Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Student Accommodation Development
13-23 Gibbons Street, Redfern

Prepared for
The Trust Company (Australia) Limited ATF WH
Gibbons Trust

Project 86266.03
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Douglas Partners
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
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Report on Geotechnical Investigation
Proposed Student Accommodation Development
13-23 Gibbons Street, Redfern

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed student accommodation development at 13-23 Gibbons Street, Redfern. The investigation was commissioned by Mr John De Fazio of The Trust Company (Australia) Limited ATF WH Gibbons Trust and was undertaken in accordance with DPs proposal SYD180784.P.001.Rev1 dated 4 September 2018.

It is understood that the proposed development on the site will include an 18-storey student accommodation building incorporating the existing single level basement.

The investigation included the drilling of six boreholes and laboratory testing of selected samples. Details of the field work undertaken are given in the report, together with comments on design and construction issues.

DP conducted a detailed site contamination investigation (DSI) on the site, the details of which are reported separately (ref: DP Report 86266.04.R.001.Rev1).

2. Site Description and Geology

The approximately square-shaped site has dimensions of about 35 m x 40 m and slopes gently down in a south-east direction. A four and five storey structure covers about two-thirds of the site and has frontages to Gibbons Street and Margaret Street. Access into the existing single level basement car park is from Margaret Street and the basement encompasses about three-quarters of the site footprint.

On the western side of Gibbons Street there is an open grassed area with some trees, which slopes up to the west along most of its length towards Rosehill Street at less than about 20 degrees. This area is understood to be underlain by the Eastern Suburbs Railway Line / Illawarra Relief Rail Tunnels. DPs records indicate that these tunnels are located within about 10 m to the west of the site (actual tunnel details should be confirmed with Transport for NSW).

The site is bound to the north by one and two storey brick warehouses associated with the Marian Street Council Depot, and to the east by a petrol station. On the southern side of Margaret Street is a similar three and four storey residential development with a basement carpark.

Reference to the Sydney 1:100 000 Geological Series Sheet 9130 (Geological Survey of NSW) indicates that the site is located within Quaternary aged alluvium. The boundary with Triassic aged Ashfield Shale occurs to the west of the site. The mapped alluvial soils typically comprise medium to fine-grained sand, whilst the Ashfield Shale typically comprises black to dark grey shale and laminite.

The 1:25,000 Acid Sulphate Soil Risk map for Botany Bay indicates that the site does not lie within an area known for acid sulphate soils. The site also does not occur within an area mapped for known soil salinity issues.

3. Previous Investigations

DP has previously completed a preliminary geotechnical investigation on the site (ref: DP Project 86266.00). The investigation included one borehole (BH1) drilled adjacent to the existing basement carpark entrance (see Drawing 1 in Appendix B) using a tight access drilling rig. The results of the previous investigation are presented in Appendix E.

DP has also previously completed geotechnical investigations on the following nearby sites:

- 39-61 Gibbons Street in 1987 and 1993 (DP Ref. 10133 and 19660);
- 9 Gibbons Street in 1971 (DP Ref. 3090);
- 32 Rosehill Street in 1980 (DP Ref. 6810); and
- 44-78 Rosehill Street in 1988 (DP Ref. 11650).

These investigations typically encountered surficial filling over very loose to loose alluvial sands to about 4 m to 5 m depth, over stiff alluvial clay, with weathered shale at a depth of about 8 m.

4. Field Work Methods

The field work for the current investigation included:

- drilling of two rock cored boreholes and one augered borehole (BH101 to BH103);
- installation of groundwater monitoring wells at each of the above locations for sampling of groundwater and measurement of water levels; and
- drilling of three shallow boreholes (BH104 to BH106), primarily for contamination purposes.

The borehole locations are shown on Drawing 1 in Appendix B.

Boreholes BH101 to BH103 were drilled within the existing basement with a tight access drilling rig. The boreholes were drilled using solid flight augers to refusal on weathered rock at depths of between 5.2 m and 6.0 m. Samples were taken at regular intervals within the soil strata for subsequent laboratory testing. BH101 and BH103 were then advanced to depths of 10.83 m and 12.93 m using NMLC-sized diamond core drilling equipment to obtain 50 mm diameter continuous core samples of the rock for identification and strength testing purposes.

The shallower boreholes were drilled using hand tools and were taken to depths of between 1.9 m and 2.0 m.

Groundwater monitoring wells were installed in BH101, BH102 and BH103 to depths of between 5.8 m and 12.9 m to allow for measurement of water levels and sampling of groundwater for the

contamination investigation. The wells were developed by removing at least three well volumes of water on 21 September 2018 and then sampled on 26 September 2018.

The boreholes were logged and sampled by an experienced geotechnical engineer.

Approximate ground surface levels for the boreholes were obtained by survey levelling with respect to spot levels provided on Linker Surveying drawing 170638 Issue 1 dated 09/08/2017.

5. Field Work Results

5.1 Subsurface Profile

Details of the subsurface conditions encountered are given in the borehole logs in Appendix C, together with notes explaining descriptive terms and classification methods used. A geotechnical cross-section (Section A-A'), showing the interpreted subsurface profile between selected boreholes, is presented as Drawing 2 in Appendix B. The section shows interpreted geotechnical divisions of underlying soil and rock together with the existing basement level.

The sequence of subsurface materials encountered at the test locations, in increasing depth order, is described below:

Filling:	encountered at all locations, to depths of between 0.3 m and 1.3 m. The filling comprises clayey sand and sand with inclusions of sandstone gravel, brick fragments (BH101 and BH106) and tile fragments (BH103); over
Sand:	pale brown and orange-brown, medium grained sand to depths of between 0.9 m and 1.7 m; over
Sandy clay/ clayey sand:	typically medium dense, orange-brown and red-brown, sandy clays and clayey sands to depths of 2.5 m to 3.5 m; over
Clay:	red-brown mottled grey, clay, becoming shaly from depths of 3.6 m to 5.2 m; over
Laminite: (Ashfield Shale)	laminite bedrock at depths of between 5.5 m to 8.4 m. The rock profile generally includes a deeply weathered profile of extremely low to low strength, fragmented to fractured laminite around 3 – 5 m thick. Medium to high strength or stronger, fresh and slightly fractured to unbroken laminite was encountered at a depth of 12 m (RL 10 m AHD) in BH101 and 8.25 m (RL 13.75 m AHD) in BH103.

5.2 Groundwater

No free groundwater was measured during auger drilling of the boreholes. The use of water during rock coring precluded the measurement of any groundwater during rock coring. Groundwater levels were measured within the monitoring wells at the conclusion of field work and prior to sampling and are summarised in Table 1.

