Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666

Austar Investments Pty Ltd
2/8 Chadwick Street
Putney NSW 2112

Project 99606.00
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R.001.Rev0
HDS:pc

Attention: Phil Newman

Email: philnewman2u@gmail.com

Preliminary Geotechnical Investigation
Proposed Residential Development
87-89 Iris Street, Beacon Hill

1. Introduction

This letter report presents the results of a preliminary geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed residential development at 87-89 Iris Street, Beacon Hill. The work was commissioned by Mr Phil Newman of Austar Investments Pty Ltd on 31 January 2020 to accompany a Development Application (DA) to Northern Beaches Council (Council), and was undertaken in accordance with DP's proposal SYD200078 dated 28 January 2020.

With reference to the provided preliminary Architectural drawings prepared by Playoust Churcher Architects Pty Ltd (A102 to A104 and A200, dated 3 February 2020), it is understood that the proposed development for the sloping site will include:

- Demolition of existing site structures;
- Excavation to a depth of up to about 6 m within the footprint of three proposed residential buildings on the northern part of the site, including for an 'L'-shaped single-level basement (design finished level of RL135.7 m);
- Construction of a retaining wall at the southern limit of the basement excavation;
- Raising of site levels within the proposed footprint of the southern three buildings; and
- Construction of seven new residential unit buildings across the site, of between one and two storeys in height.

The investigation included a site inspection by a geotechnical engineer (including of rock outcrops), drilling of six boreholes, and completion of eight dynamic penetrometer testing using hand tools. Details of the field work are given in the report, together with preliminary comments on geotechnical issues considered to be relevant to the project. Additional geotechnical investigation is likely to be required during the detailed design phase of the project.

This report should be read in conjunction with the attached Standard Notes, 'About This Report'.

2. Site Description

The approximately rectangular site (known as Lot A and Lot B in DP 415552: 87 Iris Street and 89 Iris Street, west to east respectively) is located on the southern side of Iris Street, Beacon Hill, and includes areas of relatively level ground separated by either 'stepped' areas of sandstone rock outcrop or low height concrete block or sandstone block retaining structures. Two-storey residential dwellings are present on each Lot, with some children's play and sporting equipment on the near-level areas of both Lots. The surrounding properties are also occupied by residential dwellings. Photographs of the site are presented on Plates 1 to 7, attached.

Based on aerial photographs, the site has approximate plan dimensions of 34 m (parallel to Iris Street) by 65 m and occupies an area of approximately 2,200 m^2. Site levels (relative to the Australian Height Datum) are indicated to range between RL144.4 m and RL135.5 m (ie adjacent to the southern property boundary, and Iris Street, respectively), with an overall slope angle of about 8 degrees. Outcrops of weathered sandstone are present on the eastern part of the site (ie 89 Iris Street: refer Plates 6 and 7).

Three retaining structures are present at the site, including two structures on the western part of the site (ie 87 Iris Street) constructed using a single skin of mortared sandstone blocks, whereas a concrete block wall is present at the internal property boundary between 87 and 89 Iris Street (refer Plates 3 to 5). These retaining structures are shown on Drawing 1 as "RW1", "RW2", and "RW3", respectively. The measured height of retaining structure RW1 is between 0.3 m to 1.5 m, whereas the measured height of retaining structure RW2 is 0.6 m, inclusive of two single courses of sandstone blocks, offset horizontally from each other by about 0.3 m. The retained height of retaining structure RW3 (which is about 20 m long) is up to about 1 m, tapering to a retained height of about 0.2 m near the Iris Street frontage.

The near-level areas of the site appear to have been raised / filled with clayey sand or sandy clay filling, with the southern part of the overall site appearing to be at similar levels to the neighbouring properties on either side.

At the time of the field work, no groundwater seepage was observed at the toe of the retaining structures or within the area of rock outcrop, however, evidence of seepage was observed over the top of rock on the neighbouring property to the east (refer Plate 7).

3. Geology

Reference to the Sydney 1:100 000 Geological Sheet indicates that the site is underlain by Hawkesbury Sandstone, of Triassic age. Hawkesbury Sandstone typically comprises horizontally bedded and vertically jointed, massive and cross-bedded, medium to coarse grained quartz sandstone with occasional shale or siltstone interbeds.

4. Field Work Methods

The field work was carried out on 18 February 2020 and included the following:

- Six boreholes (BH1 to BH6), drilled using a 100 mm diameter hand auger, to depths of between 0.3 m and 1.1 m;
- Eight dynamic penetrometer tests (DPTs), including one test at each borehole, taken to depths of between 0.32 m and 1.2 m below the ground surface; and
- Inspection and geological mapping by a geotechnical engineer.

It is noted that penetrometer testing at Borehole BH3 was terminated in fill at 0.93 m depth, due to encountering a redundant stormwater drainage structure, and that DPT7 was terminated in fill at 1.2 m depth.

The test locations, measured relative to site features, are shown on Drawing 1. Position co-ordinates and surface levels were obtained using a differential hand-held GPS and are considered to be accurate to within 0.1 m.

5. Field Work Results

5.1 Geological Mapping

Outcrops of medium to high strength sandstone were observed at the surface on the eastern part of the site and on the neighbouring site to the east, as shown on Drawing 1 and on Plates 6 and 7. The outcrops were up to about 1.5 m high and with overhangs up to 1 m deep in places. Some inferred sandstone boulders were observed on the north-western part of the site, near test location DPT7 (refer Photograph 9).

5.2 Boreholes and Dynamic Penetrometer Tests

The typical profile encountered within the boreholes comprised:

TOPSOIL AND FILL:	a layer of loose sandy or clayey topsoil fill (typically 0.02 m thick), over layers of clayey sand, sand or sandy clay filling, moist to wet, to depths of between 0.3 - 1.1 m. Borehole BH3 refused on an obstruction in the filling at a depth of 0.9 m;
SANDSTONE:	inferred very low to low strength sandstone. With the exception of tests BH3 and DPT7, all boreholes and penetrometer tests were terminated on equipment refusal at depths in the range 0.32 m to 1.1 m, inferred to be the top of the rock.

It is noted that DCP refusal can occur upon encountering rock, or on very dense sand, tree roots or other obstructions. Further investigation using a drilling rig will be required to confirm the depth and strength of rock on the site, if required for the detailed design.

