Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Upper Australia Habitat, Taronga Zoological Park
Bradleys Head Road, Mosman

Prepared for
Taronga Conservation Society Australia

Project 86625.00
December 2018

Integrated Practical Solutions

Douglas Partners
Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	86625.00	Document No.	R.001.Rev0
Document title	Report on Geotechnical Investigation Upper Australia Habitat, Taronga Zoological Park		
Site address	Bradleys Head Road, Mosman		
Report prepared for	Taronga Conservation Society Australia		
File name	86625.00.R.001.Rev0		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Rev0	Peter Hartcliff	Geoff Young	6 December 2018

Distribution of copies

Status	Electronic	Paper	Issued to
Rev0	1	0	Mr Michael Head, Taronga Conservation Society Australia

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
Author	[signature]	7/12/18
Reviewer	[signature]	7/12/18

bsi. ISO 9001 Quality Management
FS 604853

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

Douglas Partners
Geotechnics / Environment / Groundwater

Table of Contents

Report on Geotechnical Investigation
Upper Australia Habitat, Taronga Zoological Park
Bradleys Head Road, Mosman

1. Introduction

The report describes the results of a geotechnical investigation undertaken for the proposed Upper Australia Habitat redevelopment at Taronga Zoological Park, Bradleys Head Road, Mosman. The investigation was commissioned by Mr Michael Head from the Taronga Conservation Society Australia and was undertaken in accordance with DP's proposal SYD181062, dated 1 November 2018.

It is understood that new facilities and animal exhibits are being considered within the same area where the Australian animal exhibits are currently located. It is further understood that information is required for planning and preliminary design purposes.

The aim of the investigation was to assess the subsurface soil, rock and groundwater conditions across the site to provide comments on excavation conditions and support, vibrations, groundwater, retaining walls, foundation design and pavements.

The geotechnical investigation included the drilling of boreholes, in-situ strength testing, geological mapping/inspection and engineering analysis. Details of the field and laboratory work together with relevant comments on design and construction practice are given in this report.

Information provided for use in the investigation included a concept plan, by Green and Dale Associates, dated 12 July 2016 and a survey plan of the site titled 'Taronga Zoo Master Plan' (Drawing Number TZ-PL01, dated 23 January 2017).

The geotechnical investigation was carried out concurrently with a Preliminary Site (Contamination) Investigation (PSI) which is reported separately in DP Report No. 86625.01.R.001.

2. Site Description and Geology

The area of the proposed Upper Australia Habitat redevelopment project covers approximately 8,000 m^2 and is located within the north-eastern portion of the zoo and includes existing animal exhibits and enclosures, some buildings (Platypus House and the Nocturnal House), pathways and boardwalks, landscaped gardens and a high ropes course. A curved, sandstone block retaining wall approximately 2.5 m high and 40 m long is located adjacent to the zoo plaza in the northern-most part of the site.

The subject site is bounded by Bradleys Head Road to the east, the main zoo entrance and the zoo plaza to the north, the tree kangaroo enclosure and Australian Rainforest Aviary to the west and south-west, and the Taronga Centre (currently undergoing a redevelopment upgrade) and the Floral Clock Lawn to the south. The site is shown on Drawing 1, Appendix B.

The site is located on the southern side of a moderate to gentle slope that falls towards Sydney Harbour to the south. Sandstone rock faces and cuttings are evident throughout the zoo but not within the proposed redevelopment area. The surface levels in the area of the proposed development vary from about RL 71.4 m relative to the Australian Height Datum (AHD) at the top of the site near the zoo entrance to about RL 61.5 m AHD.

The area experiences high pedestrian traffic and occasional use by service vehicles.

Reference to the Sydney 1:100 000 Geological Series Sheet indicates that the site is underlain by Hawkesbury Sandstone Formation rocks of Triassic Age. Hawkesbury Sandstone typically comprises medium to coarse grained quartz sandstone, shale, carbonaceous claystone, laminite (thinly interbedded siltstone and fine grained sandstone) and fine to medium grained lithic sandstone.

