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Faculty of Arts and Social Sciences (FASS) Building

Prepared for
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For and on behalf of Coffey



Ross Best
Senior Principal

Quality information

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1. Introduction

This report presents the results of a preliminary geotechnical assessment carried out for the proposed Faculty of Arts and Social Sciences (FASS) Development at University of Sydney (UoS), Camperdown Campus. This preliminary geotechnical assessment was commissioned by Lend Lease Building (LLB) on behalf of UoS and was carried out in general accordance with our fee proposal (Ref: GEOTLCOV25283AE-AB dated 29 March 2016).

The objective of this preliminary assessment is to identify risks and opportunities for the development and to support the Development Application (DA).

This report provides advice in the form of a Geotechnical Desktop Study based on geotechnical investigations completed to date with a detailed Geotechnical Interpretive Report (GIR) to aid detailed design and tender following the DA submission.

2. Site

The proposed FASS development is located at the northern end of UoS, Camperdown campus between Parramatta Road and the existing UoS R.D.Watt Building. Presently east of the site is occupied by car parking, a native animal house and is bounded by an access road in north-south direction. Northern end of the site is occupied by a demountable village and a substation. Cricket nets are located towards the western end of the site. The centre of the site is occupied by temporary offices, maintenance building and hardstand.

The existing ground surface slopes up from 29 mAHd in the south-west corner of the site to 33.9 mAHd to north-east corner of the site. Figure 1 shows the location of the proposed FASS building relative to other existing buildings and features.

Figure 1- Site of the proposed FASS building



3. Project appreciation

Future development

The FASS development will involve the construction of a new 6 level facility comprising:

- Computer laboratories and general teaching spaces on Level 1;
- Lecture theatre at the western end of the building over Level 1 and Level 2;
- Tutorial rooms and consultation rooms on Level 2;
- Offices and meeting rooms on Level 3, Level 4, Level 5, and Level 6;
- Plant rooms on Level 1 and Level 6; and
- Various breakout spaces, informal lounges/seating, and facilities on each level.

Several trees will be retained along northern and southern boundary with hard and soft landscaping works including tree planting.

Internal alterations and additions to the R.D.Watt Building to facilitate uses that are complementary to the FASS development are also proposed. The FASS building will be physically separated from the R.D.Watt Building by a linear courtyard, which will function as an entry space to the new building.

The proposed development will be constructed between the demountable village in the west and access road in the east. Figure 2 shows a section through the FASS building looking north.

Figure 2- Section through the proposed FASS building looking north



LEGEND

34.05 mAHD - Proposed elevations

The proposed development involves,

- excavation of the western end of the site by about 3.5 m and eastern end of the site by about 8.5 m to achieve the proposed Level 1 ground surface elevation of 25.65 mAHD for the FASS building;
- excavation/land forming of about 8.5 m the northern area of the FASS building and approximately 4.5 m in the southern area, outside of the building to R.D.Watt Building, to Level 1 ground surface elevation of 25.65 mAHD; and
- construction of FASS building consisting of 6 levels (0.16 hectare in area).

4. Local geology

The Sydney 1:100,000 Geological Series Sheet (9130 Edition 1 1983) indicates that site is underlain by Ashfield Shale (Winamatta group), which is typically dark grey to black claystone, siltstone and fine grained sandstone and laminate.

The Sydney 1:100,000 Soil Landscape Series Sheet (9130 Edition 1 1983) indicates that site is underlain by "Blacktown Landscape" generally comprising undulating rises of shallow moderately to highly reactive soil overlying shale.

The Botany Bay 1:25,000 Acid Sulfate Soil Risk Map (9130S3 Edition 2 1997) indicated that the site is within the area of no known occurrence of acid sulfate soils.

5. Previous investigations

Coffey has carried out two geotechnical investigations previously at the proposed FASS development site. The locations of all boreholes and bedrock elevations are provided in Drawing 1 in Appendix A. Engineering borehole logs for both investigations are provided in Appendix B with Soil and Rock explanation sheets.

1. Coffey report "FASS Enabling Works" Ref: GEOTLCOV25283AD-AD dated 2 February 2015
Works involved drilling 13 boreholes up to a depth of 5 m in January 2015 and installing three standpipe piezometers. Boreholes BH01, BH02, BH04, BH05, BH07, BH08 and BH10 were drilled within the proposed FASS building footprint to depths up to 3 m.
2. Coffey report ref: GEOTLCOV24714AA-AB dated 9 November 2012 for ProDev Pty Ltd
Two boreholes EX-BH1 and EX-BH2 were drilled within the proposed FASS development and encountered shale bedrock at a depth of 1.9 m and 0.8 m below ground level respectively.

6. Geotechnical investigation

Coffey has carried out a recent geotechnical investigation on site in May 2016 to investigate the weathering and strength profile of the shale bedrock on the eastern end of the site. Two boreholes (BH14 and BH15) were drilled up to 15.5 m depth from the surface in the north-eastern corner of the site adjacent to the access road. The locations of these boreholes are shown in Drawing 1.

7. Geotechnical model

A preliminary geotechnical model was developed as below based on the existing borehole information.

Table 1: Inferred ground model

Unit	Material	Description	Depth to top of unit ² (m)	Elevation to the top of unit (mAHD)	Thickness of the unit (m)
1	Fill ³	<ul style="list-style-type: none"> Consist of asphalt /concrete surfacing, Silty Clays, Gravelly Clay, Gravelly Sand Low to high plasticity clay, fine to coarse grained sand 	0.0 (surface)	34.0 to 29.0	0.2 to 1.0
2	Residual Soil	<ul style="list-style-type: none"> Silty Clay Medium to High plasticity Very Stiff to Hard consistency 	0.3 to 1.0	28.1 to 33.6	0.2 to 0.7
3a	Extremely to highly Weathered Shale	<ul style="list-style-type: none"> Very Low to Low strength Class V to IV¹ 	0.7 to 1.7	27.6 to 33.3	1.0 to >3.9 ⁴
3b	Moderately to slightly weathered Shale	<ul style="list-style-type: none"> Low strength Class III¹ 	4.7 to 5.0 ⁵	29.1 ⁵	1.6 to 1.8 ⁵
3c	Fresh Shale and Laminite	<ul style="list-style-type: none"> Medium to high strength shale (becoming mainly high strength laminite below 21 mAHD) Class II¹ 	7.5 to 7.8 ⁵	26.3 ⁵	Not assessed

Notes on Table 1:

1. Rock classified as sandstone in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.
2. The depths are based on the Coffey boreholes and may not be representative of all areas at the site.
3. The fill is not one uniform layer but at different thicknesses at discrete locations.
4. Majority of boreholes were not extended through extremely weathered shale. Based on BH14 and BH15 cored boreholes, maximum thickness has been determined.
5. Units 3b and 3c are based on conditions observed in BH14 and BH15 locations. The weathering and strength of shale at other borehole locations may not be accurately represented in this model.

Boreholes BH01 to BH08 and BH10 were drilled (during the investigation in January 2015) within/ adjacent to the proposed FASS building footprint and were varying in depths between 2 m and 3 m. These boreholes encountered extremely weathered very low strength shale bedrock between 0.7 m to 2 m from the ground surface. Soil cover overlying weathered shale was composed of fill (clay and sand) and natural high plasticity residual silty clay. Thickness of fill material associated with the previous J.R.A McMillan Building footprint varied up to 1.0 m. The residual soil across the site varied in thickness up to 0.8 m across the building footprint. Extremely weathered, very low strength shale was encountered at 27.6 m AHD at the south-west corner and 33.2 m AHD at north-east corner of the footprint area.

Boreholes BH14 and BH15 (May 2016) were drilled on the eastern corner of the proposed footprint (in the existing car park area) to 15.5 m depth from the existing ground surface. BH14 and BH15 encountered fill and residual soils up to 0.8 m thickness with extremely weathered shale at about 33 mAHD. In BH14 and BH15 moderately to slightly weathered shale of low to medium strength was

encountered between approximately 29.1m AHD and 26.3 m AHD overlying fresh shale of mainly medium strength. Fresh laminite of mainly high strength was encountered below an elevation of about 21 m AHD.

A geological section of the subsurface conditions encountered has been developed and attached in Appendix A Drawing 2. The section is from east to west through the centre of the site, looking north.

8. Groundwater

Three standpipe piezometers were installed in BH02, BH09 and BH12 during the investigation in January 2015.

The following groundwater observations were made during the investigation works in 2015-2016.