Table 1: Summary of Groundwater Depths (RL, m AHD)

Monitoring Well	Surface Level (m AHD)	Date					
		21/09/2018 (well development) [1,2,3]		26/09/2018 (Prior to sampling)		11/10/18 (Following heavy rainfall)	
		m bgl	m AHD	m bgl	m AHD	m bgl	m AHD
BH101	22.0	4.66	17.3	4.62	17.4	Inaccessible	Inaccessible
BH102	22.0	N/A (dry) to 5.8 m	-	4.70	17.3	3.28	18.7
BH103	22.0	4.90	17.1	4.91	17.1	4.69	17.3

Notes: 1. BH101 measured 2 hours after development;
2. BH102 well dry on completion of field work;
3. BH103 measured 5 hours after development.

The groundwater measurements indicated a groundwater table at depths of about 3.28 m to 4.9 m below the existing basement slab and generally close to the shaly clay surface. Groundwater levels will fluctuate with climatic conditions and may temporarily rise following periods of rainfall, as shown by measurements made on 11 October following approximately 100 mm rainfall over the preceding week where the water level in BH102 rose by 1.4 m from RL 17.3 m to RL 18.7 m. Some of this elevated water level could be attributed to perched seepage flowing along the top of the clay.

6. Laboratory Testing Results

6.1 Soil Aggressivity

Four soil samples were analysed to assess the aggressivity of the soil to buried concrete and steel structures. A summary of the results is provided in Table 2. The laboratory test reports are included in Appendix D.

Table 2: Summary of Soil Aggressivity Results

Sample / Depth	Description	pH (pH units)	EC (µS/cm)	Chloride (mg/kg)	Sulphate (mg/kg)
BH101 / 0.9-1.0 m	sand	7.9	48	<10	24
BH101 / 2.8 -3.0 m	clay	5.1	77	20	95
BH102 / 5.8-6.0 m	shaly clay	5.3	66	10	100
BH103 / 2.8-3.0 m	clayey sand	5.1	59	<10	82

Notes: EC = electrical conductivity; All samples mixed at a ratio of 1(soil):5(water) prior to testing

6.2 Point Load Strength Index

Selected samples of the rock core were tested in the laboratory to determine the Point Load Strength Index (Is_{50}) values to assist with the rock strength classification. The results of the testing are shown on the borehole logs at the appropriate depth. The Is_{50} values for the rock ranged from 0.16 MPa to 2.78 MPa, indicating that the rock samples tested were of low to high strength.

7. Proposed Development

Based on information provided by Allen Jack + Cottier (project architects), it is understood that the proposed development will include demolition of the existing buildings to allow for the construction of an 18 storey student accommodation building with one basement level. The current single level basement structure is to be retained, however further excavation in the order of 1 m below the existing basement level (set back approximately 3 m from the existing retaining walls) will be required to achieve the current proposed basement FFL of RL 21.25 m (AHD). Local deeper excavations are expected for lift overruns and below ground services (e.g. sump and pump system) however the proposed depth of these excavations is not currently known.

8. Comments

8.1 Geotechnical Considerations Relating to the Rail Corridor

The Illawarra Relief rail tunnel passes to the west of the site, approximately parallel with Gibbons Street (in the vicinity of the site). Based on historical drawings and information provided to DP by Sydney Trains (as part of the Dial-Before-You-Dig enquiry process), it is understood that the closest edge of the tunnel lies approximately 9 – 10 m from the south-western boundary of the site. The proposed development is required to take this tunnel into consideration.

Transport for NSW (TfNSW) protects rail tunnel infrastructure by defining rail protection reserves around the tunnel. The 'first reserve' comprises the immediate surrounds of the tunnel, and represents the area that shall not be encroached upon by any future construction or development. The 'second reserve' covers areas where future development works have the potential to impact on the performance of the tunnel support elements and operation of the tunnel.

Details regarding the rail reserves, along with general guidelines on allowed construction activities and required protection measures, are provided in TfNSW document T HR CI 12051 ST – *"Development Near Rail Tunnels"*.

Based on previous experience, it is likely that TfNSW will require geotechnical assessment (possibly including numerical modelling) of proposed footing and excavation designs, vibration monitoring and dilapidation surveys of the tunnels to assess and monitor the impact of the proposed development on the surrounding tunnels. The extent of assessment and monitoring required is subject to discussion and agreement from TfNSW once final details of the proposed development are known.

8.2 Site Preparation and Earthworks

8.2.1 Excavation Conditions

It is expected that lowering the central portion of the existing basement by approximately 1.0 m will require excavation of sandy filling and natural sands, which should be achievable using conventional earthmoving equipment. The filling may contain building rubble (e.g. bricks, concrete fragment, tiles, etc) left over from previous construction works on site.

8.2.2 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). Further reference should be made to the current DSI report by DP (Ref. 86266.04.R.001.Rev1).

8.2.3 Vibration Monitoring

Given that excavations will be shallow and within soil, it is expected that vibrations from the construction works will be relatively minor.

However, based on previous experience and as noted in Section 8.1, TfNSW usually requires vibration monitoring within existing tunnels when construction works are carried out within the adjacent second rail reserve. It will be necessary to use appropriate methods and equipment to keep ground vibrations within the rail tunnel and at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors including the type of building structure (e.g. reinforced concrete, brick, etc.), its structural condition, founding conditions, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s peak particle velocity (PPV). This is generally much lower than the vibration levels required to cause structural damage to most buildings. The Standard AS/ISO 2631.2 – 2014 “Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Vibration in buildings (1 Hz to 80 Hz)” suggests an acceptable daytime limit of 8 mm/s PPVi for human comfort.

The document *“Development Near Rail Tunnels”* suggests a maximum acceptable vibration limit of 15 mm/s PPVi for the rail tunnel, however this is subject to confirmation by TfNSW.

Based on the DP’s experience and with reference to AS/ISO 2631.2, it is suggested that a maximum PPVi of 8 mm/s (measured at the first occupied level of existing buildings) be employed at this site for both architectural and human comfort considerations, although this vibration limit may need to be reduced if there are sensitive structures or equipment in the area.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be carried out at the commencement of construction. These trials may indicate that smaller or different types of construction equipment are required to reduce vibration to acceptable levels.

8.2.4 Dilapidation Surveys

Dilapidation surveys should be carried out on surrounding buildings, pavements and sensitive structures that may be affected by the construction works. The dilapidation surveys should be undertaken before the commencement of any excavation or piling work in order to document any existing defects so that any claims for damage due to construction related activities can be accurately assessed. As mentioned in Section 8.1, a dilapidation assessment of the tunnels may be required by TfNSW.

