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Report on
Geotechnical Investigation

Proposed Residential Development
Park Road, Yeronga

Prepared for
Brisbane Housing Company

Project 97679.00
January 2021

PLANS AND DOCUMENTS
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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 Residential Development
Park Road, Yeronga

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed residential development at Park Road, Yeronga. The investigation was commissioned in an email dated 8 December 2020 by Greg Coghlan of Brisbane Housing Company and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal BNE201230 dated 23 November 2020.

It is understood that the development of the site will include construction of a three to six level residential development over a single level of basement car parking.

The aim of the investigation was to assess the site in order to provide comments on the following:

- subsurface conditions (including groundwater);
- site classification in accordance with AS 2870:2011;
- excavation conditions;
- suitable temporary batter slopes
- suitable basement retention options and geotechnical basement/retaining wall design parameters;
- suitable foundation types (high level or piles), bearing pressures and estimated settlements;
- earthworks and site preparation at the base of the excavation (including trafficability and compaction);
- indicative slab-on-ground subgrade design parameters (California bearing ratio (CBR) and modulus of subgrade reaction parameters) for pavement design by others; and
- site sub-soil class in accordance with AS1170.4:2007.

The investigation included the drilling of three bores followed by laboratory testing, analysis and reporting. The details of the field and laboratory work are presented in this report, together with comments and recommendations on the items listed above.

This report must be read in conjunction with the notes entitled ‘About This Report’ in Appendix A and other explanatory notes, and should be kept in its entirety without separation of individual pages or sections.

2. Previous Investigation

DP was provided with an excerpt from a previous investigation undertaken by others (prior to site demolition). The excerpt included BH10 and the Site Plan from report entitled “Preliminary Geotechnical Investigation, Redevelopment of Yeronga Tafe, Park Road, Yeronga”, Project No. 1-19724, dated September 2017, by Soil Surveys Engineering Pty Limited.

The results of this bore indicated the site to be underlain by an upper fill layer then residual clayey sand/sandy clay to 0.95 m depth then generally low strength sandstone to bore termination at 10 m depth.

The approximate location of this bore is included on Drawing 1 in Appendix B and a copy of the borehole log is included in Appendix C.

3. Site Description

The development site is located on the eastern side of Park Road in Yeronga, as indicated on Drawing 1 in Appendix B. The site is within the Yeronga State High School extended campus with the proposed development area currently surrounded by vacant land (which is proposed to be developed by others).

At the time of the investigation the site was vacant and comprised exposed earth and grasses, with some outcropping sandstone rock evident at the surface.

Topographically the site generally slopes down to the north and north east via a series of bench and batters left from the previous development, falling from approximately RL 13 m to RL 10 m.

A general view of the site at the time of the investigation is indicated as Figure 1 below.

Figure 1: View of the site looking south west toward Park Road.

4. Regional Geology

Geological Survey of Queensland, 1:100,000 scale geological map indicates that the site is underlain by the late Triassic aged Aspley Formation, typically comprising *“sandstone, conglomerate, minor shale”*.

The natural soil and rock encountered during the field work (refer Section 5 of this report) are in general agreement with the residual soils and rock in the published geology.

5. Field Work Methods

The field work was undertaken on 21 December 2020 and comprised the drilling of three boreholes (designated Bores 1 to 3) to 5 m or 6.6 m depth. The bores were drilled using a truck mounted Hydrapower Scout drilling rig, utilising continuous solid flight augers.

Standard penetration tests (SPTs) were carried out at regular depth intervals in the bores, to provide an indication of soil strength and to collect samples for visual identification and laboratory testing. On completion of drilling, and after checking for groundwater, the bores were backfilled with drill spoil.

The test locations were selected in accessible areas with reference to existing and proposed site features. The positions of the bores were recorded using a handheld GPS device accurate to approximately 5 m and the approximate surface levels were interpolated from the client supplied drawings and Brisbane City Council (BCC) City Plan 2014, interactive mapping. The approximate locations are indicated on Drawing 1 in Appendix B.

The field work was undertaken under the supervision of a geotechnical engineer who positioned the test locations, logged the bores, and collected samples for visual and tactile assessment and for laboratory testing.