Table 2: Groundwater observations

Standpipe	Location relative to FASS building location	Groundwater elevation in January 2016 (m AHD)	Groundwater elevation in January 2015 (m AHD)	Depth to groundwater below proposed FASS Level 1 (25.7 m AHD)
BH12	35 m west of FASS building	22.1	22.5	3.6
BH02	Within FASS building, western end	26.4	26.7	Water level 0.7 m above proposed Level 1
BH09	15 m south of FASS building	30.2	28.8	Water level 4.5 m above proposed level 1

Based on the latest groundwater observations, the groundwater level in the vicinity of the FASS building varies from 26.4 m AHD in the west to 30.2 m AHD in east. Based on ground conditions encountered in BH14 and BH15, the groundwater is expected to be present within the highly weathered shale.

Groundwater levels will vary accordingly to climatic conditions and in response to rainfall and perched groundwater could occur within the shale profile.

9. Discussion

9.1. Potential issues associated with site demolition

Prior to the ground excavation for the proposed development, the existing buildings, car parking and the demountable village will need to be demolished.

Existing structures surrounding R.D.Watt Building

Prior to demolition works undertaken on the existing developments surrounding the R.D.Watt Building, assessment of footings/ building foundation of R.D.Watt building should be carried out and used to support the development of demolition methodology prior to starting demolition works. Continuous monitoring of the building is recommended during demolition. Prior to the commencement of building demolition works, dilapidation surveys of the R.D.Watt building are also recommended to be carried out.

Existing retaining walls

Existing retaining walls have been located to the east of the existing cricket nets and north of R.D.Watt Building. It is expected that these retaining walls will be removed during demolition works.

It is recommended that during demolition of these retaining walls, site visits by a geotechnical engineer to review performance of existing slope and foundations be carried out. Additionally, stockpiles or demolishing debris should not be stored above retaining walls to minimise surcharging of such retaining walls.

9.2. Impacts to adjacent structures from excavations

Eastern excavation

Presently, the proposed development involves excavation of the eastern end of the site adjacent to the access road and Hayden-Lawrence Building by about 8.5 m to achieve proposed Level 1 ground surface elevation of 25.65 mAHD.

Northern excavation

The excavation/land forming along the northern boundary to Level 1 is expected to bring the ground level of the FASS development to the level of Parramatta Road. Presently, the northern end of the site is retained by a 5 m high retaining wall. We understand that this retaining wall is to be retained during development excavation.

Southern excavation

R.D.Watt Building is located 5 m south of the proposed FASS Building footprint. After demolition of the existing maintenance building and hardstand, an excavation of about 4 m will be required to achieve Level 1 ground elevation of 25.65 mAHD.

9.2.2. Excavation-induced vibrations

Any excavation works associated with the FASS development may affect adjacent structures i.e. the adjacent heritage structures.

The use of excavation plant such as impact hammers will generate vibrations that may affect any surrounding sensitive structures (in particular the R.D Watt Building) and buried services. Measures to mitigate the risks associated with vibration such as the use of rock saws or rock grinders should be considered. For excavation, the vibration limits in Table 3 below are commonly recommended to reduce the risk of vibration damage to sensitive receptors.

Table 3: Ground Vibration Limits for Various Types of Structures

Type of Structure	Peak Particle velocity (mm/s)
Historic buildings or monuments	2
Residential or low rise buildings in good condition	10
Reinforced concrete commercial and industrial buildings in good condition	25

It is recommended that a limit is selected considering the structure of concern. It should be noted that limits set by the relevant authorities may override these commonly adopted limits

Dilapidation surveys should be carried out on neighbouring structures or sensitive services prior to commencing excavation as a baseline record of their condition. Excavation trials with vibration monitoring should also be carried out to assess appropriate distances for various excavation plant to be used to limit generated vibrations, and need for ongoing vibration monitoring during site works to check that the limits are not exceeded.

Depending on the complexity of the geotechnical problem, further assessments such as an empirical assessment or 3-dimensional finite element analyses may be required together with consultation with the project structural engineers to assess possible load influences, resulting ground movements/stresses, and additional support requirements.

9.2.3. Excavation-induced ground movements

The proposed excavation for the basement and the Level 1 ground surface elevation will induce some ground movements due to removal of lateral support. Many factors can influence the magnitude of these movements, from ground conditions to design and construction quality.

Published data suggests that an adequately designed and installed retention system in soil and weathered rock can experience lateral movements between 0.1% and 0.3% of the retained height. If this aspect is likely to be critical, a more detailed numerical analysis should be carried out to assess likely ground movements when designing the shoring system.

Based on our experience in Sydney, lateral movements (typically about 0.5 mm to 2 mm per metre of excavation) can occur due to relief of *in situ* locked-in horizontal stresses during excavation in rock. Lateral ground movements due to stress relief have been measured at distances of up to 1.5 to 2 times the excavation depth from the edge of excavations. Stress relief ground movements are unlikely to be significant at distances greater than twice the excavation depth.

These approximations will be affected by local geological structures and should only be used as a guide. The potentially damaging effects of stress redistribution on structures in the vicinity of the proposed basement excavation should be assessed as part of the detailed design process.

It is recommended that dilapidation surveys and footing investigations be carried out before the excavation to assess the condition of the buildings with the zone of influence of the FASS development excavation. Such investigation would investigate the elevation of footings (footings within the influence zone of the excavation, if any) and the foundation and assess the risk of damage to the footings due to excavation. Potential risk of damage to building footings from ground movements during excavation should be considered when developing the excavation methodology. Ground movements of the building should be monitored during excavation to reduce the risk of damage from excessive ground movements/ vibrations.

9.3. Excavation conditions

- Excavation of the northern end of the site is expected to penetrate fill, residual soil, very low to low strength Shale.

- Excavation to Level 1 on the southern side is expected to penetrate fill, residual soil, very low to medium strength Shale.
- Excavation to Level 1 on the eastern end is expected to penetrate fill, Residual soil, very low strength Shale to fresh medium strength Shale.

Fill, residual soils, and very low strength rock could likely be excavated using conventional earth moving plant such as large tracked excavators, equipped with toothed buckets. Low strength or stronger rock may require excavation techniques such as the use of hydraulic rock breakers fitted to excavators. High strength rock may require use of rock saw. Excavation contractors should inspect the engineering logs obtained during our ground investigation to make their own judgement as to likely productivity, or suitability of specific plant.

9.4. Excavation support

Unsupported excavations

Unsupported excavations in Units 1, 2 and 3a will require batters in the order of 2 to 1.5 (H):1V. Units 3b and 3c may be excavated vertically without the use of batters. Unsupported vertical excavation in Unit 3b during and Unit 3c will need to be assessed progressively during excavation to assess the need for rock bolts of other support.

Retention systems

The magnitude of excavation-induced ground movements will depend on the ground conditions and lateral pressures they induce, the shoring system adopted, and the construction sequence and workmanship.

The type of retention system used will depend upon the requirements and construction sequence. For this type of project, Soldier Pile Wall or Contiguous Pile Wall retention systems could be considered.

For depths of excavation in the order of 4 m to 8 m, it is unlikely that cantilevered pile walls will be adequate to limit the adjacent ground movements. To provide additional wall stiffness, pile walls may need to be internally propped or anchored. The use of temporary or permanent anchors under the adjoining streets and properties will require owner permission.

Numerical analysis based on site specific geotechnical investigation is recommended to assess likely ground movements for design of the shoring system.

9.5. Groundwater

The permanent groundwater level is expected to vary between 26.4 mAHD (west) to 30.2m AHD (east) across the site based on latest groundwater observations. If seepage rates into the excavation are low, the basement could be designed as drained using conventional sump and pump methods subject to appropriate approvals. (The release of groundwater to stormwater is regulated and is subject to regulatory approvals including environmental assessment and approval). If high groundwater inflows occur, basement may need to be designed as a tanked basement.

9.6. Footings

At Level 1 elevation of 25.65m AHD, the rock is expected to be of low to medium strength.

We would expect pad footings founded on rock could be designed for serviceability bearing pressures of 2.5 MPa for medium strength shale. Higher bearing pressure may be acceptable subject to field observations of footing excavations. Based on BH14 and BH15, high strength shale is encountered below 21 m AHD at the eastern end of the footprint.

For buildings founded on low strength shale, a serviceability bearing pressure of 700 kPa may be adopted.

9.7. Acid sulfate soil

Based on the Botany Bay 1:25,000 Acid Sulfate Soil Risk Map, the site is located within a "No Known Occurrence" area. It is not believed there to be a presence of acid sulfate soils on site.

