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REPORT

TO

UNIVERSITY OF TECHNOLOGY, SYDNEY

ON

GEOTECHNICAL INVESTIGATION AND HYDROGEOLOGICAL ASSESSMENT

FOR

PROPOSED BROADWAY BUILDING

AT

CORNER JONES STREET AND BROADWAY, ULTIMO, NSW

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Ref: 23970WHrptRevised

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Jeffery & Katauskas Pty Ltd have entered into a contract with the University of Technology, Sydney (UTS) and have completed a geotechnical investigation and hydrogeoloigcal assessment for the proposed Broadway Building at UTS. The proposed Broadway Building comprises a 12 storey (plus plant room) building which will be underlain by four basement levels, requiring excavation to a maximum depth of about 23m below existing grade.

The investigation comprised the drilling of sixteen boreholes and the completion of one Dynamic Cone Penetrometer (DCP) test. Ten of the boreholes were also diamond cored through the underlying sandstone bedrock to depths of at least 3m below proposed bulk excavation level.

The proposed development site is located on the side of a gently sloping west facing hillside and is bound by Jones Street, Broadway and Wattle Street to the east, south and west, respectively. The UTS Building CB10 bounds the development site to the north. At the time of our investigation, the site was used mostly as an open car park. However, there were buildings located at the eastern and western ends of the site and will be demolished.

The subsurface profile at the site comprises predominantly asphaltic concrete pavements overlying fill and residual silty clays with weathered shale and sandstone bedrock at shallow to moderate depth. The majority of the excavation required to construct the proposed basement will be through Class I/II sandstone bedrock, i.e. slightly weathered and fresh sandstone of at least medium and high strength.

Groundwater below the subject site is located deep within the sandstone bedrock profile. Groundwater inflows into the basement excavation may occur through defects present within the rock mass, but are expected to be of limited volumes.

Groundwater seepage is expected to be controlled by conventional sump and pump dewatering to the stormwater system.

In summary, the following items (with exception of the last two) are considered to be the primary geotechnical issues or constraints for the proposed development:

- The upper soil and weathered bedrock profiles will require engineered retention systems to support the expected vertical cuts;
- During demolition and excavation, stability must be maintained by perimeter retaining walls to support neighbouring buildings, buried services, footpath reserves and adjoining roadways;
- Vibrations during excavation will need to be controlled so that damage to neighbouring buildings and nearby buried services does not occur;
- Ground related movements due to stress relief will occur and the effects will need to be considered by the structural engineer;
- Minor groundwater seepage flows are anticipated into the proposed excavation and are expected to be controlled by sump and pump dewatering systems.
- We do not consider that the proposed basement excavation will drawdown surrounding groundwater levels such that settlement of the ground surface will be an issue, as the "true" groundwater level is expected to be deep within the sandstone bedrock profile; and
- The footings for the proposed building will be founded within Class I/II sandstone bedrock and therefore high bearing pressures will be possible.

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Broadway Building at the corner of Jones Street and Broadway, Ultimo, NSW. The investigation was commissioned by signed contract between Jeffery and Katauskas Pty Ltd and the client, University of Technology, Sydney (UTS), dated 24 June 2010.

Based on the supplied architectural drawings prepared by Denton Corker Marshall (DCM) (Project No. 7352, Drawing Nos. SK101 to SK119, dated 6 May 2010, SK131, dated 21 April 2010, SK132, dated 5 March 2010 and SK133, dated 27 April 2010), we understand that a 12 storey (plus plant room) multi-purpose building ("The Broadway Building") underlain by four basement levels, is proposed.

We also received several additional architectural drawings and sections prepared by DCM (Project No. 7352, Drawing Nos. CB11_AK-00254, CB11_AK-00265 and CB11_AK-00268, dated 22 September 2010) which were submitted to us well after the completion of the fieldwork and show the extent of proposed bulk excavation at the time of preparing this report.

The approximate outline of the lowest basement level below the footprint of the proposed Broadway Building is shown on Figure 1 and will extend to, or reasonably close-to, the site boundaries. The lowest basement finished floor level (FFL) extends to reduced levels (RLs) between RL-4.76m and RL-8.01m. To achieve these RLs and due to the sloping site, excavation to depths between about 13m and 23m below existing grade, will be required.

We have not been provided with the structural loads for the proposed Broadway Building. However, we expect the loads would be in the high range.

The purpose of the investigation was to assess the subsurface conditions at sixteen borehole locations and one Dynamic Cone Penetration (DCP) test location and, based on the information obtained, to present our comments and recommendations on excavation conditions and support, groundwater, footings, the lowest level basement floor slabs and hydrogeology.

This report confirms, amplifies and supersedes the preliminary information provided in our email, Ref: 23970WH email7, dated 18 May 2010, sent to Mr Greg Graham of UTS. This report also supersedes an earlier version, Ref: 23970WHrpt, dated 19 July 2010.

We were also commissioned to carry out a Stage 2 Environmental Site Assessment. This work was carried out by Environmental Investigation Services (EIS) [the environmental consulting division of the Jeffery and Katauskas Group] who prepared a report, Ref: E23970Krpt, dated September 2010. EIS also previously completed a Stage 1 Environmental Site Assessment and the results were presented in a separate report, Ref: E22549K RPT – FINAL4, dated May 2009. This geotechnical report must be read in conjunction with the above EIS reports.

We note that Jeffery & Katauskas Pty Ltd (J&K) have carried out a geotechnical investigation for the nearby UTS Multi Purpose Sports Hall and the results were presented in our report, Ref: 23119SPrpt, dated 21 July 2009. Engineers from J&K have also carried out numerous geotechnical inspections during excavation which was being undertaken at the time of this investigation.

Mr Mark Smith of Aurecon has supplied us with a borehole log (BH Trans 11) and a plan of its location, for one of the nearby boreholes drilled as part of the investigation for the Transgrid Cable Tunnel Stage 2 Project in 2001. The approximate borehole location has been replotted onto our Figure 1. The supplied BH Trans 11 borehole log is included in Appendix A.

2 INVESTIGATION PROCEDURE

Prior to the commencement of the fieldwork, the test locations were electromagnetically scanned by a specialist sub-contractor for buried services. A ground penetrating radar (GPR) device was also used to detect the presence of buried services at the test locations within and adjacent to the existing laneway.

The fieldwork for the investigation was carried out between the 3 May 2010 and 19 May 2010 and comprised the drilling of sixteen boreholes (BH1 to BH12 and BH3A, BH5A, BH7A and BH9A) and the completion of one DCP test (DCP13), at the locations shown on Figure 1. The boreholes were auger drilled to depths between 1.80m and 5.79m, below existing grade, using our truck mounted JK500 drill rig. Each borehole, with the exception of BH3A, BH5A, BH7A, BH9A, BH11 and BH12, was extended into the underlying bedrock by rotary or wireline diamond coring techniques, using either an NMLC or HQ triple tube core barrel with water flush, to final depths between 16.53m and 26.85m, below existing grade. All boreholes were drilled vertically, with the exception of BH3 and BH9 which were drilled at angles of 60° and 45°, respectively, from the horizontal.

The DCP test (DCP13) extended to a refusal depth of 1.33m below existing grade. We note that refusal of the DCP equipment often indicates the depth to the underlying bedrock, however, due to the equipment's limitations, it may also refuse on obstructions within fill, tree roots, ironstone gravel bands or other "hard" layers within the soil profile, and not necessarily on bedrock.

The test locations were set out by tape measurements from existing surface features and apparent site boundaries. The surface RLs indicated on the attached borehole logs were surveyed using an automatic optical level. However, the approximate RLs shown on BH11, BH12 and DCP13 were interpolated between spot level heights and ground contour lines shown on the supplied undated and unreferenced survey plan prepared by Rygate and Company Pty Ltd. The datum for the levels is the Australian Height Datum (AHD). Figure 1 and Figure 2 are based on the supplied survey plan.

The relative compaction and strength of the subsoil profile was assessed from the Standard Penetration Test (SPT) 'N' values and DCP test results, together with hand penetrometer readings on clayey soils recovered in the SPT split spoon sampler. The strength of the upper weathered bedrock profile was assessed by observation of auger penetration resistance when using a tungsten carbide (TC) bit, together with examination of recovered rock cuttings. The strength of the cored bedrock was assessed by examination of the recovered rock cores, together with correlations with subsequent laboratory Point Load Strength Index ($I_{S(50)}$) tests. Further details of the methods and procedures employed in the investigation are presented in the attached Report Explanation Notes.

At BH3A, BH5A, BH7A and BH9A, "shallow" casagrande standpipe piezometers were installed to typically at or just above the soil/bedrock interface. At BH10, a "deep" casagrande standpipe piezometer was installed to the base of the borehole so that the response zone could be sealed into the underlying bedrock. The standpipes comprised machine slotted and unslotted Class 18 PVC. The installation details for each standpipe are shown on the attached Table D. The purpose of the standpipe installations was to monitor groundwater levels during the fieldwork and for possible future groundwater monitoring. Furthermore, the groundwater and drilling liquids in the standpipe installed at BH10 were purged and the rate of recovery assessed so that the mass permeability of the underlying bedrock could be calculated. Groundwater observations were also made in each borehole during drilling.

Our geotechnical engineer, David Schwarzer, was present on a full-time basis during the fieldwork, to direct the electromagnetic and GPR scanning, to set out the test locations, to nominate the testing and sampling, to record the rate of groundwater recovery during the purging of the piezometer at BH10, to survey the test locations and to prepare the attached borehole logs and DCP test results. We note, however, that our Senior Environmental Scientist (Vittal Boggaram) set out BH11 and BH12 and nominated the testing and sampling and prepared the attached borehole logs for these two boreholes. The Report Explanation Notes define the logging terms and symbols used.

Our Associate (Adrian Hulskamp) also carried out a detailed walkover inspection of the topographic, surface drainage and geological conditions of the site and its immediate environs on 3 May 2010. During this inspection the extent of the adjoining Building CB10 basement, including mapping of the subsurface conditions exposed behind the eastern end of the southern basement wall from an access doorway to that area, was made. We also inspected of the excavation cuts for the proposed nearby UTS Multi-Purpose Sports Hall and discussed the excavation methodology and equipment being used to carry out the excavations, with the site foreman.

Selected disturbed soil samples were recovered from site and submitted to a NATA registered laboratory [Soil Test Services Pty Ltd (STS)] for moisture content, percentage fines and Standard Compaction and Four Day Soaked CBR testing. The results are summarised in the attached Table A and Table B. The recovered rock cores were photographed and also returned to STS for Point Load Strength Index testing. The photographs are enclosed facing the first page of the relevant cored borehole log. The Point Load Strength Index test results are summarised in the attached Table C. The unconfined compressive strengths (UCS), as estimated from the Point Load Strength Index test results, are also summarised in Table C.

An environmental screening of the soils and groundwater has been undertaken by EIS as part of the Stage 2 Environmental Site Assessment. Reference should be made to the current EIS report for further details.

3 RESULTS OF THE INVESTIGATION

3.1 Site Description

We recommend that the following site description be read in conjunction with Figures 1 to 6 and the attached photographic portfolio and complimented with a site visit, if necessary.

Topography of Site and Region

The proposed Broadway Building site is located on the side of a west facing hillside slope, which grades between about 3°and 5°, within slightly undulating topography. Refer to Plate 1 and Plate 2.

The site, which is roughly rectangular in shape, is between about 98m to 113m long (east-west) and between about 30m to 44m wide (north-south). The eastern end of the site is located at the crest of the hillside.

Jones Street, Broadway and Wattle Street bound the subject site to the east, south and west, respectively. Refer to Plates 3 to 9 inclusive.

Existing Land Use

At the time of the fieldwork, the site mostly comprised an asphaltic concrete (AC), concrete and gravel surfaced open car park. Landscaped garden beds, with scattered medium to tall trees were located along the eastern, southern and western edges of the car park. The AC surfacing within the car park was in poor condition, based on a cursory inspection, however, the concrete pavements were observed to be in good condition. Several scattered concrete obstructions, possibly remnants of 'old' pavements and/or footings and sandstone cobbles and boulders were observed at ground surface level, particularly in areas surfaced with gravel. Refer to Plate 10 and Plate 11. A brick fence ran along the southern boundary of the site, between the three buildings on site (see section below).

Types of Structures Present On And Below The Site

Unoccupied UTS owned brick buildings (CB11, CB12 and CB13) of two or three storeys, which appeared to be in generally good condition based on a cursory observation, were located at the eastern and western ends of the site. We were unable to access these buildings to check whether there were any basement levels. However, from the DCM supplied UTS drawing (Drawing No. CB13LGAP-09097-00, dated May 2004), the "Pub" building (CB13) located at the far western end of the site, contained a lower ground floor level (or basement). The finished floor level of the basement is unknown. The basement extended to the southern and western site boundaries.

A laneway was located at the western end of the site, along the northern boundary. Based on the supplied survey plan and buried service drawings from 'Dial Before You Dig', there are several buried services, including electrical conduits and buried sewer and water pipes which run below the laneway. The size, invert level and backfill materials of these buried services is unknown. There were also several grated pits above a shallow stormwater drain which ran below the northern side of the laneway.

The GPR scan also detected Underground Storage Tanks (USTs) on the western side of the eastern building, below the existing concrete pavement. The approximate area of the USTs is shown on Figure 1. For further details, reference should be made to the EIS report.

Neighbouring Structures

The neighbouring UTS multi-storey brick and concrete building to the north (CB10) abutted the proposed development site. With reference to the supplied survey plan, the lowest basement floor level of Building CB10 is at about RL7.1m. Our observations from inside Building CB10 confirmed that the basement extended to the common boundary with the subject site. Refer to Plate 12. With exception of the eastern end of the neighbouring basement, the southern basement wall of UTS

Building CB10 appeared to retain the subject site. Towards the eastern end of the basement, service pipes extended into the subject site near ground surface level.

Just behind the eastern end of the southern basement wall, there was an approximate 8m high cut face. The approximate profile of the cut face is shown on Figure 6. The cut face, where it was visible, exposed slightly weathered to fresh sandstone bedrock over the basal 2.5m, with the upper portion exposing extremely weathered shale with iron indurated bands. There was 'seepage' observed over the cut face, though we suspect it was from a leak in one of the services observed above. At the top of the cut face, adjacent to the building, a suspended concrete pavement could be seen. A concrete retaining wall supported the eastern side of the subject site, adjacent to the cut face. Refer to Plates 13, 14 and 15.

The nearby two storey brick and concrete commercial buildings and multi-storey commercial and residential building on the western side of Wattle Street were set back at least 40m from the subject site and appeared to be in good condition, based on a cursory inspection. The buildings located at the intersection of Wattle Street and Broadway did not appear to be underlain by any basements and are probably founded on high level footings. We could not confirm the extent and presence of the basement below the nearby multi-storey commercial and residential building to the west.

We understand that several multi-storey commercial and residential buildings are in the early stages of construction on the nearby Frasers Broadway site, which is located on the southern side of Broadway, opposite the subject site. The proposed buildings under-construction will have up to five basement levels, below the Broadway street level.

The nearby UTS Building CB02 is located on the eastern side of Jones Street and is set back at least 20m from the subject site and appeared to be in good condition, based on a cursory inspection. The lowest basement level of UTS Building CB02 (Basement Level 1) is understood to be at RL2.743m from information supplied by the architect and appears to extend to Jones Street.

Nearby Earthworks

As part of the fieldwork, the cut faces exposed within the excavation for the nearby UTS Multi Purpose Sports Hall project, were inspected. The UTS Multi Purpose Sports hall site is located about 150m to the north-east of the subject site. Excavation was mostly carried out by ripping with a Caterpillar D8 dozer, with some assistance by saw cutting and rock hammering with large (at least 20T size) hydraulic excavators.

The cut face at the north-eastern corner of the site exposed distinctly weathered sandstone bedrock of at least medium strength and was cross bedded up to 25°. Refer to Plate 17. However, most of the cuts exposed sub-horizontally bedded slightly weathered and fresh sandstone bedrock of at least medium strength. Few defects were exposed within the cut faces. Refer to Plate 16.

From the inspections our engineers have carried out during excavation, very little rock face stabilisation measures have been required and have only included 'dental' treatment of extremely weathered bands or clay bands in localised areas. The basement excavation was 'dry' at the time of our inspection.

3.2 Subsurface Conditions

The 1:100,000 Geological Map of Sydney indicates the site to be underlain by predominantly Hawkesbury Sandstone, however, the regional stratigraphy is for the Ashfield Shales of the Wianamatta Group to overlie rocks of the Mittagong Formation and then the Hawkesbury Sandstone. The Ashfield Shales have been identified within the boreholes located towards the eastern end of the site as well as along the Broadway frontage of the Frasers Broadway site to the south. Weathering of the Ashfield Shales produces residual clays of medium to high plasticity which usually grade into weathered shale. The Mittagong Formation comprises interbedded shale, laminate and medium-grained quartz sandstone.

The geological map also shows that the western end of the site is underlain by man-made fill and alluvial/estuarine sediments associated with the reclaimed portion of Blackwattle Bay, the current foreshore of which is located about 1.2km to the north-west of the subject site. We note, however, that the boundaries between different soil/rock units shown on the geological map are approximate only.

Generally, the boreholes encountered AC pavements overlying fill and residual silty clays with weathered shale and sandstone bedrock at shallow to moderate depth. The depth to the underlying "good" quality sandstone bedrock was shallowest at the lower, western end of the site. Reference should be made to the attached borehole logs and DCP test results for details at each specific location.

Graphical borehole summaries are presented as Figures 3 to 6 inclusive, which also present Sections A-A to D-D, the locations of which are shown on Figure 2. Each Section also shows the approximate outline (in elevation) of the proposed basement levels and an approximate indication of the site stratigraphy and different rock classes. A summary of the encountered subsurface conditions is provided below:

Pavements

AC surfacing was encountered at the tops of all boreholes (with exception of BH5A) and was between 10mm and 250mm thick.

Fill

Fill comprising silty gravel, silty sand, silty clayey sand, silty clay, sandy gravel, silty sandy gravel, sandy silty clay and silty gravelly sand was encountered below the pavements and from the ground surface in BH5 and BH5A and extended down to depths between 0.3m (BH6) and at least 1.5m (BH12) below existing grade. In BH8, however, the fill extended down to a depth of 3.0m, below existing grade. Inclusions of igneous, ironstone and sandstone gravel, sandstone cobbles and boulders, ash, brick and concrete fragments were encountered in the fill. Based on the SPT 'N' values, the fill was assessed to be predominantly well compacted.

Residual Silty Clay

Residual silty clays of medium and high plasticity were encountered below the fill in each borehole and were predominantly of hard strength. The residual soils contained ironstone gravel and medium to high strength ironstone bands.

Shale and Sandstone Bedrock

Weathered shale bedrock being predominantly extremely weathered and of extremely low strength was encountered below the residual silty clay profile in BH2, BH3, BH3A, BH4, BH6, BH10 and BH11 at depths between 1.85m (BH3A) and 2.6m (BH2, BH4 and BH10) and extended down to depths between at least 4.0m (BH4) and 5.0m (BH2 and BH3), below existing grade. The weathered shale contained low and medium strength iron indurated bands. These boreholes are located towards the higher, eastern end of the site.

Sandstone bedrock was encountered below the fill in BH8, below the residual silty clays in BH1, BH5, BH5A, BH7, BH7A, BH9 and BH9A and below the weathered shale bedrock in BH2, BH3, BH4, BH6, BH10 and BH11. The sandstone bedrock was encountered at depths between 1.5m (BH7 and BH7A) and 5.0m (BH2 and BH3) and extended down to the borehole termination depths.

The upper "poor quality" weathered sandstone bedrock profile comprised extremely weathered and distinctly weathered sandstone of extremely low to very low to low strength and was relatively thin, being less than about 1.25m thick. DCP13 refused at a depth of 1.33m below existing grade on inferred sandstone bedrock.

Below the upper weathered sandstone bedrock profile the sandstone bedrock improved to "good quality" distinctly weathered but predominantly slightly weathered and fresh sandstone of generally at least medium to high strength. The good quality sandstone bedrock was sub-horizontally bedded and contained grey to dark grey laminae which were typically spaced at less than 100mm (but up to 300mm).

The diamond cored portions of the boreholes encountered relatively few defects comprising inclined and sub-vertical joints, extremely weathered seams, crushed seams, clay seams and sub-horizontal bedding partings. The defects were usually widely spaced. There were no sub-vertical intrusions, such as an igneous 'dyke' encountered in the boreholes. The inclined boreholes encountered several sub-vertical joints, however, these were generally widely spaced.

The "core loss" zones encountered in BH8 and BH9 are inferred to be extremely weathered bands of sandstone or clay bands which have "washed away" during the coring process.

A preliminary engineering classification of the bedrock (in accordance with Pells et al. 1998) has been carried out based on the boreholes as tabulated below. We note that the engineering classification has not taken into account specific footing sizes, pile types, pile diameters and founding levels and are therefore only indicative. These preliminary classifications should be reviewed once footing sizes/pile types, pile diameters and founding levels have been selected to confirm applicability within the zone of influence of such footings/piles.

BH	Surface RL (mAHD)	Depth(m)/RL Top of Class V	Depth(m)/RL Top of Class IV	Depth(m)/RL Top of Class III	Depth(m)/RL Top of Class II	Depth(m)/RL Top of Class I
1	12.30	3.5/8.80	4.1/8.2	-	5.4/6.9 & 17.5/-5.2	11.5/0.8
2	14.92	2.6/12.32	5.0/9.92	-	6.2/8.72 & 18.0/-3.08	12.6/2.32
3A	13.82	1.9/11.92	-	-	-	-
3	13.84	2.1/11.74	5.0/8.84	-	11.0/2.84	5.5/8.34 & 13.0/0.84
4	14.38	2.6/11.78	4.7/9.68	-	5.2/9.18 & 19.0/-4.62	13.6/0.78
5A	13.12	-	4.0/9.12	-	-	-
5	13.36	-	4.0/9.36	-	8.4/4.96 & 15.2/-1.84	12.2/1.16 & 16.9/-3.54
6	13.25	2.5/10.75	4.6/8.65	-	10.3/2.95	6.1/7.15 & 13.2/-0.05
7A	8.97	1.5/7.47	-	-	-	-
7	8.93	1.5/7.43	-	-	2.5/6.43	5.4/3.53
8	10.63	3.0/7.63	-	-	4.9/5.73 & 13.4/-2.77	10.5/0.13
9A	11.53	3.0/8.53	-	-	-	-
9	11.46	4.4/7.06	5.6/5.86	-	10.2/4.2 & 15.8/-4.34	13.6/-2.14
10	12.26	2.6/9.66	-	-	5.2/7.06	-
11	≈13.8	2.0/11.8	-	-	-	-
12	≈12.5	-	-	-	-	-
Trans 11	9.5	-	3.08/6.42	-	4.7/4.8	-

Groundwater

All boreholes were 'dry' during auger drilling and on completion of auger drilling. A comment on the supplied "BH Trans 11" borehole log indicated that the *"water table was not identified during drilling process"*.

On completion of rock coring, groundwater was measured at depths between 1.0m and 10.6m below existing grade, where recorded. We note, however, that these levels have most likely been influenced by the introduced drill flush water from the coring process. Groundwater levels may not have stabilised within the short observation period.

A summary of the groundwater measurements made within the standpipes between 4 May 2010 and 7 June 2010 are tabulated below:

Date of Groundwater Measurement	Borehole (Depth Below Ground Surface/Groundwater RL mAHD)				
	BH3A	BH5A	BH7A	BH9A	BH10
4 May 2010	'Dry'	-	-	-	-
5 May 2010	'Dry'	-	-	-	-
6 May 2010	'Dry'	'Dry'	-	-	-
7 May 2010	'Dry'	'Dry'	'Dry'	-	-
10 May 2010	'Dry'	'Dry'	'Dry'	-	-
11 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	-
12 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	8.6/3.66
13 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	12.8/-0.54
14 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	13.0/-0.74
17 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	13.4/-1.14
18 May 2010	'Dry'	'Dry'	'Dry'	'Dry'	13.4/-1.14
7 June 2010	N/A*	'Dry'	1.4/7.57**	'Dry'	13.3/-1.04

* BH could not be dipped as gatic cover was covered over with spoil from archaeological excavations.

** BH dipped after prolonged wet period.

No other long term groundwater monitoring was carried out.

3.3 Laboratory Test Results

The moisture content tests carried out on recovered rock chip samples show a generally good correlation with our field assessment of bedrock strength. The results of the Point Load Strength Index tests carried out on the recovered rock cores also correlated well with our field assessment of bedrock strength. The estimated UCSs were generally between 10MPa to 60MPa, however, UCS values of less than 1MPa and as high as 74MPa, were also recorded.

The results of the percentage fines tests (percentage finer than 0.075mm) carried out on silty clayey sand fill samples from BH8 and BH9A were 48% and 20%

respectively, which imply very low coefficients of permeability, based on the relationship between coefficient of permeability and percent by weight passing No.200 sieve (approximately equivalent to 0.075mm) presented as Figure 8.5 in the DM7 Design Manual (1971).

The four day soaked CBR test carried out on a silty clayey sand fill sample from BH8, which was drilled in the vicinity of the existing laneway, resulted in a value of 3% when compacted to 98% of Standard Maximum Dry Density (SMDD) and surcharged with 9kg. This CBR value indicates that a poor quality subgrade is present at existing ground levels.

3.4 Results of Pump Test

The results of the pump test carried out in BH10 are shown on Figure 7. In summary, the groundwater in BH10 was 'drawdown' to approximately RL-5.1m AHD (the level at which the pump used could no longer lower the groundwater table) and then rose to approximately RL-1.3mAHD after a period of 50 minutes.

Using established seepage formula, the approximate mass permeability of the sandstone bedrock between RL-5.1m and RL-1.3m was calculated to be less than about 5×10^{-7} m/sec, which indicates a low mass permeability for the sandstone bedrock profile at depth.

4 COMMENTS AND RECOMMENDATIONS

4.1 Geotechnical Constraints

The primary geotechnical issues associated with construction of the proposed Broadway Building will be to maintain stability to the adjoining UTS Building CB10 to the north, adjoining footpath reserves and roadways and other nearby structures and buried services, both during excavation and in the long term. Furthermore, there will the need to reduce the risk of vibration induced damage to adjoining buildings and nearby structures, during demolition of existing buildings on site and during excavation.

We strongly recommend that prior to the commencement of excavation, a meeting be held with staff from UTS, the architect, the builder, the excavation contractor, the structural engineer and the geotechnical engineer, so that the geotechnical issues and constraints can be discussed, understood and accepted.

The geotechnical investigation has provided a basis for the comments and recommendations which follow. However, it will be essential during excavation and construction work that frequent geotechnical inspections are carried out to assess exposed subsurface conditions, so as to provide appropriate geotechnical advice.

The initial stage of bulk excavation will include removal of the existing USTs (refer to EIS report for further details in this regard). We recommend that detailed dilapidation reports be compiled on the neighbouring UTS Building CB10 to the north and the neighbouring UTS Building CB02 to the east of Jones Street, prior to the commencement of demolition. A representative from UTS should be asked to confirm that the reports present a fair record of existing conditions. The dilapidation reports may then be used as a benchmark against which to assess possible future claims for damage arising from the works.