6. Field Work Results

The subsurface conditions encountered in the bores are described in detail on the borehole log report sheets in Appendix C. These should be read in conjunction with the explanatory notes in Appendix A which describe sampling methods, soil and rock descriptions, symbols and abbreviations used in their preparation.

In summary, the subsurface conditions generally comprised **fill**, over **weathered rock** to the limit of the investigation. The subsurface conditions encountered are further described below:

- **Fill:** Variable fill was encountered from the surface to 0.4 m to 0.5 m depth in the bores. The fill comprised various portions of sandy, clay and gravel, consistent with the demolition and earthworks which has been recently undertaken on the site.

  Although apparently well compacted, in the absence of documentation to prove otherwise the fill is deemed ‘uncontrolled’.

- **Weathered Rock:** Generally, very low to low strength, sandstone was encountered underlying the fill and extended to bore termination at 5 m and 6.6 m depth. There were some strength inversions observed within the rock (i.e. weaker strata underlying stronger strata), including completely weathered rock (hard clay) bands observed in Bore 2. The bores were each terminated at auger refusal on the rock.

Groundwater seepage was observed in Bore 2, during the field work at depths of 0.5 m and 5 m. It is considered likely that this was perched groundwater due to the weaker strata overlying rock at these depths. Groundwater seepage was not observed in Bores 1 and 3 during the investigation. It should be noted, however, that groundwater depths are affected by climatic conditions and soil permeability and will therefore vary with time.

7. Laboratory Testing

Laboratory testing comprised a plasticity test and an Emerson class number dispersion test on samples from the bores. The results are summarised in Tables 1 and 2, below and the detailed laboratory report sheets are provided in Appendix D.

Table 1: Summary of Plasticity Test Results

Bore	Depth (m)	Description	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
2	2.0 – 2.4	Sandstone, weathered to clay	13.1	34	15	19	8.0

The results indicate the sample tested is of medium plasticity.

Table 2: Summary of Dispersion Test Results

Bore	Depth (m)	Description	Emerson Class Number	Dispersion Potential
1	0.5 – 0.57	Sandstone	6	Medium

The results indicate the sample tested is moderately dispersive.

8. Proposed Development

It is understood that a three to six storey apartment building is proposed over a single level basement car park. Based on similar type developments it is estimated that column loads in the order of 3,000 kN to 4,500 kN (working) are likely for the proposed building.

Excavation up to 4 m depth in the southern site area reducing to about 2 m depth in the northern site area, is understood to be required below existing site levels to achieve the bulk excavation level (BEL) of RL 9 m. It is also understood that the basement will extend close to the boundaries on all sides of the site.

9. Comments

9.1 Appreciation of Ground Conditions

The subsurface profile encountered during the investigation generally comprised upper fill overlying very low to low strength sandstone below 0.4 m to 0.5 m depth. Some strength inversions were observed within Bores 2 and 3. The bores were each terminated in low strength rock at 5 m or 6.6 m depth.

Groundwater seepage was observed in Bore 2, but is anticipated to be perched water due to the recent rainfall and strength inversions.

The method of construction for the basement will be dependent on the timing of construction and the ability to utilise the adjoining undeveloped land for battering.

Based on the subsurface conditions and if the adjoining land can be utilised a battered excavation would be possible for the site. Where the land is not able to be utilised for battering, ‘hit and miss’ panels could be used for excavations up to 2.5 m depth (i.e. northern site area) with a stiff retention system (i.e. piled wall) required around the remainder of the basement, where deeper excavations are required.

The most economical building foundations will likely comprise shallow pad and strip footings founding in the weathered rock anticipated at BEL.

9.2 Groundwater Control

Although some groundwater seepage was observed within the proposed depth of excavation, standing water was not observed. Based on this and the subsurface soil conditions (i.e. mainly clayey soils and weathered rock) encountered in the bores it is anticipated that any seepage into the basement excavation should be relatively slow and able to be controlled using sumps connected to pumps to remove water as required.

A ‘drained’ basement structure will be suitable for this development and will require full height drainage to be installed behind all basement walls and a drainage gravel layer graded to fall to sumps, with removal by pumps, beneath the lowest basement floor slab.