10. Limitations

Subsurface conditions can be complex and vary over relatively short distances – and over time. Detailed design should be based on information from geotechnical investigation report currently being developed. Detailed design and construction should not proceed on the basis of this desk study report without further geotechnical advice.

Site contamination has not been addressed as part of this geotechnical desk study. As per our proposal ref: GEOTLCOV25283AE-AB dated 29 March 2016, advice will be issued in form of a letter which considers the revised development layout and previous environmental assessments conducted for the site.

The attached document entitled "Important information about your Coffey report" forms an integral part of this report and presents additional information about its uses and limitations.



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.

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.



Important information about your **Coffey Report**

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.

Appendix A – Drawings



LEGEND

- EXISTING COFFEY BORES
- GEOTECHNICAL BORES
- ENVIRONMENTAL BORES
- STANDPIPE
- 28.8 TOP OF ROCK LEVEL (mAHd)
- APPROXIMATE FASS BUILDING FOOTPRINT
- APPROXIMATE FASS PRECINCT BOUNDARY
- SECTION LINE

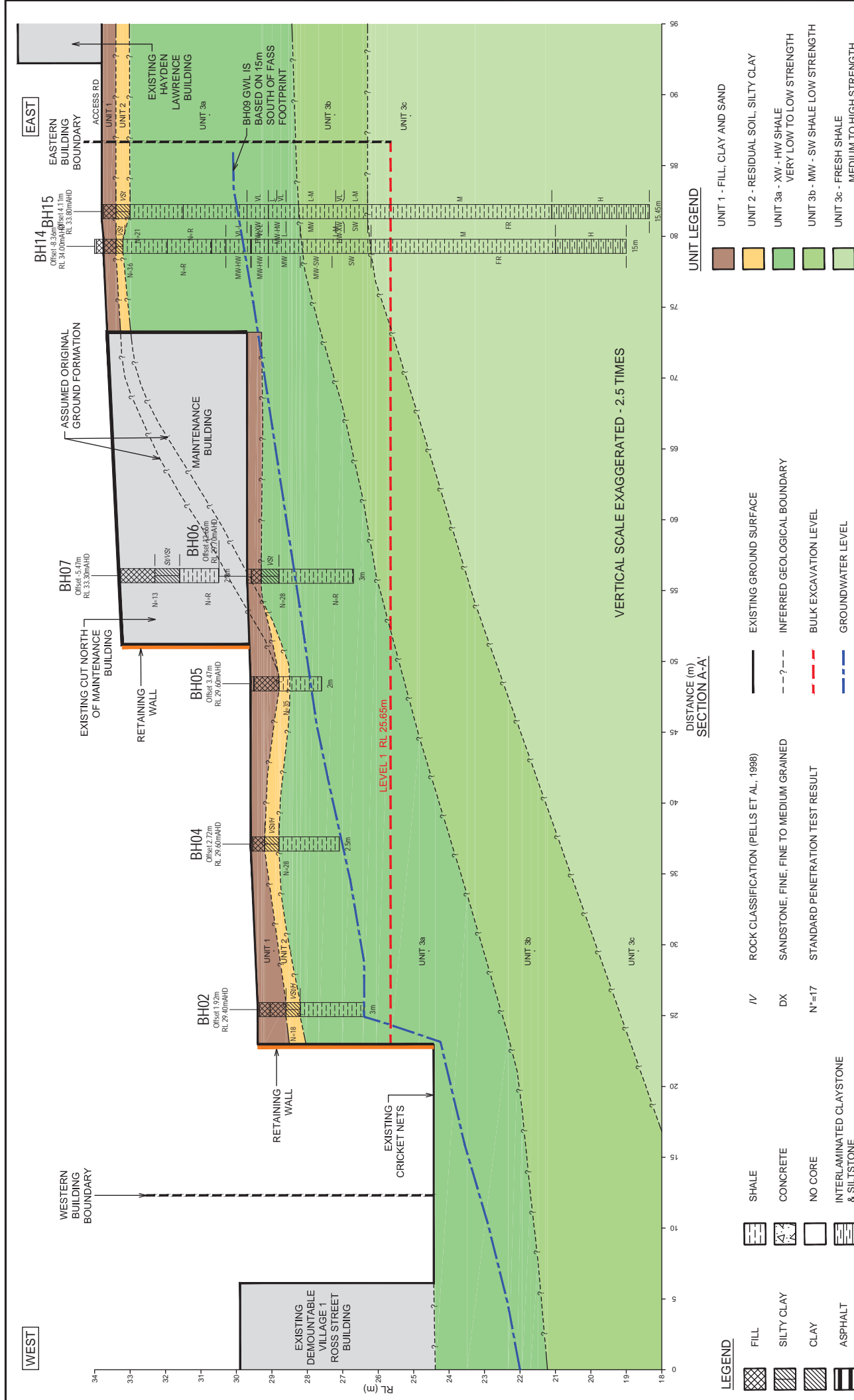
SOURCE: RPS - DWG No. PR125252-SU-001 - 16/03/2015

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date	17 / 05 / 16	scale	AS SHOWN
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client:	UNIVERSITY OF SYDNEY C/O LEND LEASE BUILDING
project:	UNIVERSITY OF SYDNEY FASS BUILDING UNIVERSITY OF SYDNEY, NSW
title:	SITE AND BOREHOLE LOCATION PLAN
project no.:	GEOTLCOV25283AE-AC
figure no.:	DRAWING 1
rev.:	A





UNIT LEGEND

	UNIT 1 - FILL, CLAY AND SAND
	UNIT 2 - RESIDUAL SOIL, SILTY CLAY
	UNIT 3a - XW - HW SHALE VERY LOW TO LOW STRENGTH
	UNIT 3b - MW - SW SHALE LOW STRENGTH
	UNIT 3c - FRESH SHALE MEDIUM TO HIGH STRENGTH

LEGEND

	FILL
	SILTY CLAY
	CLAY
	ASPHALT
	SHALE
	CONCRETE
	NO CORE
	INTERLAMINATED CLAYSTONE & SILTSTONE
	ROCK CLASSIFICATION (PELLS ET AL., 1998)
	SANDSTONE, FINE, FINE TO MEDIUM GRAINED
	STANDARD PENETRATION TEST RESULT
	BULK EXCAVATION LEVEL
	GROUNDWATER LEVEL
	EXISTING GROUND SURFACE
	INFERRED GEOLOGICAL BOUNDARY

no.	description	drawn	approved	date
A	ORIGINAL ISSUE	DK	RB	17/05/16

client: UNIVERSITY OF SYDNEY C/O LEND LEASE BUILDING

project: UNIVERSITY OF SYDNEY FASS BUILDING
UNIVERSITY OF SYDNEY, NSW

title: SECTION A-A

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rev: A

drawn: DK / AW

approved: RB

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scale: AS SHOWN

original size: A3

Horizontal Scale (metres) 1:250

Vertical Scale (metres) 1:100

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Appendix B – Engineering borehole logs

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 μ m to 2.36 mm
	medium	200 μ m to 600 μ m
	fine	75 μ m to 200 μ m

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 2.36 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 2.36 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes	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 (A 0.075 mm particle is about the smallest particle visible to the naked eye)	SILTS & CLAYS Liquid limit less than 50	IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
		DRY STRENGTH	DILATANCY	TOUGHNESS		
		None to Low	Quick to slow	None	ML	SILT
	SILTS & CLAYS Liquid limit greater than 50	Medium to High	None	Medium	CL	CLAY
		Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		Low to medium	Slow to very slow	Low to medium	MH	SILT
	SILTS & CLAYS Liquid limit greater than 50	High	None	High	CH	CLAY
		Medium to High	None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture.			Pt	PEAT	

• Low plasticity – Liquid Limit w_L less than 35%. • Medium plasticity – w_L between 35% and 50%. • High plasticity – w_L greater than 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	Tubular 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, $I_s(50)$ (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.
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.
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.
Very High	VH	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	EH	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

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 $I_s(50)$. 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. Formad by weathering of the rock substance in place.				Slickensided	Grooved or striated surface, usually polished
Notes on Defects:					Polished	Shiny smooth surface
1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.					Smooth	Smooth to touch. Few or no surface irregularities
2. Partings and joints are not usually shown on the graphic log unless considered significant.					Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.					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