Council may also request dilapidation reports be carried out on the pavement surfaces for the adjoining roadways and footpaths.

4.2 Excavation Conditions

4.2.1 Excavation Methods

Prior to the commencement of bulk excavation, the proposed development will require demolition of the existing pavements, removal of the existing USTs and demolition of the existing buildings on site.

Prior to demolition of the existing buildings, confirmation should be made as to the presence and extent of any other existing basements below the subject buildings on site, other than the basement below the "Pub" (CB13). Where existing basements extend to the site boundary, then during demolition, the builder must maintain lateral restraint to these walls by way of temporary propping or by other means of support. If sections of the basement walls do not extend to the site boundary, it may be possible to demolish these walls and then temporarily batter the soil/weathered rock profile, subject to confirmation by the geotechnical engineer. Similarly, the builder must maintain lateral restraint to the concrete retaining wall which supports the northern end of the eastern site boundary.

We understand from DCM that the existing trees on site will be cut down to ground surface level during the demolition stage of the project. The initial stage of excavation will therefore require stripping of any deleterious or contaminated fill and then disposing of these materials appropriately off site. Reference should be made to the EIS reports for guidance on the off-site disposal of soil.

Furthermore, the existing buried services which run below the site may require diversion prior to the commencement of excavation or otherwise be temporarily supported during excavation.

To achieve the lowest FFLs for the proposed basement, excavation to maximum depths between about 13m and 23m below existing grade, will be required. Based on the investigation results, the proposed excavations will extend through the fill, residual soil profile and into the Class V, Class IV and Class I/II bedrock (refer to the table in Section 3.2 above for rock depths/RLs at the top of the various rock classifications). With reference to Figure 3 to 6, most of the excavation will be through Class I/II sandstone bedrock.

Excavation of the soil profile and the Class V bedrock can be carried out using buckets attached to large hydraulic excavators or dozers. More effective excavation may be possible using buckets fitted with "tiger teeth" and/or by ripping tynes fitted to the excavators, particularly where medium and high strength iron indurated bands are present.

Excavation of the more competent Class IV bedrock, but particularly the deeper Class II and Class I sandstone bedrock, will extend through medium and high strength sandstone (occasionally very high strength) and therefore excavation productivity will be slow and higher than normal 'wear and tear' of excavation attachments is to be expected. The presence of occasional defects within the rock mass and laminations within the sandstone will help to facilitate excavation, but only marginally.

We recommend that the excavation of the Class IV or better quality sandstone bedrock be carried out by ripping using a large dozer of at least Caterpillar D9 size, with assistance using hydraulic rock hammers fitted to large hydraulic excavators of at least 30 tonne size. Grid sawing techniques in conjunction with ripping and hammering will help to facilitate excavation and reduce vibrations.

We recommend that a full copy of this report be provided to the excavation contractor so that the contractor can make their own assessment on excavation conditions.

Groundwater inflows into the excavation should be expected (particularly at depth) and may occur as local seepage flows within the fill, at the fill/residual silty clay interface, through ironstone gravel bands or relic joints/fissures within the residual soil profile, at the soil/rock interface and through joints and bedding partings within the bedrock profile, particularly after heavy or prolonged rainfall. Seepage volumes into the excavation are expected to be controllable by conventional sump and pump dewatering systems.

Groundwater seepage monitoring (included seepage locations and inflow volumes) should be carried out during bulk excavation prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

Particular care will be required during bulk excavation to avoid undermining or removing support from the neighbouring UTS Building CB10 (where in close proximity to the proposed excavation) and surrounding footpaths and roads. With reference to Figures 3 to 6, the neighbouring UTS Building CB10 is expected to be founded predominantly on Class I/II sandstone bedrock. Nevertheless, since the excavation is expected to extend up to the adjacent CB10 building footings, then a check for the potential presence of adversely oriented defects or weathered zones of sandstone below the footings should be made by the geotechnical engineer. This could be completed by excavating a “slot” adjacent to the footing and inspecting the cut face below the footing. If adversely oriented defects or weathered zones are encountered, it will be necessary to either stabilise the sandstone below the footings or to underpin the footings. However, we expect that it will be most likely that stabilisation would be preferred due to the difficulty in underpinning heavily loadings footings.

4.2.2 Stress Relief

In Sydney, there is a relatively high in-situ horizontal stress field. When excavations extend down into the sandstone bedrock, these horizontal stresses are relieved, resulting in movements of the excavated faces into the excavation. These movements are often in the order of about 0.5mm to 1mm of lateral movements for each metre depth of excavation into the sandstone bedrock.

Due to the high stresses as a result of horizontal stress relief, it is not feasible to restrain the excavated face from these movements. When considering the effect of the proposed excavation on the neighbouring UTS Building CB10 and other structures, these movements must be taken into account. Therefore, we recommend a structural engineer be asked to comment on whether such movements are likely to cause unacceptable movements to UTS Building CB10 and nearby buried services. If these movements are considered critical, then further detailed investigation comprising in-situ rock stress testing followed by detailed finite element modelling could be undertaken to better assess the potential movements. We note, however, that this level of detailed investigation and subsequent analysis is rarely undertaken in Sydney, with exception where rail infrastructure adjoins the development site.

4.2.3 Potential Vibration Risks

We recommend that caution be taken during rock excavation as there will likely be direct transmission of ground vibrations to adjoining buildings and structures. The proposed excavations will extend to, or very close to, the site boundaries.

Excavation procedures and the dilapidation reports should be carefully reviewed prior to the commencement of demolition and excavation, so that appropriate equipment is used.

The excavation with hydraulic rock hammers using a large hydraulic excavator fitted with a relatively low energy hydraulic rock hammer no larger than say, a Krupp 900 size or equivalent should commence away from likely critical areas (i.e. commence over the central portion of the site. Vertical saw cut slots should be provided along the perimeter of the excavation and the base of the slot maintained at a lower level than the adjoining rock excavation at all times. If UTS has concerns over vibrations causing damage to nearby buildings, then we recommend that continuous vibration monitoring be carried out during rock excavations. Subject to review of the dilapidation reports, vibrations, measured as Peak Particle Velocity (PPV), should be limited to no higher than 5mm/sec on the neighbouring UTS Building CB10. If it is found that transmitted vibrations are excessive, then it would be necessary to use a smaller rock hammer or alternative excavation techniques. The use of a rotary grinder and rock sawing in conjunction with ripping presents an alternative low vibration excavation technique, which is the same excavation methodology being adopted at the nearby UTS Multi Purpose Sports Hall site.

When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

The following procedures are recommended to reduce vibrations when rock hammers are used:

- Maintain rock hammer orientated towards the face and enlarge excavation by breaking small wedges off the face.
- Operate one hammer at a time and in short bursts only to reduce amplification of vibrations.
- Use excavation contractors with experience in such work with a competent supervisor who is aware of vibration damage risks, possible rock face instability issues, etc. The contractor should be provided with a full copy of this report and have all appropriate statutory and public liability insurances.

4.3 Excavation Support

4.3.1 Support Systems

As the required excavations will extend to, or very close to, the site boundaries, temporary batter slopes through the soil and upper weathered rock profiles, will not be possible. We therefore recommend that the proposed vertical cuts through the soil profile and Class V bedrock be supported by an engineered retention system.

Based on the subsurface conditions encountered, a suitable retention system includes an anchored soldier bored pile wall, with reinforced shotcrete infill panels. An allowance should be made for temporary or permanent liners through some parts of the fill due to potential shaft instability. The shotcrete and anchors must be installed progressively as excavation proceeds.

The proposed retaining wall should be founded with sufficient embedment to satisfy stability and founding considerations and can be terminated no less than 0.6m into Class IV or better quality sandstone bedrock, above bulk excavation level. A vertical face may be excavated below the toe of the pile wall but must not undermine the pile toes. Pile toe levels should be selected just below basement slab levels to provide long term support. Retaining wall design parameters are provided in Section 4.3.2 below.

Toe restraint for each pile and where the thickness of the soil and Class V bedrock profile is deeper than 2m, may be achieved by using a second lower row of temporary anchors, which must be installed prior to excavating in front of the pile toe. In addition, an allowance should be made for temporary rock bolts below pile toe level to provide lateral restraint for rock below the pile toes.

We recommend that the initial stages of excavation in front of the pile toes extend to a depth of not more than 1.5m below the pile toes and not closer than 1.5m from the face of the pile, so that a geotechnical engineer can check for the possible presence of any adverse defects or weathered zones of rock which may destabilise the pile.

We expect that Class IV or better quality sandstone bedrock may be cut vertically. However, on site stabilisation measures may be necessary if adverse defects such as inclined joints are found. Based on inspection of the excavation cuts at the nearby UTS Multi Purpose Sports Hall site, the sandstone cut face behind the UTS Building CB10 southern basement wall and the recovered rock cores, we do not expect significant stabilisation measures will be required, however, some 'dental' treatment is expected for clay seams, extremely weathered seams etc.

Nevertheless, we recommend that the rock faces be progressively inspected by a geotechnical engineer as excavation proceeds at not more than 1.8m depth increments between inspections. The purpose of the inspections is to identify potentially adverse defects and to assess appropriate stabilisation measures, such as rock bolting, shotcreting etc, if required. A small provision should be made in the contract documents (budget and program) for the above inspections and possible stabilisation measures.

A toe drain should be provided at the base of all rock cuttings to collect groundwater seepage and lead it to a sump for pumping to the stormwater system.

We note that specific geotechnical inspections will be required to check for the presence of adverse defects below the pile toes, which may result in instability of the wall above. Treatment for zones requiring stabilisation may include rock bolting, shotcreting etc.

We assume that permanent support of the retention system will be provided by bracing from the proposed structure.

4.3.2 Retaining Wall Design Parameters

The major consideration in the selection of earth pressures for the design of the retaining walls is the need to limit deformations occurring outside the excavations. The following characteristic earth pressure coefficients and subsoil parameters may be adopted for the design of temporary or permanent retention systems.

- All retaining elements (i.e. piles, etc) should be uniformly founded on the underlying Class IV or better quality sandstone bedrock. For allowable bearing pressure recommendations, refer to Section 4.4 below.
- For anchored or propped walls, where minor movements can be tolerated along the street frontages, provided there are no movement sensitive buried services, we recommend the use of trapezoidal earth pressure distribution of 6H (kPa) for the soil profile and Class V bedrock, where H is the retained height in metres. These pressures should be assumed to be uniform over the central 50% of the support system, as indicated in Figure 8.
- For anchored or propped walls, which are sensitive to lateral movement, a trapezoidal earth pressure distribution of 8H (kPa) should be adopted for the soil profile and Class V bedrock, where H is the retained height in metres. These pressures should be assumed to be uniform over the central 50% of the support system.
- Any surcharge affecting the walls (eg traffic loading, construction loads, nearby buildings, etc) should be allowed in the design using an 'at rest' earth pressure coefficient, K_o, of 0.55.
- The retaining walls should be designed as drained and measures taken to induce complete and permanent drainage of the ground behind the wall. Strip drains incorporating a geofabric to act as a filter against subsoil erosion are appropriate for soldier pile walls.
- For piles embedded into the underlying Class I/II sandstone bedrock below excavation level an allowable lateral toe resistance of 600kPa may be

adopted. This value assumes excavation is not carried out within the zone of influence of the wall toe and the rock does not contain unfavourable defects etc. The upper 0.3m depth of the socket should not be taken into account to allow for tolerance and disturbance effects during excavation. The quality of the toe restraint rock should be progressively inspected by a geotechnical engineer on exposure to confirm unexpected conditions do not exist.

- If rock anchors or rock bolts are to run below adjoining properties, then permission from the owners must be obtained before installation.
- Anchors bonded at least 3m into sandstone bedrock may be designed on the basis of the following maximum allowable bond stresses for different rock classes:
    - Class V Shale or Sandstone bedrock (150kPa)
    - Class IV Sandstone bedrock (300kPa); or
    - Class I/II Sandstone bedrock (1,000kPa).
- All anchors should be proof tested to 1.3 times the working load under the supervision of an experienced engineer independent of the anchor contractor with anchors being 'locked off' at not greater than 85% of the design working load. We recommend only experienced contractors be considered for the anchor installation.

4.4 Footings

Based on the investigation results, Class I/II sandstone bedrock will be exposed at bulk excavation level for the proposed Broadway Building.

Pad and strip footings or 'internal' bored piers founded in Class I/II sandtone bedrock below bulk excavation level may be designed for a maximum allowable bearing pressure of 8MPa, based on the strength and defects observed within the boreholes which were drilled below bulk excavation level. For this recommended bearing pressure all pad and strip footings must be visually inspected by a geotechnical engineer and at least half the footing excavations must be spoon tested by the geotechnical engineer to confirm that adequate founding materials have been exposed. If the spoon testing is omitted, then the maximum allowable bearing pressure should be limited to 3.5MPa. A programme of cored boreholes drilled from bulk excavation level prior to detailed footing excavation could be considered as an alternative to spoon testing. Such cored boreholes enable bearing pressures (and hence footing sizes) and founding levels to be confirmed prior to commencement of each footing excavation which may be cost and time effective. This recommendation has been endorsed by the structural engineer (Aurecon).

We expect that the above bearing pressures would be suitable for design, however, a maximum allowable bearing pressure of 10MPa is likely to be feasible, but would require the completion of cored boreholes in at least half of all footings, with spoon tests completed by a geotechnical engineer in all of the remaining footings.

Footings founded in Class I/II sandstone bedrock at the proposed B1 basement level at the north-eastern corner of the site (near the crest of the vertical cut down to the adjacent lower B2 basement level), should be designed for a reduced maximum allowable bearing pressure of 3.5MPa, provided the cut face adjacent to, and below the toe of, the footings are inspected by a geotechnical engineer, to identify possible adverse defects which may destabilise the footing above.

Perimeter piles founded in Class IV or better quality sandstone bedrock at the crest of a vertical cut should be designed for a reduced maximum allowable bearing pressure of 1MPa, provided the rock immediately below the pile toe is inspected by a geotechnical engineer to identify possible adverse defects and to assess the long term durability of the bedrock. We strongly recommend that the vertical loads on the shoring be reduced as much as possible, with the majority of the structural loads being carried down to the footings founded below bulk excavation level.

The above maximum allowable bearing pressures are based on serviceability which results in settlement of less than 1% of the minimum footing dimension.

Footings on the sandstone bedrock may also be designed using "Limit State Design" principles as detailed by Pells et al. (1998). An ultimate bearing capacity of 80MPa and an ultimate shaft adhesion value of 1.5MPa (compression) could be adopted for the Class I/II sandstone bedrock, where bored piles are used. Settlement limitations to the structure will still need to be satisfied and can be estimated using an elastic modulus value of 1,200MPa for the Class I/II sandstone bedrock.

It should be noted that such ultimate bearing pressures must be used in conjunction with an appropriate "*Geotechnical Strength Reduction Factor*" (ϕ_g). Provided there is good workmanship and quality control during footing construction, we recommend that a ϕ_g value of not greater than 0.5 be adopted for end bearing and shaft adhesion.

The prospective piling contractors should be provided with a full copy of our report so that appropriate drilling rigs and equipment (i.e. rock augers and cleaning buckets) are brought to site. Concrete may need to be poured through a tremie, where pile depths are deeper than say, 6m. The piling contractors must advise as to the method and proposed equipment for pile base and socket clean out.

All bored piles drilled and footings excavated, should be inspected, cleaned out, "dry" and poured on the same day as drilling. Groundwater will need to be pumped out and disposed of appropriately for any "deep" pier holes which extend below the western half of the basement. All pile holes should be cleaned out using a cleaning bucket (for all pile diameters) for effective removal of loose materials.

We note the above design recommendations for bearing and shaft adhesion are contingent on achieving good construction practice and an appropriate inspection and test plan.

4.5 Hydrogeological Assessment

This section of the report discusses the results of our hydrogeological assessment for the proposed development. In summary, the assessment comprised a review of information available in our archives for sites in the immediate surrounding area, particularly the nearby Fraser's Broadway site. The assessment also incorporated the subsurface conditions and groundwater observations from the subject investigation.

Reference should be made to Figure 9 which shows the approximate locations of relevant boreholes drilled in the vicinity of the subject site, as well as the boreholes drilled as part of this investigation.

The following table summarises the subsurface conditions and groundwater observations made in the nearby boreholes and from other investigations in the area.

BH No.	Depth to Base of Fill & Material Description (m)	Depth to Base of Natural Soils & Material Description (m)	Description of Bedrock At First Contact	Groundwater Observations/Comments (Depth/RL mAHD)
Trans 11	2.0 Silty Sand	3.08 Sandy Clay	Distinctly Weathered, Medium Strength	Water table not identified during drilling process
SB316	None Encountered	> 1.7 Sand*	Not encountered	No groundwater comment made
MW109	1.0 Building Rubble	2.9 Silty Clay	Weathered Sandstone	2.8/9.12 (Groundwater is at residual soil/bedrock interface)**
SB269	2.2 Building Rubble	3.9 Clay	Weathered Sandstone	No groundwater comment made
SB268	2.1 Building Rubble	3.8 Clay	Weathered Sandstone	No groundwater comment made
SB267	1.8 Building Rubble	3.8 Clay	Weathered Sandstone	No groundwater comment made
MW613	1.7 Road Base over Disturbed Clay	2.6 Silty Clay	Extremely Weathered (XW), Very Low to Low Strength	12.62/0.306 (Groundwater within sandstone bedrock profile)
B1	0.9 Silty Sand	2.6 Silty Clay	XW Shale	4.7/10.97 (Groundwater within sandstone bedrock profile)
SB315	0.4 Sand and Gravel	4.0 Silty Clay	Weathered Rock	3.0/10.79 (Groundwater is just above residual soil/bedrock interface)**
MW110	0.8 Sand and Gravel	3.7 Silty Clay/Gravelly Clay	No description	1.5/12.59**
B2	1.4 Sandy Clay	3.7 Interbedded XW Shale and Silty Clay	XW Shale	3.9/12.49 (Groundwater within XW shale bedrock profile)
B3	0.5 Sandy Gravelly Clay	4.4 Sandy Clay and Silty Clay	XW Shale	4.6/12.01 (Groundwater within XW shale bedrock profile)
B4	0.7 Sandy Gravelly Clay over Topsoil	4.1 Silty Clay	XW Shale	5.0/11.78 (Groundwater within XW shale bedrock profile)

* *Possibly Fill*

** Considered a 'perched' groundwater level.

Apart from a few selected boreholes where groundwater was measured above the bedrock surface (inferred to be in most cases, a "perched" groundwater level), the groundwater level in BH10 (on the UTS site) and MW613, which both contained response zones within the underlying sandstone bedrock, show that the level of the groundwater below the subject site and nearby is well below the bedrock surface (RL-1.1m at BH10 and RL0.306 at MW613). The overlying soil profile is predominantly 'dry'.

No sandy alluvium was encountered as part of the investigation of the subject UTS site.

We note that locally, groundwater inflows into the excavation may occur as local seepage flows within the fill, at the fill/residual silty clay interface and through ironstone gravel bands or relic joints/fissures within the residual soil profile, particularly during and following periods of wet weather. This process is not expected to cause any adverse effects on any surrounding structures.

Based on the above and with the "true" groundwater level being deep within the sandstone bedrock profile, the proposed basement excavation will not drawdown surrounding groundwater levels such that settlement of the ground surface will be an issue. However, some lowering of the groundwater level within the sandstone bedrock may occur, but this will have no adverse effects as the sandstone is relatively "incompressible" (in terms of dewatering induced settlements).

We further note that the only nearby buildings which may be on high level footings founded within the upper soil profile are the commercial buildings located on the western side of Wattle Street, which are set back at least 40m from the subject site. The proposed buildings under construction at Fraser's Broadway and the neighbouring UTS Buildings CB10 and CB02 will have or have a number of basement levels which are founded on or are to be founded on the underlying sandstone bedrock.

From the low permeability of the underlying sandstone bedrock, groundwater inflows into the basement excavation through defects present within the rock mass are expected to be of limited volumes and will be able to be controlled by draining them to a sump for pumped disposal to the stormwater system.

We therefore consider that a drained basement is feasible and appropriate for the proposed Broadway Building.

We note that the site spans a west facing hillside in a heavily built up area and hence groundwater inflows via infiltration are expected to be of limited volume through the low permeability subsurface profile.

4.6 Groundwater Aggressiveness

Based on the groundwater chemical test results, a "non-aggressive" exposure classification results in accordance with AS2159-2009. For further details, reference should be made to the EIS report.

4.7 Basement Level On-Grade Floor Slabs

As outlined in Section 4.4 above, we expect the proposed basement levels to be underlain by sandstone bedrock. We therefore recommend that underfloor drainage be provided. The underfloor drainage should comprise a strong, durable, single-sized washed aggregate such as 'blue metal' gravel. The underfloor drainage should include a sump and pump dewatering system. The sump/s should have an automatic level control pump to avoid flooding of the basement level. The perimeter wall drains should be connected into the underfloor drainage system.

We recommend that the underfloor drainage comprise a grid of gravel drains flowing to sumps from which pumping occurs. The spacing of the drains will depend on the seepage flows and where they occur, but as a guide we expect a grid or herringbone pattern with a spacing of about 8m as a first estimate.

On-grade floor slabs should be separated from all walls, columns, footings, etc., to permit relative movements (i.e. designed as 'floating' slabs). Joints in the concrete on-grade floor slabs should be designed to accommodate shear forces but not bending moments by using dowelled or keyed joints.

4.8 Further Geotechnical Input

We summarise below the recommended additional geotechnical input that needs to be carried out:

- A meeting with staff from UTS, the architect, the builder, the excavation contractor, the structural engineer and the geotechnical engineer, to discuss the geotechnical issues and constraints.
- Enquires should be made to the relevant service authorities regarding further information on buried services which run below the site.
- Dilapidation survey reports on the neighbouring UTS Buildings CB10 and CB02.
- Geotechnical inspections of rock faces during excavation.
- Witness the proof loading of temporary anchors.
- Geotechnical inspection of footing excavations.
- Spoon testing footing excavations, if appropriate or diamond core drilling of specific footing locations.
- Groundwater monitoring into the bulk excavation.

5 GENERAL COMMENTS

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

Occasionally, the subsurface conditions between the completed test locations may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

Adrian Hulskamp
Associate

Bruce Walker
Principal
For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD.

PLATE 1: View looking west across site from near Borehole 3, showing neighbouring UTS Building CB10.

PLATE 3: View looking north across northern end of site from near Borehole 3, showing neighbouring UTS Building CB10.

PLATE 3: View looking north along Wattle Street from western end of site.

PLATE 4: View looking south along Wattle Street from western end of site.

PLATE 5: View looking south-west at the intersection of Wattle Street and Broadway, from south-western corner of site.

PLATE 6: View looking east along southern site boundary along Broadway.

PLATE 7: View looking west from traffic island adjacent to Wattle Street across to nearby buildings on Broadway which are set back ≈50m from the subject site.

PLATE 8: View looking north-east across Jones Street from eastern site boundary.

PLATE 9: View looking south along Jones Street from opposite eastern end of site.

PLATE 10: View showing sandstone cobbles and boulders at ground surface inside site.

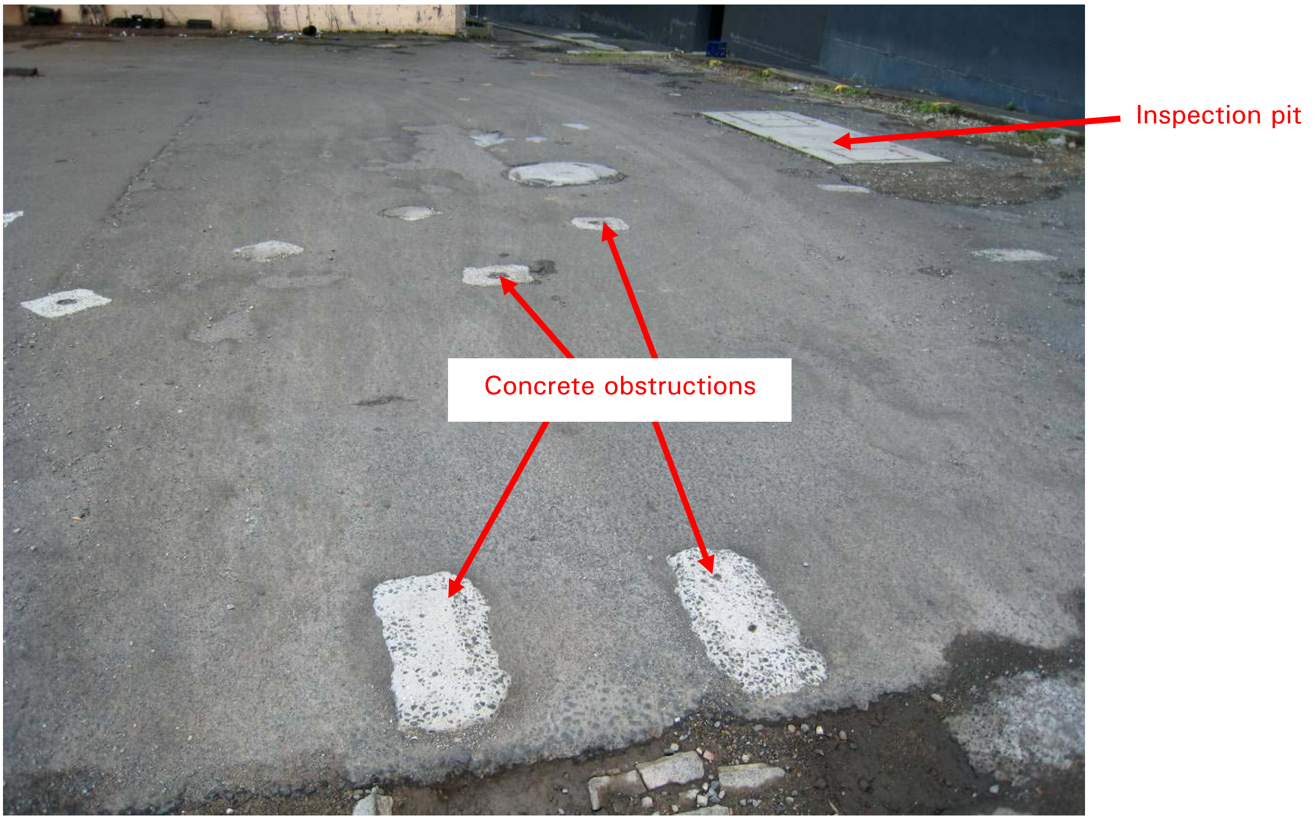

PLATE 11: View showing selected concrete obstructions at ground surface inside site and inspection pit for buried services.

PLATE 12: View looking east into neighbouring basement of UTS Building CB10 to the north from Wattle Street.

PLATE 13: View of sandstone cut face behind eastern end of southern basement wall of neighbouring UTS Building CB10 to the north.

PLATE 14: View looking into 'void' space below suspended slab behind eastern end of southern basement wall, showing extremely weathered shale in upper portion of cut face.

PLATE 15: View from ground surface looking down into 'void' space behind eastern end of southern basement wall of the neighbouring UTS Building CB10, showing extremely weathered shale in cut face.