9.3 Basement Construction

Excavation depths up to 4 m, will be required below existing site levels, across the southern site area, to achieve the BEL of approximately RL 9 m and up to 2 m to achieve BEL in the northern site area. It is understood that the excavation will extend close to all site boundaries.

Where the surrounding land can be utilised full height battering around the basement (except possibly for the western boundary along Park Road) would be achievable. Where this isn’t possible a ‘hit and miss’ panel system could be utilised for excavations up to 2.5 m and/or a stiff retention system (i.e. piled wall) will be required around the remaining site area.

9.3.1 Excavatability

Excavation of the existing fill and very low to low strength, highly weathered sandstone anticipated above the proposed BEL should be readily achieved using conventional earthmoving plant (i.e. 30 tonne hydraulic excavator, drott, etc.). Where stronger rock is encountered and to increase productivity rippers and/or rock breakers fitted to the above machinery may be useful.

It should be recognised that the above excavatability estimates are based on materials encountered at the borehole locations only and that conditions may prove more difficult (or easier) for excavatability between and beyond these test locations.

9.3.2 Temporary Slope Batters

The short term batters indicated in Table 3, below are suggested for dry, unsurcharged faces of the bulk excavation, up to 3 m in vertical height. For greater heights the faces should be benched and battered at the slopes indicated. Where water seeps from the faces, batters will need to be considerably flatter.

Table 3: Recommended Temporary Batter Slopes

Material	Suggested Batter Slope
Existing ‘uncontrolled’ fill	1.5H:1V
Very low to low strength sandstone	0.75H:1V*

*subject to geotechnical inspection during excavation to confirm stability

The above temporary batter slopes are suggested with respect to slope stability only, and do not allow for lateral stress relaxation which may result in movement of nearby in-ground services or shallow footings. If such services are settlement-sensitive, and are located such that a linear spread at 1H:1V outwards, down and away from the base of the service, intersects the cut face, then the excavation may have to be positively supported.

Confined excavations in natural soil/rock, for say footings or services, etc. up to 1 m depth cut vertically would be anticipated to remain stable in the short term. Vertical, confined excavations should not be kept open for longer than one day.

9.3.3 ‘Hit and Miss’ Panels

For cut faces less than 2.5 m in vertical height, masonry retaining walls or cast insitu/precast concrete walls could be constructed using a ‘hit and miss’ panel system

‘Hit and miss’ panel construction comprises a staged approach to the excavation and erection of basement wall panels to reduce the risk of slope instability and damage to neighbouring buildings and inground services. The use of a ‘hit and miss’ panel sequence could be considered for excavations up to about 2.5 m in height, with an ‘a,b,c, a,b,c’ sequence being adopted with panel widths of 2 m to 2.5 m. Panel widths may need to be reduced where ground conditions are unfavourable and the risks associated with slump and soil instability during construction cannot be accepted and controlled.

A typical construction sequence would involve excavating the ‘hit’ panels (i.e. ‘a’) whilst leaving the next two ‘miss’ panels (i.e. ‘b,c’) temporarily battered. Installation and backfilling of the concrete tilt panels to full height of the excavation (i.e. up to 2.5 m maximum) at the ‘hit’ panel locations would occur prior to excavation of the next series of 'hit' panels (either 'b' or 'c'), and the same process followed. The wall panels could be temporarily propped back to the basement floor slab or temporary footings prior to installation of the first suspended floor.

9.3.4 Positive Support

The installation of positive ground support may be necessary where limited space prohibits the use of temporary batters and the depth of excavation is greater than 2.5 m. The ground retention system selected will need to minimise ground movements behind the excavation faces to ensure adjacent buildings, footpaths, roads, and in-ground services are not affected as a result of basement construction.

Piled walls could comprise cantilevered or anchored/propped bored soldier pile walls.

Where significant surcharge loads are present or ground movements must be limited then anchored or propped soldier piles are likely to be the most suitable retention system. Where greater face movements can be tolerated, cantilevered walls may be suitable.