The field work confirmed the presence of Hawksbury Sandstone.

3. Field Work Methods

The geotechnical investigation included the drilling of seventeen boreholes (UA1 to UA17), mapping of areas of rock outcrop, inspection and photography of the site. The borehole locations, selected site features, mapping and photo locations are shown on Drawing 1 in Appendix B.

The field work was carried out on 26 and 27 November 2018 under the supervision of zoo keepers.

Prior to testing, the available Dial before You Dig (DBYD) drawings and the site service plan were reviewed and each borehole location checked for underground services using an electro-magnetic scanner.

Boreholes UA1 to UA6 were drilled in accessible areas such as pedestrian pathways using a bobcat-mounted drilling rig (refer Photo 1, Appendix D). Boreholes located within paved areas were commenced by drilling a 150 mm diameter concrete core hole (diatube) through the pavers. These borehole locations and those located within the asphalt pathway were then drilled into the underlying soils using solid flight augers and terminated on practical auger refusal. Standard penetration tests (SPT's) were undertaken within the overburden filling and soil within Borehole UA1 only and discontinued within the remaining bobcat drilled boreholes at the request of the zoo keepers due to the noise impacting on the animals during SPT testing.

Boreholes UA7 to UA17 were drilled in areas inaccessible to the bobcat drilling rig using a hand-auger.

Disturbed auger soil samples were collected at regular depth intervals within all boreholes to assist in strata identification and for laboratory testing.

Dynamic cone penetrometer (DCP) tests were conducted at all borehole locations except UA1 (where SPT's were completed). A DCP test is carried out to assess the penetration resistance of the near surface materials and possibly the depth to the top of weathered rock.

Dense tree cover prevented the use of differential global positioning system (DGPS) to accurately determine the test location co-ordinates and their reduced levels (RL). The borehole co-ordinates were therefore interpolated from satellite imagery and their approximate locations shown on the borehole logs. The ground surface levels (relative to AHD) at each of the test locations were interpolated from surface levels shown on the site survey plan.

4. Field Work Results

4.1 Observations

The inspection indicated that:

- Rock outcrop was not observed within the area of the proposed Upper Australia Habitat redevelopment, however, sandstone outcrop is exposed throughout other parts of the zoo including to the west of the subject site (within the bird avairy) and to the south where Taronga House was undergoing some construction work (refer Photo 2, Appendix D);
- Sandstone floaters are located in many areas of the site, however, they are unlikely to be in their original position but placed by machine within the landscaped gardens (Photo 3, Appendix D) and enclosures;
- A curved, sandstone block retaining wall approximately 2.5 m high and 40 m long is located between the zoo plaza and the 'Wetland' exhibit (refer Photo 4, Appendix D). The wall appears to be in good condition;
- Existing structures located within the subject area include the Nocturnal House (underground), the Platypus House (above ground), the High Ropes Course, paved pathways (refer Photo 5, Appendix D) and asphalt pathways (refer Photo 6, Appendix D), animal enclosures, ponds, boardwalks and small retaining walls. All of these structures appeared to be in a relatively good condition;
- The site has been reworked over the years and a typical profile appears to be with shallow depth of soil, expected to be mainly filling, overlying sandstone; and
- Water seepage was not observed within the subject area.

4.2 Boreholes

Due to practical refusal encountered within the hand-augered boreholes caused by difficult drilling conditions or obstructions within the filling, the maximum depth of the drilling with the hand-auger was between 0.2 m and 1.1 m below the existing surface levels. The DCP test results (discussed in Section 5.2) provided a more accurate indication for the depth to the top of weathered bedrock at the hand-auger locations.

The machine drilled boreholes were successfully drilled to the top of weathered bedrock which was encountered within UA1 to UA6 at depths of between 0.3 m and 1.3 m below existing surface levels.