PLATE 16: Excavation underway at the nearby UTS Multi-Purpose Sports Hall site. Excavation is being carried out using rock hammers and rock saws fitted to 20T and 30T hydraulic excavators with ripping by a D8 dozer (not shown in this photograph).

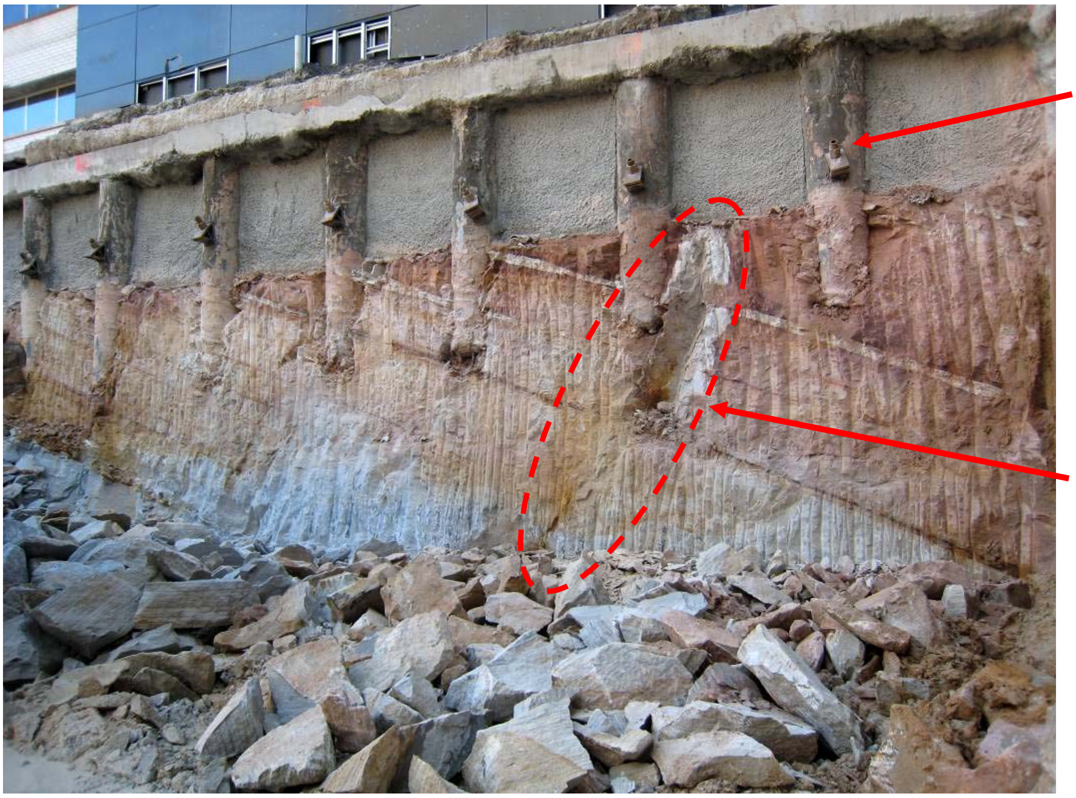

PLATE 17: View at sandstone cut face at north-eastern corner of excavation for the UTS Multi-Purpose Sports Hall. Sandstone bedrock is predominantly distinctly weathered and of at least medium strength, cross bedded at up to about 25°.

PLATE 18: View of test pit excavation dug by archaeologist near our Borehole 9, showing 'old' buried sandstone footings just below surface.

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SOIL TEST SERVICES
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Ref No:23970WH
Table A:Page 1 of 1

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.6.1
BOREHOLE NUMBER	DEPTH	MOISTURE CONTENT	PERCENTAGE FINER THAN 0.075mm
	m	%	%
2	3.00-3.12	9.5	
8	0.50-1.00		48
9A	0.50-0.95		20
4	1.50-1.95	18.7	
4	3.00-3.45	15.0	
4	5.20-5.50	5.9	
6	3.00-3.45	11.0	
6	4.00-4.50	4.9	
6	4.70-5.00	4.9	
10	3.00-3.45	15.6	
10	4.00-4.20	7.3	

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Table B: Page 1 of 1

TABLE B
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULT

BOREHOLE NUMBER	8
DEPTH (m)	0.50 - 1.00
Surcharge (kg)	9.0
Maximum Dry Density (t/m^3)	1.876 STD
Optimum Moisture Content (%)	12.3
Moulded Dry Density (t/m^3)	1.84
Sample Density Ratio (%)	98
Sample Moisture Ratio (%)	102
Moisture Contents	
Insitu (%)	15.2
Moulded (%)	12.6
After soaking and	
After Test, Top 30mm(%)	17.4
Remaining Depth (%)	15.4
Material Retained on 19mm Sieve (%)	0
Swell (%)	2.0
C.B.R. value: @5.0mm penetration	3.0

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

NATA
NATA Accredited Laboratory
Number:1327

Approved Signatory
(A.Tatikonda)

Date: 27/5/10

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1	4.79-4.82	0.4	8
	5.29-5.32	0.1	2
	5.87-5.89	0.7	14
	6.45-6.48	0.8	16
	7.19-7.21	0.8	16
	7.95-7.98	1.0	20
	8.56-8.59	0.8	16
	9.15-9.18	1.6	32
	9.94-9.97	1.0	20
	10.50-10.53	0.6	12
	11.14-11.16	0.5	10
	11.93-11.95	1.7	34
	12.29-12.32	2.4	48
	13.18-13.21	2.6	52
	13.87-13.90	3.7	74
	14.52-14.55	1.2	24
	15.04-15.07	1.1	22
	15.75-15.77	0.9	18
	16.36-16.39	1.0	20
	17.09-17.11	3.0	60
	17.89-17.91	0.7	14
	18.47-18.50	1.1	22
	19.07-19.10	1.3	26
	19.81-19.84	1.4	28
	20.44-20.47	0.6	12

NOTES: See Page 11 of 11

Ref No: 23970WH
TABLE C Page 2 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1	21.07-21.09	1.4	28
	21.83-21.85	1.3	26
	22.41-22.44	1.7	34
2	5.90-5.92	0.2	4
	6.31-6.34	0.4	8
	6.93-6.96	1.0	20
	7.35-7.38	0.8	16
	7.92-7.95	1.0	20
	8.48-8.51	0.4	8
	9.42-9.45	1.6	32
	9.84-9.87	0.5	10
	10.58-10.61	1.2	24
	11.28-11.31	1.1	22
	11.90-11.92	0.4	8
	12.54-12.56	0.5	10
	13.19-13.21	1.2	24
	13.80-13.83	0.9	18
	14.56-14.59	1.2	24
	15.07-15.10	2.2	44
	15.73-15.76	1.7	34
	16.37-16.39	1.3	26
	17.11-17.14	1.3	26
	17.87-17.90	1.3	26
	18.56-18.58	1.1	22
	19.04-19.07	0.7	14

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
2	19.67-19.70	1.5	30
	20.40-20.43	0.5	10
3	6.16-6.19	1.4	28
	6.69-6.72	0.8	16
	7.42-7.46	1.2	24
	8.00-8.03	1.2	24
	8.87-8.90	1.3	26
	9.47-9.52	1.6	32
	10.75-10.81	1.2	24
	11.12-11.17	0.9	18
	11.80-11.83	1.0	20
	12.57-12.60	0.3	6
	13.00-13.04	1.8	36
	13.63-13.68	1.1	22
	14.27-14.30	1.1	22
	15.08-15.11	1.8	36
	15.62-15.65	1.2	24
	16.42-16.46	2.0	40
	17.35-17.39	1.7	34
	17.74-17.77	2.3	46
	18.40-18.44	2.9	58
	19.05-19.09	1.1	22
	19.70-19.75	1.2	24
	20.55-20.60	1.5	30
	21.12-21.15	1.1	22

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
3	21.80-21.85	1.1	22
	22.48-22.53	1.4	28
	23.18-23.20	2.1	42
4	5.75-5.78	1.0	20
	6.29-6.32	1.5	30
	6.92-6.94	0.7	14
	7.53-7.56	1.0	20
	8.30-8.33	1.1	22
	8.91-8.94	0.9	18
	9.45-9.48	0.7	14
	10.20-10.23	1.4	28
	10.82-10.85	1.3	26
	11.48-11.51	0.8	16
	12.15-12.18	1.2	24
	12.79-12.82	1.2	24
	13.56-13.58	0.7	14
	14.15-14.18	1.4	28
	14.80-14.83	2.1	42
	15.52-15.54	1.7	34
	16.13-16.16	2.9	58
	16.80-16.82	1.8	36
	17.41-17.44	0.9	18
	18.10-18.13	1.2	24
	18.85-18.88	1.4	28
	19.48-19.51	0.9	18

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
4	20.10-20.13	0.9	18
	20.77-20.79	1.7	34
5	5.78-5.81	0.8	16
	6.20-6.23	1.0	20
	6.87-6.90	0.7	14
	7.50-7.52	2.4	48
	8.09-8.12	1.6	32
	8.80-8.82	0.7	14
	9.61-9.64	0.9	18
	10.17-10.21	1.9	38
	10.88-10.91	1.0	20
	11.47-11.50	1.0	20
	12.19-12.21	0.5	10
	12.89-12.92	1.8	36
	13.45-13.47	2.4	48
	14.15-14.18	3.0	60
	14.85-14.88	2.2	44
	15.54-15.56	0.8	16
	16.16-16.19	1.2	24
	16.80-16.82	0.9	18
	17.49-17.51	2.9	58
	18.24-18.26	1.5	30
	18.85-18.88	1.9	38
	19.58-19.61	1.3	26
	20.21-20.23	0.8	16

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
5	20.80-20.83	1.3	26
	21.49-21.52	1.5	30
	22.21-22.24	2.5	50
	22.91-22.94	1.3	26
	23.50-23.52	2.0	40
6	5.46-5.48	0.9	18
	6.17-6.20	1.0	20
	6.84-6.88	0.8	16
	7.49-7.52	1.2	24
	8.06-8.09	1.1	22
	8.85-8.88	1.7	34
	9.53-9.56	2.0	40
	10.14-10.17	1.2	24
	10.79-10.82	0.8	16
	11.48-11.50	0.9	18
	12.24-12.27	1.5	30
	12.91-12.94	0.6	12
	13.46-13.49	2.0	40
	14.09-14.12	2.7	54
	14.81-14.83	2.4	48
	15.58-15.61	1.8	36
	16.22-16.25	1.4	28
	16.92-16.95	1.1	22
	17.62-17.65	1.6	32
	18.22-18.25	1.3	26

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
6	18.91-18.94	1.3	26
	19.51-19.54	2.2	44
	20.22-20.25	1.8	36
	20.90-20.93	1.3	26
	21.50-21.53	2.2	44
	22.17-22.19	1.7	34
	22.63-22.64	1.4	28
7	3.27-3.30	0.8	16
	3.83-3.86	0.7	14
	4.46-4.48	0.8	16
	5.21-5.23	0.6	12
	5.82-5.85	1.9	38
	6.52-6.55	0.9	18
	7.24-7.27	1.0	20
	7.80-7.84	1.3	26
	8.52-8.55	1.0	20
	9.07-9.11	1.8	36
	9.85-9.88	1.2	24
	10.50-10.53	1.7	34
	11.06-11.09	3.6	72
	11.85-11.89	1.7	34
	12.45-12.47	1.3	26
	13.11-13.13	1.6	32
	13.85-13.87	1.5	30
	14.46-14.48	1.6	32

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
7	15.08-15.10	1.0	20
	15.78-15.81	1.0	20
	16.38-16.41	1.3	26
8	3.80-3.84	0.7	14
	4.31-4.34	0.9	18
	5.11-5.13	1.3	26
	5.84-5.87	0.9	18
	6.49-6.52	1.5	30
	7.11-7.13	0.8	16
	7.84-7.87	1.6	32
	8.42-8.45	0.8	16
	9.09-9.11	1.1	22
	9.85-9.88	0.7	14
	10.47-10.50	0.6	12
	11.07-11.10	1.3	26
	11.82-11.85	1.4	28
	12.59-12.61	1.7	34
	13.10-13.13	1.4	28
	13.82-13.85	0.8	16
	14.47-14.50	1.1	22
	15.12-15.14	0.9	18
	15.81-15.84	0.9	18
	16.35-16.37	1.2	24
	17.13-17.16	0.6	12
	17.80-17.84	0.8	16
	18.54-18.56	0.8	16

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
9	5.76-5.80	0.2	4
	6.35-6.40	0.7	14
	6.84-6.87	0.5	10
	7.39-7.43	0.2	4
	8.15-8.19	0.5	10
	8.81-8.85	0.8	16
	9.51-9.54	0.3	6
	10.16-10.21	0.5	10
	10.81-10.84	0.6	12
	11.62-11.66	1.4	28
	12.16-12.20	0.8	16
	12.77-12.81	1.7	34
	13.55-13.58	0.9	18
	14.08-14.13	1.1	22
	14.79-14.83	1.2	24
	15.61-15.65	1.2	24
	16.15-16.18	0.7	14
	16.69-16.73	1.0	20
	17.38-17.42	1.5	30
	18.27-18.31	1.1	22
	18.89-18.93	1.3	26
	19.54-19.58	1.6	32
	20.19-20.23	1.1	22
	20.81-20.85	1.0	20
	21.44-21.49	1.6	32

NOTES: See Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
9	22.14-22.17	1.1	22
	22.80-22.84	1.1	22
	23.45-23.50	1.1	22
	24.21-24.24	1.2	24
	24.84-24.87	1.1	22
	25.50-25.54	0.9	18
	26.12-26.16	0.8	16
10	4.79-4.82	0.04	<1
	5.29-5.32	0.6	12
	5.89-5.92	1.2	24
	6.48-6.51	2.5	50
	7.17-7.21	1.2	24
	7.72-7.76	1.5	30
	8.43-8.47	1.8	36
	9.56-9.61	2.0	40
	9.96-10.00	1.4	28
	10.47-10.52	1.7	34
	11.12-11.15	1.5	30
	11.80-11.83	1.1	22
	12.49-12.53	1.6	32
	13.15-13.18	1.6	32
	13.76-13.80	1.5	30
	14.36-14.40	1.8	36
	15.13-15.17	1.4	28
	15.79-15.82	1.7	34

NOTES: See Page 11 of 11

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001

SOIL TEST SERVICES
ABN 43 002 145 173

Ref No: 23970WH
TABLE C Page 11 of 11

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
10	16.28-16.31	1.2	24
	17.69-17.73	1.1	22
	18.50-18.54	1.1	22
	19.20-19.23	0.7	14
	19.87-19.91	0.6	12
	20.09-20.12	1.7	34
	21.57-21.61	1.1	22

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RTA T223.
4. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S(50)}$

TABLE D
CASAGRANDE STANDPIPE PIEZOMETER INSTALLATION DETAILS

BOREHOLE	Depth of Installation (m)	Depth below ground surface (m)			
		Sand Backfill Response Zone	Bentonite Base Seal	Bentonite Top Seal	Backfill and Gatic Cover to Surface
BH3A	3.5	0.5 – 3.5	N/A	0.2 – 0.5	0 – 0.2
BH5A	3.7	0.7 – 3.0	N/A	0.2 – 0.7	0 – 0.2
BH7A	1.5	0.5 – 1.5	1.5 – 1.8	0.2 – 0.5	0 – 0.2
BH9A	3.0	0.5 – 3.0	N/A	0.2 – 0.5	0 – 0.2
BH10	22.5	4.0 – 22.5	N/A	3.0 – 4.0	0 – 3.0

Borehole No.
1
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 12.3 m
Date: 03/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING							ASPHALTIC CONCRETE: 200mm.t		-		
						-	FILL: Silty gravel, fine to coarse grained igneous, dark grey.	D	-		APPEARS WELL COMPACTED
	■			■	SPT 10/150mm REFUSAL	-	FILL: Silty sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel, brick and concrete fragments.				
						CL-CH	SILTY CLAY: medium to high plasticity, light grey, with fine to medium grained ironstone gravel.	MC~PL	H		RESIDUAL
	■			■	N = 29 9,11,18					>600 >600 >600	
				■	N > 13 8,13/150mm REFUSAL					>600 >600 >600	
				■		-	SANDSTONE: fine to medium grained, light grey, with M strength iron indurated bands.	XW	EL		LOW TO MODERATE 'TC' BIT RESISTANCE
								DW	VL - L		
				■			SANDSTONE: fien to medum grained, orange brown.		M		MODERATE RESISTANCE
							REFER TO CORED BOREHOLE LOG				

RL (m AHD): 12, 11, 10, 9, 8, 7, 6
Depth (m): 1, 2, 3, 4, 5, 6

BOREHOLE 1


JEFFERY & KATAUSKAS PTY LTD
Job No: 23970WH BH1 START CORINGAT 4·48m
4
5
6
7
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9
10
11
12
13
14
15
16
17
18
19
20
21
22
END OF BH AT 23.00m

Borehole No.
1

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 03/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 12.3 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

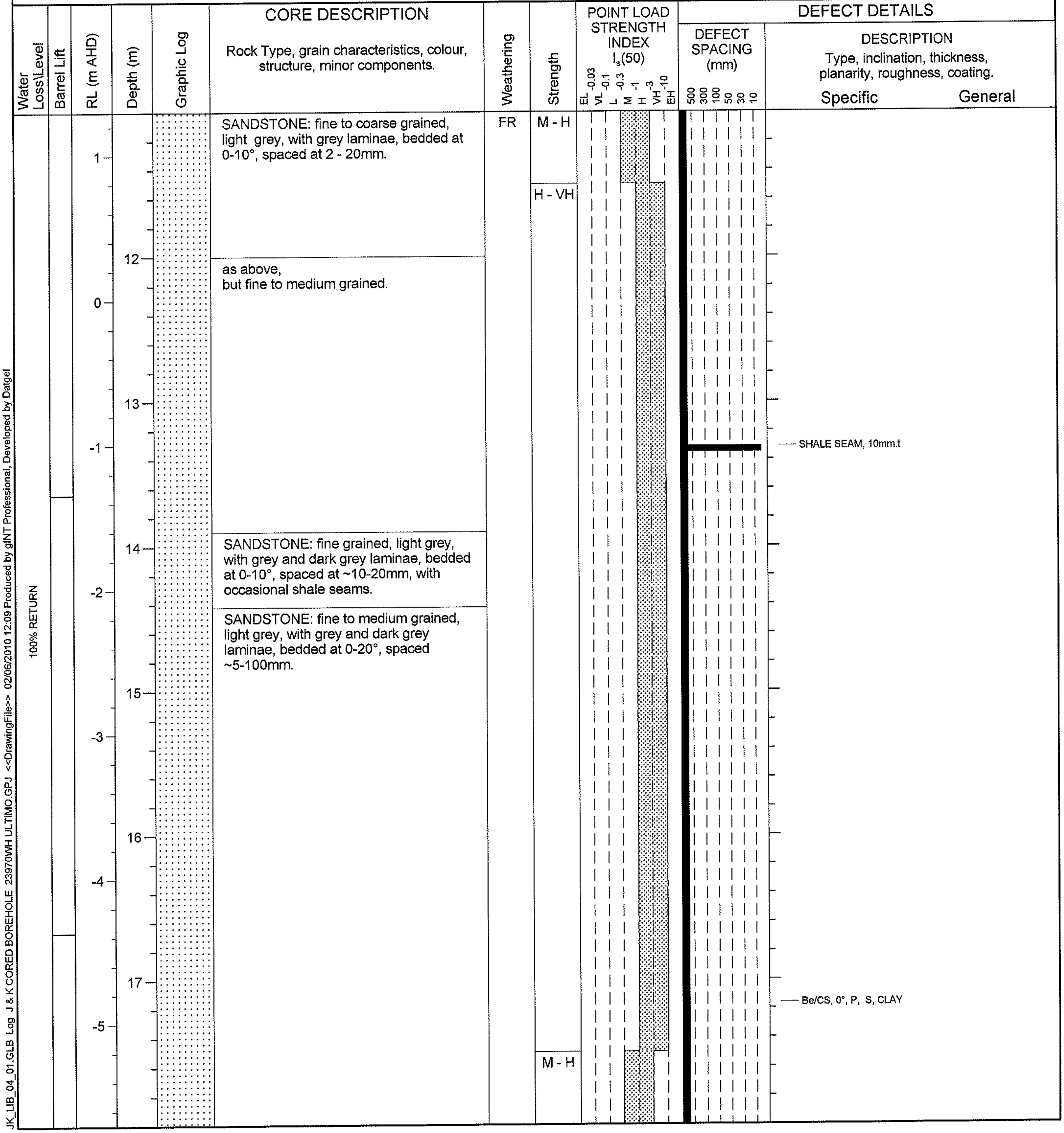
Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 4.48m	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500, 300, 100, 50, 30, 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		8									
100% RETURN		7	5		SANDSTONE: fine to medium grained, orange brown, bedded at 0-5°.	DW	L - M			Be, 20°, Un, R, IS	
					SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 0-10°, with occasional light brown bands.	SW				CS, 0°, 5 mm.t CS, 0°, 3 mm.t Be, 0°, Un, R, 3 mm.t CS, 0°, 10 mm.t	
		6	6		SANDSTONE: fine to coarse grained, light grey, with occasional grey laminae, bedded at 0-10°, spaced at 2-50mm.	SW - FR	M - H			CS, 0°, 5 mm.t CS, 0°, 9 mm.t	
ON COMPLETION OF CORING		5 4 3 2	7 8 9 10		SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 0-10°, spaced at 2-50mm.					CS, 0°, 15mm.t XWS, 0°. 40mm.t CS, 0°, P, S	
						FR					

CORED BOREHOLE LOG

Borehole No.
1
3 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 03/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 12.3 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./



SANDSTONE: fine to coarse grained, light grey, with grey laminae, bedded at 0-10°, spaced at 2 - 20mm.

as above,
but fine to medium grained.

SANDSTONE: fine grained, light grey, with grey and dark grey laminae, bedded at 0-10°, spaced at ~10-20mm, with occasional shale seams.

SANDSTONE: fine to medium grained, light grey, with grey and dark grey laminae, bedded at 0-20°, spaced ~5-100mm.

SHALE SEAM, 10mm.t

Be/CS, 0°, P, S, CLAY

JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:09 Produced by gINT Professional, Developed by Datgel

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

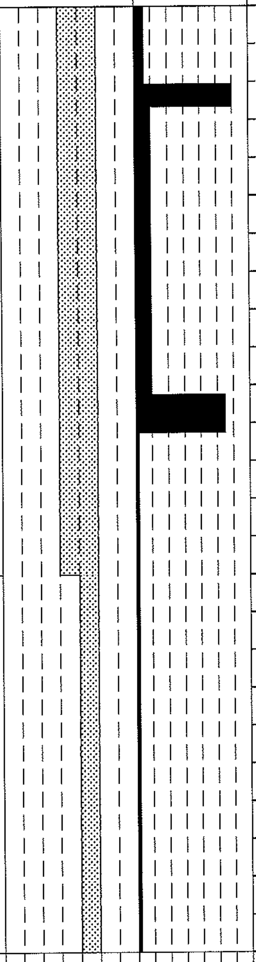
CORED BOREHOLE LOG

Borehole No.
1
4 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 12.3 m
Date: 03/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		-6			SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 0-20°, spaced at 5-50mm.	FR	M - H			XWS, 0°, 10 mm.t	
			19								
		-7									
			20							Be, 5°, P, S, IS	
		-8									
			21				H				
		-9									
			22								
		-10									
			23		END OF BOREHOLE AT 23.00 m						
		-11									
			24								
		-12									



BOREHOLE 2

JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH BH2 START CORING AT 5.72 m
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
END OF BH AT 20.93m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
2
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 14.92 m
Date: 04/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING								■	-	ASPHALTIC CONCRETE: 210mm.t				
	■							▩	-	FILL: Silty sandy gravel, fine to coarse grained igneous, ironstone and sandstone gravel, dark grey.	D	-		APPEARS WELL COMPACTED
	■			■	N = 15 5,7,8	14	1	▩	-	FILL: Sandy silty clay, medium plasticity, brown and red brown, fine to medium grained sand, with fine to medium grained ironstone and sandstone gravel and ash.	MC>PL			
	■			■	N = 27 6,9,18	13	2	▨	CL-CH	SILTY CLAY: medium to high plasticity, light grey and red brown, with M-H strength ironstone bands.	MC<PL	H	>600 >600 >600	RESIDUAL BANDS OF VERY LOW 'TC' BIT RESISTANCE
						12		☰	-	SHALE: mid grey, with M strength iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
				■	SPT 18/120mm REFUSAL	11	3 4	☰						VERY LOW RESISTANCE WITH LOW BANDS
				■	N = 48 10,23,25			☰			XW - DW	EL - VL		
				■		10	5	⠿	-	SANDSTONE: fine to medium grained, brown.	DW	L - M		LOW TO MODERATE RESISTANCE
						9 8	6			REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Borehole No.
2
2 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 14.92 m
Date: 04/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 5.72m	Weathering	Strength	POINT LOAD STRENGTH INDEX I$_s$(50) EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH	DEFECT SPACING (mm) 500, 300, 100, 50, 30, 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		9	6		SANDSTONE: fine to medium grained, brown.	DW	L - M				
					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded 0-5°, spaced at 5-15mm.	SW					
		8	7		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced at 5-150mm.	FR	M - H			XWS, 0°, 25 mm.t XWS, 0°, 15 mm.t	
		7 6	8 9		as above, but with grey laminae, spaced at 2-40mm.					J, 60°, P, S XWS, 0°, 15 mm.t XWS, 0°, 20 mm.t J, 75°, Un, R J, 75°, Un, R	
		5			as above, but with grey laminae, spaced at 10-70mm.						
ON COMPLETION OF CORING		4	10 11		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 5-20°, spaced at 5-20mm.					XWS, 10°, 20 mm.t	
		3			SANDSTONE: as below.						