8.2.5 Subgrade Preparation and Engineered Filling

Site preparation for lightly loaded pavements and/or raising site levels should incorporate the following:

- stripping of any obvious unsuitable material (vegetation, organic topsoil, deleterious material, oversize material larger than 150 mm diameter);
- rolling of the exposed subgrade with at least 8 passes of a smooth drum roller with a minimum static weight of 10 tonnes. The final pass (test roll) of the subgrade should be inspected by a geotechnical engineer to detect any soft spot or heaving areas. Any soft spots defected during test rolling would generally need to be stripped to a stiff base or depth of approximately 0.5 m, subject to confirmation by a geotechnical engineer, and replaced with engineered filling;
- engineered filling for replacing soft spots or raising site levels should be placed in layers of 300 mm maximum loose thickness and compacted to a dry density ratio of between 98% and 102% relative to Standard compaction with moisture contents strictly within 2% of Standard optimum moisture content (OMC). The density ratio should be increased to between 100% and 102% Standard compaction within 0.3 m of the finished surface. The existing filling and sandy/clayey soils on site should generally be suitable for re-use as engineered filling provided it has a maximum particle size of 150 mm and moisture content within 2% of Standard OMC. Reuse of material should also consider the contamination status of the soil, which may require further assessment;
- density testing of each layer of filling should be undertaken in accordance with AS 3798-2007 “Guidelines for Earthworks for Commercial and Residential Developments” to verify that the specified density ratios have been achieved.

8.3 Excavation Support

Vertical excavations within the filling and soils, including material retained by the existing basement retaining walls, will require both temporary and permanent lateral support during and after construction. It is expected that temporary batters will be possible for excavation works to lower site levels in the centre of the site subject to the proximity to existing basement walls and assessment of the existing wall stability. If temporary batters are not possible, then shoring must be used to provide the required excavation support.

8.3.1 Batter Slopes

Suggested temporary and permanent batter slopes for unsupported excavations above the water table, up to a maximum height of 2 m are shown in Table 3. If surcharge loads are applied near the

crest of the slope, then further geotechnical review and probably flatter batters or stabilisation soil nails may be required.

Table 3: Recommended Batter Slopes for Exposed Material

Exposed Material	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
filling / clayey sand	1.5 : 1	2 : 1
clay/shaly clay	1 : 1	2 : 1

8.3.2 Retaining Walls/Shoring

It is likely that the existing floor slabs are providing lateral support to the existing basement retaining walls. Retention of the existing retaining walls will require some form of temporary support (e.g. bracing or propping) until such time as the basement and ground floor slabs provide permanent lateral support for the walls.

The use of ground anchors for temporary or permanent lateral support may not be possible along Gibbons Street, given the proximity of the basement to adjacent rail infrastructure and rail reserves. Additionally, the use of anchors along the eastern site boundary may be problematic due to the presence of underground storage tanks within the petrol station.

Detailed design should ideally be undertaken using a computer program such as WALLAP, FLAC or PLAXIS to model soil-structure interactions during different phases of construction. Table 4 outlines material and strength parameters that could be used for the analysis and design of retaining/shoring walls.

Table 4: Parameters for Retaining Wall / Shoring Design

Material	Dry Unit Weight (kN/m^3)	Saturated Unit Weight (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Passive Earth Pressure*
filling	20	10	0.40	0.60	N/A
l-md Sands	20	10	0.33	0.45	K_p = 3.4
st-vst Clays	20	10	0.30	0.5	100 kPa
shaly Clay	22	12	0.30	0.5	250 kPa
LS+ Laminite	22	12	N/A	N/A	2000 kPa

Notes: l-md = loose to medium dense; st-vst = stiff to very stiff, LS+ = low strength or stronger
*Ultimate values and only below bulk excavation level. May need to be reduced where batter slopes are located nearby

Unless the material behind the existing basement walls is effectively free draining, hydrostatic pressure should be assumed to act on the full height of the basement walls to account for increases in groundwater levels caused by significant rainfall events and flooding. Surcharge pressures from adjacent structures, construction machinery and traffic should also be incorporated into the design of the wall as necessary.

8.4 Foundations

Based on preliminary information provided by Webber Design, it is expected that column working loads will be in the order of 10,000 kN. Based on the existing site conditions, it is considered that structural loads should be transferred into the underlying bedrock by the use of piles. These piles will most likely need to be socketed into at least medium strength (or better) rock, which is expected at depths of approximately 8.25 m to 12 m below the existing basement slab.

Pile excavation holes will not remain open in the sandy filling and natural sands, therefore it is recommended that the piles be installed by continuous flight auger (CFA) methods or cased bored piling methods. If cased bored methods are used, seepage should be expected within the open piles holes and therefore allowance for pumping to remove water or the use of tremmie methods to place concrete should be considered. Relatively high seepage flows can sometimes occur within the fractured laminite.

Recommended maximum design pressures for the various rock strata are presented in Table 5. For piles shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the values for compression.

Table 5: Recommended Design Parameters for Foundation Design

Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure		Young's Modulus E (MPa)
	End Bearing (kPa)	Shaft Adhesion[(1)] (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion[(1)] (Compression) (kPa)	
Extremely low to very low strength rock	800	80	3,000	100	100
Low to medium strength rock	1,500	150	6,000	350	200
Medium strength rock	3,500	300	10,000	400	500
High strength rock	6,000	600	30,000	1200	2000

Notes: (1) Shaft adhesion applicable for the design of bored piers, uncased over rock socket length, where adequate sidewall cleanliness and roughness is achieved.

High strength, slightly fractured laminite was encountered below 8.8 m and 12.0 m depths (RL 13.75 m AHD and RL 10 m AHD) in BH 101 and BH 103 respectively. Higher design parameters can be adopted for the high strength rock however further investigation would be required to confirm the depth to this rock across the site and to assess the consistency of this rock below the proposed pile toe level.

The foundation design parameters given in Table 5 assume that the pile excavations are clean and free of loose debris, with pile sockets free of smear and adequately roughed immediately prior to concrete placement.

Settlement of a pile is dependent on the loads applied to the pile and the foundation conditions in the socket zone and below the pile toe. The total settlement of bored or CFA piles designed using the 'allowable' parameters provided in Table 5 should be less than 1% of the pile diameter upon application of the design load.

It should be noted that the serviceability limit-state is likely to govern the design of the CFA piles and the ultimate bearing pressures provided in Table 5 will probably need to be lowered in order to limit settlements to an acceptable level. An appropriate geotechnical strength reduction factor should be applied when using the limit-state approach as outlined in AS 2159 – 2009 Piling – Design and installation.

Soil decompression can occur during CFA piling when a strong stratum is encountered. In this case, the augers continue to rotate but the rate or auger progression decreases and soil from around the auger is displaced upwards towards the surface. Decompression can cause weakening and settlement of the soils adjacent to the pile and should be avoided by monitoring auger speed and progression closely.

8.5 Soil Aggressivity

Aggressivity to concrete piles was assessed using the laboratory test results. The exposure classification for concrete and steel piles is assessed as being mildly aggressive in accordance with Australian Standard AS 2159 – 2009 *Piling – Design and installation*.

8.6 Seismicity

In accordance with AS1170-2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia" a hazard factor (Z) of 0.08 and a site subsoil Class C_e is considered to be appropriate for the site.