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix C together with notes defining descriptive terms and classification methods.

The conditions encountered within the boreholes are summarised below:

PAVEMENT - Concrete pavers (generally 50 mm thick) or asphalt pavement encountered within boreholes UA2 to UA6 only, overlying;

FILLING - Sand, gravelly sand, clay, silty sand to depths of 0.3 m to 1.8 m; and

BEDROCK - Sandstone bedrock generally initially of very low and low strength from depths of between 0.2 m and 1.5 m below existing surface levels.

Table 1 summarises the levels at which the different materials were encountered in the boreholes.

Table 1: Summary of Material Strata Level in Boreholes

Bore	RL of Top of Stratum (m, AHD)		
	Ground Surface/Filling	Very Low or Low Sandstone	Base of Borehole
UA01	69.8	68.6	68.7
UA02	68.4	68.0	67.8
UA03	67.1	66.9	66.9
UA04	66.2	64.9	64.6
UA05	64.0	63.4	63.3
UA06	64.4	63.1	63.0
UA07	70.0	NE	63.0
UA08	68.7	NE	61.1
UA09	69.3	NE	68.4
UA10	68.0	NE	68.5
UA11	67.6	NE	67.4
UA12	66.3	NE	65.9
UA13	68.0	NE	67.2
UA14	69.2	NE	68.2
UA15	69.4	NE	68.4
UA16	67.9	NE	67.2
UA17	67.3	NE	66.9

NE = Bedrock not encountered

Ground water was observed during auguring in the boreholes UA16 at 0.7 m depth (RL 67.2) and borehole UA14 at 0.8 m depth (RL 68.4).

Dynamic Cone Penetrometer (DCP) Test

Dynamic cone penetrometer tests (DCP2 to DCP17) at various locations across the site (refer Drawing 1 in Appendix C) encountered bouncing refusal at depths ranging from about 0.1 m to 1.6 m. Bouncing of the drop hammer generally indicates the top of weathered bedrock.

The dynamic cone penetrometer tests were conducted adjacent to the similarly numbered boreholes.

The number of blow counts (per 150 mm penetration depth) indicated that the subsurface material at the test locations was generally variable, indicating filling to depths of between about 1.0 m and 1.6 m. The DCP results are shown on the borehole logs and also provided in Appendix C with the RL of bouncing refusal, which is inferred as being the ‘top of rock’ (TOR) indicated on Drawing 1.

Table 2 summarises the levels at which inferred bedrock was encountered in the DCP tests.

Table 2: Summary of Inferred Bedrock Level based on the DCP Test Results

DCP	RL of Top of Stratum (m, AHD)	
	Ground Surface/Filling	Inferred Bedrock
UA01	69.8	DCP not conducted
UA02	68.4	68.0
UA03	67.1	66.9
UA04	66.2	64.9
UA05	64.0	63.4
UA06	64.4	63.1
UA07	70.0	69.2*
UA08	68.7	67.6*
UA09	69.3	67.8
UA10	68.0	67.3*
UA11	67.6	67.1*
UA12	66.3	65.3*
UA13	68.0	66.9*
UA14	69.2	68.2*
UA15	69.4	68.3*
UA16	67.9	67.2*
UA17	67.3	66.8*

4.3 Mapping and Inspection

An inspection of the general slope and existing structures on the site, including the exterior walls of the buildings, indicated no evidence of major defects attributable to significant slope instability. Based on the relatively shallow depth of bedrock and the sound condition of the site buildings and structures, it is anticipated that the buildings and structures are founded upon the sandstone bedrock that underlies the site.

5. Geotechnical Model

The interpreted geological model for the site comprises an overall gentle slope with a generally shallow thickness soil profile (characteristically of sand and gravel filling) typically less than 1.5 m deep, overlying low and medium strength sandstone bedrock. The soil profile will include sandstone fragments and potentially large sandstone boulders or floaters which may not be in their original position or in a flat lying orientation.