CORED BOREHOLE LOG

Borehole No.
2
3 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 14.92 m
Date: 04/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	RL (m AHD)	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN	2	13	SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 0-5°, spaced 1- 10mm.	FR	M - H		
	1	14	as above, but with grey laminae, spaced at 150-250mm.		H		
	0	15	SANDSTONE: fine grained, light grey, massive.				
	-1	16	SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0°, spaced at 2-5mm.			HEALED J, 75°, P	
			SANDSTONE: fine grained, light grey, with dark grey laminae, bedded at 0°, spaced at 1-2mm.				
	-2 -3	17 18	SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced at 10-20mm.				
	-4		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 20°, spaced at 5-10mm.		M - H		

POINT LOAD STRENGTH INDEX $I_s(50)$: EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH
DEFECT SPACING (mm): 500, 300, 100, 50, 30, 10

Borehole No.
2
4 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH | **Core Size:** NMLC | **R.L. Surface:** 14.92 m
Date: 04/05/10 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK500 | **Bearing:** N/A | **Logged/Checked By:** D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 20°, spaced at 5-10mm.	FR	M - H				
		-5	20		as above, but with dark grey laminae, spaced at 5-100mm.						
		-6	21		END OF BOREHOLE AT 20.93 m						
		-7	22								
		-8	23								
		-9	24								
		-10	25								
		-11									

Borehole No.
3A
1 / 1

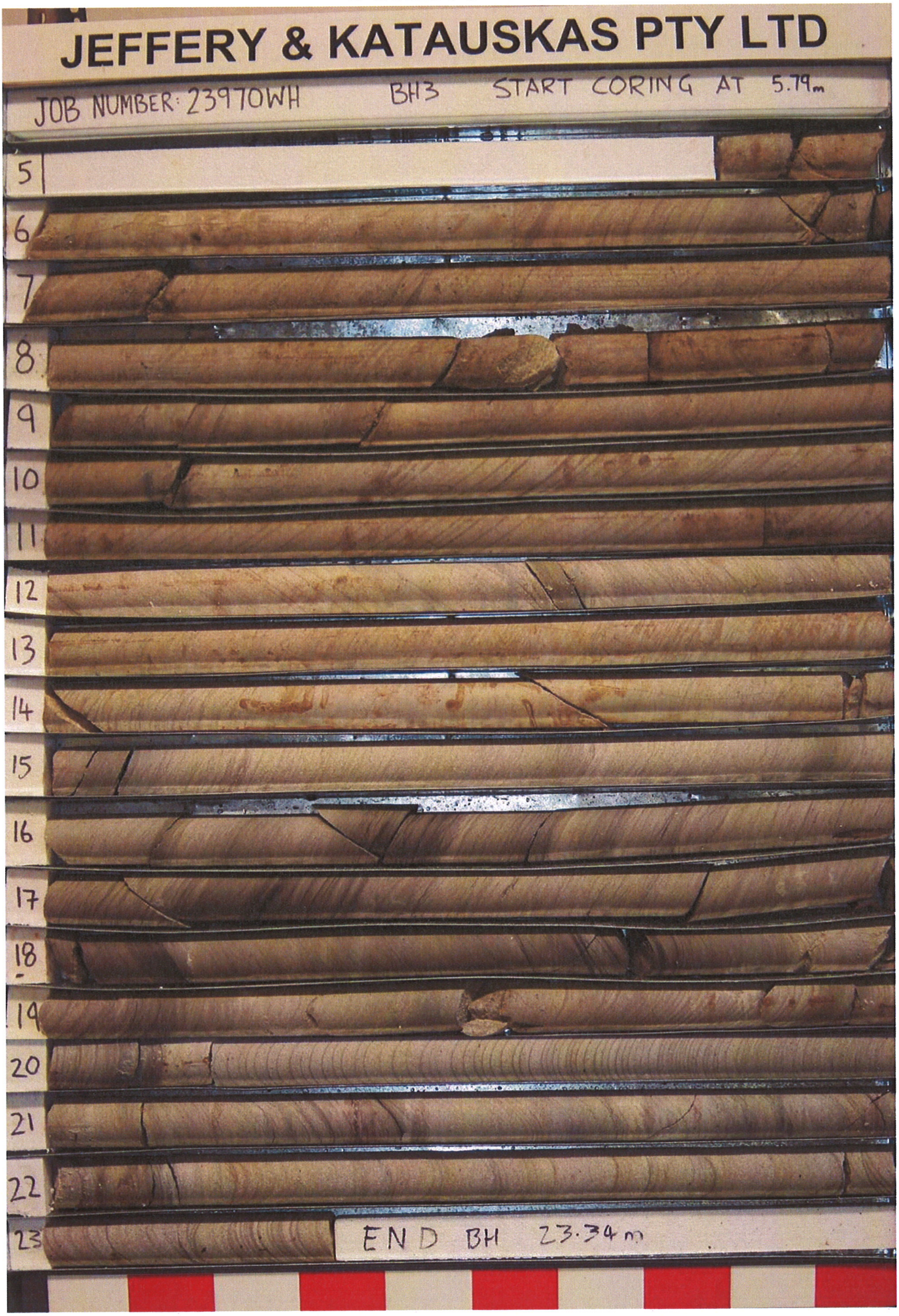
BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 13.82 m
Date: 04/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION									-	ASPHALTIC CONCRETE: 15mm.t	DW	M		LOW 'TC' BIT RESISTANCE
									-	FILL: Sandstone cobble, fine to medium grained, yellow brown.	MC<PL	-		
				■	N = 17 4,8,9	13	1			FILL: Silty clay, medium plasticity, light grey and red brown, with fine to medium grained ironstone and sandstone gravel and ash.			>600 >600 >600	APPEARS WELL COMPACTED
				■	N = 50 14,20,30	12			CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC<PL	H	>600 >600 >600	RESIDUAL
						11 10	2 3		-	SHALE: light grey, with M strength iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
						9 8 7	4 5 6			END OF BOREHOLE AT 4.00 m				50mm DIA. PVC STANDPIPE INSTALLED TO 3.5m DEPTH. FOR INSTALLATION DETAILS REFER TO TABLE D

BOREHOLE 3


JEFFERY & KATAUSKAS PTY LTD
JOB NUMBER: 23970WH
BH3
START CORING AT 5.79m
5
6
7
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11
12
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20
21
22
23
END BH 23.34m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
3
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 13.84 m
Date: 17/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: G.F./A.J.H.

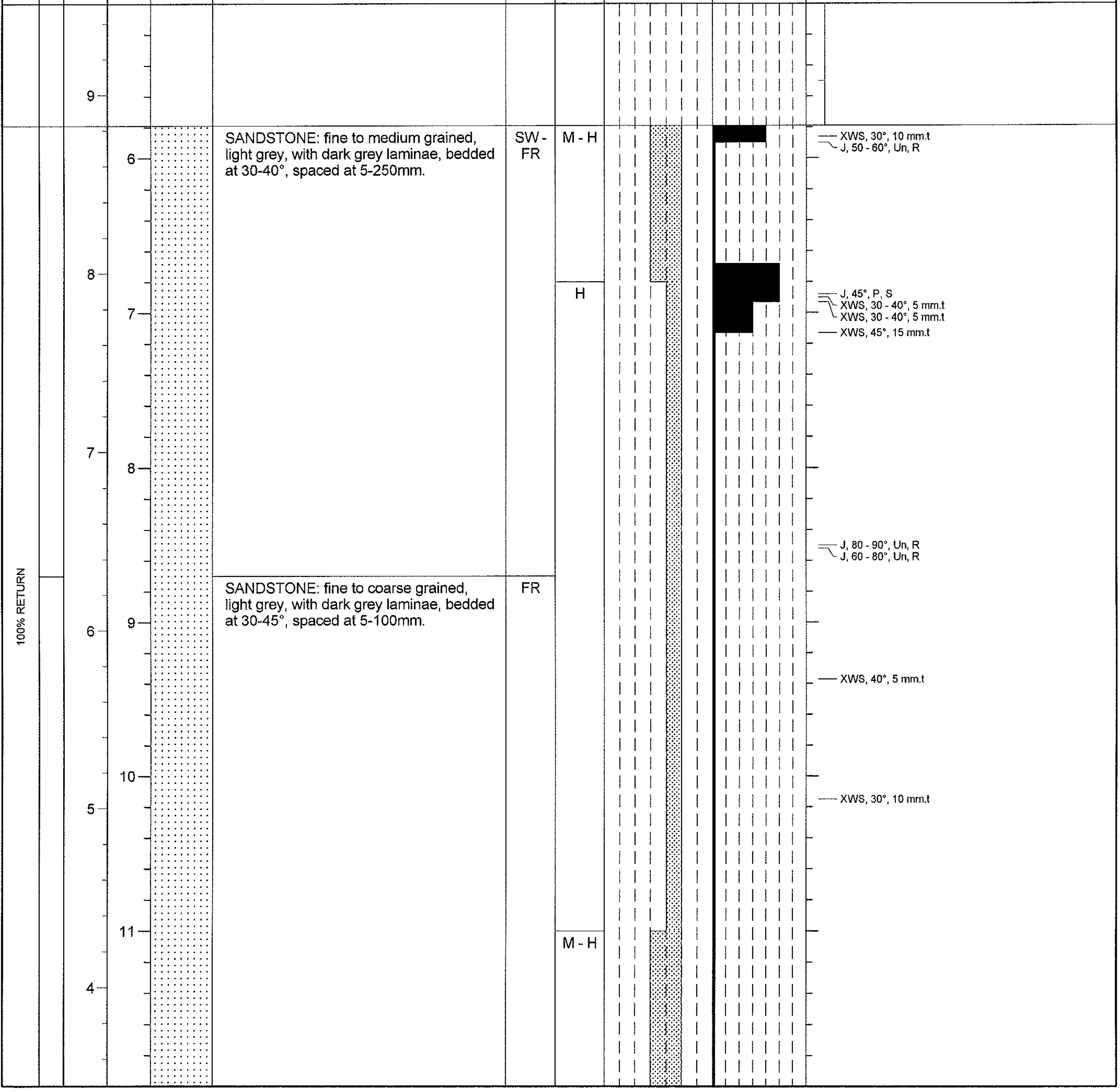
Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING									-	ASPHALTIC CONCRETE: 15mm.t FILL: Sandstone cobbles, fine to medium grained, yellow brown.	DW	M		LOW 'TC' BIT RESISTANCE
						13	1		-	FILL: Silty clay, medium plasticity, light grey and red brown, with fine to medium grained ironstone and sandstone gravel and ash.	MC<PL	-		-
							2		CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC<PL	H		RESIDUAL
						12 11 10	3 4		-	SHALE: light grey, with M strength iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
							5			SANDSTONE: fine to medium grained, orange brown.	DW	L - M		LOW RESISTANCE
						9				as above, but light grey.	SW - FR	M - H		LOW TO MODERATE RESISTANCE
						8	6			REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Borehole No.
3
2 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 13.84 m
Date: 17/05/10
Inclination: -60°
Datum: AHD
Plant Type: JK500
Bearing: 090°
Logged/Checked By: G.F./A.J.H./



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 5.79m	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		9									
100% RETURN		8 7	6 7 8		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 30-40°, spaced at 5-250mm.	SW - FR	M - H H			XWS, 30°, 10 mm.t J, 50 - 60°, Un, R J, 45°, P, S XWS, 30 - 40°, 5 mm.t XWS, 30 - 40°, 5 mm.t XWS, 45°, 15 mm.t J, 80 - 90°, Un, R J, 60 - 80°, Un, R	
		6 5 4	9 10 11		SANDSTONE: fine to coarse grained, light grey, with dark grey laminae, bedded at 30-45°, spaced at 5-100mm.	FR	M - H			XWS, 40°, 5 mm.t XWS, 30°, 10 mm.t	

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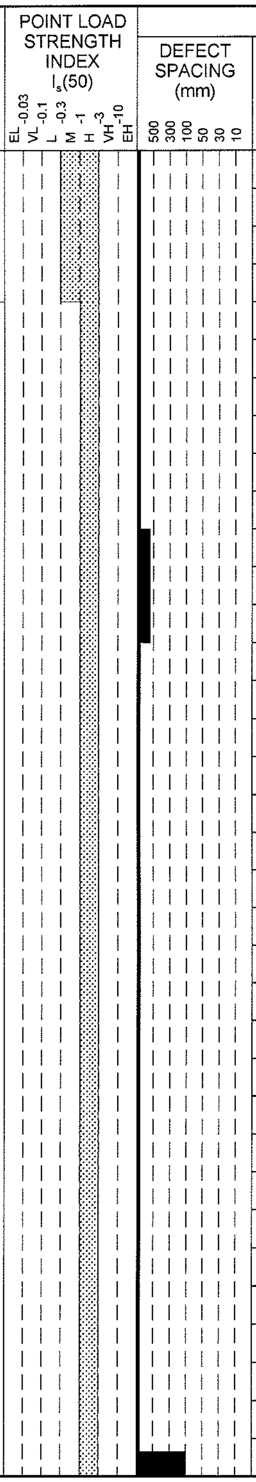
CORED BOREHOLE LOG

Borehole No.
3
3 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 13.84 m
Date: 17/05/10
Inclination: -60°
Datum: AHD
Plant Type: JK500
Bearing: 090°
Logged/Checked By: G.F./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to coarse grained, light grey, with dark grey laminae, bedded at 30-40°, spaced at 5-100mm.	FR	M - H		
		3							
							H		
			13						
		2							
			14					J, 50°, P, S	
								J, 50 - 60°, P, S	
		1							
			15		as above, but fine to medium grained.				
		0	16						
								J, 50 - 60°, P, S	
			17					J, 60°, P, S	
		-1							
			18						
		-2							
								J, 60°, Un, R	
								J, 60°, Un, R	



JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/08/2010 15:37 Produced by gINT Professional, Developed by Datgel

Borehole No.
3
4 / 4

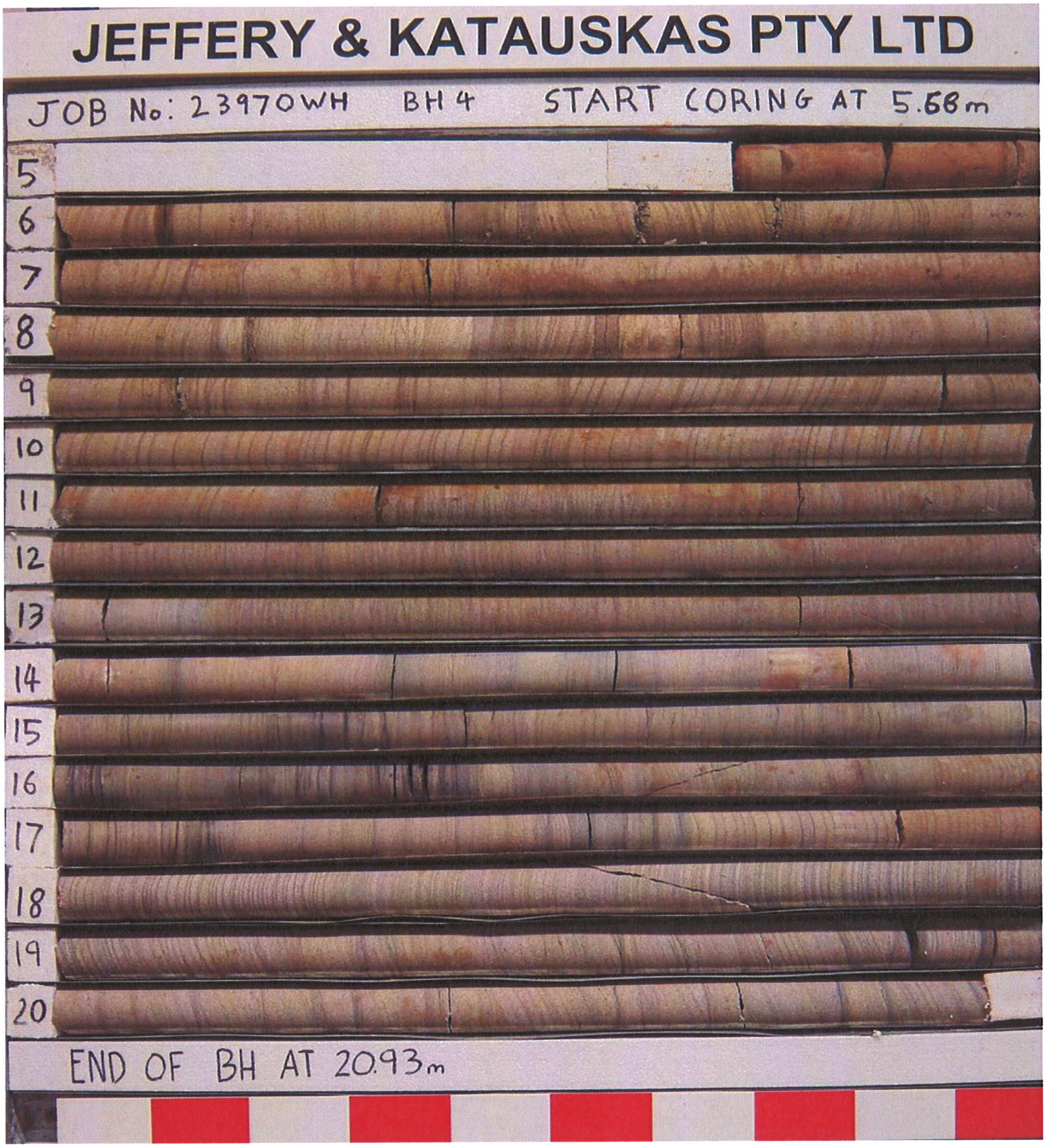
CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 13.84 m
Date: 17/05/10
Inclination: -60°
Datum: AHD
Plant Type: JK500
Bearing: 090°
Logged/Checked By: G.F./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 30-45°, spaced 5-100mm.	FR	H			J, 60°, P, R	
										J, 60°, Un, R J, 60°, Un, R	
		-3									
										J, 60°, Un, R	
										J, 60°, Un, R	
			20								
					as above, but spaced at 5-20mm.						
		-4									
			21		as above, but spaced at 5-200mm.						
										J, 60°, Un, R, 0 mm.t	
		-5									
										J, 60°, Un, R, 0 mm.t	
			22								
										Be, 10°, P, S, 0 mm.t	
		-6									
			23								
					END OF BOREHOLE AT 23.34 m						
		-7	24								
			25								
		-8									

BOREHOLE 4


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH BH4 START CORING AT 5.68m
5
6
7
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14
15
16
17
18
19
20
END OF BH AT 20.93m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
4
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 14.38 m
Date: 05/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING								■	-	ASPHALTIC CONCRETE: 50mm.t	M			
	■					14		▩		FILL: Silty clayey sand, fine to medium grained, brown, with fine to medium grained igneous, ironstone and sandstone gravel and ash.				
	■			■	N = 8 2,2,6			▩	-	FILL: Silty clay, medium plasticity, brown, with fine to medium grained ironstone gravel and ash.	MC>PL		100 120 130	APPEARS POORLY COMPACTED
	■			■	N = 22 5,9,13	13 12	1 2	▨	CL-CH	SILTY CLAY: medium to high plasticity, light grey and red brown, with ironstone gravel bands.	MC~PL	H	550 >600 >600	RESIDUAL
				■	N = 37 16,14,23	11	3	▤	-	SHALE: light grey, with M strength iron indurated bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
				■ ■	SPT 20/150mm REFUSAL	10 9	4 5	░	-	SANDSTONE: fine grained, light grey and orange brown, with M strength iron indurated bands.	XW DW	EL L - M M - H		LOW TO MODERATE RESISTANCE
						8	6			REFER TO CORED BOREHOLE LOG				

Borehole No.
4
2 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 05/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 14.38 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

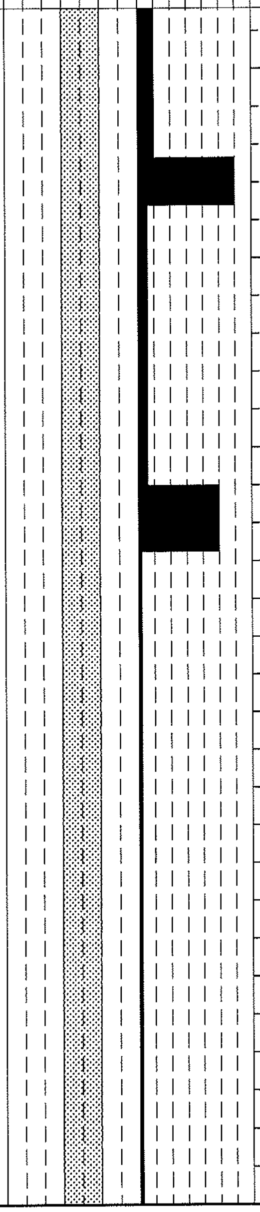
Water Loss\Level: 100% RETURN; 05/05/10, ON COMPLETION OF CORING

RL (m AHD): 9, 8, 7, 6, 5, 4, 3

Depth (m): 6, 7, 8, 9, 10, 11

CORE DESCRIPTION — Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 5.68m

CORE DESCRIPTION	Weathering	Strength
SANDSTONE: fine to medium grained, light grey and orange brown, bedded at 0-5°.	DW	M - H
SANDSTONE: fine to medium grained, light grey, bedded at 0-5°.	SW - FR	
SANDSTONE: fine to medium grained, light grey and light brown, with dark grey laminae, bedded at 0-20°, spaced 5mm-100mm.		
SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-10°, spaced 5mm-210mm.		
as above, but bedded at 20°, spaced 2-60mm.		
as above, but bedded at 0-5°, spaced 2-10mm.		



DEFECT DETAILS — DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific / General

- Be, 2°, Un, S, IS
- XWS, 0°, 12 mm.t
- XWS, 0°, 15 mm.t
- XWS, 0°, 5 mm.t
- XWS, 0°, 10 mm.t
- XWS, 0°, 25 mm.t
- XWS, 0°, 15 mm.t
- Be, 0°, Un, S, 0 mm.t

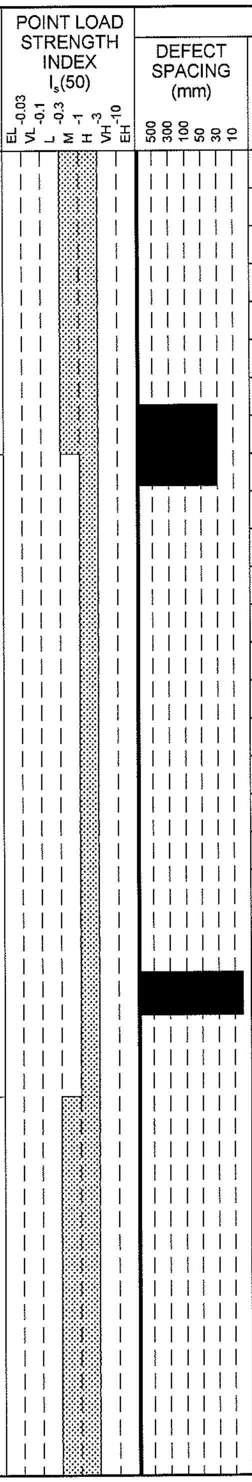
Borehole No.
4
3 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 05/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 14.38 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN				SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 2mm-10mm.	FR	M - H		
		2						
			13					
		1					HEALED J, 70°, Un	
						H	HEALED J, 70°, Un HEALED J, 70°, Un	
			14	SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced at 1-20mm.				
		0						
			15					
		-1					Be, 3°, P, S, 0 mm.t, IS	
			16					
		-2		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5-100mm.			XWS, 0°, 20 mm.t J, 70°, Un, R	
			17			M - H		
		-3						
				SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 20°, spaced 5-15mm.				
			18					
		-4		as above, but spaced at 1-10mm.			J, 70°, Un, R	



Borehole No.
4
4 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 05/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 14.38 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 10-20°, spaced 1-10mm.	FR	M - H				
		-5			as above, but spaced 60-120mm.						
					as above, but bedded at 0-20°, spaced 5-20mm.						
			20		as above, but spaced 10-130mm.						
		-6									
			21		END OF BOREHOLE AT 20.93 m						
		-7									
			22								
		-8									
			23								
		-9									
			24								
		-10									
			25								
		-11									

JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:10 Produced by gINT Professional, Developed by Datgel

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
5A
1 / 1

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 13.12 m
Date: 06/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION						13			-	FILL: Sandy gravell, fine to medium grained, ironstone, sandstone and igneous, brown, fine to medium grained sand, with concrete fragments.	D			APPEARS WELL COMPACTED
						12	1			FILL: Silty sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel and ash.				
						11 10	2 3		CL-CH	SILTY CLAY: medium to high plasticity, light grey, with M strength ironstone bands.	MC~PL	H		RESIDUAL
						9	4		-	SANDSTONE: fine to medium grained, light brown.	DW	L - M		LOW 'TC' BIT RESISTANCE
						8 7	5 6			END OF BOREHOLE AT 4.10 m				50mm DIA. PVC STANDPIPE INSTALLED TO 3.7m DEPTH. FOR INSTALLATION DETAILS REFER TO TABLE D.

JK_LIB_04_01.GLB Log J & K AUGERHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:03 Produced by gINT Professional, Developed by Datgel

BOREHOLE 5


JEFFERY & KATAUSKAS PTY LTD
JOB No.: 23970WH BH5 START CORING AT 5.63m
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
END OF BH AT 24.00m

Borehole No.
5
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH **Method:** SPIRAL AUGER **R.L. Surface:** 13.36 m
Date: 06/05/10 **Datum:** AHD
Drill Type: JK500 **Logged/Checked By:** D.S./A.J.H.

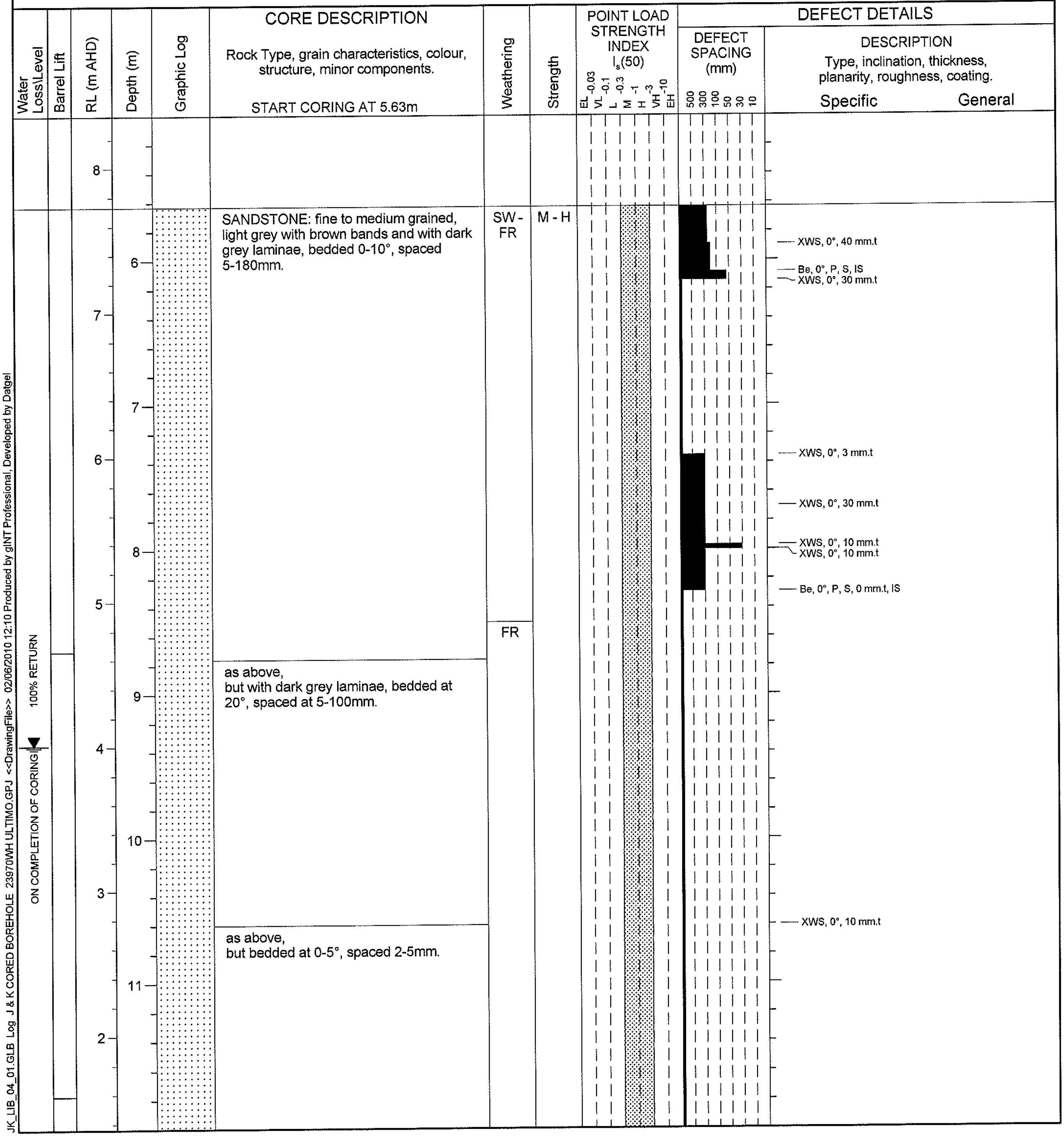
Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING								▨	-	FILL: Sandy gravel, fine to medium grained ironstone, sandstone and igneous, brown, fine to medium grained sand, with concrete fragments.	D			APPEARS WELL COMPACTED
	■					13		▨		FILL: Silty sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel and ash.				
	■				N = 21 6,14,7			▨						
							1	▨						
						12		▧	CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC~PL	H		RESIDUAL
	■			■	N = 21 6,10,11			▧					480 520 >600	
						11	2	▧						
				■	N = 28 5,10,18	10	3	▧						
				■		9	4	⁘	-	SANDSTONE: fine to medium grained, light grey, with M strength iron indurated bands.	DW	L - M		LOW 'TC' BIT RESISTANCE
				■		8	5	⁘		SANDSTONE: fine to coarse grained, light grey and brown.	SW	M		LOW TO MODERATE RESISTANCE
						7	6			REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Borehole No.
5
2 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH	**Core Size:** NMLC	**R.L. Surface:** 13.36 m
Date: 06/05/10	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** D.S./A.J.H./



START CORING AT 5.63m

SANDSTONE: fine to medium grained, light grey with brown bands and with dark grey laminae, bedded 0-10°, spaced 5-180mm.