8.7 Groundwater

Groundwater has been measured on the site at between RL 17.1 m AHD and 18.7 m AHD (depths below the existing basement surface varying between 3.3 m and 4.9 m) which is about 2.5 m to 4.1 m below the proposed lowered basement level FFL (RL 21.25 m AHD). On this basis it is expected that groundwater will generally be below the basement level. However, the groundwater table will fluctuate and may temporarily rise by at least 1-2 m following heavy and prolonged rainfall.

It is noted that the current isolated measurements have occurred during a particularly dry season and groundwater levels may be lowered. Ongoing monitoring of water levels with data loggers is recommended to more accurately assess groundwater levels and fluctuations.

Based on the proposed depth of excavation, and groundwater information obtained during the investigation, the proposed basement will be above the groundwater table and therefore DP expect

that there will be no impact on groundwater levels/quality, no impact in terms of the NSW Aquifer Interference Policy, and no requirement to obtain a dewatering license or approval under the Water Act 1912 or Water Management Act 2000. This advice is subject to review and approval from the project planner and Council.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at 13-23 Gibbons Street, Redfern in accordance with DP's proposal SYD180784.P.001.Rev1 dated 4 September 2018 and acceptance received from Mr John De Fazio of The Trust Company (Australia) Limited ATF WH Gibbons Trust dated 17 September 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of The Trust Company (Australia) Limited ATF WH Gibbons Trust for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials. Reference should be made to DP's Detailed Site Investigation Report (ref: 86266.04.R.001.Rev1) for further information on soil contamination.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP.

DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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. They may not be the same at the time of construction as are indicated in the report; and
- 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 first be washed out of the hole if water measurements are to be made.

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

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP 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 and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report 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. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil 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.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud 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 the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils 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 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

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

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This 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.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