Free groundwater was not observed during the site work, however, the soil in most boreholes was observed to be wet within about 0.15 m above the top of the rock.

The site layout and test locations, together with the outline of the proposed excavation and building footprints, are shown on Drawing 1. The borehole logs and DPT results sheets are also attached.

6. Proposed Development

Based on the supplied architectural drawings prepared by Playoust Churcher Architects Pty Ltd (Project No. 19-771, Drawings A102 to A014 and A200, dated 3 February 2020), it is understood that the proposed development includes:

- Demolition of both existing brick residences, existing retaining walls, concrete driveways and a car port;
- Excavation to a depth of up to about 6 m within the footprint of three new residential buildings / five units on the northern part of the site (ie Units 3 to 7), including for an 'L'-shaped single-level of basement car parking (design finished level of RL135.7 m);
- Construction of a retaining wall at the southern limit of the basement excavation;
- Raising of site levels within the proposed footprint of the southern three buildings by up to about 1.5 m; and
- Construction of seven new residential unit buildings across the site, each of between one and two storeys in height.

Excavation for the basement car park has a horizontal setback of 3 m from the eastern and western property boundaries, with the exception of localised excavations for access stairs, and it is noted that the proposed excavation is likely to be in close proximity to the existing alignment of buried services (such as on the western side of the site). Dependent upon the alignment of these services relative to the proposed excavation, the depth of foundations for buildings and shoring may need to be modified to meet any imposed Sydney Water requirements.

7. Geotechnical Model

The geotechnical model for the site is a 'stepped' site with an overall slope to the north, with sandy and clayey fill materials overlying medium to high strength sandstone with overhanging rock ledges, which are exposed in the central part of the site. The thickness of soil across the site (prior to excavation) within the proposed building footprint varies between 0 m (exposed rock) to 1.1 m.

8. Comments

8.1 Site Preparation

Prior to the commencement of construction activities, it is recommended that dilapidation surveys be undertaken on neighbouring properties to document any existing defects so that any claims for damage due to construction activities can be properly assessed.

It is expected that site preparations will include the removal of the existing buildings, concrete slabs/driveways, some trees, and demolition of both existing brick and sandstone block retaining structures.

Although rock is likely to be exposed at design finished levels over most of the development footprint, a portion of the upper, south-eastern part of the site will require the placement of additional materials to raise surface levels to RL142.2 m for the ‘First’ level. The provided drawings indicate that these additional materials are to be placed and compacted adjacent to the southern limit of the basement excavation, for which a retaining wall will be required. Dependent upon the design, piling machinery may be required to install the foundations for this wall, for which a working platform will be needed.

As the fill materials are indicated to be generally in a loose condition, to minimise total and differential settlements beneath the buildings it is suggested that all existing fill materials be removed from the building footprint, and the underlying materials inspected by a geotechnical engineer prior to placement and compaction of layers of additional fill. A Specification for the placement of fill materials for general earthworks, and for the support of ground slabs, should be developed for the project which should include a minimum density ratio of 98% (relative to Standard compaction) for the support of structures or major roadways.

8.2 Groundwater

Groundwater was observed as seepage across the top of rock on a neighbouring site to the east (at a slightly lower elevation), with a zone of wet soil observed near to the top of rock at most borehole locations within the fill. Given that the site is located on a hill, the observed seepage over the top of rock is likely to be perched water, and it is expected that the permanent groundwater table will be located below the proposed limit of bulk excavations. Groundwater levels have been known to fluctuate by over 1 m, dependent upon the prevailing weather conditions and downslope drainage conditions.

Appropriate drainage should be provided on the upslope side of the proposed building, to ensure that any surface or sub-surface seepage is controlled.

8.3 Excavation Conditions

Excavation is expected to be required through about 0.5 m - 1 m of sandy and clayey fill materials, over medium to high strength sandstone. Based on the architectural drawings provided, the depth of excavation for the proposed basement to a design finished level of RL135.7 m ranges between about 1 m on its eastern side, about 4.6 m in the south-western corner, and about 6 m in the south-eastern corner. The strength of the sandstone at the design finished levels across the site was not confirmed during the investigation.

Excavation of the fill soils should be readily achieved using conventional earthmoving equipment such as tracked excavators, however, excavation into medium strength and stronger sandstone will require the use of rock hammers or rock saws. Excavation contractors should make their own assessment based on their equipment capabilities and operator skills. It is noted that site access to the rear of the site for machinery is currently limited, with challenges including a stepped slope (steps up to about 1.5 m high), sections of rock overhangs, and narrow existing access routes.

Excavation near to the eastern, southern and western property boundaries should be carried out with due consideration of the proximity to the existing neighbouring residences, improvements (eg swimming pools) and boundary fences.

8.4 Batter Slopes and Excavation Support

The preliminary architectural drawings provided show that the eastern and western limits of the proposed excavations are set back about 3 m from the property boundaries. The strength of the rock within the excavation footprint will need to be confirmed, so that an assessment of appropriate batter angles (and shoring requirements) can be made.

Where space permits, it is usually most practical to batter the slopes of excavations, as vertical excavations in filling, soil and weathered sandstone will not remain stable for an extended period. For temporary slope batters not exceeding a depth of 1.5 m, it is recommended that slopes in soil and extremely low to very low strength sandstone are not excavated steeper than 1.5H:1V, subject to geotechnical inspection during construction. If this batter slope is adopted, excavations within close proximity to existing property boundaries may be required.

Excavations in medium strength sandstone are likely to remain stable when cut vertically, subject to inspection and approval by a geotechnical engineer at every 1.5 m 'drop' of excavation level, to check whether additional stabilisation measures are required (such as to mitigate against adversely-oriented joints, or other issues which may reduce the excavation stability). If adverse conditions are observed, then further remedial work and follow-up inspections may be required to ensure that site stability is maintained.

Where insufficient space is available to permit the construction of temporary batters, it will be necessary to install shoring to ensure site stability is maintained, in which case further geotechnical advice should be sought.