SW - FR

M - H

FR

as above,
but with dark grey laminae, bedded at 20°, spaced at 5-100mm.

as above,
but bedded at 0-5°, spaced 2-5mm.

XWS, 0°, 40 mm.t
Be, 0°, P, S, IS
XWS, 0°, 30 mm.t
XWS, 0°, 3 mm.t
XWS, 0°, 30 mm.t
XWS, 0°, 10 mm.t
XWS, 0°, 10 mm.t
Be, 0°, P, S, 0 mm.t, IS
XWS, 0°, 10 mm.t

Borehole No.
5
3 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 13.36 m
Date: 06/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded 0-5°, spaced 2-50mm.	FR	M - H				
		1					H				
					SANDSTONE: fine grained, light grey, massive.						
			13								
					as above, but with dark grey laminae, bedded at 0-10°, spaced 2-5mm.						
		0									
					SANDSTONE: fine grained, light grey, massive.						
					SANDSTONE: fine grained, light grey, with dark grey laminae, bedded at 0-10°, spaced at 5-60mm.						
			14								
		-1									
			15							XWS, 0°, 63 mm.t Cr, 0°, 20 mm.t	
					as above, but with dark grey laminae, spaced at 2-70mm.		M - H				
		-2									
			16								
		-3								Be, 0°, Un, S, 0 mm.t	
							H				
			17								
		-4									
					SANDSTONE: fine to medium grained, light grey.						
			18		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded 0-20°, spaced 5-120mm.						
		-5									

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Borehole No.
5
4 / 4

CORED BOREHOLE LOG

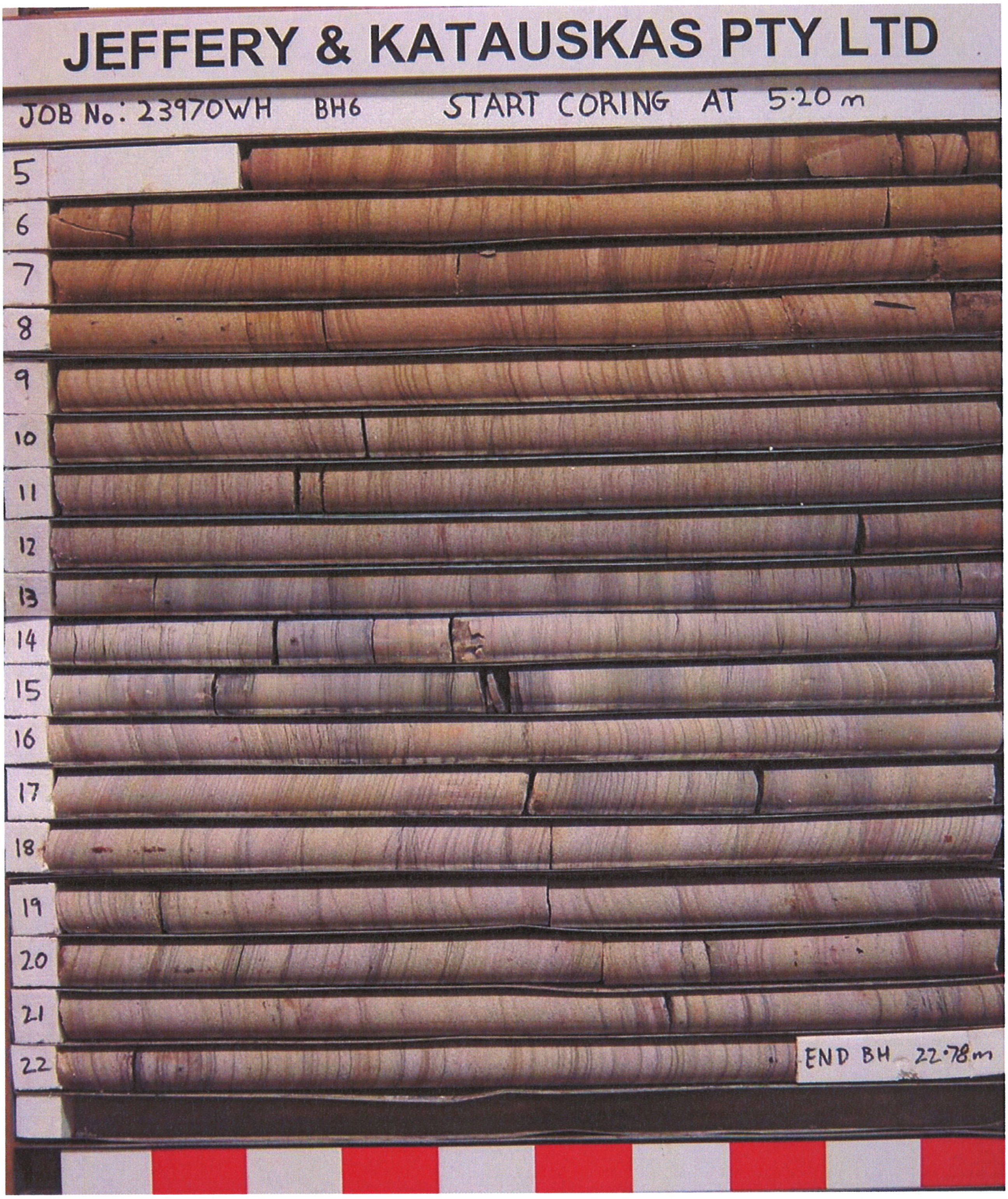
Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 06/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 13.36 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500, 300, 100, 50, 30, 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		-6 -7	20		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded 0-20°, spaced 5-120mm.	FR	H				
70% RETURN		-8 -9 -10	21 22 23							J, 70°, Un, R J, 70°, Un, R	
		-11 -12	24 25		END OF BOREHOLE AT 24.00 m						

JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:10 Produced by gINT Professional, Developed by Datgel

BOREHOLE 6


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH BH6 START CORING AT 5·20 m
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
END BH 22·78m

Borehole No.
6
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 13.25 m
Date: 06/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING		13		-	ASPHALTIC CONCRETE: 10mm.t FILL: Sandstone boulder, fine to medium grained, yellow brown.	DW	L - M		LOW 'TC' BIT RESISTANCE
	N = 15 8,5,10			CL CL-CH	SILTY CLAY: medium plasticity, brown, with fine to medium grained ironstone gravel. SILTY CLAY: medium to high plasticity, red brown, with M strength ironstone bands.	MC~PL	H	>600 >600 >600	RESIDUAL
		12	1						
	N = 30 11,13,17	11	2	CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC<PL		>600 >600 >600	
▼ ON COMPLETION OF CORING	N > 40 5,20,20/100mm REFUSAL	10	3	-	SHALE: light grey, with M strength iron indurated bands.	XW	EL		VERY LOW RESISTANCE WITH LOW BANDS
		9	4	-	SANDSTONE: fine to medium grained, light grey, with H strength iron indurated bands.	XW - DW	EL - VL		VERY LOW TO LOW RESISTANCE WITH HIGH BANDS
			5		SANDSTONE: fine to medium grained, light brown.	SW	M - H		MODERATE RESISTANCE
		8 7	6		REFER TO CORED BOREHOLE LOG				

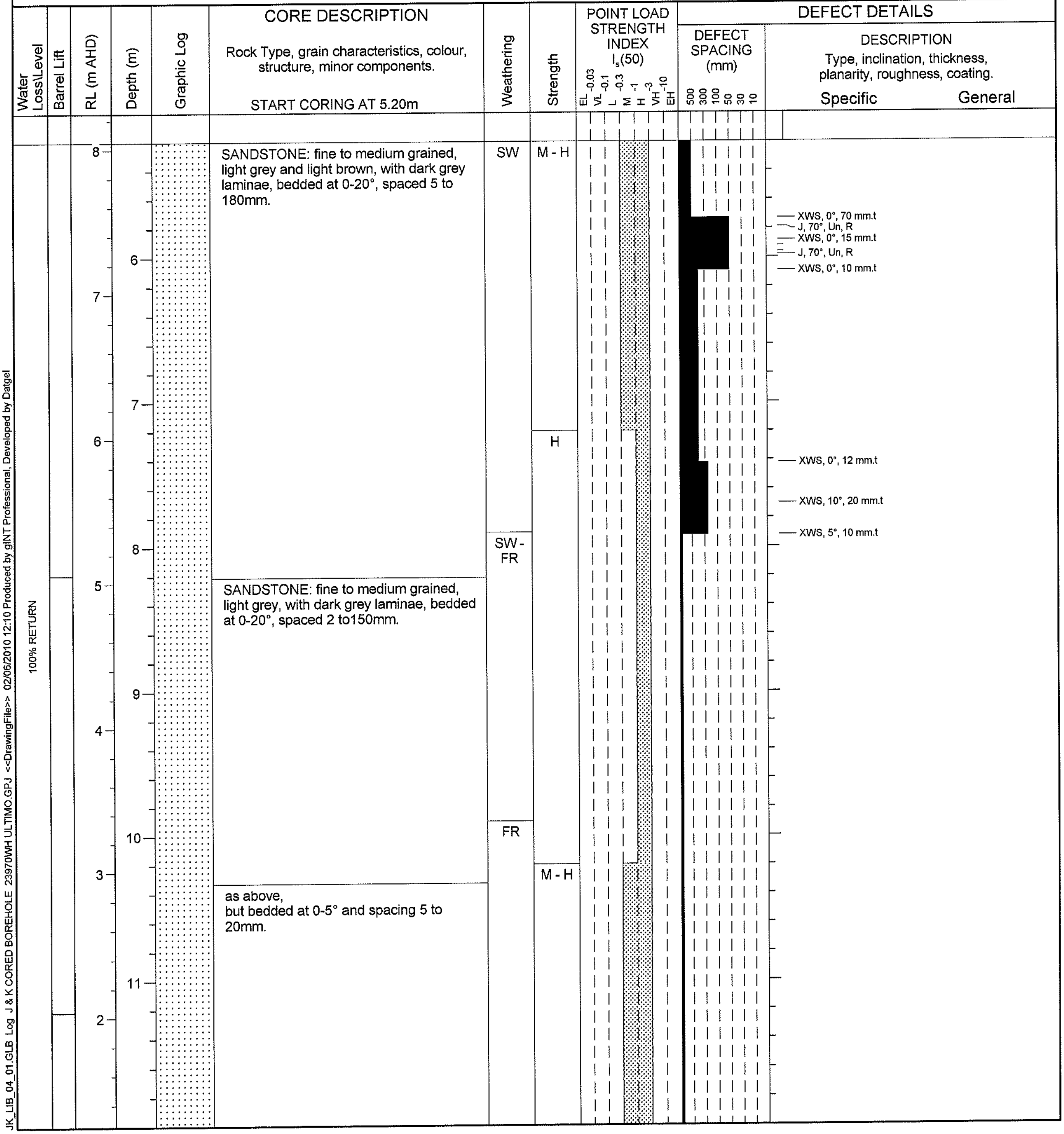
JK_LIB_04_01.GLB Log J & K AUGERHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:01 Produced by gINT Professional, Developed by Datgel

Borehole No.
6
2 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 06/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 13.25 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./



CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 5.20m	Weathering	Strength
SANDSTONE: fine to medium grained, light grey and light brown, with dark grey laminae, bedded at 0-20°, spaced 5 to 180mm.	SW	M - H
		H
	SW - FR	
SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 2 to150mm.		
	FR	
		M - H
as above, but bedded at 0-5° and spacing 5 to 20mm.		

DEFECT DETAILS

DESCRIPTION
Type, inclination, thickness, planarity, roughness, coating.

Specific	General
XWS, 0°, 70 mm.t	
J, 70°, Un, R	
XWS, 0°, 15 mm.t	
J, 70°, Un, R	
XWS, 0°, 10 mm.t	
XWS, 0°, 12 mm.t	
XWS, 10°, 20 mm.t	
XWS, 5°, 10 mm.t	

CORED BOREHOLE LOG

Borehole No.
6
3 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 06/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 13.25 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		1			SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 2 to 20mm.	FR	M - H				
		0	13		SANDSTONE: fine grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 10 to 100mm.		H				
		-1 -2	14 15		as above, but bedded at 0-5°, spaced 2 to 10mm.					Cr, 0°, 20 mm.t	
		-3	16		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5 to 50mm.						
		-4	17		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 10°, spaced 5 to10mm.						
		-5	18		as above, but bedded at 0-20° and spaced 5 to 100mm.						

CORED BOREHOLE LOG

Borehole No.
6
4 / 4

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 06/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 13.25 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		-6 -7 -8 -9	20 21 22		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5 to 100mm.	FR	H			Be, 0°, P, S, CLAY COATED Be, 10°, P, S, IS Be, 0°, P, S, IS	
		-10 -11 -12	23 24 25		END OF BOREHOLE AT 22.78 m						

BOREHOLE LOG

Borehole No.
7A
1 / 1

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 8.97 m
Date: 07/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION								■		ASPHALTIC CONCRETE: 100mm.t				
								▩	-	FILL: Sandy gravel, fine to medium grained igneous, dark grey, fine to medium grained sand.	D			
				■				▨	CL	SILTY CLAY: medium plasticity, brown, with fine to medium grained ironstone gravel.	MC>PL	VSt		RESIDUAL
						8	1	▨	CL-CH	SILTY CLAY: medium to high plasticity, light grey and red brown, with ironstone gravel bands.				
								⠿	-	SANDSTONE: fine to medium grained, light grey.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						7	2			END OF BOREHOLE AT 1.80 m				50mm DIA. PVC STANDPIPE INSTALLED TO 1.5m DEPTH. FOR INSTALLATION DETAILS REFER TO TABLE D.
						6	3							
						5	4							
						4	5							
						3	6							

Borehole No.
7
1 / 3

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 8.93 m
Date: 07/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING										ASPHALTIC CONCRETE: 100mm.t				
									-	FILL: Sandy gravel, fine to medium grained igneous, dark grey, fine to medium grained sand.	D			
					N = 6 2,2,4				CL	SILTY CLAY: medium plasticity, brown, with fine to medium grained ironstone gravel.	MC>PL	VSt	200 300 250	RESIDUAL
						8	1							
									CL-CH	SILTY CLAY: medium to high plasticity, light grey and red brown, with ironstone gravel bands.				
									-	SANDSTONE: fine to medium grained, light grey and red brown.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
▼ ON COMPLETION OF CORING						7	2							
											DW	M		LOW RESISTANCE
						6	3							
										REFER TO CORED BOREHOLE LOG				
						5	4							
						4	5							
						3	6							
						2								

BOREHOLE 7


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH BH7 START CORING AT 3·04m
3
4
5
6
7
8
9
10
11
12
13
14
15
16
END BH AT 16·53m

CORED BOREHOLE LOG

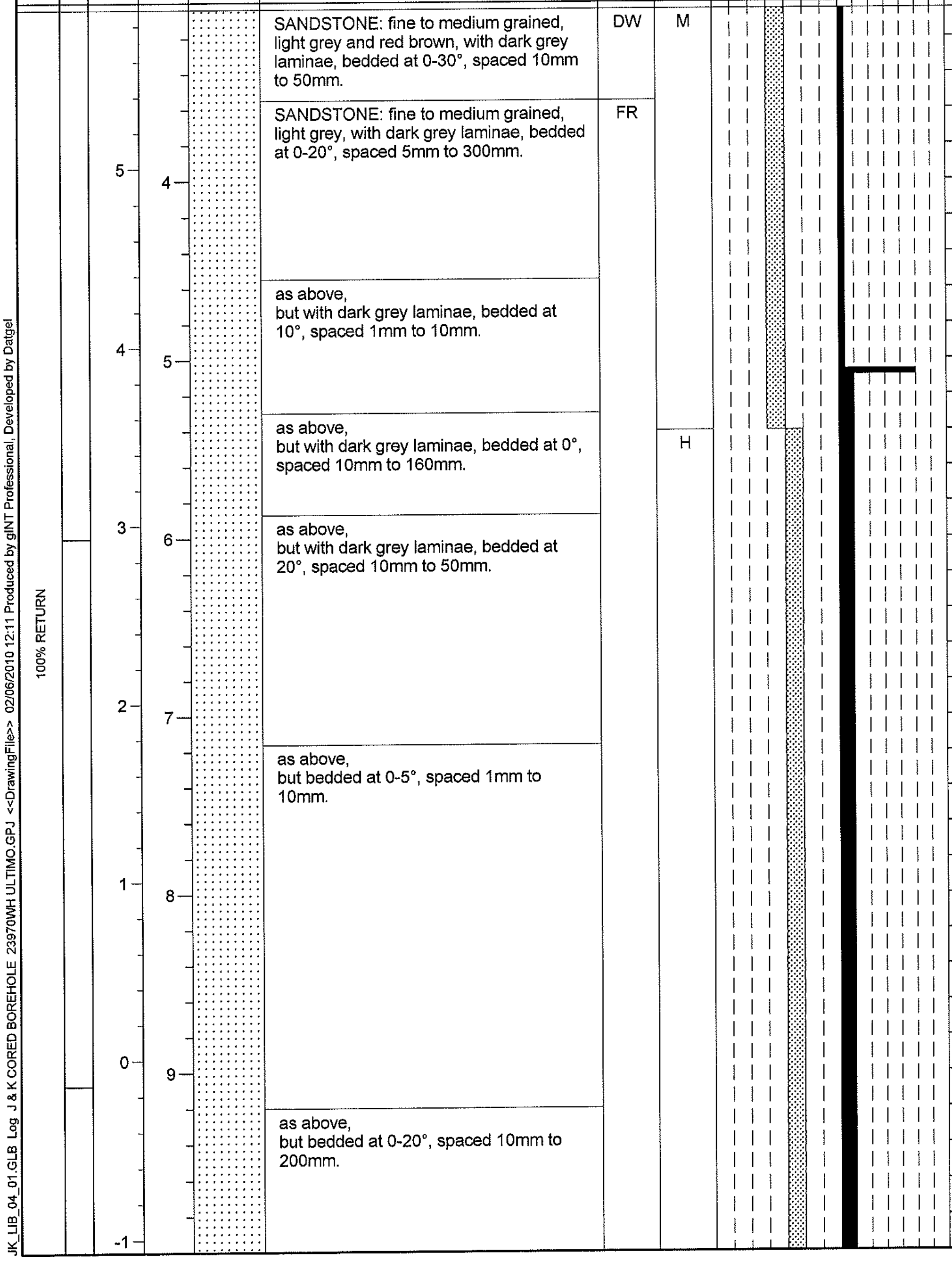
Borehole No.
7
2 / 3

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 8.93 m
Date: 07/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level: 100% RETURN

CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 3.04m	Weathering	Strength
SANDSTONE: fine to medium grained, light grey and red brown, with dark grey laminae, bedded at 0-30°, spaced 10mm to 50mm.	DW	M
SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5mm to 300mm.	FR	
as above, but with dark grey laminae, bedded at 10°, spaced 1mm to 10mm.		
as above, but with dark grey laminae, bedded at 0°, spaced 10mm to 160mm.		H
as above, but with dark grey laminae, bedded at 20°, spaced 10mm to 50mm.		
as above, but bedded at 0-5°, spaced 1mm to 10mm.		
as above, but bedded at 0-20°, spaced 10mm to 200mm.		



DEFECT DETAILS
DESCRIPTION
Type, inclination, thickness, planarity, roughness, coating.
Specific General

XWS, 0°, 5 mm.t
Be, 5°, P, S, CLAY COATED
XWS, 2°, 5 mm.t
Cr, 0°, 15 mm.t
XWS, 0°, 40 mm.t
Be, 0°, P, S, 0 mm.t
XWS, 0°, 25 mm.t

CORED BOREHOLE LOG

Borehole No.
7
3 / 3

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 8.93 m
Date: 07/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 10mm to 200mm.	FR	H - VH				
										Be, 5°, P, S, CLAY COATED	
		-2	11								
										Be, 0°, P, S, 0 mm.t, CLAY	
										Cr, 5°, P, S, 10 mm.t	
		-3	12								
										Be, 10°, P, S, IS	
		-4	13		as above, but with dark grey laminae, bedded at 20°, spaced 2mm to 20mm.						
		-5	14		as above, but with dark grey laminae, bedded at 0-20°, spaced 5mm to 100mm.						
		-6	15								
					as above, but with dark grey laminae, spaced 5mm to 50mm.						
		-7	16								
					END OF BOREHOLE AT 16.53 m						
		-8									

JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:11 Produced by gINT Professional, Developed by Datgel

Borehole No.
8
1 / 4

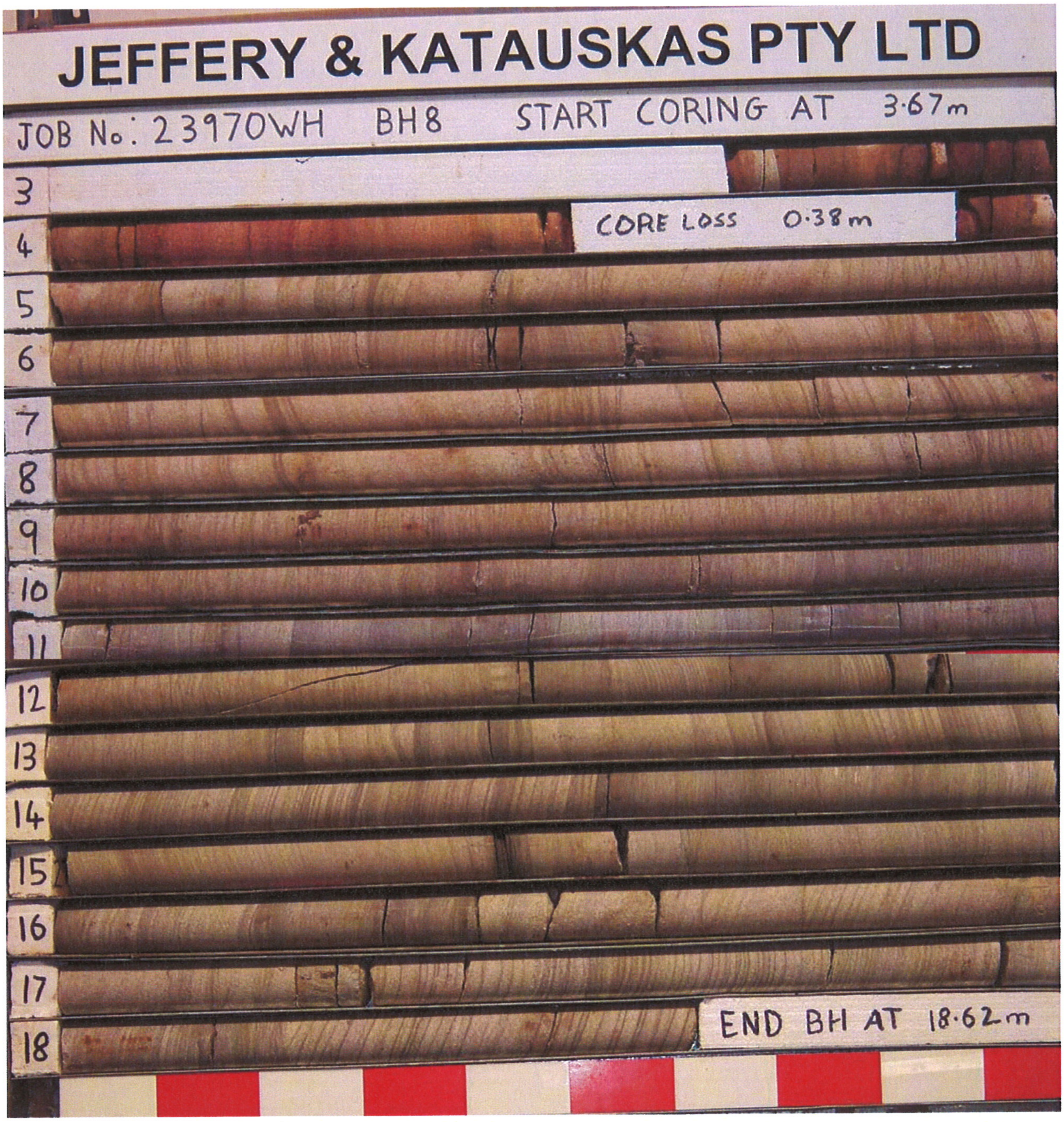
BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 10.63 m
Date: 11/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	Field Tests	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION			ASPHALTIC CONCRETE: 100mm.t				
			FILL: Silty sandy gravel, fine to medium grained, dark grey igneous, fine to medium grained sand.	D			APPEARS WELL COMPACTED
	N = 11 2,5,6		FILL: Silty clayey sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel, with a trace of ash.			250 300 300	
ON COMPLETION OF CORING	N > 6 5,6/100mm REFUSAL		FILL: Sandy gravel, fine to coarse grained sandstone, light grey.				
			FILL: Silty clayey sand, fine to medium grained, light grey and brown.				
	SPT 10/130mm REFUSAL	-	SANDSTONE: fine to medium grained, light grey and brown, with XW bands.	DW	M		LOW TO MODERATE 'TC' BIT RESISTANCE WITH VERY LOW BANDS
			REFER TO CORED BOREHOLE LOG				

BOREHOLE 8


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH
BH8
START CORING AT 3·67m
3
4
CORE LOSS 0·38m
5
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10
11
12
13
14
15
16
17
18
END BH AT 18·62m