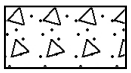
Symbols & Abbreviations

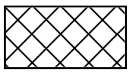
Graphic Symbols for Soil and Rock

General

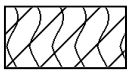

Asphalt

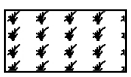

Road base

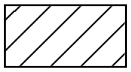

Concrete

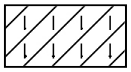

Filling

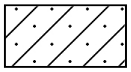
Soils


Topsoil

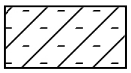

Peat

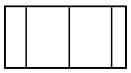

Clay

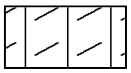

Silty clay

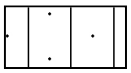

Sandy clay

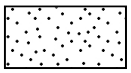

Gravelly clay

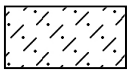

Shaly clay

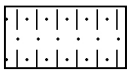

Silt


Clayey silt


Sandy silt

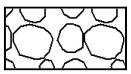

Sand

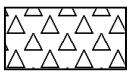

Clayey sand


Silty sand


Gravel

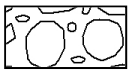

Sandy gravel


Cobbles, boulders

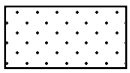

Talus

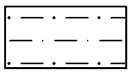
Sedimentary Rocks

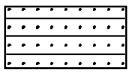

Boulder conglomerate

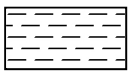

Conglomerate


Conglomeratic sandstone

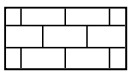

Sandstone


Siltstone

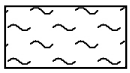

Laminite

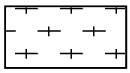

Mudstone, claystone, shale

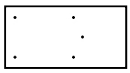

Coal


Limestone

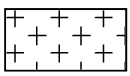
Metamorphic Rocks

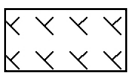

Slate, phyllite, schist

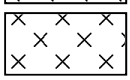

Gneiss

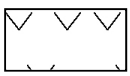

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia

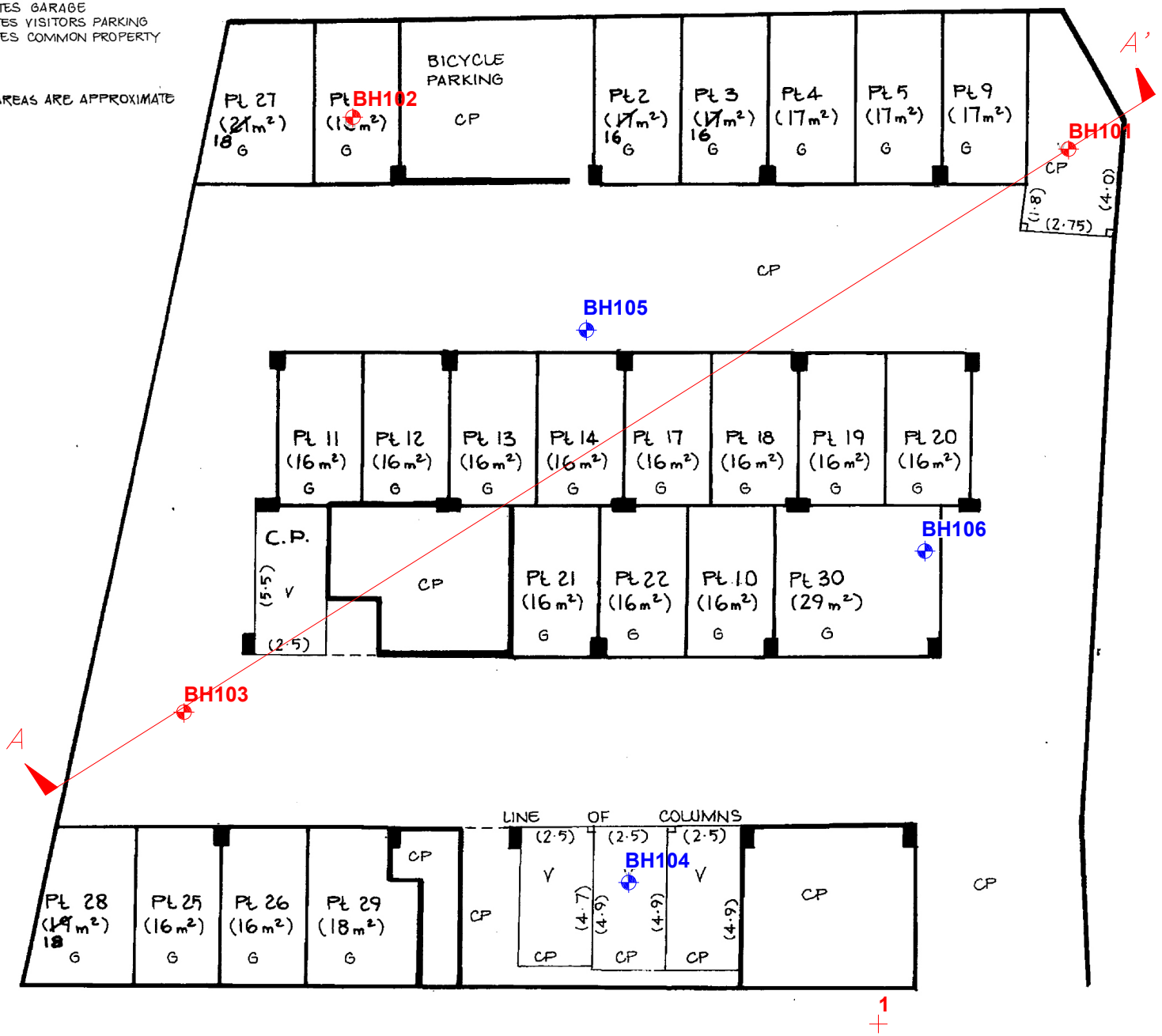

Porphyry

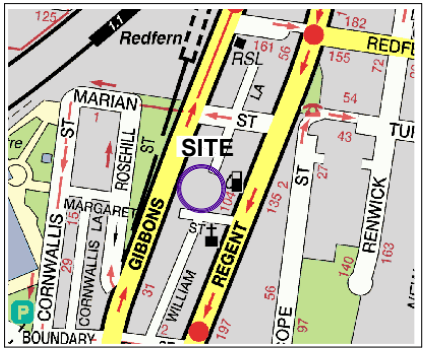
Appendix B

Drawings

G - DENOTES GARAGE
V - DENOTES VISITORS PARKING
CP - DENOTES COMMON PROPERTY

NOTE: AREAS ARE APPROXIMATE





Locality Plan

NOTE:
1: Base drawing from April Group (Dwg SP60485)
2: Test locations are approximate only and are shown with reference to existing features.

0 1.0 2.0 3.0 4.0 5.0 7.5 10 15m
1:150 @ A3

LEGEND

- Previous borehole
- Current borehole
- Current shallow environmental borehole
- Geotechnical Cross Section A-A'

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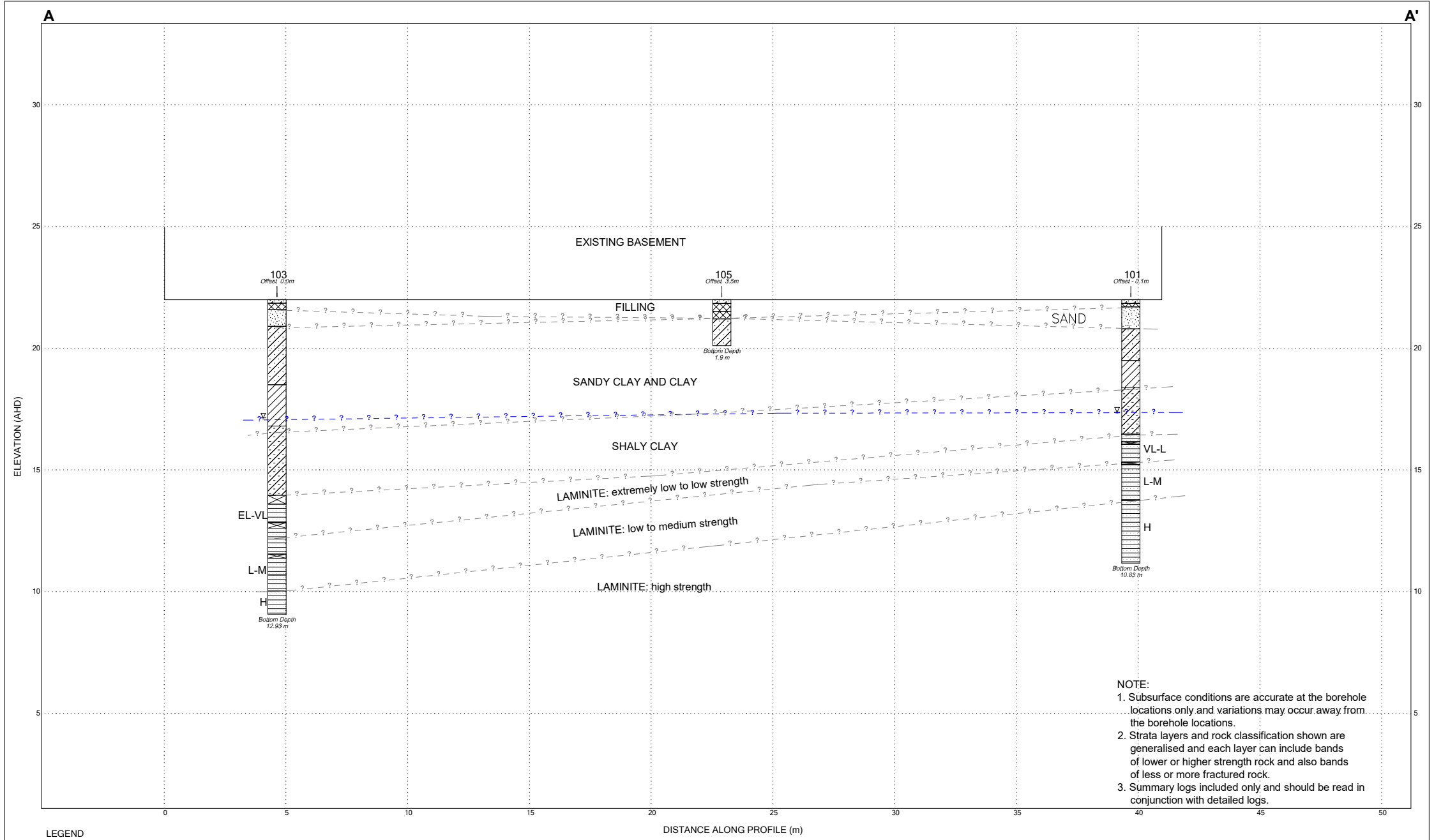
CLIENT: The Trust Company (Australia) Limited ATF WH Gibbons Trust		TITLE: **Test Location Plan**	PROJECT No: 86266.03
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Multi-Storey Residential Development**	DRAWING No: 1
SCALE: 1:150 @ A3	DATE: 5.10.2018	**13-23 Gibbons Street, REDFERN**	REVISION: 0



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs included only and should be read in conjunction with detailed logs.