9.3.4.1 Piled Walls

A soldier pile and shotcrete panel wall will be suitable on this site to support the upper fill and natural highly weathered rock within the proposed depth of excavation. A soldier pile wall will not prevent the seepage of water into the excavation and also carries the risk of ground loss between the piles; neither of these are anticipated to be significant issues on this site. Soldier piles are typically spaced at two to three pile diameters, centre to centre around basement excavations.

If lateral movement of the ground surface behind the wall cannot be accepted then it is expected that one row of anchors or props would be required to support the piled wall sections to ensure stability, reduce pile head deflections and bending moments.

Cantilevered, or single anchored or propped piled walls could be designed using the parameters given in Section 9.3.4.2.

Determination of pile depths and anchor spacing and lengths is a matter for detailed design. DP could assist in this design if required.

9.3.4.2 Wall Design Pressures

The design of flexible or rigid walls with a single row of anchors or props could be undertaken using a triangular earth pressure distribution based on the earth pressure parameters given in Table 4 below. Flexible walls are those which are free to rotate or tilt (such as cantilevered walls) and should be designed using an active earth pressure coefficient (Ka). Rigid walls are those which are restrained against rotation or tilt (i.e. single row anchored/propped walls founded soil) and should be designed using the 'at-rest' earth pressure coefficient (Ko).

Table 4: Earth Pressure Coefficients (non-sloping crest backfill)

Material	Unit Weight γ (kN/m^3)	At rest Ko	Active Ka	Passive Kp
Existing ‘uncontrolled’ fill	18	0.6	0.4	2.5
Very low to low strength sandstone	21	0.45	0.3	3.4

For the design of conventional retaining walls:

- Due allowance should be made for surcharge loadings (over and above the lateral earth pressure coefficients presented above) where the finished ground level above retaining walls is above horizontal and where additional loading is likely to be applied from existing or future upslope structures, or from traffic.
- Drainage material behind the wall, should be installed for the full height of the wall, for a width of at least 0.3 m. The material must be free draining and granular, and have a perforated or slotted drainage pipe at the heel of the wall to rapidly remove the water into the stormwater system.
- If full height drainage is not installed behind all retaining walls, then these walls should be designed for full hydrostatic pressure build-up.
- Wall footings could be designed for the allowable bearing pressures presented in Section 9.4 of this report, reduced by one third to allow for lateral load affects.

It is recommended that a factor of safety of 2 be adopted for overturning and sliding stability, and 1.5 for global stability of all retaining walls.

For limit state design methods, the ultimate parameters provided above in Table 3 will need to be factored in accordance with AS 4678:2002. Guidance on the selection of material strength partial factors is provided in Section 5.2 of AS 4678 and is dependent upon the nature and state of the natural in situ soil/rock or fill material.

9.3.4.3 Anchors

Temporary ground anchors may be required to support the piled walls at the perimeter of the excavation where movement is not acceptable (i.e. adjacent existing buildings, roads, or in-ground services etc).

An ultimate bond stress of 250 kPa could be used for the design of ground anchors in the very low to low strength rock. This stress should be divided by a factor of safety of 2 to assess suitable working bond stress in the design of fixed anchor lengths. All temporary ground anchors should be load tested to 1.3 times their working load after installation.

9.4 Foundations

It is anticipated that the exposed subgrade at BEL will comprise very low to low strength sandstone. Given the conditions at BEL and the anticipated 3,000 kN to 4,500 kN working column loads, it is anticipated the high level pad a strip footings founding on the weathered rock will be suitable on this site.

High level footings (pads or strips) founding in the very low to low strength rock, may be designed for an ultimate unfactored bearing pressure of 1,500 kPa.

For high level pad or strip footings founded as above, it is considered that settlements under such applied loading will be less than 1% of footing width.

Given the relatively heavy column loads and the susceptibility to differential movements, it is recommended all footings be founded in similar strength material.

For working bearing pressure the value given above, should be divided by a factor of safety of 2.5.

Where limit state methods are used to design the footings, the ultimate value given can be multiplied by a suitable geotechnical strength reduction factor (ϕ_g) to obtain the design geotechnical strength ($R_{d,g}$). After assessing the overall design average risk rating in accordance with the guidelines presented in AS2159:2009, a ϕ_g value of 0.5 is suggested for the site.