8.5 Vibration Control

Vibration can be generated during construction, particularly during excavations within and ripping of weathered rock using rock hammers or impact breakers, as well as when using vibratory compaction equipment. During completion of excavation at the site, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors, including the type of building structure (eg reinforced concrete, brick, etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

Assuming that the nearby buildings are founded on medium or high strength sandstone, it is suggested that vibrations be provisionally limited to a peak particle velocity (PPV) of 8 mm/sec at the ground level of the neighbouring buildings to protect architectural features.
This provisional limit complies with ASO/ISO 2361.2 (2014) and is below the normal building damage threshold level. It is suggested that the client assess whether the proposed vibration limit will have a serviceability impact on nearby sensitive structures (if present), or for human comfort. This provisional limit may need to be modified depending on the results of such assessments.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of any excavation within rock. The trial may indicate that smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

8.6 Foundations

8.6.1 Footings

Shallow footings for buildings and retaining walls, founded on the underlying sandstone, could be designed on the basis of an allowable bearing pressure of 1000 kPa, assuming each of the footings are bearing uniformly on insitu low to medium strength (or better) sandstone and not boulders or ‘floaters’. Settlements of footings founded on rock are considered to be negligible. For areas of the site which are to be raised using compacted fill, it is suggested that the footings be taken down to the rock to minimise the potential for differential settlement. Further geotechnical advice should be sought to refine the footing design when further details are known.

Footings for buildings on the southern part of the site will need to take into consideration the possible presence of shallow sandstone overhangs / caves within the development footprint. Due to the risk of excessive settlement due to failure of the rock ledge material for footings founded on a sandstone overhang, the affected footings will need to be either taken deeper to the underlying competent sandstone (ie excavated through any cave/overhang), relocated laterally / horizontally onto a nearby of sandstone, or the overhang be underpinned to ‘span across’ the void. This should be further assessed during the detailed design phase of the project, and geotechnical advice during construction will be required if footings are to be located in areas of overhangs.

Due to groundwater seepage, it will be necessary to provide under-floor drainage for structures founded on rock, to safeguard against uplift pressures if the basement floor and walls are designed for drained conditions. This could comprise a minimum 100 mm thick, durable, open-graded crushed rock with subsurface drains and sumps.

8.6.2 Retaining Walls

Further investigation will be required to confirm design parameters for retaining walls, however, preliminary evaluation for estimating purposes could be based on a rectangular lateral earth pressure, a bulk density of 18 kN/m^3, an effective modulus of 5 MPa, a Poisson's Ration of 0.35, and the preliminary material parameters presented in Table 1.

Additional pressures should be allowed for where surcharging occurs, either from traffic loading, loadings associated with the use of the adjoining property, or arising from construction plant. Hydrostatic pressure acting on the retaining wall should also be included in the design, where drainage is not provided behind the full height of the wall.

Table 1: Typical Material and Strength Parameters for Excavation Support Structures – Earth Pressures

Material	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Effective Friction Angle (ϕ')	Ultimate Passive Earth Pressure (kPa)
Fill	0.4	0.6	20	0
Sandstone – extremely low to very low strength	0.1	0.2	30	400
Sandstone – low strength	0	0.1	30	2000

8.7 Disposal of Excavated Material

Consideration should be given to the segregation of site materials which are suspected to be contaminated.

All excavated materials will need to be disposed of in accordance with current NSW Environment Protection Authority (EPA) regulations. Under the NSW EPA Waste Classification Guidelines (2014) a waste/fill receiving site must be satisfied that materials received meet the environmental criteria for the proposed land use. This includes filling and virgin excavated natural materials (VENM), such as may be removed from this site. Accordingly, environmental testing will need to be carried out to classify spoil prior to disposal. The type and extent of testing undertaken will depend on the final use or destination of the spoil, and requirements of the receiving site.

The scope of this investigation did not include sampling and testing for Waste Classification or Contamination Assessment purposes.

9. Geotechnical Monitoring During Construction

As a minimum, geotechnical advice should be sought at the following construction stages:

- Prior to commencement of construction – review of the structural drawings;
- At commencement of excavation – inspections to confirm site stability is maintained, and to confirm that design assumptions are appropriate; and
- Following preparation of the foundation excavations – to confirm the founding materials are suitable for the design bearing pressures.

10. Additional Investigation

It is recommended that supplementary geotechnical investigation be completed at a later stage of the project, to confirm the geotechnical model. The supplementary investigations could include:

- Additional test pits or boreholes to confirm the thickness of filling and the depth to rock across the site;
- Cored boreholes to obtain detailed information on the underlying rock, which may enable higher bearing pressures to be adopted (possibly leading to a reduction in some construction costs).

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 87-89 Iris Street, Beacon Hill, in accordance with DP's proposal SYD 200078 dated 28 January 2020 and acceptance received from Mr Phil Newman dated 31 January 2020. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Mr Newman for this project only and for the purposes as described in the report. It should not be used by or be 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 pages 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 investigation/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.

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.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Huw Smith
Associate

Reviewed by

Michael J Thom
Principal

Attachments:
About this Report
Site photographs – Plates 1 to 7
Site and Test Location Plan – Drawing 1
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs
Dynamic Penetrometer Test Results

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

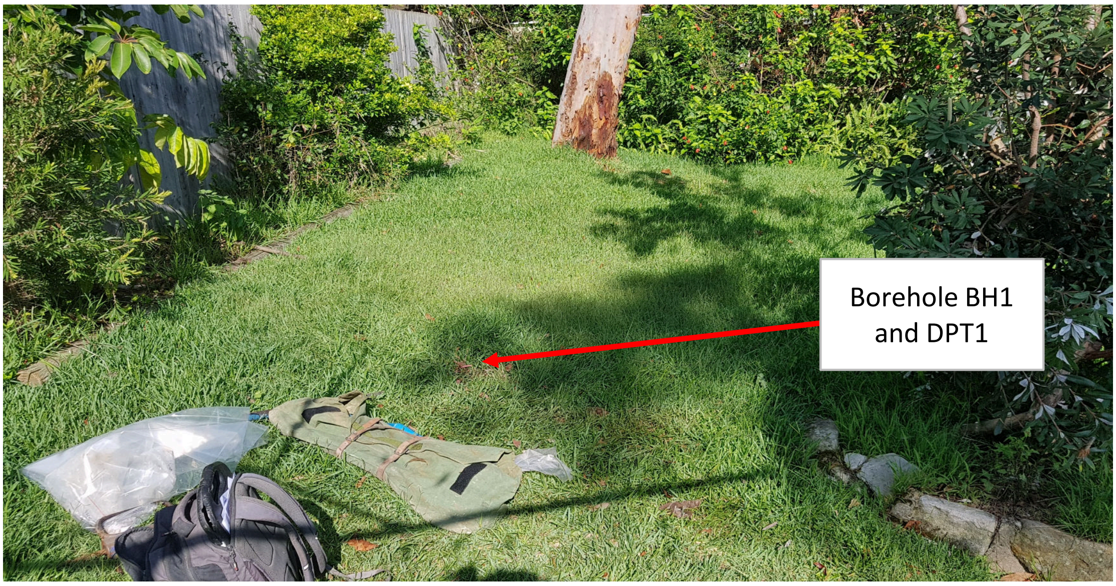
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