LEGEND

- Core Loss
- Clay
- Concrete
- Filling
- Laminite
- Sand
- Sandy Clay
- Shaly Clay

TESTS / OTHER
N - Standard penetration test value
▽ - Water level
PP - Pocket penetrometer test value

0 3
Horizontal Scale (metres)
Natural Scale

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CLIENT: The Trust Company (Australia) Limited ATF WH Gibbons Trust		TITLE: **Interpreted Geotechnical Cross-Section A-A`**	PROJECT No: 86266.03
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Multi-Storey Residential Development**	DRAWING No: 2
SCALE: 1:150 (H) 1:150 (V) @ A3	DATE: 8.10.2018	**13-23 Gibbons Street, REDFERN**	REVISION: 0

Appendix C

Results of Field Work

BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 86266.03
DATE: 20 - 21/9/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
22	0.16	CONCRETE (SLAB)										
	0.3	FILLING: grey-brown, fine to medium sand filling with some brick fragments, damp							A/E			PID < 1
									A/E			PID < 1
21	1	SAND: pale brown, fine to medium sand, damp 0.8m: clayey							A/E			PID < 1
	1.2	SANDY CLAY: red-brown, sandy clay, Mc~PL							A/E			PID < 1
20	2								A/E			PID < 1
	2.5	CLAY: red-brown mottled grey, clay, Mc<PL							A			
19	3											
	3.6	SHALY CLAY: grey-brown, shaly clay							A			
18	4											
17	5					21-09-18		Note: Unless otherwise stated, discontinuities are planar, rough, iron coating to 1mm, dipping 0-5°				
	5.53								A			
		LAMINITE: very low to low strength, highly to moderately weathered, fractured, brown and grey laminite with some medium to high strength ironstone bands						5.6m: B, sm, vn 5.7m: Cs, 20mm 5.77m: Ds, 10mm 5.79m: B, vn 5.84m: CORE LOSS: 110mm 5.95-6.04m: Ds, 90mm 6.05-6.35m: Cs(x5), 5-20mm	C	100	0	
16	6								C	87	0	
	6.78											
15	7	LAMINITE: low to medium strength, slightly weathered, fractured, dark grey laminite, (60% siltstone, 40% sandstone), horizontal and lenticular bedding						6.52-6.61m: Sz, 90mm 6.61m: Ds, 10mm 6.69m: CORE LOSS: 90mm 6.81m: B 6.85m: Ds, 10mm 6.91m: B, ir 7.02-7.14m: B(x4) 7.33m: B, 3mm 7.41m: B, vn 7.51m: Ds, 40mm 7.75m: B, sm, vn 7.95m: B, 5mm 7.98m: B, sm, vn, cly 8.08-8.47m: B(x4) 8.64m: B, sm, vn, cly 8.8m: B, sm, sn, cly	C	89	37	PL(A) = 0.29
14	8								C	100	84	PL(A) = 0.61
	8.25	LAMINITE: high strength, fresh, slightly fractured, dark grey laminite (80% siltstone, 20% sandstone), bedding dipping 0-5°										PL(A) = 2.06
13	9								C	100	100	PL(A) = 2.4
								9.8-9.96m: J50-90°, ir,	C	100	100	PL(A) = 2.55

RIG: Rig 1 (CE150) **DRILLER:** BG Drilling **LOGGED:** ARM **CASING:** HQ to 2.7m

TYPE OF BORING: 200mm diacore to 0.16m; solid flight auger (TC-bit) to 5.53m; NMLC-coring to 10.83m

WATER OBSERVATIONS: Groundwater observed at 4.66 m depth two hours after installation and development of monitoring well

REMARKS: groundwater monitoring well installed to 10.47 m (screen 1.2-10.47m; gravel 0.6-10.47m; bentonite seal 0.2-0.6m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 86266.03
DATE: 20 - 21/9/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
12		LAMINITE: high strength, fresh, slightly fractured, dark grey laminite (80% siltstone, 20% sandstone), bedding dipping 0-5° *(continued)*						stn, cly	C	100	100	
								10.15m: B5-10°, cu, sm, sn, cly	C	100	100	
								10.58m: B, sm, sn, cly				PL(A) = 2.2
	10.83	Bore discontinued at 10.83m - limit of investigation										
11	11											
10	12											
9	13											
8	14											
7	15											
6	16											
5	17											
4	18											
3	19											

RIG: Rig 1 (CE150) **DRILLER:** BG Drilling **LOGGED:** ARM **CASING:** HQ to 2.7m

TYPE OF BORING: 200mm diacore to 0.16m; solid flight auger (TC-bit) to 5.53m; NMLC-coring to 10.83m

WATER OBSERVATIONS: Groundwater observed at 4.66 m depth two hours after installation and development of monitoring well

REMARKS: groundwater monitoring well installed to 10.47 m (screen 1.2-10.47m; gravel 0.6-10.47m; bentonite seal 0.2-0.6m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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BORE: 101 PROJECT: 86266.03 SEPTEMBER 2018

5.53 – 10.00 m

BORE: 101 PROJECT: 86266.03 SEPTEMBER 2018

10.00 – 10.83m

BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 86266.03
DATE: 21/9/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
22	0.12	CONCRETE (SLAB): 8mm reinforcement at 0.09m							Flush gatic cover
		FILLING: brown, clayey fine to medium sand filling with some fine to medium grained sandstone gravel, damp		A/E	0.2 0.3		PID < 1		
	0.6			A/E	0.4 0.5		PID < 1		Bentonite
21	1	CLAYEY SAND: orange-brown, clayey fine to medium sand, damp		A/E	0.9 1.0		PID = 1		
				A/E*	1.4 1.5		PID < 1		
20	2			A/E	1.8 2.0		PID < 1		
		2.5m: damp to moist		A	2.8 3.0				Machine slotted PVC screen
19	3								Gravel
	3.5	CLAY: red-brown, clay with a trace of fine to medium grained sand, Mc<PL		A	3.8 4.0				
18	4								
		4.5m: red-brown mottled grey							
17	5								
	5.6	SHALY CLAY: grey and brown, shaly clay with ironstone bands (possibly extremely low strength laminite)		A	5.8				End cap
16	6	Bore discontinued at 6.0m - limit of investigation			6.0				
15	7								
14	8								
13	9								

RIG: Rig 1 (CE150) **DRILLER:** BG Drilling **LOGGED:** ARM **CASING:** Uncased

TYPE OF BORING: 200mm diacore to 0.12m; solid flight auger (TC-bit) to 6.0m

WATER OBSERVATIONS: No groundwater observed in monitoring well one hour after installation