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH01**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.50 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance								
method & support	penetration	samples & field tests	water	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	E	Not Encountered	29	0.5		E	FILL: Gravelly CLAY low plasticity, dark grey, grey, with concrete, shale, brick and timber fragments of gravel size.	<Wp		100 200 300 400	FILL
								FILL: Silty CLAY medium plasticity, red brown, brown, dark grey and dark brown, with construction rubble such as concrete, brick and shale of gravel size.				PID: 5.8 ppm
								Silty CLAY : high plasticity, red brown, orange brown, grey.				PID: 5.3 ppm
								SHALE : red brown, grey, extremely weathered, estimated very low strength.				PID: 5.2 ppm
		SPT 4, 7, 11 N*=18		1.0					VSt / H			RESIDUAL SOIL
		SPT 7, 15, 25 N*=40		2.5								EXTREMELY WEATHERED BEDROCK
				3.0				Borehole BH01 terminated at 3.0 m Target stratum				
				-26	3.5							

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:29

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH02**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.40 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance						
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	E	29.0		D	ASPHALT: 0.05m.	D	VSt / H	100 200 300 400	PAVEMENT
			29.5			FILL: Gravelly SAND medium to coarse grained, dark brown, dark grey, fine to medium grained gravel.				FILL
			30.0			FILL: CLAY: high plasticity, dark grey, grey, with trace of gravel.				PID: 4 ppm
			30.5			Silty CLAY: high plasticity, red brown.				PID: 3.3 ppm
AD/T	SPT 4, 7, 11 N*=18	E	31.0		CH	SHALE: red brown, brown, pale grey, extremely weathered, estimated very low strength.	<Wp	VSt / H	100 200 300 400	RESIDUAL SOIL
			31.5			EXTREMELY WEATHERED BEDROCK				
AD/T	D	D	32.0			Borehole BH02 terminated at 3.0 m			100 200 300 400	
			32.5			Target stratum				
AD/T			33.0						100 200 300 400	
			33.5							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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Piezometer Installation Log

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Hole ID: **BH02**

sheet: 1 of 1

project no: **GEOTLCOV25283AD**

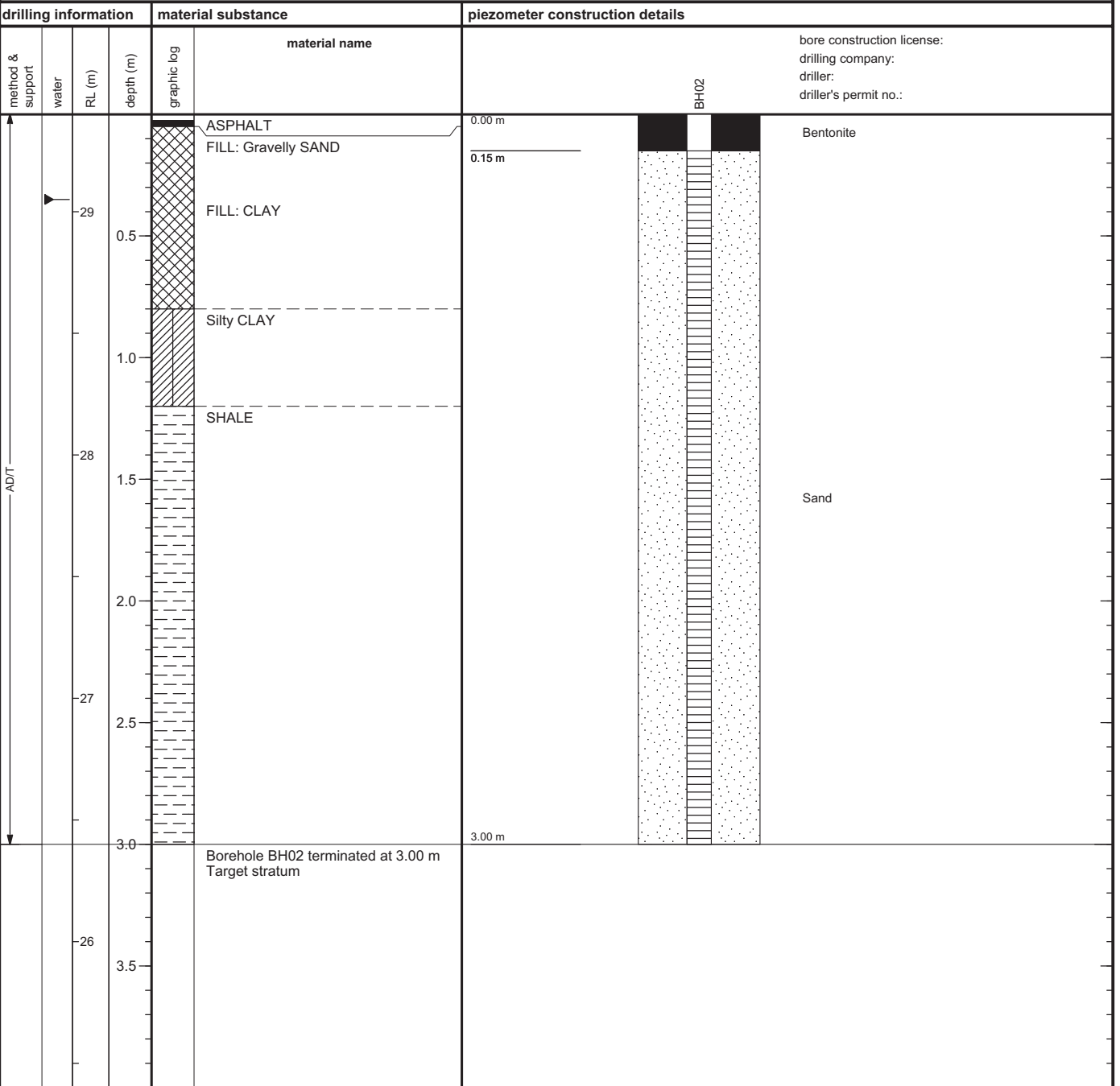
date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.40 m (AHD) angle from horizontal: 90°
 equipment type: Commacchio 305, Track mounted hole diameter : 100 mm



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method & support		graphic log / core recovery		ID	type	stick up & RL	tip depth & RL	install. date	water level
see engineering log for details				BH02	standpipe		3.00 m 26.40 m AHD		
water 10-Oct-12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss water pressure test result (lugeons) for depth interval shown									

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH03**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.00 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information			material substance							
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
DT	1 2 3		28			CONCRETE 0.12m.				PAVEMENT
		E	0.5			Gravelly Sandy CLAY low plasticity, dark brown, dark grey, fine to coarse grained sand, with sandstone and bricks of gravel size.	<Wp			FILL PID: 6.1 ppm
		E								PID: 5.3 ppm
		E	1.0		CH	Silty CLAY : high plasticity, red brown, pale grey, grey, with a trace of fine grained ironstone gravel.		VSt		RESIDUAL SOIL
		SPT 4, 5, 8 N*=13	1.5			SHALE : pale grey, red brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
			2.0							
			2.5							
		SPT 8, 20, 16 N*=36	3.0			Borehole BH03 terminated at 3.0 m Target stratum				
			3.5							

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method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration water water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH04**

sheet: 1 of 1

project no: **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.60 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance							
method & support	penetration	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	Not Encountered	E	29	[Cross-hatched pattern]	D	ASPHALT: 0.06m.	D	VSt / H	100 200 300 400	PAVEMENT
							FILL: Gravelly SAND medium to coarse grained, brown, dark brown, gravel sized brick and asphaltic concrete.				FILL
							Silty CLAY: medium plasticity, pale grey, grey, mottled red brown.				RESIDUAL SOIL
							SHALE: red brown, brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
		SPT 8, 12, 16 N*=28	-28	1.0	[Horizontal line pattern]						
			-27	2.5			Borehole BH04 terminated at 2.5 m Target stratum				
			-26	3.5							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration water 	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH05**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.60 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance								
method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
	1 2 3							SOIL TYPE plasticity or particle characteristic, colour, secondary and minor components			100 200 300 400	
								ASPHALT: 0.1m.				PAVEMENT
			E					FILL: Gravelly SAND medium to coarse grained, dark grey, dark brown, fine to coarse grained gravel.	D			FILL PID: 2.2 ppm
			E		0.5							PID: 1.9 ppm
			E		0.9			SHALE: orange brown, pale grey, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK PID: 2.5 ppm
			SPT 9, 15, 20 N*=35		1.0							
					1.5							
					2.0			Borehole BH05 terminated at 2.0 m Target stratum				
					2.5							
					3.0							
					3.5							
					26							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration water 	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH06**

sheet: 1 of 1

project no: **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 29.70 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance								
method & support	penetration	samples & field tests	water	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
	1 2 3							SOIL TYPE plasticity or particle characteristic, colour, secondary and minor components			100 200 300 400	
DT								CONCRETE 0.12m.				PAVEMENT
		E						FILL: Gravelly CLAY high plasticity, grey, brown, gravel sized sandstone and construction rubble.	<Wp			FILL PID: 6.4 ppm
		E			0.5		CH	Silty CLAY: high plasticity, pale grey, red brown, with a trace of fine grained gravel.		VSt		RESIDUAL SOIL PID: 6.3 ppm
				-29				SHALE: pale grey, red brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
		SPT 7, 10, 18 N*=28	Not Encountered		1.0							
					1.5							
				-28								
					2.0							
					2.5							
		SPT 11, 17, 10/80mm N*=R			2.5							
					3.0			Borehole BH06 terminated at 3.0 m Target stratum				
					3.5							
				-27								
					3.0							
					3.5							
				-26								

CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:29

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH07**

sheet: 1 of 1

project no: **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 33.30 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance							
method & support	penetration	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD HA	1 2 3	E	33	0.5			ASPHALT: 0.03m.	<Wp			PAVEMENT
							FILL: Gravelly CLAY low plasticity, dark brown, dark grey, brick, ironstone, sandstone and glass fragments of gravel size.				FILL
											PID: 5.7 ppm odourous PID: 8.7 ppm PID: 6.9 ppm
		SPT 4, 5, 8 N*=13	32	1.0		CH	Silty CLAY: high plasticity, red brown, pale grey.	St / VSt		RESIDUAL SOIL	
			31	2.0			SHALE: pale grey, red brown, brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
		SPT 10, 18, 5/0mm HB N*=R	30	2.5							
			30	3.0			Borehole BH07 terminated at 2.8 m Target stratum				

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 17:40

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH08**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 33.90 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance							
method & support	penetration	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	Not Encountered	E	0.5	[diagonal hatching]	CH	ASPHALT: 0.1m.	<Wp	VS / H	100 200 300 400	PAVEMENT
							FILL: CLAY: medium plasticity, dark brown, brown, with some fine to medium grained gravel and fine to coarse grained sand.				FILL PID: 2.4 ppm
							Silty CLAY: high plasticity, red brown, grey.				RESIDUAL SOIL PID: 1.1 ppm
							SHALE: red brown, grey, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
		E SPT 12, 20, 5/10mm N*=R	-33	1.0	[horizontal dashes]						
			-32	2.0			Borehole BH08 terminated at 2.0 m Target stratum				
			-31	3.0							
			-30	3.5							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration water 	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:30

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH09**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 32.50 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance							
method & support	penetration	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	Not Encountered	-	32.0	[Cross-hatched pattern]	D	ASPHALT: 0.06m.	D			PAVEMENT
				31.5			FILL: Gravelly SAND medium plasticity, orange brown, brown, dark brown, asphalt, brick and construction rubble of gravel size.				FILL
				31.0			Silty CLAY: medium plasticity, orange brown, red brown, brown.				RESIDUAL SOIL
				30.0			SHALE: pale grey, orange brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
				5.0			Borehole BH09 terminated at 5.0 m Target depth				

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration water 	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 17:40

Piezometer Installation Log

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Hole ID. **BH09**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **18 Jan 2016**

date completed: **18 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 34.50 m (AHD) angle from horizontal: 90°
 equipment type: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information		material substance		piezometer construction details				
method & support	water	RL (m)	depth (m)	graphic log	material name	bore construction license: drilling company: driller: driller's permit no.:		
AD/T Not Encountered		34	1		ASPHALT FILL: Gravelly SAND	BH09 Cuttings Bentonite Sand		
		33	2		Silty CLAY			1.50 m
		32	3		SHALE			2.00 m
		31	4					
		30	5					5.00 m
		29	6		Borehole BH09 terminated at 5.00 m Target depth			
		28	7					
		27						

method & support see engineering log for details water 10-Oct-12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss water pressure test result (lugeons) for depth interval shown	graphic log / core recovery core recovered (graphic symbols indicate material) no core recovered	<table border="1"> <thead> <tr> <th>ID</th> <th>type</th> <th>stick up & RL</th> <th>tip depth & RL</th> <th>install. date</th> <th>water level</th> </tr> </thead> <tbody> <tr> <td>BH09</td> <td>standpipe</td> <td></td> <td>5.00 m 29.50 m AHD</td> <td></td> <td></td> </tr> </tbody> </table>	ID	type	stick up & RL	tip depth & RL	install. date	water level	BH09	standpipe		5.00 m 29.50 m AHD		
ID	type	stick up & RL	tip depth & RL	install. date	water level									
BH09	standpipe		5.00 m 29.50 m AHD											

CDF_0_9_04BB.GLB Log COF PIEZOMETER INSTALLATION LOG GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 16:29

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH10**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 34.00 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance						
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	E	34		D	ASPHALT: 0.05m.	D	VS	100 200 300 400	PAVEMENT
			0.5			FILL: Gravelly SAND medium to coarse grained, dark brown, dark grey, fine to medium grained gravel.				FILL
			0.5			Silty CLAY: high plasticity, red brown, pale grey.				RESIDUAL SOIL
			1.0			SHALE: pale grey, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
		E	33							PID: 5.9 ppm
		E	32							PID: 5.5 ppm
			2.0			Borehole BH10 terminated at 2.0 m Target depth				PID: 5.3 ppm
			2.5							
			3.0							
			3.5							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:30

Engineering Log - Borehole

Borehole ID: **BH11**
 sheet: 1 of 1
 project no: **GEOTLCOV25283AD**
 date started: **19 Jan 2016**
 date completed: **19 Jan 2016**
 logged by: **CL**
 checked by: **DS**

client: **University of Sydney c/o Lend Lease Building**
 principal:
 project: **FASS Enabling Works**
 location: **FASS Development, University of Sydney, Camperdown Campus**

position: Not Specified surface elevation: 26.80 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance					
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	structure and additional observations
DT	1	E	0.0	△	CH	CONCRETE 0.13m.			PAVEMENT
	2	E	0.1	△	CH	FILL: Gravelly CLAY medium plasticity, dark brown, dark grey, fine to medium grained gravel.	<Wp	St	FILL
	3	E	0.5	△	CH	CLAY: high plasticity, dark brown, pale grey.		VSt / H	RESIDUAL SOIL PID: 5.7 ppm
		E	1.0	△	CH				PID: 6.7 ppm
		E	1.8	△	CH				PID: 1.8 ppm
		E	2.0	△	CH	SHALE: dark grey, red brown, brown, extremely weathered, estimated very low strength.			EXTREMELY WEATHERED BEDROCK
		E	2.0	△	CH	Borehole BH11 terminated at 2.0 m Target depth			

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud C casing N nil penetration water 	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:30

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH12**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 24.00 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance						
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T	1 2 3	E	24		CH	ASPHALT: 0.02m.	D	VSt / H	100 200 300 400	PAVEMENT
			23			FILL: Gravelly SAND fine to coarse grained, brown, dark brown, gravel sized ballast and road base.				FILL PID: 7.1 ppm PID: 10.1 ppm PID: 9.2 ppm
			22			Silty CLAY: high plasticity, red brown, pale grey, with visible minor rock structures.				RESIDUAL SOIL
			21			SHALE: pale grey, red brown, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK PID: 8.8 ppm
			20			becoming dark grey				
			19			Borehole BH12 terminated at 5.0 m Target depth				

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	support M mud N nil C casing penetration no resistance ranging to refusal water 10-Oct-12 water level on date shown water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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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CDF_0_9_04BB.GLB Log COF BOREHOLE: NON CORED GEOTLCOV25283AD.GPJ <<DrawingFile>> 25/01/2016 11:30

Piezometer Installation Log

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Hole ID. **BH12**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 24.00 m (AHD) angle from horizontal: 90°
 equipment type: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information		material substance		piezometer construction details	
method & support	water	RL (m)	depth (m)	material name	
AD/T Not Encountered		24	0	ASPHALT FILL: Gravelly SAND	BH12 bore construction license: drilling company: driller: driller's permit no.: Cuttings Bentonite Sand
			1	Silty CLAY	
			2	SHALE	
			3		
			4		
		5	5.00 m	Borehole BH12 terminated at 5.00 m Target depth	
		6			
		7			

