately weathered HW highly weathered XW extremely weathered DW distinctly weathered (covers MW and HW) strength VL very low L low M medium H high VH very high EH extremely high	defect type JT joint PT parting SM seam SZ sheared zone SS sheared surface CS crushed seam planarity PL planar CU curved UN undulating ST stepped IR irregular	roughness VR very rough RO rough SO smooth SL slickensided coating CN clean SN stained VN veneer CO coating
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CORED BOREHOLE GEOTLCOV23589AA.GPJ COFFEY.GDT 12.9.08



drawn	MT		client: THIESS PTY LTD	
approved	DS		project: ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT, ST LEONARDS	
date	09/09/2008		title: ROCK CORE PHOTOGRAPH – BH201	
scale	Not to scale		project no: GEOTLCOV23589AA	
original size	A4		Photo no: BH201 1 of 3	



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date	09/09/2008		title: ROCK CORE PHOTOGRAPH - BH201	
scale	Not to scale		project no: GEOTLCOV23589AA	
original size	A4		Photo no: BH201 2 of 3	



drawn	MT		client: THIESS PTY TLD	
approved	DS		project: ROYAL NORTH SHORE HOSPITAL REDEVELOPMENT, ST LEONARDS	
date	09/09/2008		title: ROCK CORE PHOTOGRAPH – BH201	
scale	Not to scale		project no: GEOTLCOV23589AA	
original size	A4		Photo no: BH201 3 of 3	