REMARKS: *BD1/20180921 is replicate of 1.4-1.5m sample; groundwater monitoring well installed to 5.8m (screen 1.2-5.8m; gravel 0.85-5.8m; bentonite seal 0.15-0.85m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 86266.03
DATE: 19 - 20/9/2018
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
22	0.15	CONCRETE (SLAB): 8mm reinforcement at 0.08m							A/E			PID < 1
	0.4	FILLING: brown, fine to medium sand filling with a trace of tile fragments, damp							A/E			PID < 1
21	1	SAND: orange-brown, fine to medium sand, damp							A/E			PID < 1
	1.1	SANDY CLAY: orange-brown, sandy clay, fine to medium grained sand, damp to moist										
20	2								A/E			PID < 1
19	3								A/E			PID < 1
	3.5	CLAY: red-brown mottled grey, clay with a trace of fine to medium grained sand, Mc~PL										
18	4								A			PID < 1
17	5	5.0m: becoming shaly				21-09-18			A			PID < 1
	5.2	SHALY CLAY: hard, grey mottled red-brown, clay with 20% ironstone bands (extremely weathered laminite)							A			PID < 1
16	6								C	100	0	pp = 300
15	7							Note: Unless otherwise stated, discontinuities are planar, smooth, iron coating to 1mm, dipping 0-5°	C	100	0	pp = 250 pp = 200
14	8	CORE LOSS						8.04m: CORE LOSS: 360mm				
	8.4	LAMINITE: extremely low to very low strength, extremely to highly weathered, fractured, grey-brown, laminite, 50% extremely weathered seams, bedding dipping 30-45°						8.63-8.89m: Cs(x4), 10-15mm 9.06-9.27m: Ds, 110mm	C	68	0	
13	9							9.17m: CORE LOSS: 220mm				
	9.39							9.52m: Ds, 30mm 9.61m: Ds, 5mm 9.67-9.79m: Ds, 120mm	C	83	43	
	9.84	LAMINITE										PL(A) = 0.19

RIG: Rig 1 (CE150) **DRILLER:** BG Drilling **LOGGED:** ARM **CASING:** HQ to 3.7m

TYPE OF BORING: 200mm diacore to 0.15m; solid flight auger (TC-bit) to 5.2m; NMLC-coring to 12.93m

WATER OBSERVATIONS: Groundwater observed at 4.90 m depth five hours after development of monitoring well

REMARKS: groundwater monitoring well installed to 12.93m (screen 1.4-12.93m; gravel 1.15-12.95m; bentonite seal 0.2-1.15m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 86266.03
DATE: 19 - 20/9/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
12	10.0	LAMINITE: low strength, slightly weathered, fractured, dark grey laminite (70% siltstone, 30% sandstone), horizontally bedded						9.8m: B, ro, co, 2mm 9.81m: Cs, 20mm 10.02-10.14m: J70°, ro, vn 10.28m: Ds, 10mm 10.30-10.34m: B(x2), ro 10.44m: Cs, 5mm 10.46m: CORE LOSS: 170mm 10.63-10.78m: fg 10.86m: B, vn 10.93-10.97m: B(x2) 11.07-11.27m: B(x2), ro 11.28m: J45°, st, ro, stn 11.32m: Ds, 10mm 11.37m: Ds, 2mm 11.50-11.83m: B(x6), sm, 1-2mm 11.93-11.98m: Sz, 50mm 12.01m: B, vn	C	83	43	
	10.63											PL(A) = 0.16
11												
	11.32	LAMINITE: medium strength, slightly weathered, fractured, dark grey laminite (70% siltstone, 30% sandstone), horizontally bedded							C	88	33	PL(A) = 0.26
10	11.98	LAMINITE: high strength, fresh, slightly fractured, dark grey laminite (80% siltstone, 20% sandstone), horizontally bedded							C	100	92	PL(A) = 1.07
9	12.93	Bore discontinued at 12.93m - limit of investigation										PL(A) = 2.78
8	13											
7	14											
6	15											
5	16											
4	17											
3	18											
	19											

RIG: Rig 1 (CE150) **DRILLER:** BG Drilling **LOGGED:** ARM **CASING:** HQ to 3.7m

TYPE OF BORING: 200mm diacore to 0.15m; solid flight auger (TC-bit) to 5.2m; NMLC-coring to 12.93m

WATER OBSERVATIONS: Groundwater observed at 4.90 m depth five hours after development of monitoring well

REMARKS: groundwater monitoring well installed to 12.93m (screen 1.4-12.93m; gravel 1.15-12.95m; bentonite seal 0.2-1.15m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

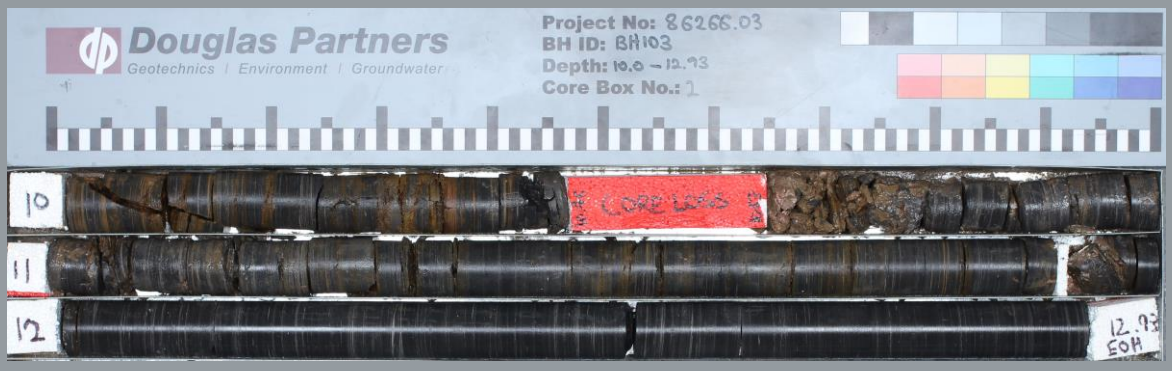
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 103 PROJECT: 86266.03 SEPTEMBER 2018

5.20 – 10.00 m

BORE: 103 PROJECT: 86266.03 SEPTEMBER 2018



10.00 – 12.93m

BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 86266.03
DATE: 20/9/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
22	0.12	CONCRETE (SLAB): 8mm reinforcement at 0.06m		A/E	0.15		PID < 1		
		FILLING: brown, fine to medium sand filling with a trace of clay and fine sandstone gravel, damp		A/E	0.2 0.4 0.5		PID < 1		
	0.7	SAND: medium dense, pale brown, medium sand, damp		A/E	0.7 0.8		PID < 1		
21	0.9 1	CLAYEY SAND: medium dense, orange-brown, clayey medium sand, damp		A/E	0.9 1.0		PID < 1		
				A/E	1.4 1.5		PID < 1		
20	2 2.0	Bore discontinued at 2.0m - limit of investigation		A/E	1.9 2.0		PID < 1		
19	3								
18	4								
17	5								
16	6								
15	7								
14	8								
13	9								

RIG: Hand Tools **DRILLER:** ARM **LOGGED:** ARM **CASING:** Uncased

TYPE OF BORING: 150mm diacore to 0.12m; 60mm hand auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 86266.03
DATE: 19/9/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
22	0.16	CONCRETE (SLAB): 8mm reinforcement at 0.12m							
		FILLING: orange-brown, clayey fine to medium sand filling with a trace of fine sandstone gravel, damp		A/E	0.2 0.3 0.4		PID < 1 PID < 1		
	0.5	FILLING: grey-brown, fine to medium sand filling with some clay and a trace of fine gravel, damp		A/E	0.5 0.6		PID < 1		
	0.8	SANDY CLAY: medium dense, orange-brown, sandy clay, fine to medium sand, damp		A/E	0.7 0.8 0.9		PID < 1		
21	1			A/E*	1.4 1.5		PID < 1		
	1.9	Bore discontinued at 1.9m - limit of investigation							
20	2								
19	3								
18	4								
17	5								
16	6								
15	7								
14	8								
13	9								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** ARM **LOGGED:** ARM **CASING:** Uncased