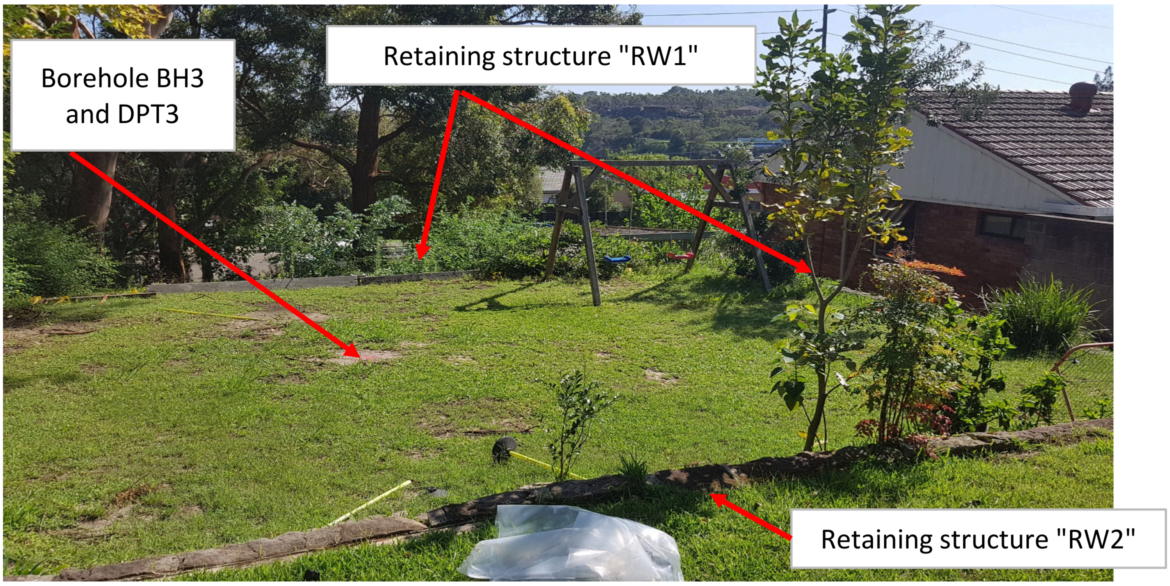
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



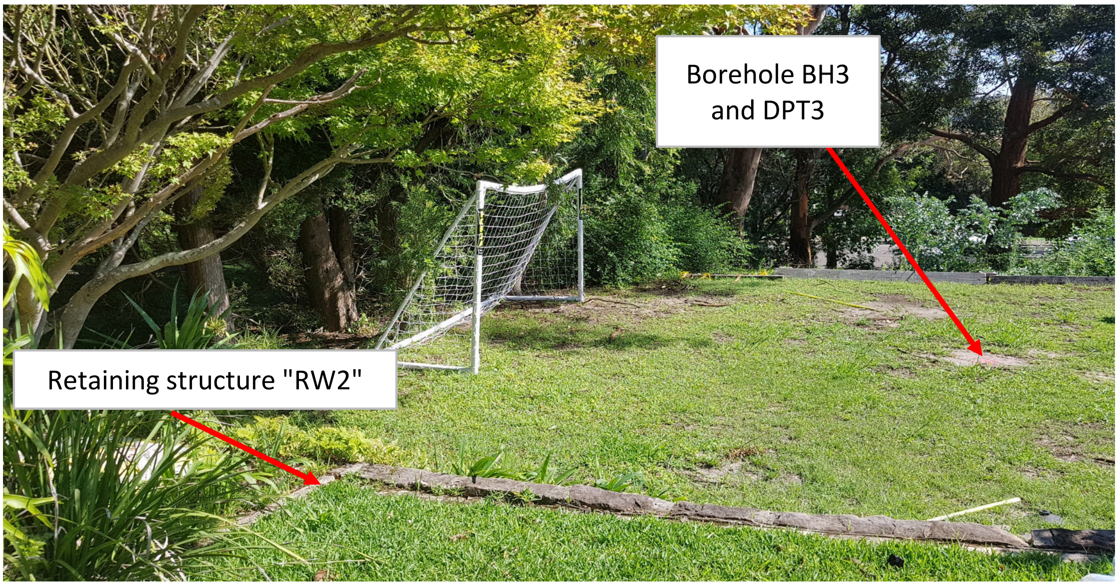
Photograph 1 - View south-west at the rear of 87 Iris Street, towards the southern property boundary. The location of Borehole BH1 (and dynamic penetrometer test) is indicated as shown.

Photograph 2 - View north from the rear of 87 Iris Street, along its eastern property boundary.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	99606.00
	87-89 Iris Street	PLATE No:	1
	Beacon Hill	REV:	A
	CLIENT: Austar Investments Pty Ltd	DATE:	18-Feb-20



Photograph 3 - View north from the front yard of 87 Iris Street, towards Iris Street. The location of Borehole BH3 (and dynamic penetrometer test), and retaining walls "RW1" and "RW2" are indicated as shown.