The factored design bearing pressures (either limit state or working stress) can be used to size pad footings up to a maximum width of 2 m and strip footings up to up to a maximum width of 1 m.

It is essential that footing excavations be inspected by experienced geotechnical engineering personnel, during construction, to ensure the preliminary assumptions are valid.

9.5 Site Preparation at the Base of the Excavation

Following bulk excavation to BEL at RL 9 m, the exposed subgrade is expected to comprise very low to low strength sandstone.

Trafficability across the subgrade may become difficult for all but tracked equipment and vehicles after wet weather. A working platform design can only be definitively carried out once the size and loading of construction equipment is known; however, it is believed that at this stage a platform in the order of (say) 0.3 m thick of crushed gravel should be allowed for in basement design and costing. The rock subgrade should be air blasted to remove and loose material. If water softened areas are encountered they should be excavated and replaced with controlled fill as below.

Any new fill, if required to achieve design levels, should be undertaken under ‘Level 1’ supervision and testing as detailed in AS 3798:2007. Fill should be placed in layers not exceeding 0.2 m ‘loose’ thickness, with a maximum particle size of 75 mm, with each layer compacted to a minimum dry density ratio of 100% relative to Standard compaction within ±2% of optimum moisture content.

The above procedures will require geotechnical inspection and testing services to be employed during construction. DP is suitably qualified to conduct earthworks testing and supervision services, as well as engineering inspections of excavation faces and footing excavations, as may be required during construction of the development.

9.6 On-Ground Floor Slabs

Provided site preparation is carried out as recommended above, it is expected that the ground conditions underlying the on-ground slabs and access driveways will comprise very low to low strength sandstone. For design of on-ground basement floor slabs founding on weathered sandstone, a soaked California bearing ratio (CBR) value of 10% is recommended or a modulus of subgrade reaction (k) of 50 kPa/mm.

Where imported filling in excess of 0.5 m is placed under controlled conditions at the site, then a combined subgrade CBR value should be used for that material and the natural subgrade, subject to confirmation by laboratory testing.

For loaded areas of different proportion or different load intensity to standard wheel loads, DP should be contacted for further advice.

Suitable under-slab drainage will need to be provided beneath on-ground basement slabs where a ‘drained’ basement is adopted. The under-slab drainage should comprise a suitably sized and graded gravel layer graded to direct seepage to suitably sized sumps with pumps for removal.

9.7 Site Earthquake Sub-Soil Class

In accordance with AS 1170.4–2007, it is recommended that a site sub-soil classification of “Class B_e – Rock Site” be adopted, in accordance with the definitions presented in *Section 4.2 – Class Definitions*. This is based on a sub-soil profile of no more than 3 m of soil or extremely low strength rock.

9.8 Site Classification

Site classification of foundation soil reactivity strictly only applies to residential buildings up to two-storeys and to other buildings of similar size, loading and flexibility as defined in accordance with AS2870:2011. Such classification however, as well as the results of the laboratory testing, provide an indication of the propensity of the ground surface to move with seasonal variation in moisture content, and has been used (along with general climatic zoning and experience) to assess the potential depth of seasonal cracking and potential for softening under soaked conditions.

The basement excavation is deeper than the depth of suction and the following, which is for information purposes only, is only relevant to any footings or services founding within the upper approximately 2 m depth (from natural surface).

A shrink-well index of 1.3 % per ΔpF was approximated using the plasticity test results and local experience, and input into DP’s in-house program *REACTIVE*, which is used to calculate the characteristic surface movement (y_s) value in general accordance with AS 2870. It should be noted that AS 2870 provides recommended values of change in suction (Δu) and depth of suction (H_s) for major and regional centres throughout Australia. Based on published data by Fox (2000), relating climatic conditions to suction, a value of 1.2 pF was adopted for Δu and 1.8 m for H_s in the *REACTIVE* calculations. This is based on a ‘wet temperate’ climatic zone. A cracking depth of 0.9 m was used in the analysis, based on $0.5H_s$.

The results of the analysis indicate that the y_s movements of the insitu soil/highly weathered rock profile in response to seasonal moisture variation are in the order of 15 mm to 20 mm, consistent with a 'Class S' site classification (slightly reactive).