Borehole No.
8
2 / 4

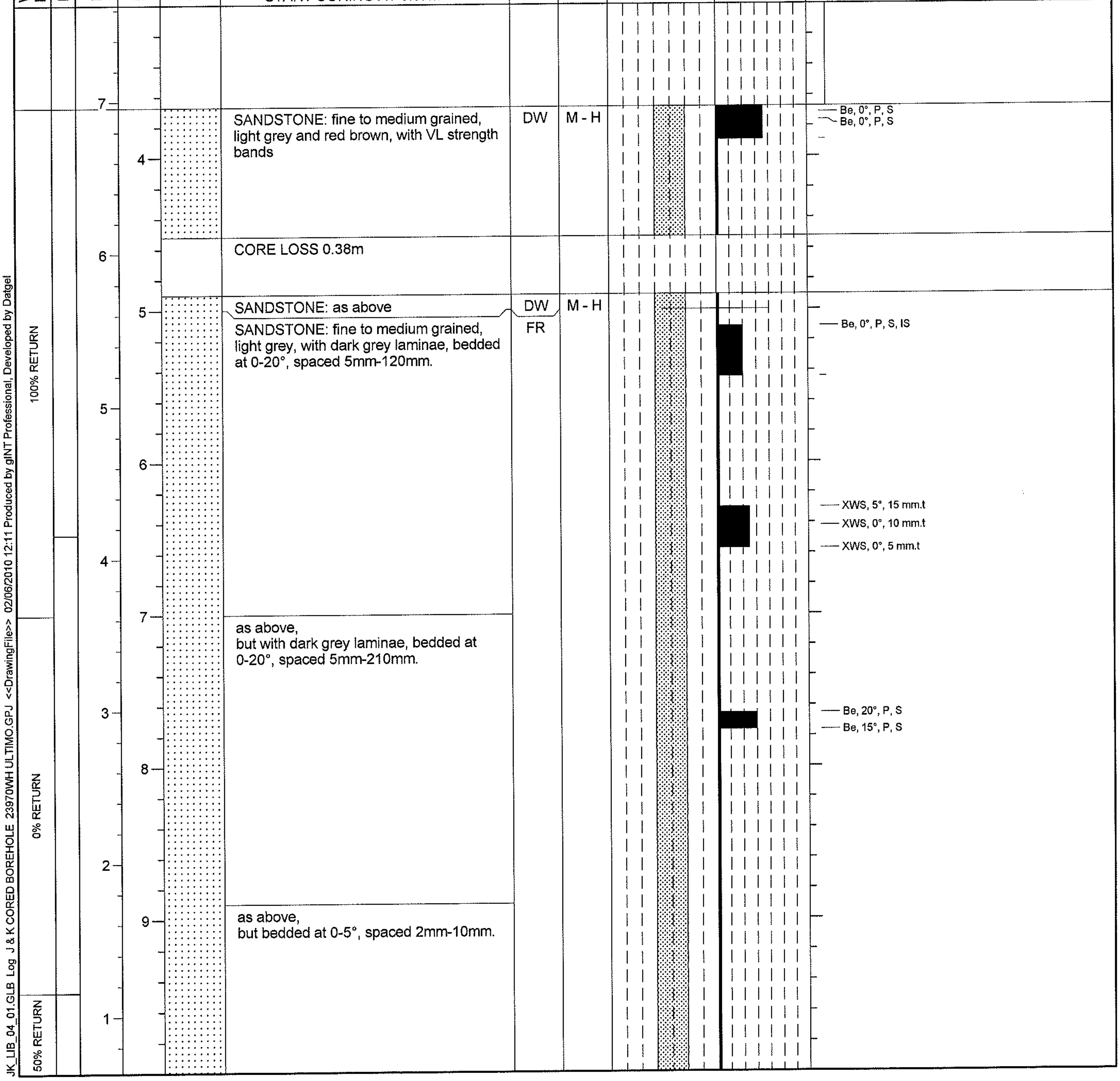
CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 11/05/10
Plant Type: JK500

Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A

R.L. Surface: 10.63 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./



Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 3.67m	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		7	4		SANDSTONE: fine to medium grained, light grey and red brown, with VL strength bands	DW	M - H			Be, 0°, P, S Be, 0°, P, S	
		6			CORE LOSS 0.38m						
			5		SANDSTONE: as above	DW	M - H				
		5 4	6		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5mm-120mm.	FR				Be, 0°, P, S, IS XWS, 5°, 15 mm.t XWS, 0°, 10 mm.t XWS, 0°, 5 mm.t	
0% RETURN		3 2	7 8		as above, but with dark grey laminae, bedded at 0-20°, spaced 5mm-210mm.					Be, 20°, P, S Be, 15°, P, S	
50% RETURN		1	9		as above, but bedded at 0-5°, spaced 2mm-10mm.						

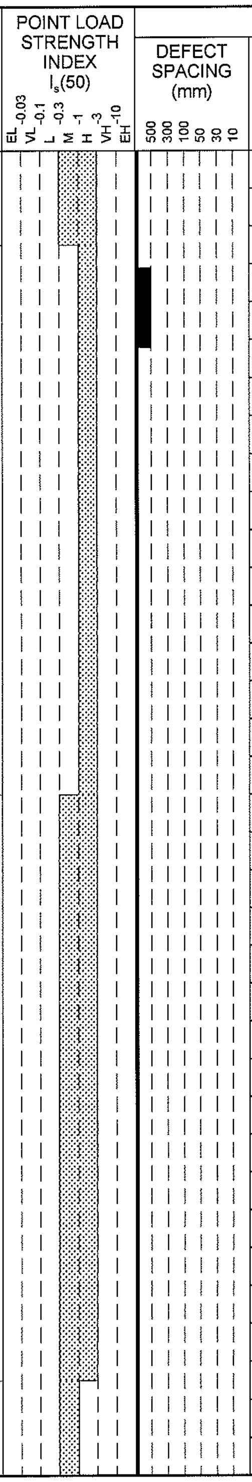
Borehole No.
8
3 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY, SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 11/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 10.63 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
50% RETURN					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 5mm-10mm.	FR	M - H		
		0					H	XWS, 0°, 5 mm.t	
			11					XWS, 0°, 5 mm.t	
					SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 5mm-90mm.				
		-1							
			12						
		-2							
			13				M - H		
		-3			as above, but with dark grey laminae, bedded at 20°, spaced 2mm-20mm.				
			14						
		-4							
			15		as above, but with dark grey laminae, bedded at 20°, spaced 5mm-140mm.				
		-5							
			16					Be, 0°, Un, R, CLAY COATED Be, 20°, Un, S	
		-6			SANDSTONE: fine to coarse grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5mm-160mm.		M		



Borehole No.
8
4 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 10.63 m
Date: 11/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
50% RETURN		-7	18		SANDSTONE: fine to coarse grained, light grey, with dark grey laminae, bedded at 0-20°, spaced 5mm-160mm.	FR	M			Be, 0°, P, S, 0 mm.t	
		-8 -9 -10 -11 -12 -13	19 20 21 22 23		END OF BOREHOLE AT 18.62 m						

COPYRIGHT

Borehole No.
9A
1 / 1

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 11.53 m
Date: 11/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION										ASPHALTIC CONCRETE: 100mm.t				
					N = 32 10,12,20	11	1		-	FILL: Silty clayey sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel and ash.	D			APPEARS WELL COMPACTED
					N = 30 6,10,20	10 9	2 3		CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC<PL	H	>600 >600 >600	RESIDUAL
					SPT 19/150mm REFUSAL				-	SANDSTONE: fine to medium grained, light grey.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
						8 7 6 5	4 5 6			END OF BOREHOLE AT 3.15 m				50mm DIA. PVC STANDPIPE INSTALLED TO 3.0m DEPTH. FOR INSTALLATION DETAILS REFER TO TABLE D

BOREHOLE 9


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH
BH9
START CORING AT 5.14m
5
CORE LOSS 0.35m
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
END BH 26.85m

Borehole No.
9
1 / 5

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: 11.46 m
Date: 13/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: D.S./A.J.H.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION OF AUGERING										ASPHALTIC CONCRETE: 100mm.t				
						11 10	1 2		-	FILL: Silty clayey sand, fine to medium grained, brown, with fine to medium grained ironstone and sandstone gravel and ash.				
						9	3 4		CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC<PL	H		RESIDUAL
						8	5		-	SANDSTONE: fine to medium grained, light grey and red brown, with XW bands.	DW	M		LOW TO MODERATE 'TC' BIT RESISTANCE WITH VERY LOW BANDS
						7	6			REFER TO CORED BOREHOLE LOG				

Borehole No.
9
2 / 5

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 13/05/10
Plant Type: JK500
Core Size: HQ
Inclination: -45°
Bearing: 270°
R.L. Surface: 11.46 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components. START CORING AT 5.14m	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		8	5								
100% RETURN					SANDSTONE: fine to medium grained, red brown.	DW	L - M				
					CORE LOSS 0.35m						
		7	6 7		SANDSTONE: fine to medium grained, red brown, with light grey bands, bedded at 40-50°.	DW	L - M			Be, 50°, P, S, IS XWS, 60°, 40 mm.t J, 50°, Un, R Be, 50°, P, S, IS	
		6 5	8 9		SANDSTONE: fine to medium grained, light brown and red brown, bedded at 10-50°.					XWS, 50°, 10 mm.t J, 50°, P, S, CLAY COATED Be, 50°, P, S, IS	
		4	10		SANDSTONE: fine to medium grained, light grey and light brown, with occasional grey laminae, bedded at up to 40°.	SW	 M			Be, 45°, Un, R, CLAY COATED J, 45°, Un, R XWS, 45°, 5 mm.t XWS, 45°, 5 mm.t	

CORED BOREHOLE LOG

Borehole No.
9
3 / 5

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 11.46 m
Date: 13/05/10
Inclination: -45°
Datum: AHD
Plant Type: JK500
Bearing: 270°
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN				SANDSTONE: fine to medium grained, light grey and light brown, with occasional grey laminae, bedded at up to 40°.	SW	M - H		
				SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 30-50°, spaced 5-140mm.			J, SUBVERTICAL, P, R	
					FR			
							Be, 45°, P, S, IS	
		3	12					
			13					
		2						
						H		
			14					
							Be, 30°, Un, R, CLAY COATED	
				as above, but with dark grey lamiane, bedded at 35-50°, spaced 3-15mm.				
							J, 60°, Un, R	
		1					J, 60°, P, R	
			15					
						M - H		
							J, 60°, P, R	
			16					
		0						
						H		
			17				Be, 35°, P, S, 0 mm.t	
		-1						

POINT LOAD STRENGTH INDEX $I_s(50)$: EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH

DEFECT SPACING (mm): 500, 300, 100, 50, 30, 10

CORED BOREHOLE LOG

Borehole No.
9
4 / 5

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 11.46 m
Date: 13/05/10
Inclination: -45°
Datum: AHD
Plant Type: JK500
Bearing: 270°
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		-2	19 20		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 35-50°, spaced 3-15mm.	FR	H			XWS, 45°, 10 mm.t XWS, 45°, 10 mm.t	
		-3	21		as above, but with dark grey laminae, spaced 5-150mm.						
		-4 -5 -6	22 23 24		as above, but with dark grey laminae, bedded at 40-50°, spaced 5-50mm.					J, 60°, P, R J, 60°, P, S	

Borehole No.
9
5 / 5

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: HQ
R.L. Surface: 11.46 m
Date: 13/05/10
Inclination: -45°
Datum: AHD
Plant Type: JK500
Bearing: 270°
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DETAILS: DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		-7	26		SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 40-50°, spaced 10-70mm.	FR	M			Be, 45°, P, S	
		-8 -9 -10 -11	27 28 29 30 31		END OF BOREHOLE AT 26.85 m						

BOREHOLE 10


JEFFERY & KATAUSKAS PTY LTD
JOB No: 23970WH BH 10 START CORING AT 4.48m
4
5
6
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17
18
19
20
21
22
END BH AT 22.61m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
10
1 / 4

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY, SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH **Method:** SPIRAL AUGER **R.L. Surface:** 12.26 m
Date: 12/05/10 **Datum:** AHD
Drill Type: JK500 **Logged/Checked By:** D.S./A.J.H.

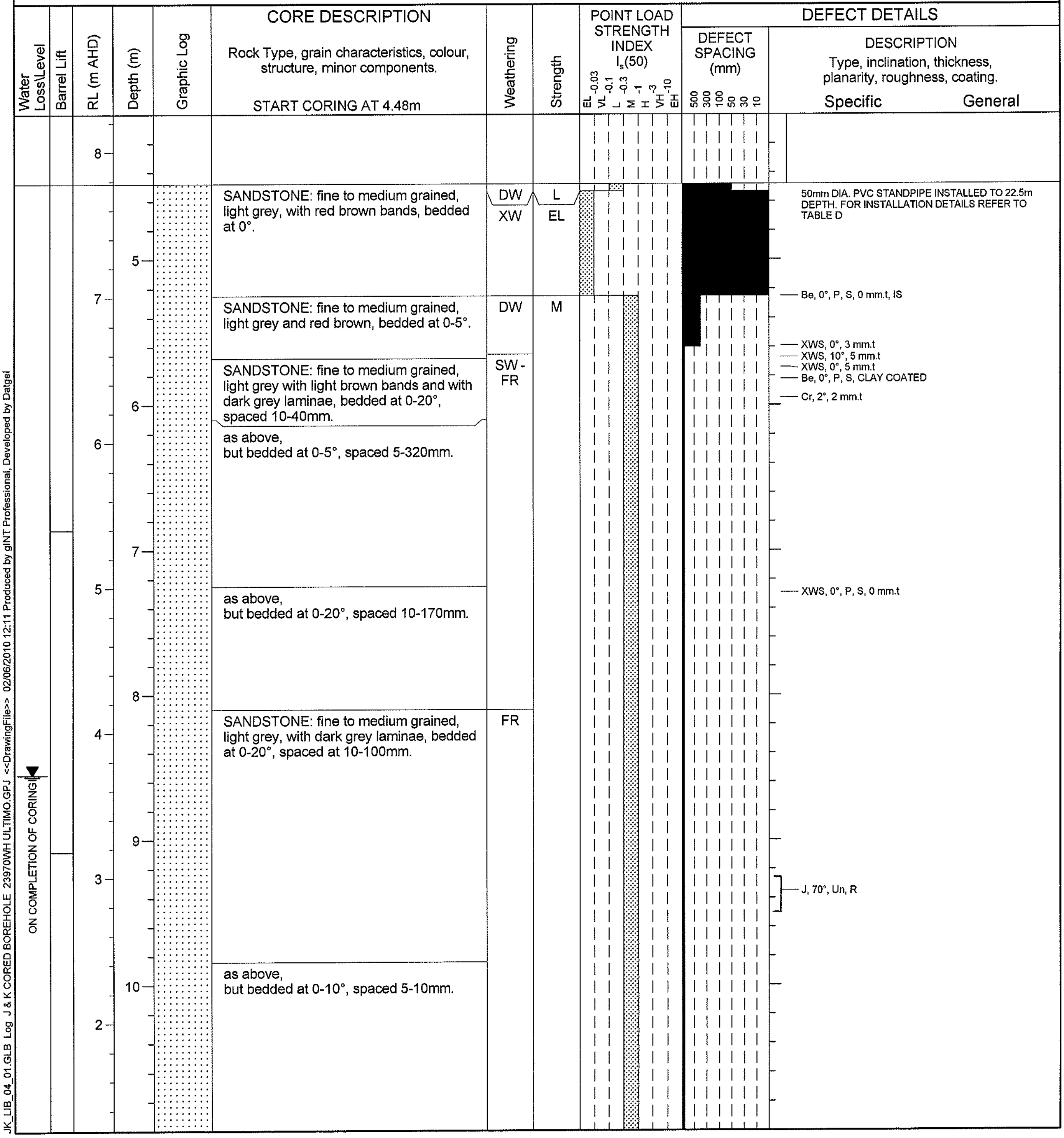
Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING									-	ASPHALTIC CONCRETE: 10mm.t	D			APPEARS MODERATELY COMPACTED
										FILL: Silty sand, fine to medium grained, brown, with fine to medium grained sandstone, ironstone and igneous gravel.				
					N = 6 3,3,3				-	FILL: Sandy silty clay, medium to high plasticity, brown, fine to medium grained sand, with fine to medium grained ironstone and sandstone gravel.	MC>PL		150 180 200	
					N = 16 3,7,9				CL-CH	SILTY CLAY: medium to high plasticity, light grey, with ironstone gravel bands.	MC~PL	VSt - H	350 450 500	RESIDUAL
					N = 50 14,19,31				-	SHALE: light grey, with L-M strength iron indurated bands.	XW	EL	>600 >600 >600	VERY LOW 'TC' BIT RESISTANCE WITH LOW BANDS
									-	SANDSTONE: fine to medium grained, light grey, with M strength iron indurated bands and XW bands.	DW	L		LOW TO MODERATE RESISTANCE WITH VERY LOW BANDS
										REFER TO CORED BOREHOLE LOG				

Borehole No.
10
2 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Core Size: NMLC
R.L. Surface: 12.26 m
Date: 12/05/10
Inclination: VERTICAL
Datum: AHD
Plant Type: JK500
Bearing: N/A
Logged/Checked By: D.S./A.J.H./



Core Description	Weathering	Strength
SANDSTONE: fine to medium grained, light grey, with red brown bands, bedded at 0°.	DW XW	L EL
SANDSTONE: fine to medium grained, light grey and red brown, bedded at 0-5°.	DW	M
SANDSTONE: fine to medium grained, light grey with light brown bands and with dark grey laminae, bedded at 0-20°, spaced 10-40mm.	SW-FR	
as above, but bedded at 0-5°, spaced 5-320mm.		
as above, but bedded at 0-20°, spaced 10-170mm.		
SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-20°, spaced at 10-100mm.	FR	
as above, but bedded at 0-10°, spaced 5-10mm.		

50mm DIA. PVC STANDPIPE INSTALLED TO 22.5m DEPTH. FOR INSTALLATION DETAILS REFER TO TABLE D

- Be, 0°, P, S, 0 mm.t, IS
- XWS, 0°, 3 mm.t
- XWS, 10°, 5 mm.t
- XWS, 0°, 5 mm.t
- Be, 0°, P, S, CLAY COATED
- Cr, 2°, 2 mm.t
- XWS, 0°, P, S, 0 mm.t
- J, 70°, Un, R

Borehole No.
10
3 / 4

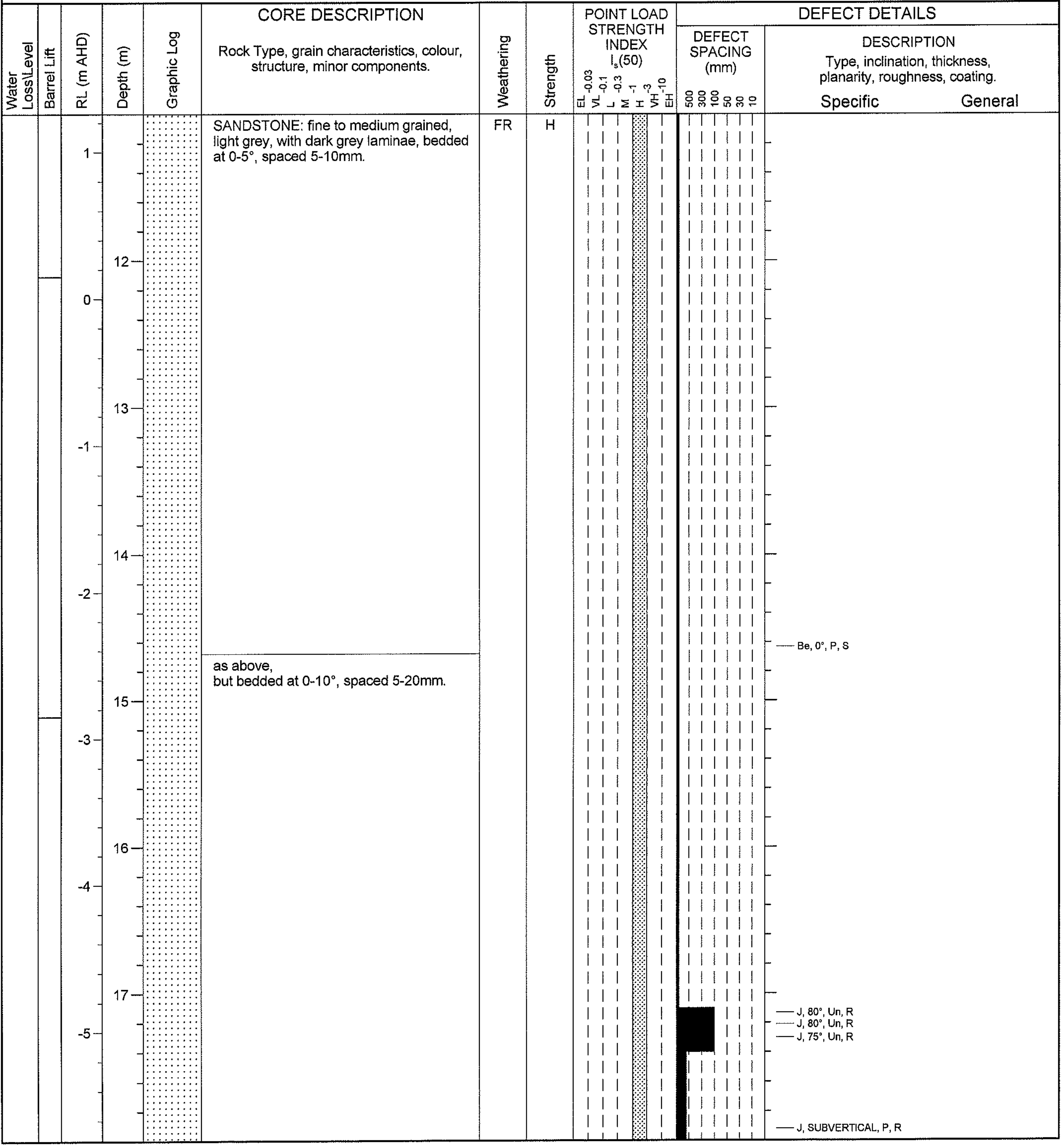
CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 12/05/10
Plant Type: JK500

Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A

R.L. Surface: 12.26 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./



SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-5°, spaced 5-10mm. FR H

as above,
but bedded at 0-10°, spaced 5-20mm.

— Be, 0°, P, S
— J, 80°, Un, R
— J, 80°, Un, R
— J, 75°, Un, R
— J, SUBVERTICAL, P, R

JK_LIB_04_01.GLB Log J & K CORED BOREHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:11 Produced by gINT Professional, Developed by Datgel

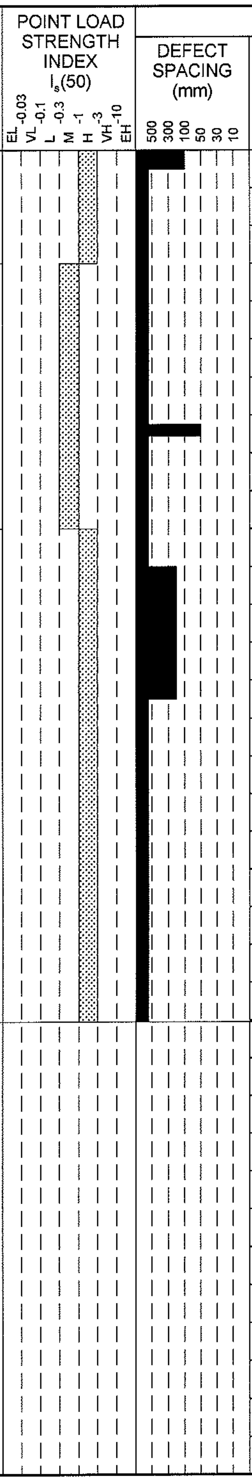
Borehole No.
10
4 / 4

CORED BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Date: 12/05/10
Plant Type: JK500
Core Size: NMLC
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: 12.26 m
Datum: AHD
Logged/Checked By: D.S./A.J.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength
		-6			SANDSTONE: fine to medium grained, light grey, with dark grey laminae, bedded at 0-10°, spaced 5-20mm.	FR	H
			19				M
		-7			as above, but bedded at 0-30°, spaced 3-70mm.		
		-8	20				H
		-9	21				
		-10	22				
					END OF BOREHOLE AT 22.61 m		
		-11	23				
		-12	24				



DEFECT DETAILS
DESCRIPTION
Type, inclination, thickness, planarity, roughness, coating.
Specific
General

- J, 75°, Un, R
- J, 45°, Un, R
- J, 90°, Un, R, 0 mm.t
- J, 55°, Un, R
- J, 75°, Un, R
- J, 85°, Un, R
- J, 40°, P, S
- J, 85°, P, S
- J, 50°, P, S
- J, 85°, Un, R
- J, 85°, Un, R
- Cr, 0°, 50 mm.t

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
11
1 / 1

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: ~13.8 m
Date: 18/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: V.B./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION									-	ASPHALTIC CONCRETE: 20mm.t	DW	M		LOW 'TC' BIT RESISTANCE
	■									FILL: Sandstone cobble, fine to medium grained, yellow brown.	M	-		-
										FILL: Silty sand, fine to medium grained, brown, with clay nodules, and a trace of sandstone and igneous gravel.				
	■ ■				N = 11 3,3,8 N = 26 8,12,14	13 12	1		CL-CH	SILTY CLAY: medium to high plasticity, red brown mottled grey, with ironstone gravel bands.	MC<PL	H		RESIDUAL
	■					11	2 3		-	SHALE: light grey, with M strength iron indurated bands.	XW	EL		VERY LOW RESISTANCE WITH LOW BANDS
	■					10	4		-	SANDSTONE: fine to medium grained, red brown, with clay and shale bands.				
						9 8 7	5 6			END OF BOREHOLE AT 4.50 m				

JK_LIB_04_01.GLB Log J & K AUGERHOLE 23970WH ULTIMO.GPJ <<DrawingFile>> 02/06/2010 12:02 Produced by gINT Professional, Developed by Datgel

Borehole No.
12
1 / 1

BOREHOLE LOG

Client: UNIVERSITY OF TECHNOLOGY. SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

Job No.: 23970WH
Method: SPIRAL AUGER
R.L. Surface: ~12.5 m
Date: 18/05/10
Datum: AHD
Drill Type: JK500
Logged/Checked By: V.B./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION								▨		ASPHALTIC CONCRETE: 20mm.t	W			FILL WAS SATURATED DUE TO SURFACE WATER INGRESS FROM RECENT RAINFALL
	■					12		▨		FILL: Silty gravelly sand, fine to coarse grained, grey brown, fine grained igneous gravel.				
	■ ■						1	▨		as above, but with inclusions of clay nodules and a trace of sandstone gravel.				
						11 10 9 8 7 6	2 3 4 5 6			END OF BOREHOLE AT 1.50 m				

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DYNAMIC CONE PENETRATION TEST RESULTS

Client: UNIVERSITY OF TECHNOLOGY, SYDNEY
Project: PROPOSED BROADWAY BUILDING
Location: CNR. JONES STREET & BROADWAY, ULTIMO, NSW

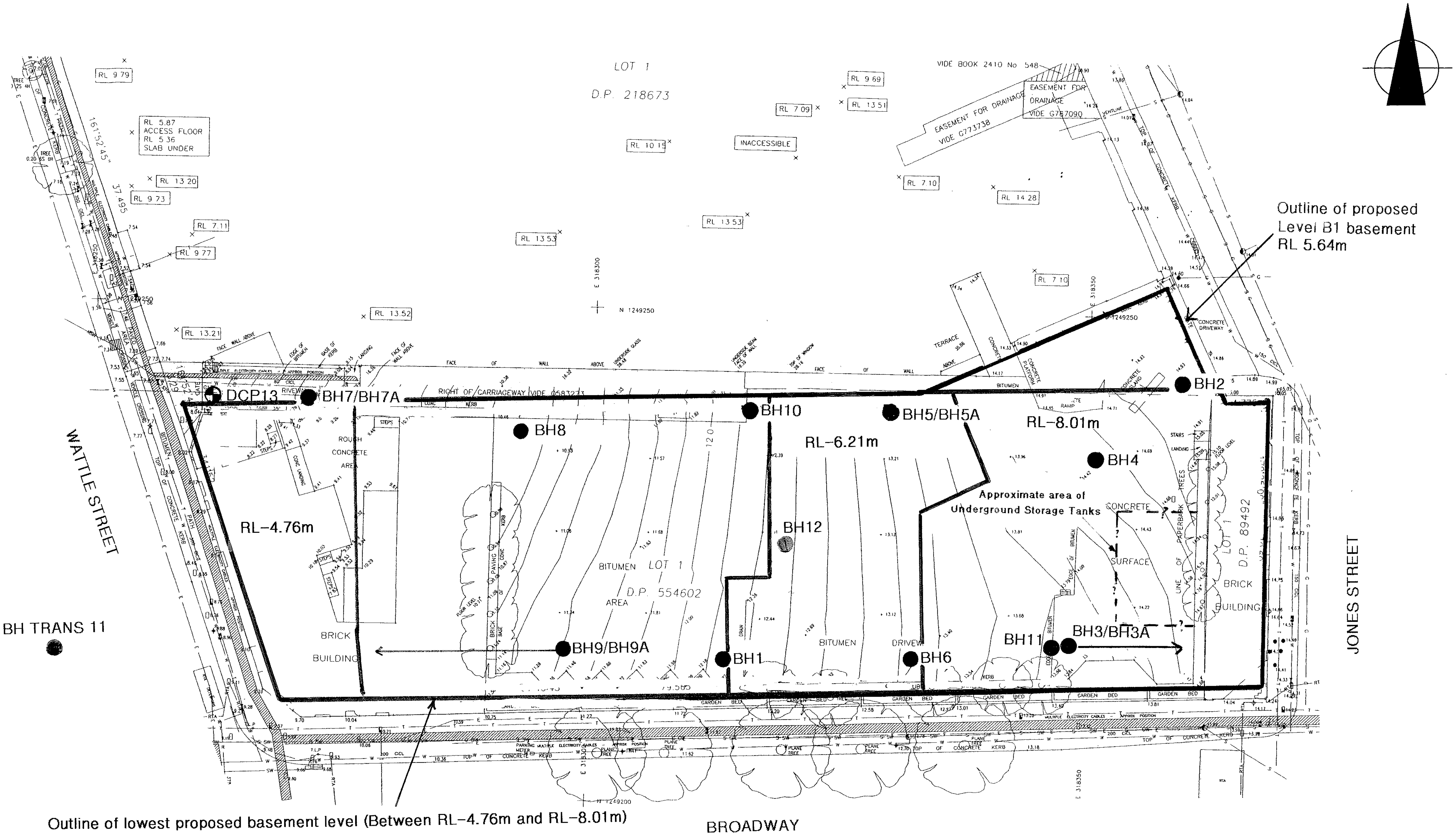
Job No. 23970WH
Date: 19-5-10
Tested By: D.S.