Photograph 4 - View north-west from the front yard of 87 Iris Street, towards the western property boundary. The location of Borehole BH3 (and dynamic penetrometer test) and retaining structure "RW2" are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT: 99606.00
	87-89 Iris Street	PLATE No: 2
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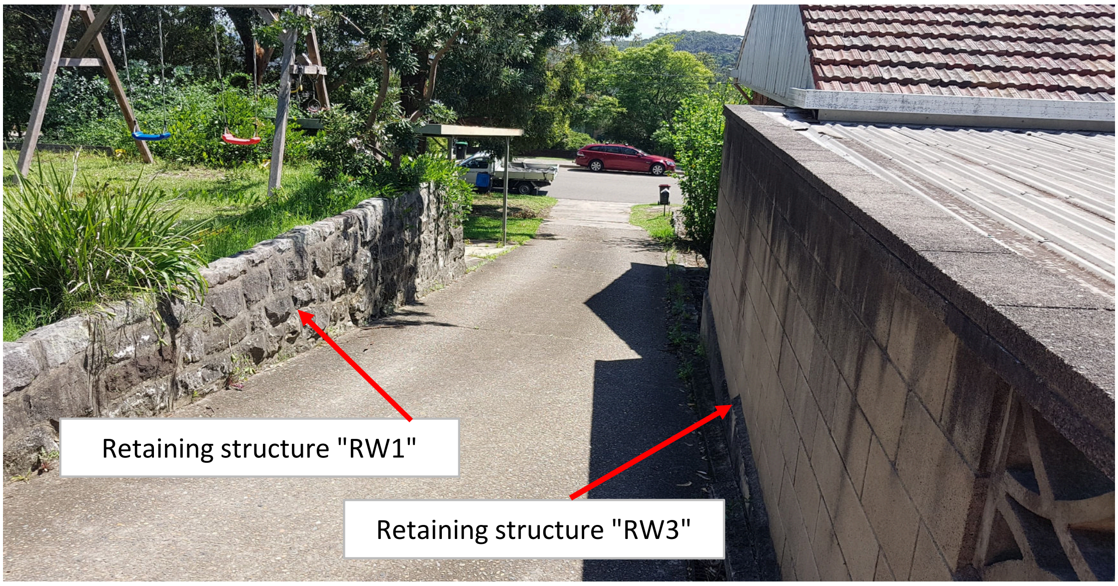
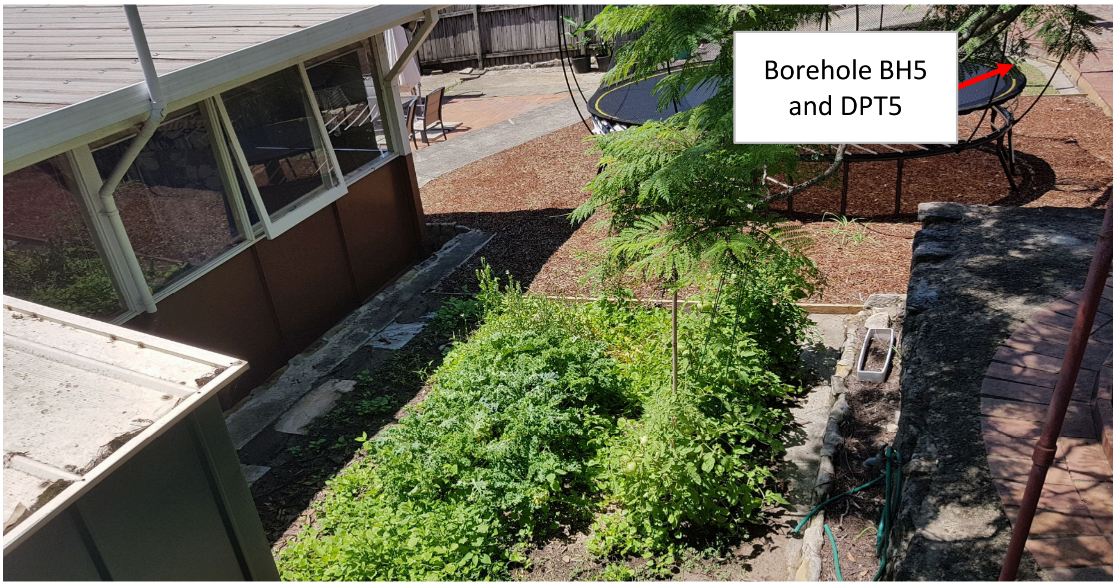
Photograph 5 - View south from the front yard of 87 Iris Street, towards the existing residence. The location of Borehole BH2 (and dynamic penetrometer test), and retaining structure "RW2" are indicated as shown.



Photograph 6 - View north down the driveway of 87 Iris Street towards Iris Street. The location of retaining structures "RW1" and "RW3" are indicated as shown.

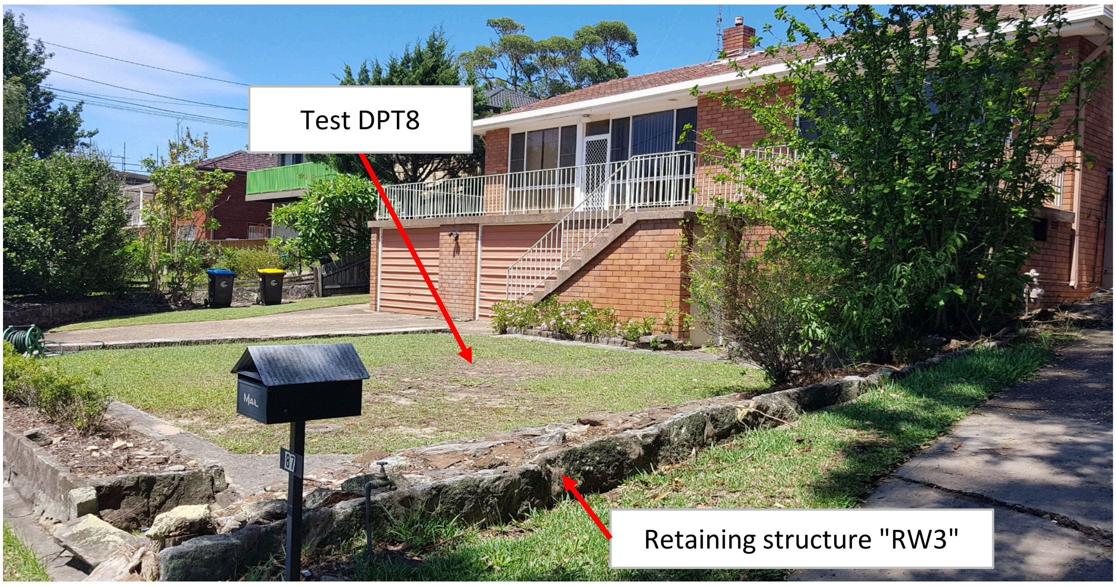


Photograph 7 - View east over retaining structure "RW3" into the rear yard of 89 Iris Street. The location of Borehole BH5 (and dynamic penetrometer test) is indicated as shown.