The underlying sandstone bedrock levels are anticipated to step down towards the south, possibly in a series of small rock ledges and steps, so rock levels are likely to vary over short distances. The upper levels of bedrock are likely to contain thin layers of highly weathered clayey sandstone, particularly along the natural bedding planes.

6. Proposed Development

It is understood that the Upper Australia Habitat redevelopment will comprise new animal enclosures, landscaped gardens/pathways and a new ‘Kakadu Wetlands Aviary’ in the approximate location of the existing wetlands exhibit. The existing nocturnal house, Platypus House, Taronga Centre, high ropes course and main zoo entrance plaza will remain. It is understood that maximum excavation depths of 1.5 m below existing surface levels are proposed.

The geotechnical issues that may be relevant to the proposed development include excavation, excavation support, vibrations, slope stability, site preparation, ground water, foundations and pavements

7. Comments

7.1 Excavation

Excavation for the proposed redevelopment will be mainly within the filling, natural soils and sandstone bedrock. Excavation in filling, soils and extremely low strength sandstone should be readily achievable using an excavator with bucket attachment.

Excavation in medium and high strength sandstone, expected close to the rock surface, will probably require ripping, hammering and / or sawing.

7.2 Excavation Support

Excavations in filling, soils and weathered rock will not be able to stand vertically for extended periods of time but may be able to be supported by temporary batters where space permits. A maximum temporary batter slope of 1(H):1(V) is recommended for excavations of up to about 2 m depth in these materials provided they are protected against erosion. Permanent batters should be flattened to no steeper than 2(H):1(V).

Medium and high strength rock should be able to stand vertically provided adverse jointing is not present.

Retaining walls (temporary and or permanent) may be required in some areas of the site and could be designed using the material and strength parameters outlined in Table .

Table 3: General Material and Strength Parameters for Retaining Structures

Material	Bulk Unit Weight (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth pressure at Rest (K_0)	Ultimate Passive Earth Pressure (kPa)
Filling	20	0.4	0.6	
Natural Soil	20	0.3	0.45	
ELS Sandstone	22	0.2[1]	0.3[1]	750[2]
LS/MS/HS Sandstone	22	0[1]	0[1]	3000[2]

Notes: [1] Unless unfavourable jointed;
[2] Only below ground level and where jointing is favourable;
ELS = extremely low strength; LS = low strength; MS = medium strength; HS = high strength.

A triangular lateral earth pressure distribution could be assumed for cantilevered walls, and a rectangular lateral earth pressure distribution for walls propped at their top and base. Lateral pressures due to surcharge loads from sloping ground surfaces, adjacent buildings, construction machinery and vehicles should be included where relevant. Hydrostatic pressure acting on the retaining walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

7.3 Disposal of Excavated Material

All excavated material taken off site will need to be disposed in accordance with the provisions of the current legislation and guidelines, including Wastes Classification Guidelines.

Refer to DP Report 86625.01.R.001.Rev0.

7.4 Vibration Induced by Excavation Plant

Excavation within sandstone will result in vibrations. In order to reduce the level of excavation generated vibration, the rock could be removed using multiple rock saw cuts, rock splitting and rotary milling methods rather than the continuous use of a hydraulic rock breaking attachment.

It is also recommended that dilapidation surveys be carried out on neighbouring structures prior to commencement of construction activities. This is to allow appropriate responses to any claims for damage arising from construction activities.

From current information, it is considered likely that the buildings surrounding the site can withstand vibration levels higher than those required to maintain the comfort of the occupants. A human comfort criterion is therefore indicated and that a vector sum peak particle velocity (VSPPV) limit, is proposed as the control parameter. It is recommended that a VSPPV Limit of 8.0 mm/sec be set during normal working hours, measured at foundation level of the potentially affected buildings.