Hammer Weight & Drop: 9kg/510mm
Rod Diameter: 16mm
Point Diameter: 20mm

	Number of Blows per 100mm Penetration						
Test Location	RL ~8.0m						
Depth (mm)	**13**						
0 - 100	EXCAVATED						
100 - 200	12						
200 - 300	4						
300 - 400	2						
400 - 500	3						
500 - 600	3						
600 - 700	3						
700 - 800	2						
800 - 900	3						
900 - 1000	2						
1000 - 1100	2						
1100 - 1200	4						
1200 - 1300	12						
1300 - 1400	9/30mm						
1400 - 1500	REFUSAL						
1500 - 1600							
1600 - 1700							
1700 - 1800							
1800 - 1900							
1900 - 2000							
2000 - 2100							
2100 - 2200							
2200 - 2300							
2300 - 2400							
2400 - 2500							
2500 - 2600							
2600 - 2700							
2700 - 2800							
2800 - 2900							
2900 - 3000							

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal
3. Survey datum is AHD.

Ref: Scala3.xls April 99



SCALE (m)

0 20

LEGEND

● BOREHOLE

◒ DCP TEST

TEST LOCATION PLAN

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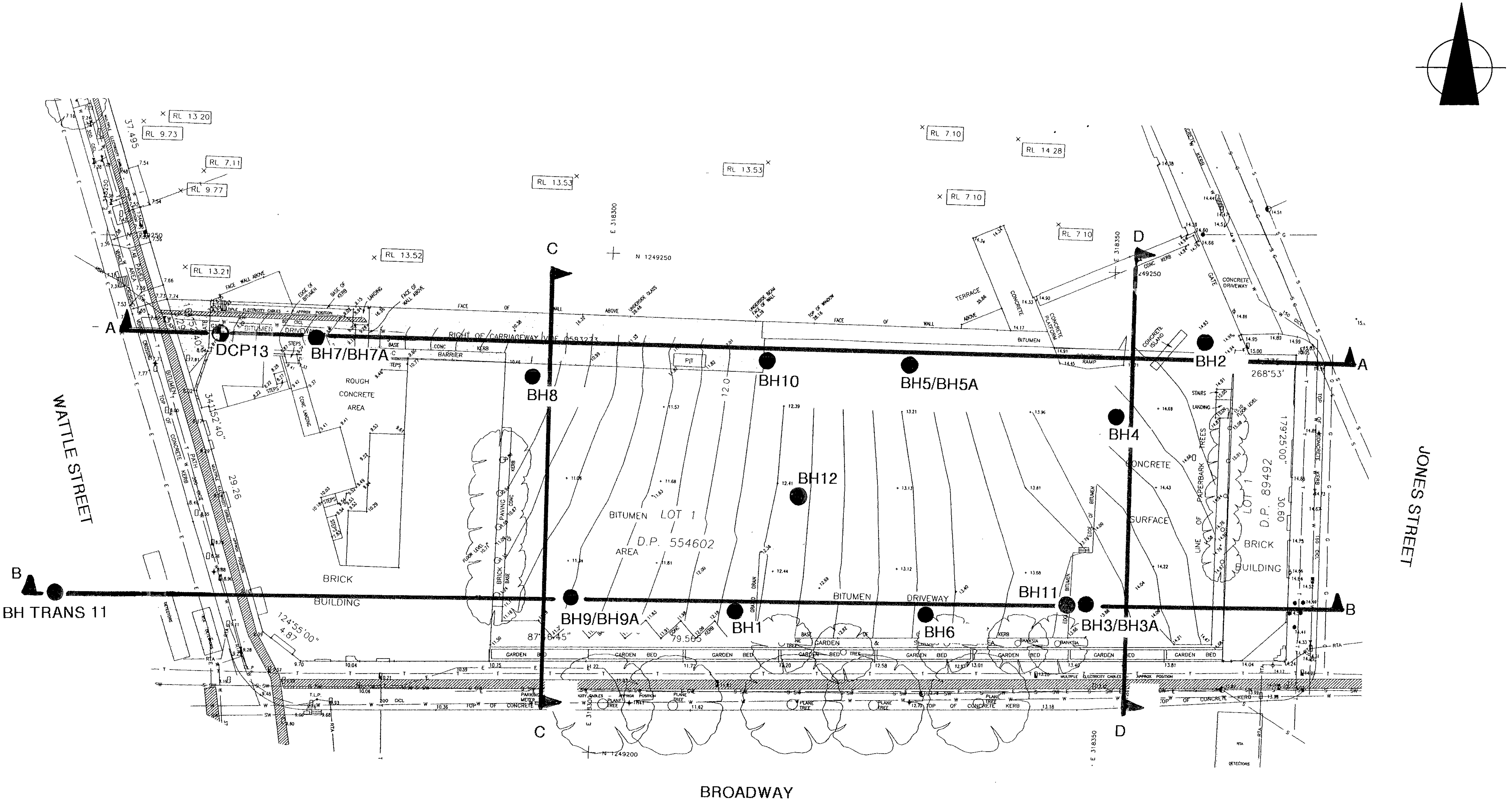
Report No. 23970WH

Figure No. 1



CROSS SECTION LOCATION PLAN

SCALE (m)

0 20

LEGEND

● BOREHOLE

◐ DCP TEST

Notes:

1. To be read in conjunction with the text of the report.
2. For details of Section A-A to Section D-D, refer to Figure 3 to Figure 6, respectively.

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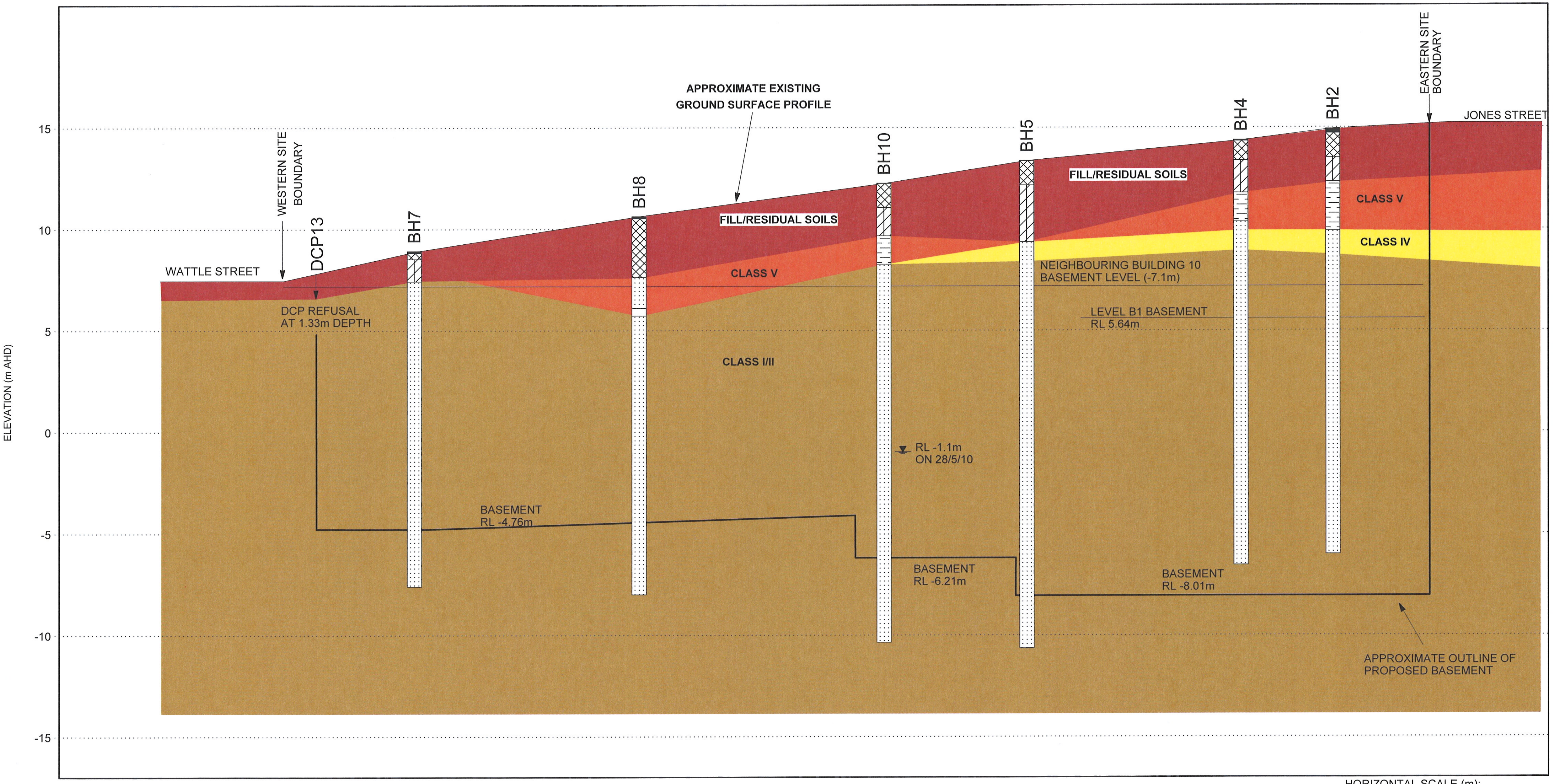
Report No. 23970WH **Figure No. 2**



NOTE: UNIT BOUNDARIES ARE APPROXIMATE ONLY, 2 x VERTICAL EXAGGERATION

HORIZONTAL SCALE (m):

0 20

LEGEND

- ■ ASPHALTIC CONCRETE
- ⁙ SANDSTONE
- 🟥 FILL/RESIDUAL SOIL
- 🟫 CLASS III BEDROCK
- ☐ CORE LOSS
- ☰ SHALE
- 🟧 CLASS V BEDROCK
- 🟫 CLASS I/II BEDROCK
- ▨ SILTY CLAY
- ☒ FILL
- 🟨 CLASS IV BEDROCK

No.	Amendment Description	Initials	Date

A3 Original

This sheet may be prepared using colour and may be incomplete if copied

Coordinate System: MGA94 Zone 56

Height Datum: AHD

PREPARED BY
JEFFERY AND KATAUSKAS
PTY LTD - CONSULTING
GEOTECHNICAL AND
ENVIRONMENTAL
ENGINEERS

DESIGNED: A.J.H.

REVIEWED: B.F.W.

Jeffery and Katauskas Pty Ltd

UNIVERSITY OF TECHNOLOGY. SYDNEY
PROPOSED BROADWAY BUILDING
CNR. JONES STREET & BROADWAY, ULTIMO, NSW
SECTION A-A (LOOKING NORTH)

SCALES

H 1:400

V 1:200

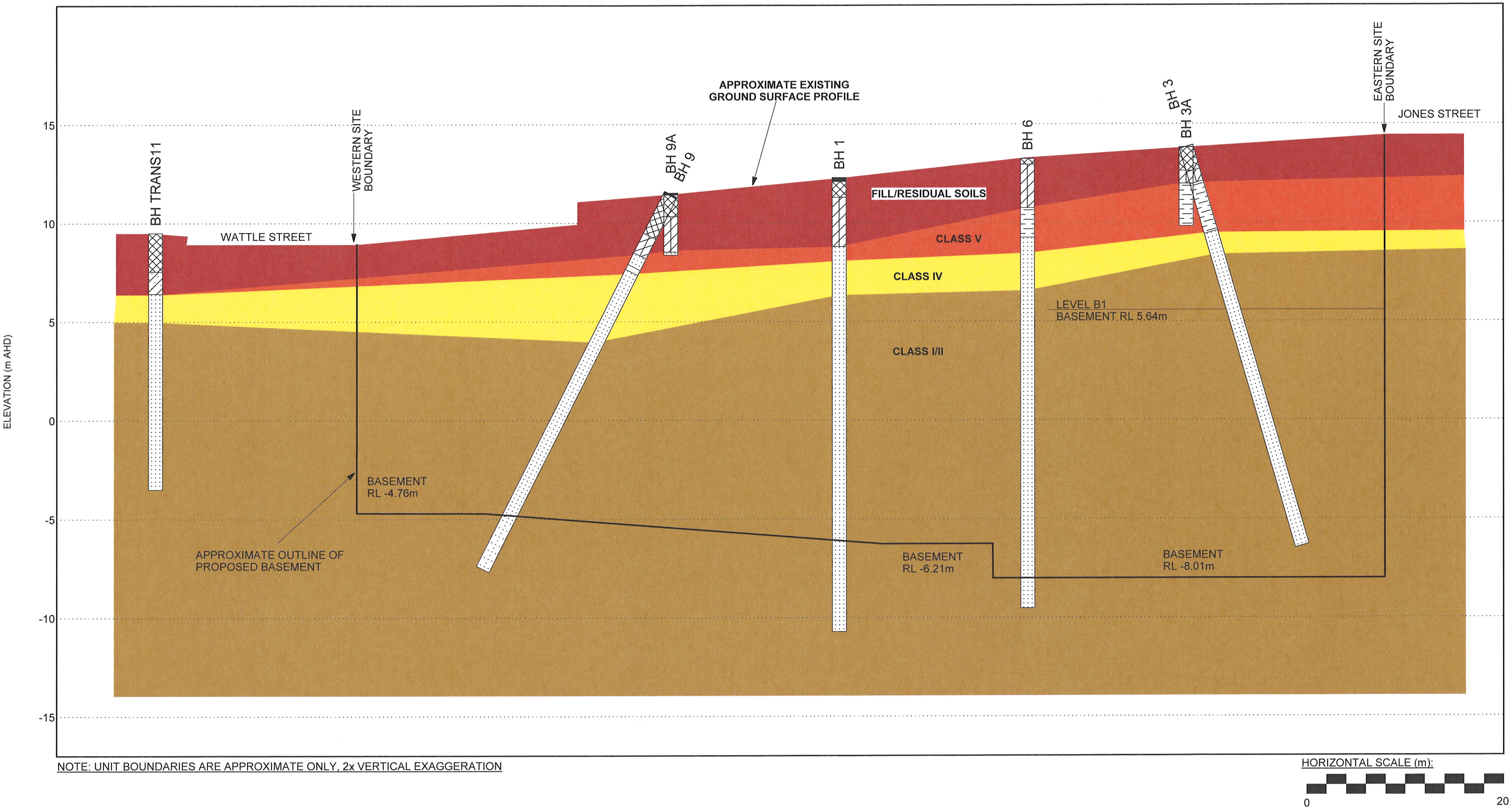
JOB NUMBER

23970WH

FIGURE NUMBER

3

JK_LIB_04_01.GLB Fence FENCE A3L NO PLAN 23970WH ULTIMO.GPJ 23970WH - FIG3 - SECTION AA - NO TUNNEL.GDW 03/06/2010 14:42 Produced by gINT Professional, Developed by Datgel



NOTE: UNIT BOUNDARIES ARE APPROXIMATE ONLY, 2x VERTICAL EXAGGERATION

■ ASPHALTIC CONCRETE	▨ SILTY CLAY	▩ FILL	🟨 CLASS IV BEDROCK
☐ CORE LOSS	⁘ SANDSTONE	🟥 FILL/RESIDUAL SOIL	🟫 CLASS III BEDROCK
▨ SANDY CLAY	☰ SHALE	🟧 CLASS V BEDROCK	🟫 CLASS I/II BEDROCK

JK_LIB_04_01.GLB Fence FENCE A3L NO PLAN 23970WH ULTIMO.GPJ 23970WH - FIG4 - SECTION BB.GDW 03/06/2010 14:53 Produced by gINT Professional, Developed by Datgel

No.	Amendment Description	Initials	Date
A3 Original	This sheet may be prepared using colour and may be incomplete if copied		

Coordinate System: MGA94 Zone 56
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JEFFERY AND KATAUSKAS PTY LTD - CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

DESIGNED: A.J.H.
REVIEWED: B.F.W.

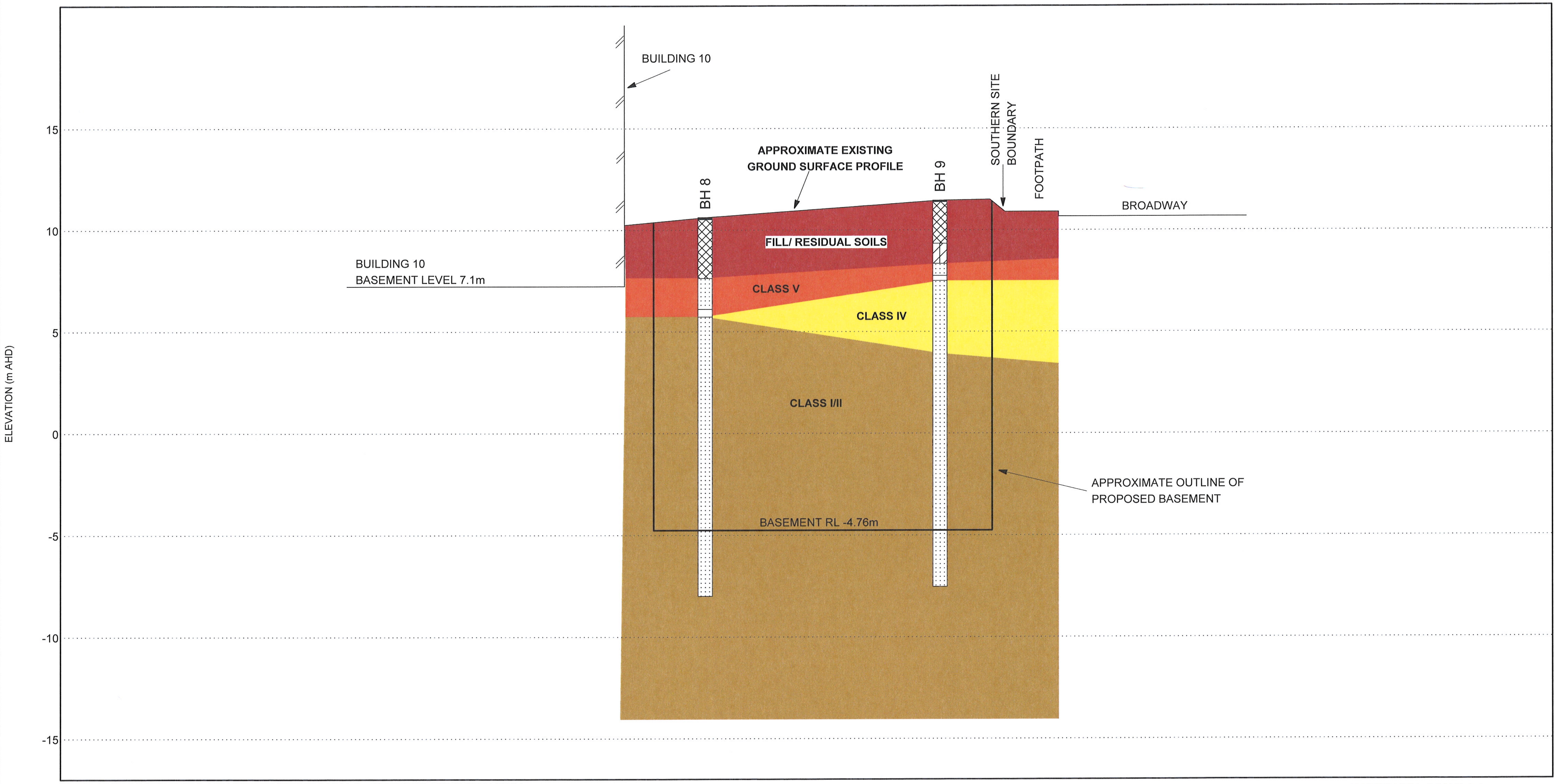
Jeffery and Katauskas Pty Ltd

UNIVERSITY OF TECHNOLOGY. SYDNEY
PROPOSED BROADWAY BUILDING
CNR. JONES STREET & BROADWAY, ULTIMO, NSW
SECTION B-B (LOOKING NORTH)

SCALES
H 1:400
V 1:200

JOB NUMBER
23970WH

FIGURE NUMBER
4



NOTE: UNIT BOUNDARIES ARE APPROXIMATE ONLY, 2 x VERTICAL EXAGGERATION

HORIZONTAL SCALE (m):
0 20

LEGEND

■ ASPHALTIC CONCRETE	▩ FILL	🟥 CLASS V BEDROCK	🟫 CLASS I/II BEDROCK
☐ CORE LOSS	⁙ SANDSTONE	🟨 CLASS IV BEDROCK	
▨ SILTY CLAY	🟥 FILL/RESIDUAL SOILS	🟫 CLASS III BEDROCK	

No.	Amendment Description	Initials	Date
A3 Original	This sheet may be prepared using colour and may be incomplete if copied		

Coordinate System: MGA94 Zone 56
Height Datum: AHD

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DESIGNED: A.J.H.
REVIEWED: B.F.W.

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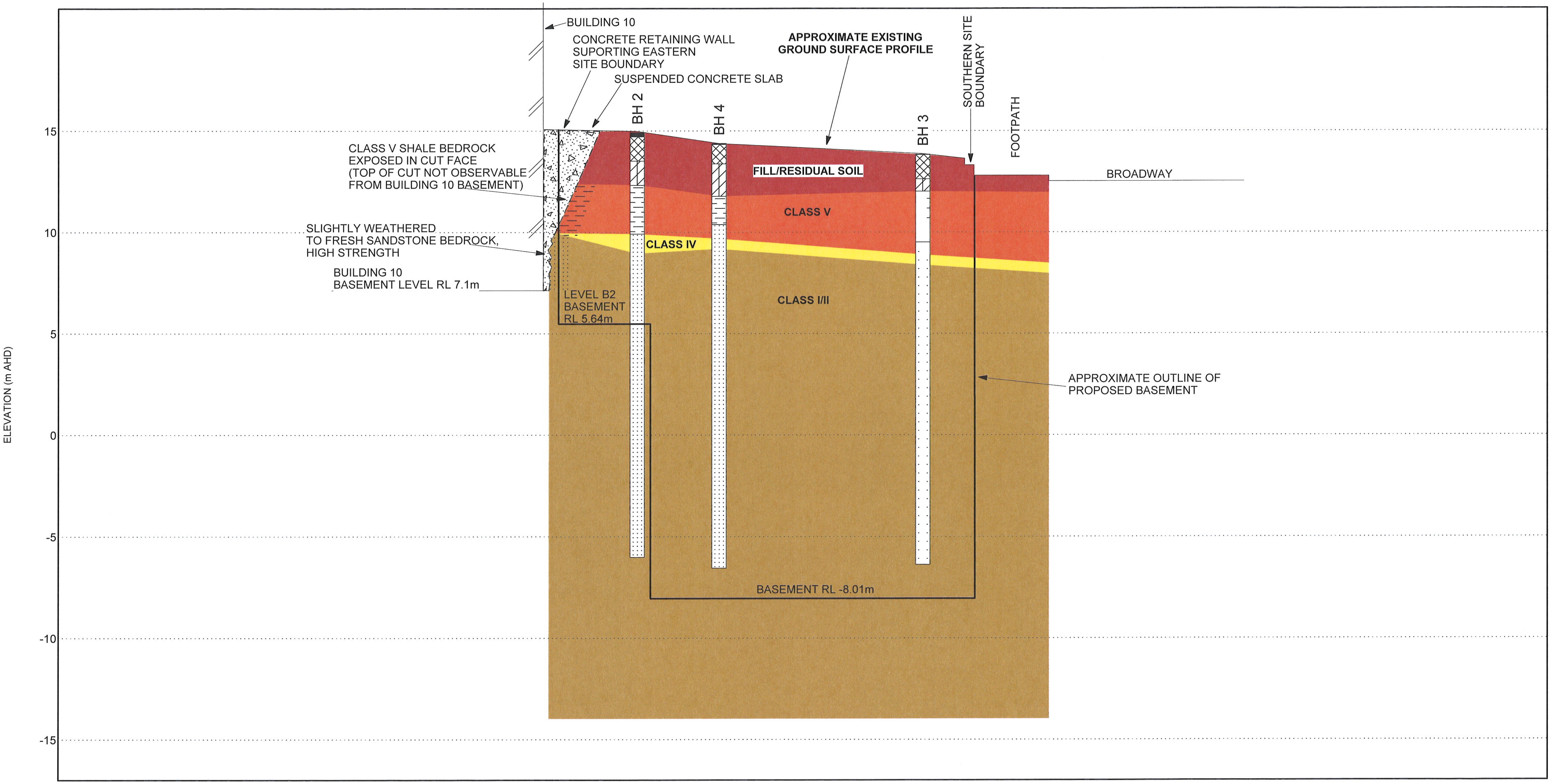
UNIVERSITY OF TECHNOLOGY. SYDNEY
PROPOSED BROADWAY BUILDING
CNR. JONES STREET & BROADWAY, ULTIMO, NSW
SECTION C-C (LOOKING EAST)

SCALES
H 1:400
V 1:200

JOB NUMBER
23970WH

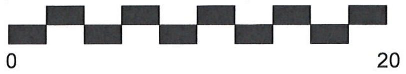
FIGURE NUMBER
5

JK_LIB_04_01.GLB Fence FENCE A3L NO PLAN 23970WH ULTIMO.GPJ 23970WH - FIGS - SECTION CC.GDW 03/06/2010 14:56 Produced by gINT Professional, Developed by Datgel



NOTE: UNIT BOUNDARIES ARE APPROXIMATE ONLY, 2 x VERTICAL EXAGGERATION

HORIZONTAL SCALE (m):



LEGEND

- ■ ASPHALTIC CONCRETE
- ▨ SILTY CLAY
- ☰ SHALE
- ▩ FILL
- ⁙ SANDSTONE
- 🟥 FILL/RESIDUAL SOILS
- 🟧 CLASS V BEDROCK
- 🟨 CLASS IV BEDROCK
- ■ CLASS III BEDROCK
- 🟫 CLASS I/II BEDROCK

JK_LIB_04_01.GLB Fence FENCE A3L NO PLAN 23970WH ULTIMO.GPJ 23970WH - FIG6 - SECTION DD.GDW 03/06/2010 14:58 Produced by gINT Professional, Developed by Datgel

No.	Amendment Description	Initials	Date

A3 Original

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Coordinate System: MGA94 Zone 56

Height Datum: AHD

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DESIGNED: A.J.H.