TYPE OF BORING: 150mm diacore to 0.16m; 60mm hand auger to 1.9m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *BD1/20180919 is replicate of 1.4-1.5m sample

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: WH Gibbons Trust
PROJECT: Proposed Multi-Storey Residential Development
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 22 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 86266.03
DATE: 19/9/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
22	0.17	CONCRETE (SLAB): 8mm reinforcement at 0.11m							
		FILLING: grey-brown, fine to medium sand filling with some fine gravel, brick fragments (up to 100mm) to 0.3m depth, damp		A/E	0.2		PID < 1		
				A/E	0.3 0.4		PID < 1		
		0.60m: mottled orange, possibly natural			0.5				
21	1			A/E	0.9		PID < 1		1
	1.3	SAND: orange-brown, fine to medium sand with a trace of clay, damp		A/E	1.4 1.5		PID < 1		
	1.7	SANDY CLAY: red-brown, sandy clay, fine to medium sand, damp		A/E	1.9 2.0		PID < 1		
20	2 2.0	Bore discontinued at 2.0m - limit of investigation							2
19	3								3
18	4								4
17	5								5
16	6								6
15	7								7
14	8								8
13	9								9

RIG: Hand Tools **DRILLER:** ARM **LOGGED:** ARM **CASING:** Uncased

TYPE OF BORING: 150mm diacore to 0.17m; 60mm hand auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix D

Results of Laboratory Testing

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 201560

Client Details

Client	Douglas Partners Pty Ltd
Attention	Andrew Mcintyre
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86266.03, Redfern**
Number of Samples	4 SOIL
Date samples received	25/09/2018
Date completed instructions received	25/09/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	03/10/2018
Date of Issue	28/09/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Soil Aggressivity					
Our Reference		201560-1	201560-2	201560-3	201560-4
Your Reference	UNITS	BH101	BH101	BH102	BH103
Depth		0.9-1.0	2.8-3.0	5.8-6.0	2.8-3.0
Date Sampled		20/09/2018	20/09/2018	21/09/2018	19/09/2018
Type of sample		SOIL	SOIL	SOIL	SOIL
pH 1:5 soil:water	pH Units	7.9	5.1	5.3	5.1
Electrical Conductivity 1:5 soil:water	µS/cm	48	77	66	59
Resistivity by calculation	ohm m	210	130	150	170
Chloride, Cl 1:5 soil:water	mg/kg	<10	20	10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	24	95	100	82

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	7.9	7.9	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	48	50	4	102	[NT]
Resistivity by calculation	ohm m	0.1	Inorg-002	<0.1	1	210	200	5	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	102	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	24	32	29	106	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CHAIN OF CUSTODY DESPATCH SHEET

Project No:	86266.03	**Suburb:**	Redfern	**To:**	Envirolab
Project Name:	12-23 Gibbons Street, Redfern	**Order Number**			12 Ashley Street, Chatswood, NSW
Project Manager:	Andrew McIntyre	**Sampler:**	ARM	**Attn:**	Aileen Hie
Emails:	andrew.mcintyre@douglaspartners.com.au			**Phone:**	
Date Required:	Standard ☐			**Email:**	

Prior Storage: ☐ Shelf Do samples contain 'potential' HBM? No ☐ (If YES, then handle, transport and store in accordance with FPM HAZID)

Sample ID	Lab ID	Date Sampled	Sample Type (S - soil, W - water)	Container Type (G - glass, P - plastic)	Analytes									Notes/preservation
					EC (1:5)	pH (1:5)	SO4	Cl						
BH101/0.9-1.0	1	20/09/18	S	P	X	X	X	X						
BH101/2.8-3.0	2	20/09/18	S	P	X	X	X	X						
BH102/5.8-6.0	3	21/09/18	S	P	X	X	X	X						
BH103/2.8-3.0	4	19/09/18	S	P	X	X	X	X						
PQL (S) mg/kg													**ANZECC PQLs req'd for all water analytes** ☐	

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 201560
Date Received: 25/9/18
Time Received: 13:15
Received By: LN
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here:

Lab Report/Reference No:

Total number of samples in container: 2 **Relinquished by:** ARM **Transported to laboratory by:**

Send Results to: Douglas Partners Pty Ltd **Address:** **Phone:** **Fax:**

Signed: **Received by:** ELS LILY NOTT **Date & Time:** 25/9/18 13:15

Appendix E

Results of Previous Field Work

BOREHOLE LOG

CLIENT: GSA Australia Pty Ltd
PROJECT: Proposed Student Accomodation
LOCATION: 13-23 Gibbons Street, Redfern

SURFACE LEVEL: 23.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 0086266.00
DATE: 29/1/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
23	0.07	PAVERS and bedding sand										
	0.25	CONCRETE										
		FILLING - grey sand filling with concrete fragments							A/E			
	0.95								A/E			
22	1.05	CONCRETE										
		FILLING - grey gravelly sand filling with occasional concrete fragments							A/E			
									A/E			
21									A/E			
		3.0m: with some tile fragments										
20									A/E			
	3.7	SAND - pale orange, medium grained sand, damp							A/E			
19	4.3	SANDY CLAY - orange-brown, fine to medium grained sandy clay, moist							A/E			(duplicate)
	4.8	CLAY - stiff, orange-brown and grey mottled, clay							S			4,5,6 N = 11
18	6.0	SHALY CLAY - very stiff to hard, pale-grey and brown mottled shaly clay										
17	7.03	SHALY CLAY - pale-grey and brown mottled shaly clay							S			15/30mm refusal
									C	100	0	
16	7.51	LAMINITE - medium strength, highly to moderately weathered, grey and brown-grey laminite with some clay bands						7.56-7.64m: DS 80mm clay 7.68-7.70m: DS 20mm clay				PL(A) = 0.35
15	7.95	LAMINITE - low strength, slightly weathered, grey laminite (silstone 70%, fine grained sandstone 30%)						7.88m: DS 15mm clay 8.15-8.17m: J90°, fe healed, discontinuous 8.34m: B0°, pl, sl, 5mm clay	C	100	0	PL(A) = 0.16
14	8.85	Bore discontinued at 8.85m - target depth reached						8.66-8.70m: DS 40mm clay				

RIG: Dando Terrier **DRILLER:** BG Drilling **LOGGED:** LJH **CASING:** HQ to 6.0m

TYPE OF BORING: Diacore to 0.25m; SFA to 0.95m; Diacore to 1.05m; SFA to 7.03m; NMLC to 8.85m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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