CDF_0_9_04BB.GLB Log COF PIEZOMETER INSTALLATION LOG GEOTLCOV25283AD.GPJ <DrawingFile> 25/01/2016 16:29

method & support	graphic log / core recovery	ID	type	stick up & RL	tip depth & RL	install. date	water level
see engineering log for details water 10-Oct-12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss water pressure test result (lugeons) for depth interval shown	core recovered (graphic symbols indicate material) no core recovered	BH12	standpipe		5.00 m 19.00 m AHD		

Engineering Log - Borehole

client: **University of Sydney c/o Lend Lease Building**

principal:

project: **FASS Enabling Works**

location: **FASS Development, University of Sydney, Camperdown Campus**

Borehole ID: **BH13**

sheet: 1 of 1

project no. **GEOTLCOV25283AD**

date started: **19 Jan 2016**

date completed: **19 Jan 2016**

logged by: **CL**

checked by: **DS**

position: Not Specified surface elevation: 25.40 m (AHD) angle from horizontal: 90°
 drill model: Commacchio 305, Track mounted hole diameter : 100 mm

drilling information				material substance								
method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
	1 2 3							SOIL TYPE plasticity or particle characteristic, colour, secondary and minor components			100 200 300 400	
								ASPHALT: 0.02m.	D			PAVEMENT
			E		0.5			FILL: Gravelly SAND medium to coarse grained, brown, dark brown, gravel sized shale, brick and plastic fragments.				FILL
			E					with a trace of clay content				PID: 9.9 ppm
			E		1.0							PID: 10.4 ppm
			E									PID: 7.1 ppm
							CH	Silty CLAY: high plasticity, pale grey, red brown.	<Wp	St / VSt		RESIDUAL SOIL
					1.5							
								SHALE: red brown, pale grey, extremely weathered, estimated very low strength.				EXTREMELY WEATHERED BEDROCK
					2.0							PID: 8.1 ppm
								Borehole BH13 terminated at 2.0 m Target depth				
					2.5							
					3.0							
					3.5							

method AD auger drilling* AS auger screwing* HA hand auger W washbore DT diatube HA hand auger	support M mud N nil C casing penetration water water inflow water outflow	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System moisture D dry M moist W wet Wp plastic limit Wl liquid limit	consistency / relative density 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 - Borehole

client: **University of Sydney c/o- Lend Lease Building**
 principal:
 project: **University of Sydney FASS Building**
 location: **adjacent to container rooms**

Borehole ID: **BH14**
 sheet: 1 of 3
 project no: **GEOTLCOV25283AE**
 date started: **04 May 2016**
 date completed: **04 May 2016**
 logged by: **DK**
 checked by: **RT**

position: Not Specified surface elevation: 34.00 m (Datum Not Specified) angle from horizontal: 90°
 drill model: Commachchio 205, Track mounted drilling fluid: casing diameter : NW

drilling information				material substance							
method & support	penetration	samples & field tests	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations	
method & support: 1 AD/T 2 NW casing 3 penetration Not Observed	1 2 3	BX2	34			FILL: ASPHALT: dark grey, 50 mm thickness. FILL: Gravelly SAND: fine to medium grained, brown, fine to medium sub-angular gravel. FILL: Silty CLAY: high plasticity, brown, trace of fine sand and gravel. Silty CLAY: high plasticity, pale grey and red-brown mottling. SHALE: pale grey and red-brown, extremely weathered, estimated very low strength.	D			PAVEMENT	
			33	1.0	CH			<Wp		FILL	
		SPT 18, 16, 20 N*=36							VSt		RESIDUAL SOIL
											EXTREMELY WEATHERED SHALE
											HIGHLY WEATHERED SHALE
		SPT 20, 25/90mm HB N*=R	31	3.0		SHALE: pale grey and orange-red, highly weathered, estimated very low to low strength.				HIGHLY TO MODERATELY WEATHERED SHALE	
			30	4.0		Borehole BH14 continued as cored hole					
			29	5.0							
			28	6.0							
			27	7.0							

method AD auger drilling* AS auger screwing* HA hand auger W washbore	support M mud N nil C casing	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System	consistency / relative density 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
* bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	penetration  water 10-Oct-12 water level on date shown water inflow water outflow	moisture D dry M moist W wet Wp plastic limit Wl liquid limit		

CDF_0_9_06_LIBRARY.GLB rev: AM Log COF BOREHOLE: NON CORED GEOTLCOV25283AE GPJ <<DrawingFile>> 10/05/2016 12:10

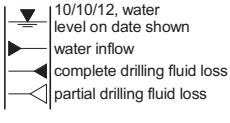
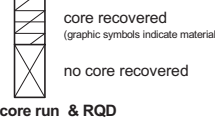
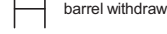
Engineering Log - Cored Borehole

client: **University of Sydney c/o- Lend Lease Building**
 principal:
 project: **University of Sydney FASS Building**
 location: **adjacent to container rooms**

Borehole ID: **BH14**
 sheet: 2 of 3
 project no: **GEOTLCOV25283AE**
 date started: **04 May 2016**
 date completed: **04 May 2016**
 logged by: **DK**
 checked by: **RT**

position: Not Specified surface elevation: 34.00 m (Datum Not Specified) angle from horizontal: 90°
 drill model: Commachchio 205, Track mounted drilling fluid: casing diameter : NW vane id.:

drilling information		material substance				rock mass defects			
method & support	water	depth (m)	material description	weathering & alteration	estimated strength & Is(50)	samples, field tests & Is(50) (MPa)	core run & RQD	defect spacing (mm)	additional observations and defect descriptions
			ROCK TYPE: grain characteristics, colour, structure, minor components						(type, inclination, planarity, roughness, coating, thickness, other)
									particular general
		3.70							
		3.70 - 3.72	start coring at 3.70m						
		3.72 - 3.74	SHALE: dark grey and orange-brown, distinctly laminated at 0-10°, core partially weathered to clay.	MW - HW			93%		SM, 0°, PL, Clay, =20 mm closed joint, 50°, PL, Fe SN closed joint, 90°, PL SM, 0°, PL, Clay, =10 mm closed joint, 85 - 90°, PL PT, 5°, PL, SO, Clay CO closed joint, 85 - 90°, PL SM, Clay, =4 mm
		3.74 - 3.76	NO CORE: 0.02 m	MW - HW					
		3.76 - 3.78	SHALE: dark grey and orange-brown, distinctly laminated at 0-10°, core partially weathered to clay.	MW			60%		JT, 90°, IR, RO, Fe SN SM, 0°, PL, Clay, =4 mm closed annealed joints at 50-60°
		3.78 - 3.80	SHALE: dark grey with orange-brown staining, annealed defects, distinctly laminated at 0-10°.	MW		a=0.09 d=0.09 a=0.11			SM, 0°, PL, Clay, =4 mm JT, 0°, IR, RO, Fe SN SM, 0°, PL, Clay, =30 mm SM, 0°, PL, Clay, =40 mm
		3.80 - 3.82	5.80 m: becoming moderately to slightly weathered	MW - SW		d=0.20 a=0.36			JT, ST, RO, Fe SN
		3.82 - 3.84	6.70 m: becoming slightly weathered	SW		a=0.20 d=0.16	72%		JT, 15°, IR, RO, Clay CO JT, 55°, IR, RO, Clay CO JT, 55°, IR, RO, Clay CO JT, 40°, IR, RO, Fe SN JT, 20°, IR, RO, Fe SN JT, 20°, PL, SO, CN
		3.84 - 3.86		FR		a=0.90 d=0.19	86%		JT, 90°, PL, RO, Fe SN SM, 0°, PL, Clay, =10 mm