REVIEWED: B.F.W.

Jeffery and Katauskas Pty Ltd

UNIVERSITY OF TECHNOLOGY. SYDNEY
PROPOSED BROADWAY BUILDING
CNR. JONES STREET & BROADWAY, ULTIMO, NSW
SECTION D-D (LOOKING EAST)

SCALES

H 1:400

V 1:200

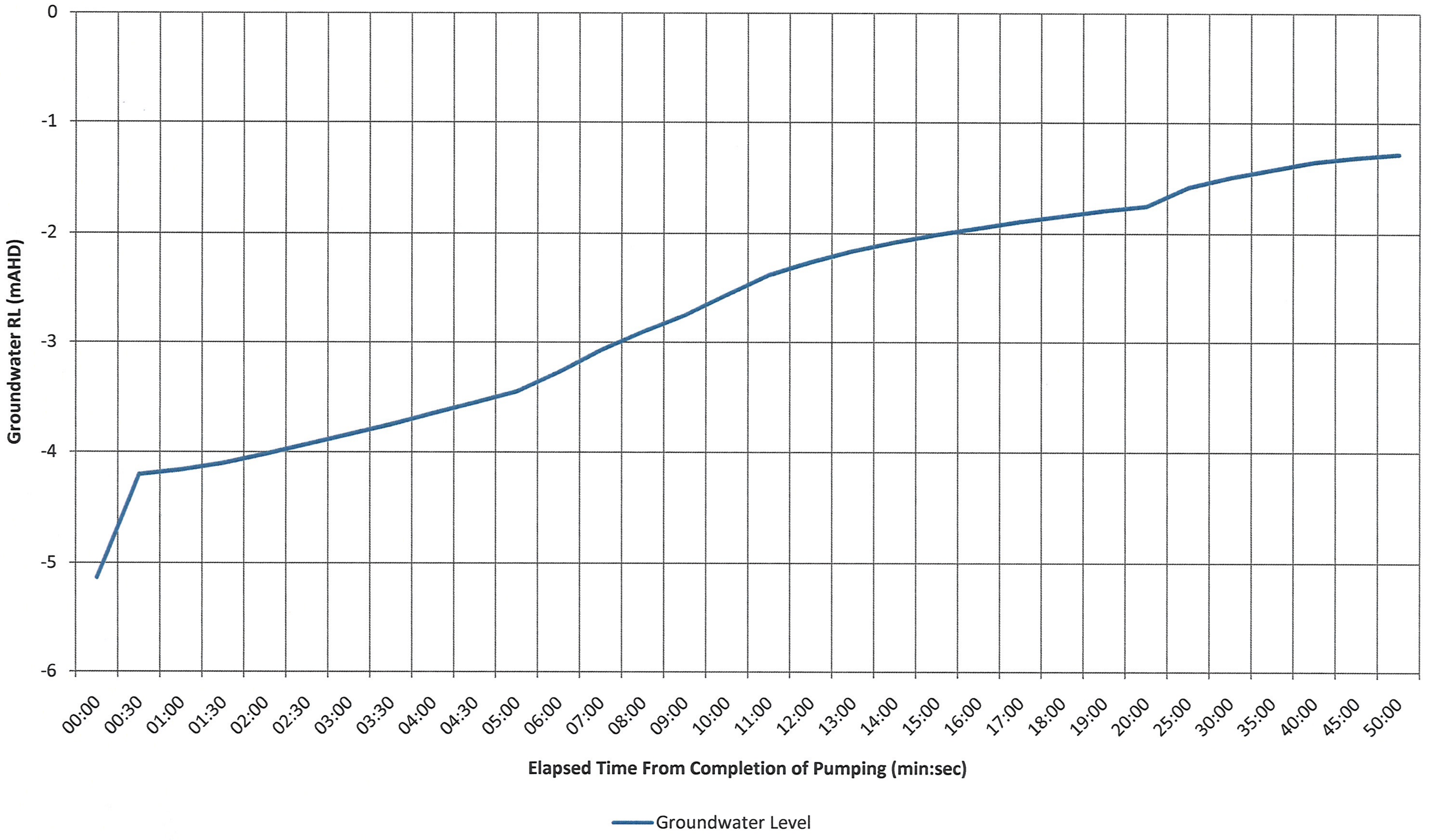
JOB NUMBER

23970WH

FIGURE NUMBER

6

Results of Pump Test (BH10)
Showing Rise in Groundwater Level On Completion of Pumping



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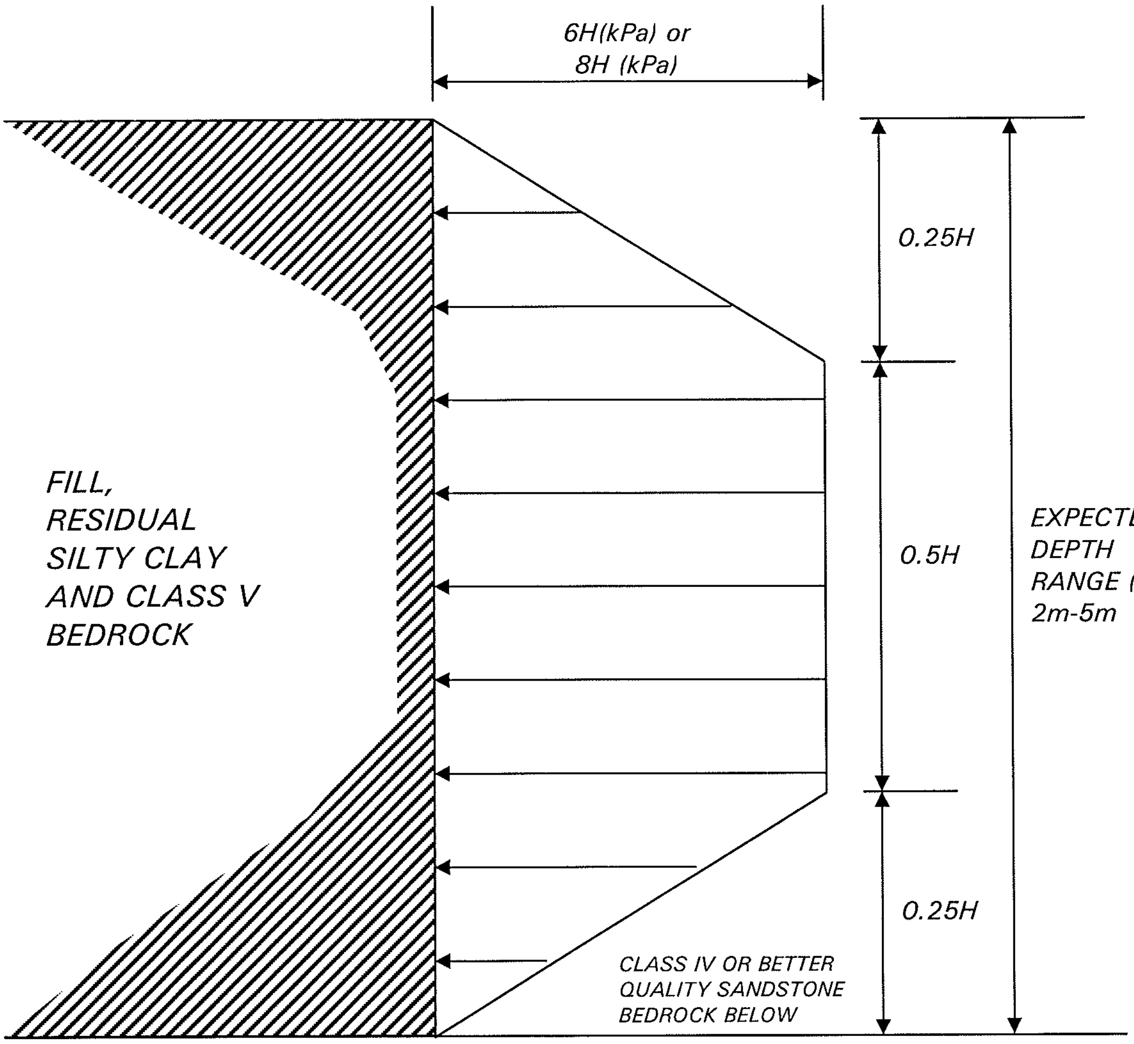
Report No. 23970WH Figure No. 7



NOTES:

1. USE 6H FOR DESIGN WHERE NO MOVEMENT SENSITIVE STRUCTURES OR SERVICES ARE LOCATED WITHIN 2H FROM LINE OF EXCAVATION.
2. USE 8H FOR DESIGN WHERE MOVEMENT SENSITIVE STRUCTURES OR SERVICES ARE LOCATED WITHIN 2H FROM LINE OF EXCAVATION.
3. SURCHARGE AND GROUNDWATER PRESSURES MUST BE ADDED TO THE ABOVE IF APPLICABLE.
4. REFER TO TEXT OF REPORT

RECOMMENDED DESIGN PRESSURES FOR ANCHORED OR PROPPED RETAINING WALLS

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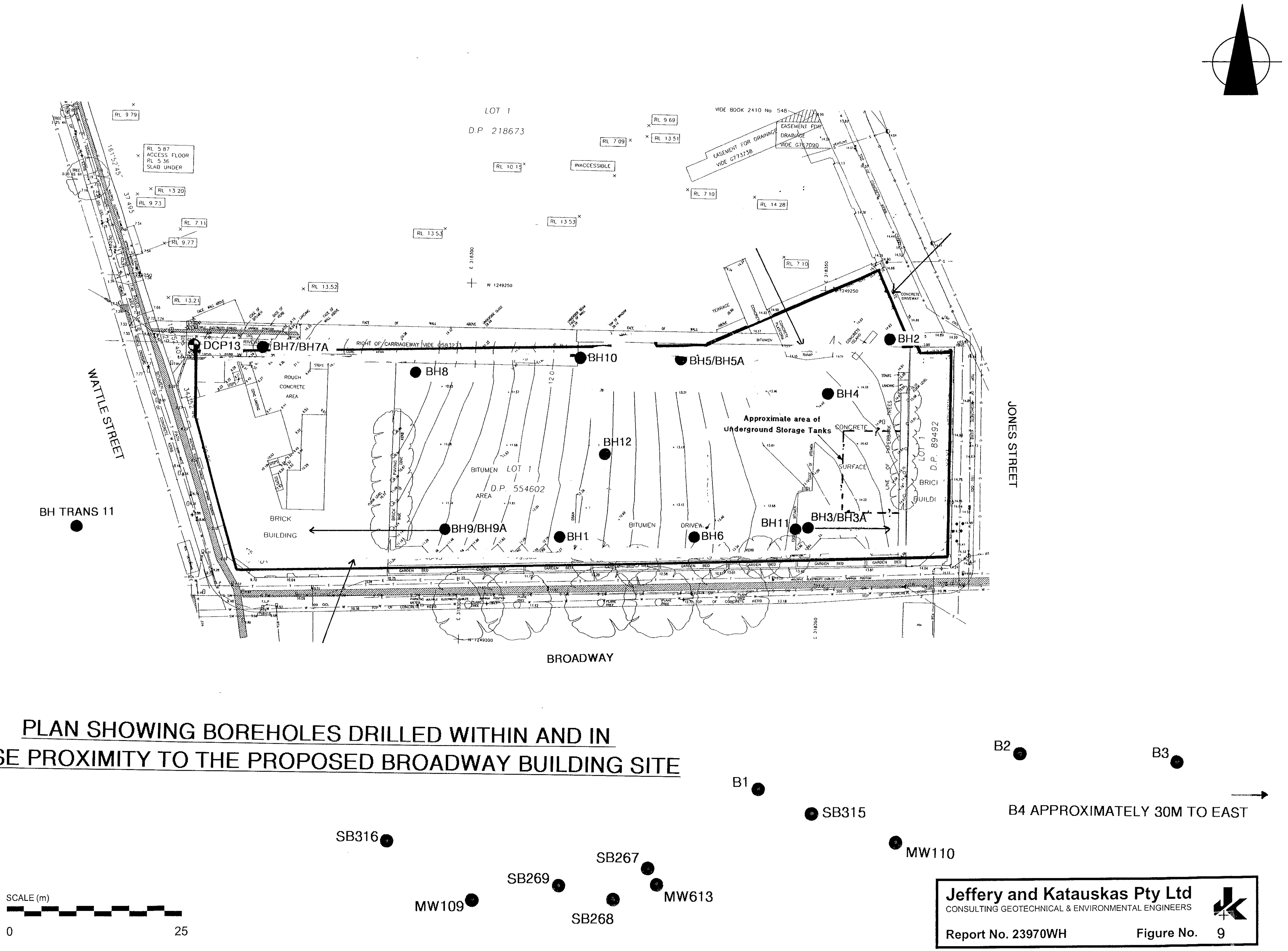
Report No. 23970WH Figure No. 8

PLAN SHOWING BOREHOLES DRILLED WITHIN AND IN CLOSE PROXIMITY TO THE PROPOSED BROADWAY BUILDING SITE



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Report No. 23970WH **Figure No.** 9

APPENDIX A

Borehole No: TRANS11

Engineering Log - Borehole

Sheet 1 of 4

Client	Transgrid	Borehole Location	Wattle St (see Figure 2)
Project	Transgrid Cable Tunnel - Stage 2	Logged By	TR
Project No.	5862.04.CT	Checked By	

Started Drilling	21-03-01	N		Slope	90	Drill Rig	XC
Completed Drilling	21-03-01	E		Bearing		Ground Level	9.5

DRILLING				SOIL CHARACTERISTICS						
Method	Water Table	RL (m)	Depth (m)	Graphic Log	Classification	Description of Soil (soil type: plasticity, colour, other components)	Moisture Cond'n	Consistency	Samples and tests	Additional Comments
		9				TOPSOIL: Silty Sand, fine to medium grained, dark brown, minor tree roots	M			
		8	1	▩		FILL: Silty Sand, fine to medium grained, grey to brown colour, minor clay, brick, slag,and occasional gravel	M			rocks and/or gravel
				▩		AS ABOVE: becoming Silty clay, fine grained, light grey to red colour, minor brick and slag fragments				
		7	2 3	▨		SANDY CLAY: medium plasticity, orange brown colour, iron stained, minor ironstone bands towards upper boundary	MC~PL	St		Residual
		6 5	4 5			V bit auger refusal @ 3.08m Refer to cored borelog for continuation				

Remarks:
No samples or tests performed due to the anticipated fill overlying shallow bedrock

Borehole No: TRANS11

Engineering Log - Cored Borehole

Sheet 2 of 4

Client	Transgrid	Borehole Location	Wattle Street (see Figure 2)
Project	Transgrid Cable Tunnel - Stage 2	Logged By	TR
Project No.	5862.04.CT	Checked By	

Started Drilling	21-03-01	N		Slope	90	Drill Rig	XC
Completed Drilling	21-03-01	E		Bearing		Ground Level	9.5

DRILLING				ROCK MASS CHARACTERISTICS						DISCONTINUITIES	
Method	Water Table	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength EL VL L M H VH EH	Is50 (MPa) D A	Core Rec'y (%)	RQD (%)	Description of Defects (defect type: inclination, roughness, thickness, infilling)
		9									
			1								
		8									
			2								
		7									
			3		Coring commenced @ 3.08m						
NML	C		3.28		SANDSTONE: light brown to pink colour, medium grained, iron stained	DW			100	88	Jo,30,P,r,clean
		6	3.43								Be,~90,p-i,r,clean
			3.655								Be~90,p-i,r,clean
			3.80					0.76			
			3.85					0.8.03			
			43.80					0.7477			
			3.95								
			4.0								Fractured Core,100mm
			4.16								Be,80,p,s,clay infill
			4.195								Jo,60-80,i,r,clean
		5	4.22								Clay Band,soft,25mm,CH
			4.265								
			4.7								Clay Band,soft,10mm,CH
			4.71								Iron indurated band,30mm
			4.8		SANDSTONE: as above	SW		0.53 0.89 0.58 0.77	100	96	Be,90,p,r,clean
			54.85								

Remarks: 4.9

4.95

Water table not identified during drilling process

Template: COSCTEMP Rev 2, File: TGIIROCK

Connell Wagner

Engineering Log - Cored Borehole

Borehole No: TRANS11

Sheet 3 of 4

Client	Transgrid	Borehole Location	Wattle Street (see Figure 2)
Project	Transgrid Cable Tunnel - Stage 2	Logged By	TR
Project No.	5862.04.CT	Checked By	

Started Drilling	21-03-01	N		Slope	90	Drill Rig	XC
Completed Drilling	21-03-01	E		Bearing		Ground Level	9.5

DRILLING				ROCK MASS CHARACTERISTICS							DISCONTINUITIES	
Method	Water Table	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength EL VL L M H VH EH	Is50 (MPa) D	Is50 (MPa) A	Core Rec'y (%)	RQD (%)	Description of Defects (defect type: inclination, roughness, thickness, infilling)
					SANDSTONE:becoming light grey to brown colour, fine to medium grained, minor iron staining, cross-bedded							
			5.365									Be,80,p,r,clean
		4	5.5					1.24				
			5.55					1.2	1.28			
			5.6									
			6									
			6.05					1.51	1.59			
			6.1									
			6.18			SW				100	96	Be,80,p,r,clean
		3										
			7									
		2	7.5									Cs,90,r,10mm,clay+CR
			7.65		AS ABOVE: becoming light grey, medium grained, massive to flaser bedding			1.22	1.00			
			7.7									
			8									
			8.05					0.89	0.96			
			8.10									Be,90,i,r,clean
			8.115									
		1										
						SW				99	98	
			9									
			9.07									Cs,90,r,22mm,clay+CR
			9.13									Be,85,p,s,2mm clay infill
			9.64									Be,90,p,r,clean
			9.7					1.16	1.34			
			9.75									
			9.9									Be,90,p,r,clean
			10 9.985									Be,85,p,s,35mm,clean

Remarks:
Water table not identified during drilling process

Template: COSCTEMP Rev 2. File: TGIIROCK

Connell Wagner

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

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

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

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

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company will be pleased to review the report and the sufficiency of the investigation work.

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

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

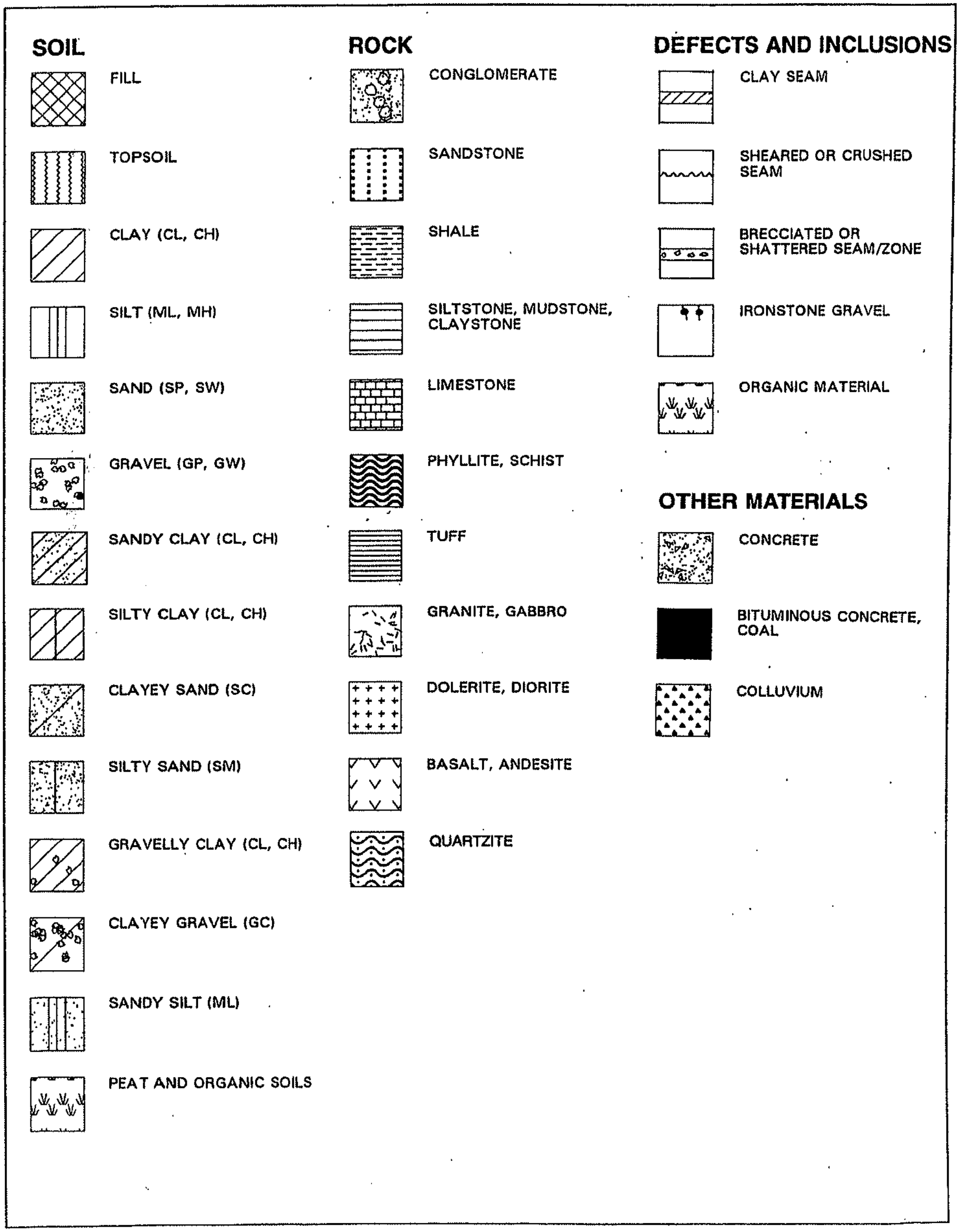
Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS



SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

DEFECTS AND INCLUSIONS

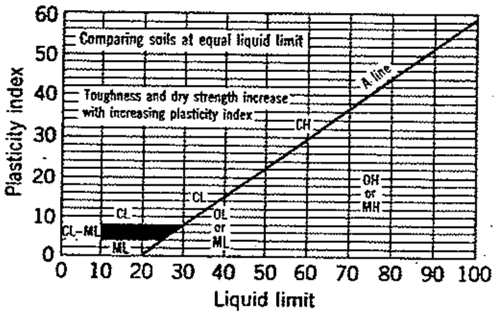
- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)				Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well - graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel: maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7

Identification Procedures on Fraction Smaller than 380 μm Sieve Size								
		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	 Plasticity chart for laboratory classification of fine grained soils
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	▼	Standing water level. Time delay following completion of drilling may be shown.
	—C—	Extent of borehole collapse shortly after drilling.
	▶—	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	⊤ 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

Ref: Standard Sheets Log Symbols
August 2001

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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered 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 rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

Ref: Standard Sheets Log Symbols
August 2001

Borehole No: TRANS11

Engineering Log – Cored Borehole

Sheet 4 of 4

Client	Transgrid	Borehole Location	Wattle Street (see Figure 2)
Project	Transgrid Cable Tunnel – Stage 2	Logged By	TR
Project No.	5862.04.CT	Checked By	

Started Drilling	21-03-01	N	Slope	90	Drill Rig	XC
Completed Drilling	21-03-01	E	Bearing		Ground Level	9.5

DRILLING				ROCK MASS CHARACTERISTICS							DISCONTINUITIES	
Method	Water Table	RL (m)	Depth (m)	Graphic Log	Description of Rock (rock type: colour, grain size, structure, minor components)	Weathering	Strength EL VL L M H VH EH	Is50 (MPa) D	Is50 (MPa) A	Core Rec'y (%)	RQD (%)	Description of Defects (defect type: inclination, roughness,thickness, infilling)
					SANDSTONE: becoming light grey, fine grained, thinly bedded	SW				99		
			10.195									Be,90,p,r,minor clay
			10.215		AS ABOVE: becoming medium grained							Be,90,p,r,minor clay
			10.26									Be,90,p,r,clean
		-1	10.265									Be,80,p,r,clean
			10.68									Be,85,p,r,clean
			10.76					1.48	1.57			Be,90,p,r,clean
			10.8									
			11 10.85									
			11.09									Be,90,p,r,clean
		-2	11.515							100	77	Be,85,p,r,clean
			11.595			SW						Be,90,p,r,clean
			11.65					0.86	1.22			
			11.7									
			12									
			12.145									Be,i,r,clean
		-3	12.49									Be,70,i,r,clean
			12.64					1.4	1.56			Be,70,p,r,clean
			12.68									
			12.73									Be,80,i,r,clean
			12.83									Be,90,i,r,clean
			13 12.91									
					End of borehole @ 13.0m							
			14									
			15									

Remarks:
Water table not identified during drilling process

Template: COSCTEMP Rev 2, File: T611ROCK

Connell Wagner