It is noted that no allowance for the removal of trees has been included in the above calculations and the design engineer should use the guidance provided in AS2870 in this regard.

Where "abnormal" soil moisture conditions occur the site would need to be classified as "Class P" (problem site) which require more extensive foundation works to avoid adverse foundation performance. Abnormal soil moisture conditions are defined in AS 2870 (Clause 1.3.3).

10. References

AS 2870:2011, *Residential Slabs and Footings*, Standards Australia.

AS 1170.4:2007, *Structural Design Actions, Part 4: Earthquake actions in Australia*, Standards Australia.

AS 3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

AS 2159:2009, *Piling – Design and installation*, Standards Australia.

AS 4678:2002, *Earth – Retaining Structures*, Standards Australia.

Fox E (2000), *A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites Under AS 2870:1996*, Australian Geomechanics, Vol 35, No 4.

11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Park Road, Yeronga in accordance with DP's proposal BNE201230 dated 23 November 2020 and acceptance received from Greg Coghlan dated 8 December 2020. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Brisbane Housing Company 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.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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.

Douglas Partners Pty Ltd

Appendix A

About this Report

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 Methods

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

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 Descriptions

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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

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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

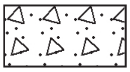
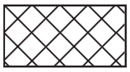
Other

fg	fragmented
bnd	band
qtz	quartz

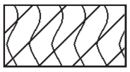
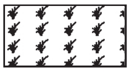
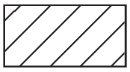
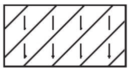
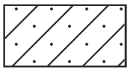
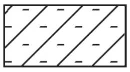
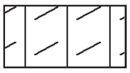
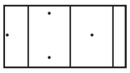
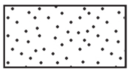
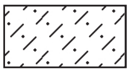
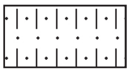
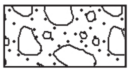
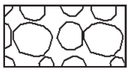
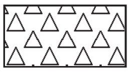
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

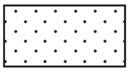
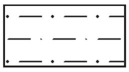
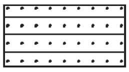
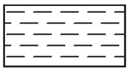
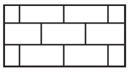
General

■	Asphalt
	Road base
	Concrete
	Filling

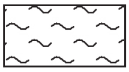
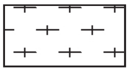
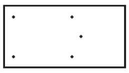
Soils

	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

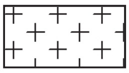
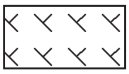
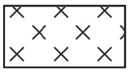
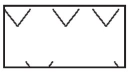
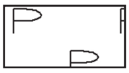
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
■	Coal
	Limestone

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

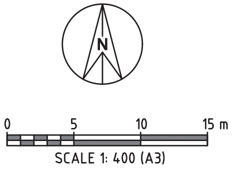
Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Appendix B

Drawing 1 – Site and Test Location Plan

Location Plan



LEGEND:-

⊕	Borehole Location and Number
⊕	Previous Borehole Locations
▪▪▪▪	Approximate Site Boundary

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Metromap. Date of imagery 13-08-2020.

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Brisbane Housing Company
OFFICE: Brisbane DRAWN BY: JST
SCALE: As shown DATE: 7 January 2021

TITLE: **Site and Test Location Plan**
Proposed Residential Development
Park Road, Yeronga

PROJECT No: 97679.00
DRAWING No: 1
REVISION: 0

P:\97679.00 - YERONGA - Proposed Residential Developme\7.0 Drawings\7.2 Out\97679.00.D.001.Rev0.dwg

Appendix C

Field Work Results

BOREHOLE LOG

CLIENT: Brisbane Housing Company
PROJECT: Proposed Residential Development
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 11.0 AHD
EASTING: 502035.91
NORTHING: 6956439.21
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 97679.00
DATE: 21/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
11		FILL Clayey SAND (SC): medium to coarse, brown, with fine to coarse angular to subrounded quartz gravel, moist, estimated dense							
	0.4	SANDSTONE: medium to coarse grained, brown, with fine to medium quartz gravel, very low to low strength, extremely to highly weathered		S	0.5 0.57		30/65mm		
10	1								1
9	2			S	2.0 2.05		30/50mm		2
		- dark brown, with fine to coarse angular dolomite gravel, low strength, highly weathered							
8	3								3
		- dark grey							
		- white-grey, with fine to medium quartz gravel		S	3.5 3.55		30/50mm		
7	4								4
6	5			S	5.0 5.05		30/45mm		5
	5.05	Bore discontinued at 5.05m depth - Refusal on sandstone							
5	6								6
4	7								7