method & support AS auger screwing AD auger drilling CB claw or blade bit W washbore NMLC NMLC core (51.9 mm) NQ wireline core (47.6mm) HQ wireline core (63.5mm) PQ wireline core (85.0mm) SPT standard penetration test	water  10/10/12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss water pressure test result (ugeons) for depth interval shown	graphic log / core recovery  core recovered (graphic symbols indicate material) no core recovered core run & RQD  barrel withdrawn RQD = Rock Quality Designation (%)	weathering & alteration* RS residual soil XW extremely weathered HW highly weathered DW distinctly weathered MW moderately weathered SW slightly weathered FR fresh *W replaced with A for alteration strength VL very low L low M medium H high VH very high EH extremely high	defect type PT parting JT joint SZ shear zone SS shear surface CO contact CS crushed seam SM seam roughness SL slickensided POL polished SO smooth RO rough VR very rough	planarity PL planar CU curved UN undulating ST stepped IR irregular coating CN clean SN stain VN veneer CO coating
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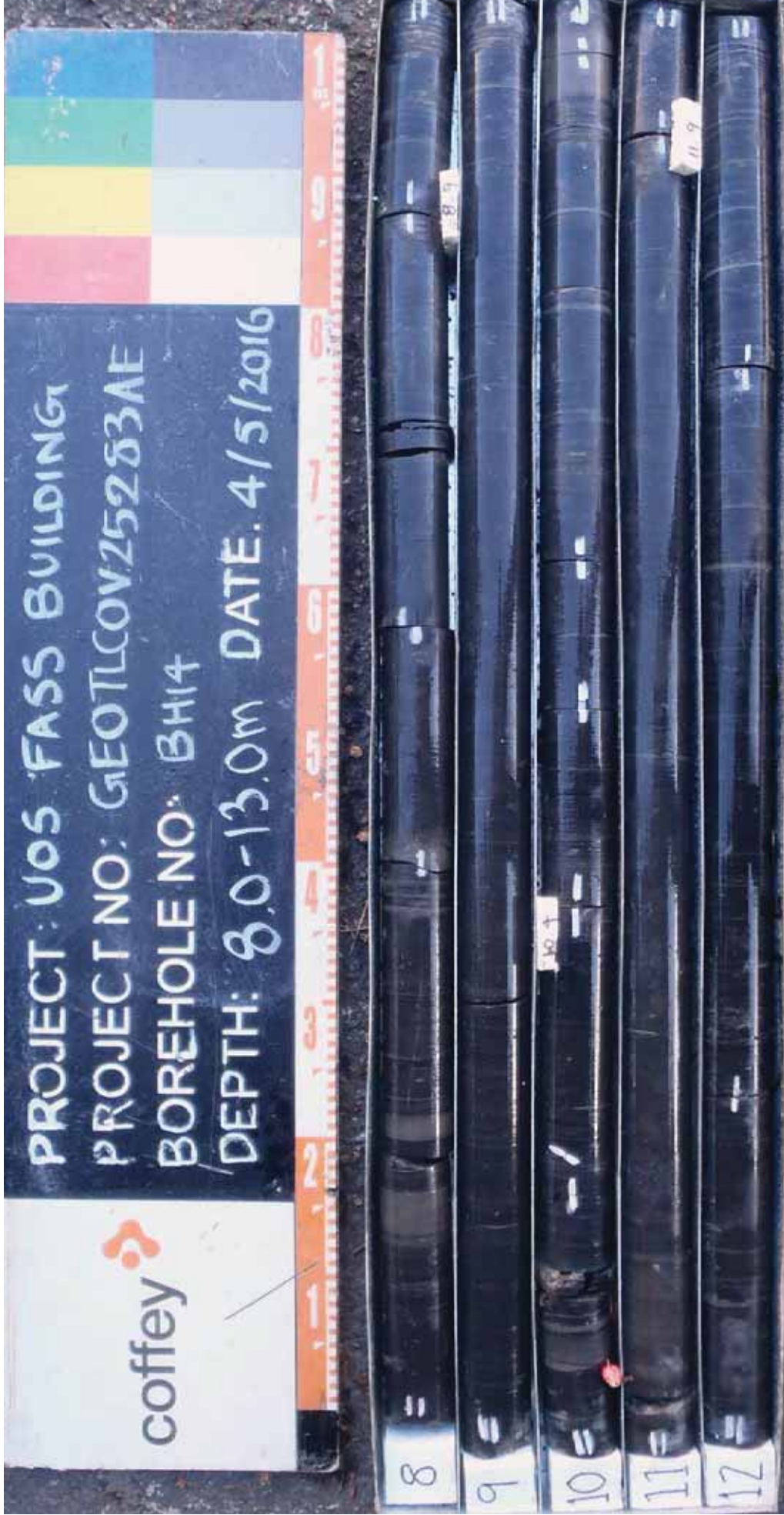
CDF_0_9_06_LIBRARY.GLB rev: AM Log COF BOREHOLE: CORED GEOTLCOV25283AE.GPJ <<DrawingFile>> 10/05/2016 12:08

Defects are: PT, 0 - 10°, PL, RO, Fe SN, unless otherwise described



PointID : BH14 Depth Range: 3.70 - 8.00 m

drawn	DK			client:	University of Sydney c/o- Lend Lease Building
approved	RT			project:	University of Sydney FASS Building
date	10/05/2016			title:	CORE PHOTOGRAPH BH14
scale	N.T.S.			project no:	GEO TLCOV25283AE
original size	A4			fig no:	FIGURE 1
				rev:	



PointID : BH14 Depth Range: 8.00 - 13.00 m

drawn	DK
approved	RT
date	10/05/2016
scale	N.T.S.
original size	A4

client:	University of Sydney c/o- Lend Lease Building
project:	University of Sydney FASS Building
title:	CORE PHOTOGRAPH BH14
project no:	GEOTLCOV25283AE
fig no:	FIGURE 2
rev:	



PointID : BH14 Depth Range: 13.00 - 15.00 m

drawn	DK
approved	RT
date	10/05/2016
scale	N.T.S.
original size	A4






client:	University of Sydney c/o- Lend Lease Building
project:	University of Sydney FASS Building
title:	CORE PHOTOGRAPH BH14
project no:	GEOTLCOV25283AE
fig no:	FIGURE 3
rev:	

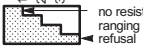
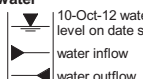
Engineering Log - Borehole

client: **University of Sydney c/o- Lend Lease Building**
 principal:
 project: **University of Sydney FASS Building**
 location: **adjacent to animal house**

Borehole ID: **BH15**
 sheet: 1 of 3
 project no: **GEOTLCOV25283AE**
 date started: **05 May 2016**
 date completed: **05 May 2016**
 logged by: **DK**
 checked by: **RT**

position: Not Specified surface elevation: 33.80 m (Datum Not Specified) angle from horizontal: 90°
 drill model: Commachchio 205, Track mounted drilling fluid: casing diameter : NW

drilling information				material substance								
method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
method & support: 1 ADV 2 NW casing 3 Not Observed	penetration: BX2 SPT 5, 8, 13 N*=21	water: Not Observed	samples & field tests: BX2 SPT 23, 22, 25/120mm HB N*=R	33.80	0.0		CH	FILL: ASPHALT: dark grey, 50 mm thickness. FILL: Silty CLAY: medium plasticity, brown, trace of sand. Silty CLAY: high plasticity, orange-brown and red, trace of fine sub-angular gravel.	D	<Wp	100	PAVEMENT
				33.00	1.0			SHALE: pale grey and red-brown, extremely weathered, estimated very low strength.	VS		200	FILL
				32.00	2.0			SHALE: pale grey and orange-brown, highly weathered, estimated very low to low strength.			300	RESIDUAL SOIL
				31.00	3.0						400	EXTREMELY WEATHERED SHALE
				30.00	4.0							HIGHLY WEATHERED SHALE
				29.00	5.0			Borehole BH15 continued as cored hole				
				28.00	6.0							
				27.00	7.0							
				26.00								

method AD auger drilling* AS auger screwing* HA hand auger W washbore	support M mud N nil C casing	samples & field tests B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	classification symbol & soil description based on Unified Classification System	consistency / relative density VS very soft S soft F firm St stiff VS very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense
penetration  no resistance ranging to refusal	water  10-Oct-12 water level on date shown water inflow water outflow	moisture D dry M moist W wet Wp plastic limit Wl liquid limit		

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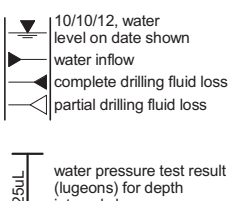
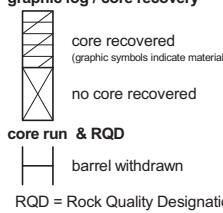
Engineering Log - Cored Borehole

client: **University of Sydney c/o- Lend Lease Building**
 principal:
 project: **University of Sydney FASS Building**
 location: **adjacent to animal house**