Photograph 8 - View south along the driveway of 87 Iris Street towards a carport and the existing residence. The location of retaining structure "RW1" is indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **87-89 Iris Street** **Beacon Hill**	PROJECT: 99606.00 PLATE No: 4 REV: A
	CLIENT: Austar Investments Pty Ltd	DATE: 18-Feb-20

Photograph 9 - View south-west across 87 Iris Street towards a carport and the western property boundary. The location of dynamic penetrometer test DPT7 is indicated as shown.



Photograph 10 - View south-east across the front of 89 Iris Street, from the street frontage towards the existing residence. The location of dynamic penetrometer test DPT8 and retaining structure "RW3" are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT: 99606.00
	87-89 Iris Street	PLATE No: 5
	Beacon Hill	REV: A
	CLIENT: Austar Investments Pty Ltd	DATE: 18-Feb-20

Photograph 11 - View south along the eastern property boundary of 89 Iris Street. The location of Borehole BH6 (and dynamic penetrometer test) is indicated as shown.

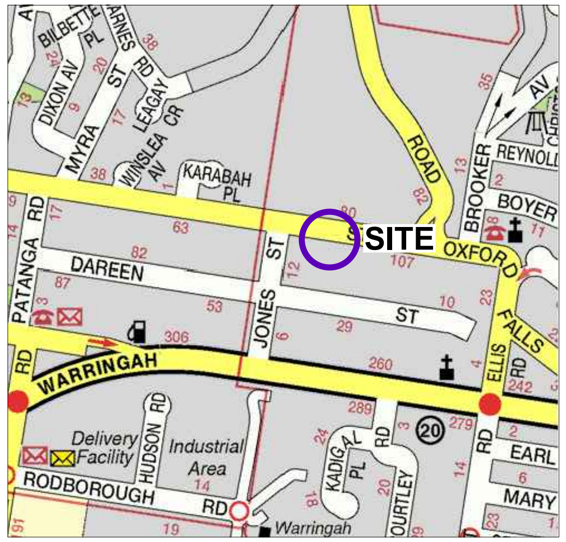
Photograph 12 - View south-west within the 'stepped' back yard of 89 Iris Street. The location of rock outcrop and Borehole BH5 (and dynamic penetrometer test) are indicated as shown.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT: 99606.00
	87-89 Iris Street	PLATE No: 6
	Beacon Hill	REV: A
	CLIENT: Austar Investments Pty Ltd	DATE: 18-Feb-20

Photograph 13 - View south-east within the 'stepped' back yard of 89 Iris Street towards the eastern property boundary. Rock outcrop (with an overhang) is present in the foreground.

Photograph 14 - View east across the eastern property boundary into the backyard of the neighbouring property (81 Iris Street), showing the rock outcrop extending further east.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	99606.00
	87-89 Iris Street	PLATE No:	7
	Beacon Hill	REV:	A
	CLIENT: Austar Investments Pty Ltd	DATE:	18-Feb-20



Locality Plan

LEGEND

- Borehole Location and Dynamic Penetrometer Test Location
- Dynamic Penetrometer Test Location
- Photograph Number with Direction of View
- Outline of existing retaining structure (approximate)
- Outline of sandstone outcrop (approximate)

NOTE:
1: Base image from Nearmap.com (Dated 21 January 2020)
2: Outline of proposed basement and building footprints are based on drawings IrisBH-A102, IrisBH-A103 and IrisBH-A104 (Dated 17 February 2020)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Austar Investments Pty Ltd		TITLE: **Site and Test Location Plan**	PROJECT No: 99606.00
OFFICE: Sydney	DRAWN BY: BZ	**Proposed Residential Development**	DRAWING No: 1
SCALE: 1:500 @ A3	DATE: 19.2.2020	**87-89 Iris Street, Beacon Hill**	REVISION: 0

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 generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.

  Soil tends to stick together.

  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.

  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Rock Descriptions

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Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it 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 Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* 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
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

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 occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

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

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

where 'sound' rock is assessed to be rock of low strength or stronger. 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

BOREHOLE LOG

CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 144.4
EASTING: 337836.2
NORTHING: 6264154.7
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 99606.00
DATE: 18/2/2020
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)
	0.02	FILL/TOPSOIL: Clayey SAND, fine to medium, dark brown, low plasticity fines, generally in a loose condition							
		FILL/Clayey SAND: fine to medium, brown, with sandstone gravel (5-30mm), sub-angular to sub-rounded, dry to moist, generally in a loose condition		A	0.1–0.2				
		Below 0.3m: grading to yellow-brown							
144	0.4	FILL/Sandy CLAY: low to medium plasticity, yellow-brown, fine to medium, with sandstone gravel (5-30mm), sub-angular to sub-rounded, moist, generally in a loose condition		A	0.4–0.5				
		Below 0.6m: grading to moist to wet							
	0.7	Bore discontinued at 0.7m Hand auger refusal on sandstone							
	1								
143									

RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
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