RIG: Hydrapower Scout **DRILLER:** Ground Test **LOGGED:** YG **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture, PL = plastic limit. Surface levels interpolated from BCC City Plan 2014.

☐ 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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Brisbane Housing Company
PROJECT: Proposed Residential Development
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 13.0 AHD
EASTING: 502035.41
NORTHING: 6956405.64
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 97679.00
DATE: 21/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 0mm) 5 10 15 20
				Type	Depth	Sample	Results & Comments		
13		FILL Sandy GRAVEL (GW): fine to coarse, brown, trace sandstone, basalt and quartz cobbles, trace clay, moist, medium dense							
	0.5	SANDSTONE: brown some white, very low strength, highly weathered		S	0.5 0.59		30/90mm	▷	
12	1								1
		- pale grey and red-brown, weathered to hard clay							
11	2				2.0				2
		- brown		S			4, 13, 30/105mm		
					2.41				
10	3								3
				S	3.5 3.53		30/25mm		
9	4								4
	4.5	Silty CLAY (CL): low plasticity, brown, with fine to medium angular dolomite gravel, trace sand, w>PL, estimated hard							
8	5 5.0	SANDSTONE: medium to coarse grained, pale brown some brown, very low strength, highly weathered		S	5.0 5.14		30/135mm	▷	5
7	6 6.0	Silty CLAY (CL): low plasticity, brown, with fine to coarse angular dolomite gravel, w>PL, estimated hard							6
	6.4	SANDSTONE: fine to medium grained (conglomeratic), grey, very low to low strength, highly weathered		S	6.5		30/90mm		
	6.59	Bore discontinued at 6.59m depth - Refusal on sandstone			6.59				
6	7								7

RIG: Hydrapower Scout **DRILLER:** Ground Test **LOGGED:** YG **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.5m and 5.0m
REMARKS: w = moisture, PL = plastic limit. Surface levels interpolated from BCC City Plan 2014.

☐ 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: Brisbane Housing Company
PROJECT: Proposed Residential Development
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 12.5 AHD
EASTING: 502000.94
NORTHING: 6956404.21
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 97679.00
DATE: 21/12/2020
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 0mm)
	FILL Silty CLAY (CL): low plasticity, with fine to coarse sand, with fine to coarse basalt, dolomite and quartz gravel, moist, medium dense						
0.5	SANDSTONE: fine to coarse grained, pale brown some grey, low strength, extremely weathered	S	0.5 0.51		30/5mm (HB)		
	- white-grey						
	- brown, extremely to highly weathered						
	- pale brown some white, very low strength	S	2.0 2.12		30/120mm		
	- pale brown, low strength, highly weathered	S	3.5 3.53		30/30mm		
	- brown						
5.04	Bore discontinued at 5.04m depth - Refusal on sandstone	S	5.0 5.04		30/40mm		

RIG: Hydrapower Scout **DRILLER:** Ground Test **LOGGED:** YG **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: w = moisture, PL = plastic limit. Surface levels interpolated from BCC City Plan 2014.

☐ 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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Geotechnics / Environment / Groundwater

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SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH 10
Project Number: 1-19724
Project Name: Redevelopment of Yeronga TAFE
Location: Park Road, Yeronga
Client: Queensland Government
Date: 28/09/2017
Page: 1 OF 2