Borehole ID: **BH15**
 sheet: 2 of 3
 project no: **GEOTLCOV25283AE**
 date started: **05 May 2016**
 date completed: **05 May 2016**
 logged by: **DK**
 checked by: **RT**

position: Not Specified surface elevation: 33.80 m (Datum Not Specified) angle from horizontal: 90°
 drill model: Commachchio 205, Track mounted drilling fluid: casing diameter : NW vane id.:

drilling information		material substance				rock mass defects					
method & support	water	RL (m)	depth (m)	graphic log	material description ROCK TYPE: grain characteristics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 X = axial O = diametral a = axial, d = diametral	samples, field tests & Is(50) (MPa)	core run & RQD	defect spacing (mm)	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other)
							VL L M H VH EH		core run & RQD	30 100 300 1000 3000	particular general
		33	1.0								
		32	2.0								
		31	3.0								
		30	4.0		start coring at 4.10m						
		29	5.0		SHALE: pale grey and grey, indistinctly laminated, core partially weatered to clay.	HW - XW				33%	JT, CU, RO, Clay CO JT, 40°, PL, RO, Clay CO
		28	6.0		SHALE: grey and orange-brown, distinctly laminated at 0-10° with some pale grey fine grained sandstone laminations.	MW - HW		a=0.42 d=0.09		14%	JT, 85°, IR, RO, Fe SN JT, 80°, PL, RO, Fe SN SM, 0°, PL, Clay, =30 mm multiple partings at 30 mm spacing
		27	7.0		5.70 to 6.10 m: multiple annealed joints at 5-20°	MW		a=0.10 d=0.10			SM, 0°, PL, Clay, =20 mm SM, 0°, PL, Clay, =30 mm CS, 0°, PL, =10 mm CS, 0°, PL, =5 mm multiple partings and clay seams at 30 mm spacing
		26				HW - XW SW		a=0.36 d=0.09		74%	SM, 0°, PL, Clay, =10 mm SM, 0°, PL, Clay, =60 mm JT, CU, RO, Fe SN JT, CU, RO, Fe SN
						FR		a=0.11 d=0.12			CS, 0°, PL, =5 mm JT, 0 - 5°, IR, RO, Fe SN CS, 0°, PL, =2 mm CS, 0°, PL, =2 mm JT, 5° PL, RO, Fe SN
								a=3.77 d=0.82			
								a=0.51			

method & support AS auger screwing AD auger drilling CB claw or blade bit W washbore NMLC/NMLC core (51.9 mm) NQ wireline core (47.6mm) HQ wireline core (63.5mm) PQ wireline core (85.0mm) SPT standard penetration test	water  10/10/12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss 25µL water pressure test result (ugeons) for depth interval shown	graphic log / core recovery  core recovered (graphic symbols indicate material) no core recovered core run & RQD barrel withdrawn RQD = Rock Quality Designation (%)	weathering & alteration* RS residual soil XW extremely weathered HW highly weathered DW distinctly weathered MW moderately weathered SW slightly weathered FR fresh *W replaced with A for alteration strength VL very low L low M medium H high VH very high EH extremely high	defect type PT parting JT joint SZ shear zone SS shear surface CO contact CS crushed seam SM seam roughness SL slickensided POL polished SO smooth RO rough VR very rough	planarity PL planar CU curved UN undulating ST stepped IR irregular coating CN clean SN stain VN veneer CO coating
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CDF_0_9_06_LIBRARY.GLB rev: AM Log COF BOREHOLE: CORED GEOTLCOV25283AE.GPJ <<DrawingFile>> 10/05/2016 12:08

Engineering Log - Cored Borehole

client: **University of Sydney c/o- Lend Lease Building**
 principal:
 project: **University of Sydney FASS Building**
 location: **adjacent to animal house**

Borehole ID: **BH15**
 sheet: 3 of 3
 project no: **GEOTLCOV25283AE**
 date started: **05 May 2016**
 date completed: **05 May 2016**
 logged by: **DK**
 checked by: **RT**

position: Not Specified surface elevation: 33.80 m (Datum Not Specified) angle from horizontal: 90°
 drill model: Commachchio 205, Track mounted drilling fluid: casing diameter : NW vane id.:

drilling information		material substance			rock mass defects				
method & support	water	RL (m)	depth (m)	material description	weathering & alteration	estimated strength & Is(50)	samples, field tests & Is(50) (MPa)	defect spacing (mm)	additional observations and defect descriptions
			graphic log	ROCK TYPE: grain characteristics, colour, structure, minor components		VL = axial X = diametral a = axial d = diametral	a = axial d = diametral	30 100 300 1000 3000	(type, inclination, planarity, roughness, coating, thickness, other)
									particular
				<p>SHALE: dark grey, with some pale grey fine grained sandstone bands. Indistinctly laminated at 0-5°. Mainly medium strength with some low and high strength bands. <i>(continued)</i></p> <p>8.50 m: becoming distinctly laminated with pale grey fine grained sandstone (about 5%)</p>	FR		d=0.54 a=0.67 d=0.34	74%	JT, 50°, PL, RO, CN JT, 50°, PL, RO, CN
				<p>10.65 to 10.72 m: pale grey fine grained sandstone band</p>			a=0.51 d=0.12	94%	
				<p>12.50 m: with some pale grey fine grained sandstone laminations</p> <p>LAMINITE: dark grey shale (60%) and pale grey fine grained sandstone (40%), distinctly laminated at 0-5°. Mainly high strength.</p> <p>13.00 m: laminations becoming 50% shale and 50% fine grained sandstone</p>			a=0.26 d=0.06 a=0.34 a=5.71 d=2.26 a=0.73 d=0.29	96%	JT, 40°, PL, RO, Clay CO SM, 0°, PL, Clay, =2 mm CS, 0°, PL, =5 mm CS, 0 - 10°, PL, =20 mm
							a=0.50 d=0.43	100%	
							a=0.78 d=0.10		
							a=0.67 d=0.59	100%	
							a=1.07 d=1.01	97%	
							a=1.22 d=0.79		JT, 30°, PL, RO, Clay CO SM, 0°, PL, Clay, =20 mm
							a=3.78 d=0.51	100%	
							a=2.79 d=1.62		
				Borehole BH15 terminated at 15.45 m Target depth					

<p>method & support</p> <p>AS auger screwing AD auger drilling CB claw or blade bit W washbore NMLCNMLC core (51.9 mm) NQ wireline core (47.6mm) HQ wireline core (63.5mm) PQ wireline core (85.0mm) SPT standard penetration test</p>	<p>water</p> <p>10/10/12, water level on date shown water inflow complete drilling fluid loss partial drilling fluid loss</p> <p>water pressure test result (ugeons) for depth interval shown</p>	<p>graphic log / core recovery</p> <p>core recovered (graphic symbols indicate material) no core recovered</p> <p>core run & RQD</p> <p>barrel withdrawn RQD = Rock Quality Designation (%)</p>	<p>weathering & alteration*</p> <p>RS residual soil XW extremely weathered HW highly weathered DW distinctly weathered MW moderately weathered SW slightly weathered FR fresh *W replaced with A for alteration</p> <p>strength</p> <p>VL very low L low M medium H high VH very high EH extremely high</p>	<p>defect type</p> <p>PT parting JT joint SZ shear zone SS shear surface CO contact CS crushed seam SM seam</p> <p>roughness</p> <p>SL slickensided POL polished SO smooth RO rough VR very rough</p>	<p>planarity</p> <p>PL planar CU curved UN undulating ST stepped IR irregular</p> <p>coating</p> <p>CN clean SN stain VN veneer CO coating</p>
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CDF_0_9_06_LIBRARY.GLB rev: AM Log COF BOREHOLE: CORED GEOTLCOV25283AE.GPJ <<DrawingFile>> 10/05/2016 12:08

Defects are: PT, 0 - 5°, PL, RO, CN, unless otherwise described



PointID : BH15 Depth Range: 4.10 - 8.00 m

drawn	DK
approved	RT
date	10/05/2016
scale	N.T.S.
original size	A4

client:	University of Sydney c/o- Lend Lease Building
project:	University of Sydney FASS Building
title:	CORE PHOTOGRAPH BH15
project no:	GEOTLCOV25283AE
fig no:	FIGURE 1
rev:	



PointID : BH15 Depth Range: 8.00 - 13.00 m

drawn	DK		client:	University of Sydney c/o- Lend Lease Building
approved	RT		project:	University of Sydney FASS Building
date	10/05/2016		title:	CORE PHOTOGRAPH BH15
scale	N.T.S.		project no:	GEOTLCOV25283AE
original size	A4		fig no:	FIGURE 2
			rev:	



PointID : BH15 Depth Range: 13.00 - 15.45 m

drawn	DK		client:	University of Sydney c/o- Lend Lease Building
approved	RT		project:	University of Sydney FASS Building
date	10/05/2016		title:	CORE PHOTOGRAPH BH15
scale	N.T.S.		project no:	GEOTLCOV25283AE
original size	A4		fig no:	FIGURE 3
			rev:	

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