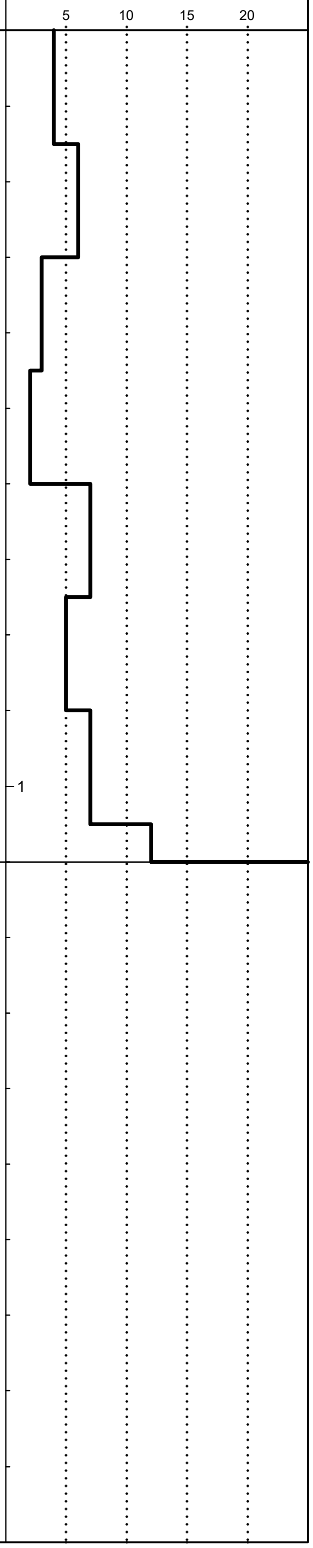
CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 140.2
EASTING: 337837.5
NORTHING: 6264187.2
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 99606.00
DATE: 18/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILL/Clayey SAND: fine to medium, dark grey-brown, low plasticity fines, with sandstone gravel (5-30mm), sub-angular to sub-rounded, moist, generally in a medium dense condition		A	0.1 0.2			
140								
				A	0.5 0.6			
	0.7	FILL/Sandy CLAY: low to medium plasticity, yellow-brown and pale yellow, fine to medium, with sandstone gravel (5-40mm), sub-angular to sub-rounded (ripped sandstone), moist to wet, generally in a stiff to very stiff condition						
	1	Below 1.0m, grading to wet		A	1.0 1.1			
	1.1	Bore discontinued at 1.1m Hand auger refusal on sandstone						
139								

Dynamic Penetrometer Test
(blows per 150mm)



RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
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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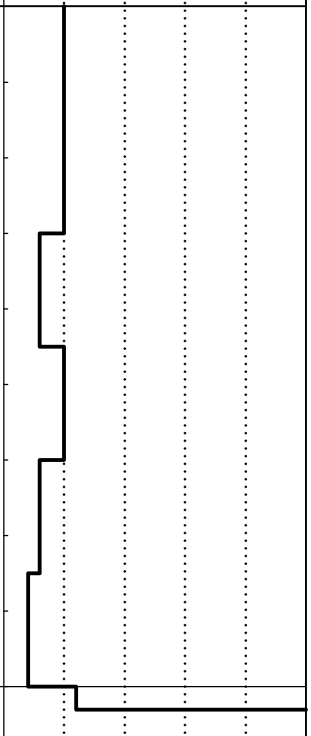
BOREHOLE LOG

CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 139.4
EASTING: 337839.3
NORTHING: 6264194.3
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 99606.00
DATE: 18/2/2020
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)
139		FILL/Clayey SAND: fine to medium, dark grey-brown, low plasticity fines, with sandstone gravel (5-30mm), sub-angular to sub-rounded, moist, generally in a medium dense condition							
	0.75	FILL/Sandy CLAY: low to medium plasticity, yellow-brown and pale yellow, fine to medium, with sandstone gravel (5-40mm), sub-angular to sub-rounded (ripped sandstone), moist to wet, generally in a firm to stiff condition							
	0.9	Bore discontinued at 0.9m Hand auger refusal, possibly on redundant stormwater drainage structure							
	1								
138									



RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
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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Geotechnics / Environment / Groundwater

BOREHOLE LOG

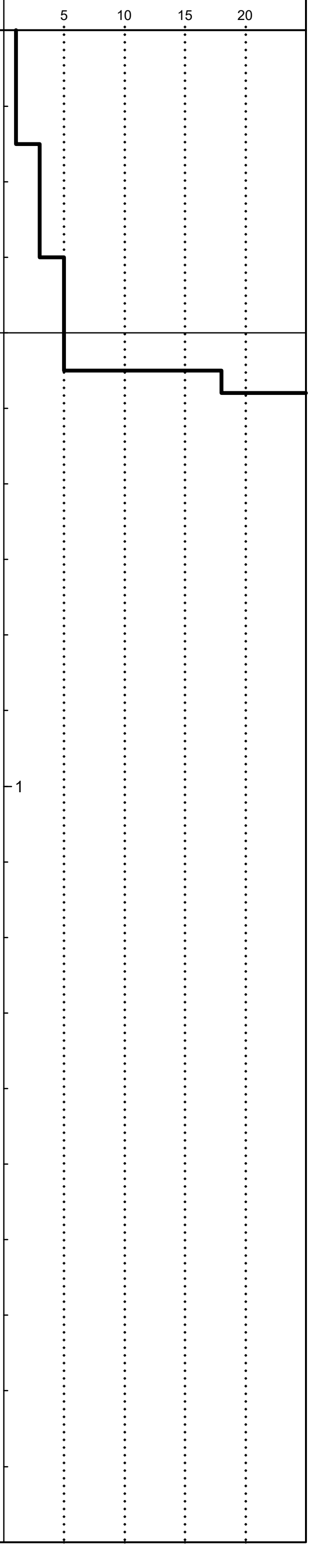
CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 141.9
EASTING: 337856.7
NORTHING: 6264161.5
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 99606.00
DATE: 18/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.02	FILL/TOPSOIL: Silty SAND, fine, dark grey, moist			0.02			
		FILL/Clayey SAND: fine to medium, dark grey-brown, with sandstone gravel (5-20mm), sub-angular to sub-rounded (ripped sandstone), moist, generally in a loose condition		A	0.1			
	0.3	FILL/SAND: fine to coarse, pale grey, with brick fragments (10-20mm), moist to wet, generally in a medium dense condition						
	0.4	Bore discontinued at 0.4m Hand auger refusal on sandstone						
141								
	1							
140								