Easting: 502010 Northing: 6956450 RL:
Logger: BM Operator: BM Machine: Scout 1

Drilling Method TC	WB	RR	NMLC	Casing	Depth	Graphic	Description	Weathering	Strength Estimated RS VL L M H VH EH	Defect Spacing 20 60 200 600	TCR (%)	RQD	Samples and Remarks
					0.05		FILL Bitumen.						
					0.20		FILL Sandy GRAVEL (GP) Very dense, fine to medium sized, yellow brown, fine to coarse grained sand, dry.						
					28/09/17 0.40		NATURAL Clayey SAND (SC) Medium dense, fine to medium grained, yellow brown grey mottled, high plasticity fines, moist.						
					1.0 0.95		Sandy CLAY (CH) Hard, high plasticity, yellow brown grey mottled, fine to medium grained sand, moist.						SPT 23, 12, 30/120mm N=R
					2.0 3.0 4.0 5.0 5.20		SANDSTONE (XW-HW) Extremely to highly weathered, low strength, yellow brown grey mottled.						SPT 30/30mm N=R SPT 30/30mm N=R SPT 30/40mm N=R
					5.80		SANDSTONE (XW-HW) Extremely to highly weathered, low strength, light grey.						
					6.0 6.80		SANDSTONE (XW-HW) Extremely to highly weathered, low strength, light grey, fine to medium grained sand.						SPT 30/50mm N=R
					7.0 8.0 8.50		SANDSTONE (XW-HW) Extremely to highly weathered, low strength, light grey, fine to medium grained sand, with bands of mudstone.						SPT 30/30mm N=R
					8.90		SANDSTONE (XW-HW) Extremely to highly weathered, low strength, light grey, with bands of coal.						
					9.0 10.0		SANDSTONE (HW) Highly weathered, low strength to medium strong, light grey.						SPT 30/30mm N=R

Comments:
1. Groundwater not encountered during augering.
2. Borehole bailed upon completion.
3. Steady water depth recorded at 0.60m, 6 hour post bailing.

Water First Noted Water Steady Level

Defects - 1.54m : F,60°,P,R,O,C

Depth (m)	Type	Dip (deg)	Planarity	Roughness	Aperture	Infill
	B - Bedding		C - Curvilinear	L - Slickensides	C - Closed	C - Clay
	C - Clay seam		D - Discontinuous	P - Polished	F - Filled	F - Iron Oxide
	F - Foliation		P - Planar	R - Rough	N - Clean	K - Calcite
	H - Schistosity		S - Subplanar	S - Smooth	O - Open	L - Limonite
	J - Joint		T - Stepped	V - Very rough	S - Stain	Q - Quartz
	L - Cleavage		U - Undulating			S - Secondary mineral
	R - Fracture					U - Unidentified mineral
	S - Shear zone					W - Weathered rock
	T - Contact					X - Carbonaceous
	V - Vein					Z - Clean
	Z - Decomposed Zone					

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50 ▮
SPT]
Disturbed Sample [
Bulk Sample [

Approved: MG
Date: 2/11/2017

Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
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Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Aimee Cartwright
Laboratory Technician

NATA Accredited Laboratory Number: 828

Report Number:	**97679.00-1**
Issue Number:	1
Date Issued:	15/01/2021
Client:	Brisbane Housing Company Level 1, Spring Hill QLD 4000
Contact:	Greg Coghlan
Project Number:	97679.00
Project Name:	Proposed Residential Development
Project Location:	Park Road, Yeronga
Work Request:	9845
Sample Number:	BN-9845A
Date Sampled:	21/12/2020
Dates Tested:	06/01/2021 - 12/01/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department *The results apply to the sample as received*
Sample Location:	**Bore 2 (2.00 - 2.40 m)**
Material:	Sandstone

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	15		
Plasticity Index (%)	**19**		
Weighted Plasticity Index (%)	1740		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	8.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	13.1

Material Test Report

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Approved Signatory: Aimee Cartwright
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Report Number:	**97679.00-1**
Issue Number:	1
Date Issued:	15/01/2021
Client:	Brisbane Housing Company Level 1, Spring Hill QLD 4000
Contact:	Greg Coghlan
Project Number:	97679.00
Project Name:	Proposed Residential Development
Project Location:	Park Road, Yeronga
Work Request:	9845
Sample Number:	BN-9845B
Date Sampled:	21/12/2020
Dates Tested:	06/01/2021 - 14/01/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department *The results apply to the sample as received*
Sample Location:	**Bore 1 (0.50 - 0.57 m)**
Material:	Sandstone

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		