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
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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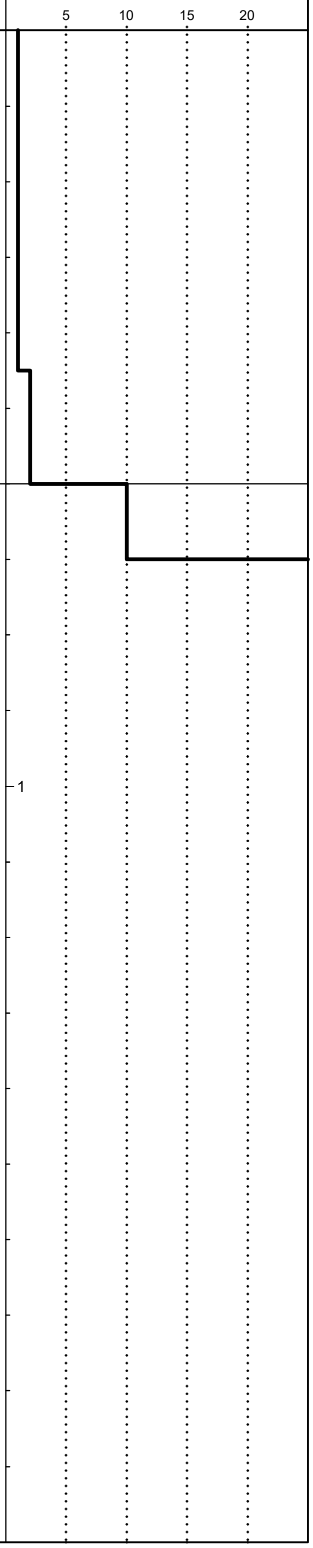
BOREHOLE LOG

CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 138.3
EASTING: 337857.1
NORTHING: 6264182.3
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 99606.00
DATE: 18/2/2020
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)
		FILL/Clayey SAND: fine to medium, dark grey-brown, low plasticity fines, moist to wet, generally in a loose to very loose condition							
138	0.2	FILL/SAND: fine to medium, pale grey, with clay, moist becoming wet, generally in a loose condition							
	0.6	Bore discontinued at 0.6m Hand auger refusal on sandstone							
	1								
137									



RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: Bark (20mm thick layer) over geofabric at the surface

☒ 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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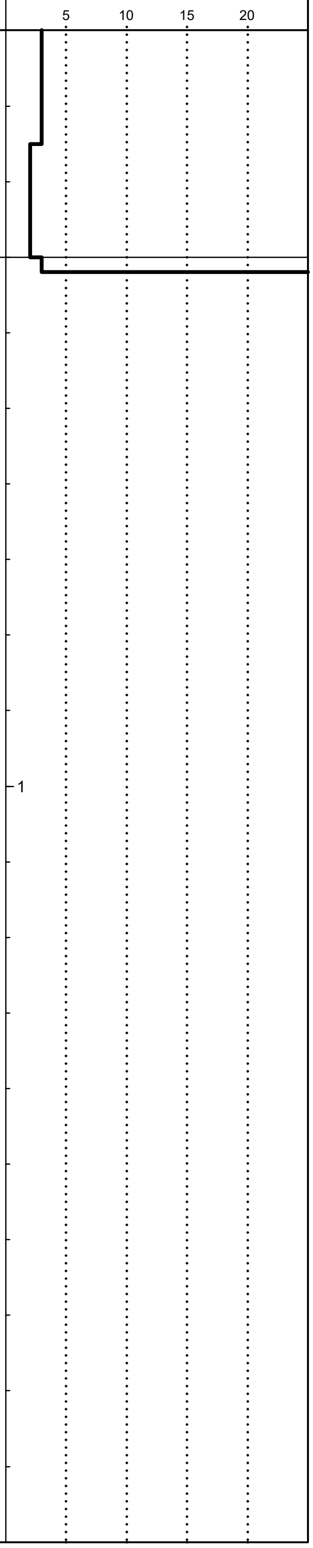
BOREHOLE LOG

CLIENT: Austar Investments Pty Ltd
PROJECT: Residential Development
LOCATION: 87-89 Iris Street, Beacon Hill

SURFACE LEVEL: 136.4
EASTING: 337866.2
NORTHING: 6264198.7
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 99606.00
DATE: 18/2/2020
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)
	0.02	FILL/TOPSOIL: Sandy CLAY, medium plasticity, dark grey, fine sand, geogrid at lower interface							
		FILL/Clayey SAND: fine to medium, brown, low plasticity fines, with sandstone gravel (5-30mm), sub-angular to sub-rounded (crushed sandstone), dry to moist, generally in a loose to medium dense condition							
	0.3	Bore discontinued at 0.3m Hand auger refusal on sandstone							
136									
	1								1
135									



RIG: Hand Tools **DRILLER:** LS **LOGGED:** LS **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free groundwater observed
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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Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client Austar Investments Pty Ltd | Project No. 99606.00
Project Residential Development | Date 18/02/2020
Location 87-89 Iris Street, Beacon Hill | Page No. 1 of 1

Test Location	BH1	BH2	BH3	BH4	BH5	BH6	DPT7	DPT8
Easting Co-ordinate	337836.2	337837.5	337839.3	337856.7	337857.1	337866.2	337840.5	337857.2
Northing Co-ordinate	6264154.7	6264187.2	6264194.3	6264161.5	6264182.3	6264198.7	6264208.8	6264210.4
Elevation (RL m)	144.4	140.2	139.4	141.9	138.3	136.4	137.2	135.7
Depth (m)	**Penetration Resistance** Blows/150 mm							
0 - 0.15	2	4	5	1	1	3	3	2
0.15 - 0.30	3	6	5	3	1	2	8	4
0.30 - 0.45	2	3	3	5	1	3/20	12	4
0.45 - 0.60	2	2	5	18/25	2	B	4	3
0.60 - 0.75	3	7	3	B	10/100		4	3
0.75 - 0.90	7/0	5	2		B		2	4
0.90 - 1.05	B	7	6/25				3	9/140
1.05 - 1.20		12/50	B				6	B
1.20 - 1.35		B						
1.35 - 1.50								
1.50 - 1.65								
1.65 - 1.80								
1.80 - 1.95								
1.95 - 2.10								
2.10 - 2.25								
2.25 - 2.40								
2.40 - 2.55								
2.55 - 2.70								
2.70 - 2.85								
2.85 - 3.00								

Test Method AS 1289.6.3.2, Cone Penetrometer ☐ **Tested By** LS
AS 1289.6.3.3, Flat End Penetrometer ☑ **Checked By** HS

Remarks R = Refusal, 12/50 indicates 12 blows for 50 mm penetration
B = Bouncing