It is noted, however, that the affect that vibrations have on animals, is unknown. Typically we recommend that a vector sum peak particle velocity (VSPPV) limit of 3 - 5 mm/sec for sensitive structures be adopted.

As a guide, a (VSPPV) value in the range of about 3 - 5 mm/sec could be adopted for animals located nearby, however, it is strongly recommended that zoo keepers/staff assess the affects that vibrations may have on the animals and therefore determine their own vibration limits.

Vibration trials are recommended prior to the commencement of rock excavation to determine vibration levels and the possible need for vibration monitoring during excavation.

7.5 Site Preparation

Areas of the site that require filling to raise site levels should be stripped of vegetation and existing filling materials prior to proof-rolling with a minimum 10 tonne steel smooth drum roller. Any areas exhibiting significant heaving should be assessed by a geotechnical engineer to determine any rectification measures that may be required. Proof-rolling will not be required if the subgrade is sandstone bedrock.

Approved filling should then be placed on the prepared subgrade in 250 mm thick layers and compacted to achieve a dry density ratio of at least 98% relative to Standard compaction. This density criteria could be relaxed to a dry density of at least 95% relative to Standard compaction in areas that are not required to support structures or pavements. The moisture content of the filling should be within 2% of optimum if it exhibits clay like properties. Density testing should be undertaken in accordance with the provisions of AS 3798 – 2007 *Guidelines on earthworks for commercial and residential developments*.

The subgrade in non-structural and unpaved areas where filling and excavation are not required such as in animal enclosures, it would be prudent to proof roll the areas to detect any soft spots which require repairs. Some moisture conditioning and compaction of the surface may be required.

7.6 Groundwater

The source of the water encountered within borehole UA16 at 0.7 m depth (RL 67.2) is likely to be water seeping through the filling from the adjacent pond, and the water source encountered at borehole UA14 at 0.8 m depth (RL 68.4) is likely to be perched water above the top of rock or possibly a broken service.

The regional groundwater table is expected to be well below the bedrock surface and flow in a southerly direction towards the Harbour. However, seepage through and along strata boundaries and jointing in the rock should be expected and this should be considered in the design of the drainage systems on the site.

7.7 Foundations

Due to relatively shallow depth of rock on the site it is recommended that all new structures be founded on the sandstone bedrock on spread footings (e.g. pad footings and strip footings) or on short bored piles. The footings and piles could be designed using the design bearing pressures and shaft adhesions provided in Table .

If bored piles are used, temporary casing may be required in some cases to support the sides of the hole.

Table 4: Preliminary Design Parameters for Spread Footing and Bored Piles.

Material Description	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion[1] (kPa)
ELS Sandstone	700	50
LS/MS/HS Sandstone	3000	300

Notes: [1] Only for piles where adequate socket-roughness has been achieved;
ELS = extremely low strength; MS = medium strength; HS = high strength

Higher bearing pressures for the sandstone bedrock are possible based on the strength of the rock outcrops to the south and west of the site, but would require further investigations and some rock strength testing to justify the higher parameters.

The settlement of a footing is dependent on the dimension of the footing, the load applied and the underlying foundation conditions. Spread footings and piles designed using the information contained in this report should experience settlement of less than 10 mm upon application of the design load.

All new footings should be inspected by an experienced geotechnical professional to check the suitability of foundation material. Additionally in the case of bored piles the socket roughness and the base cleanliness should be checked.

7.8 Pavements

Each pavement area should be individually assessed based on the subsurface profile and the loading after earthworks are completed because subgrade conditions are expected to vary across the site. It is expected that the subgrade CBR value will probably be in excess of 5%. For lightly loaded pavements on the existing filling, it may be possible to found on the filling after a satisfactory proof roll. For heavy loaded pavements, some treatment of the underlying filling may be required before the pavement is constructed.

8. Limitations

Douglas Partners (DP) has prepared this report for this project at Taronga Zoological Park, Bradleys Head Road, Mosman in accordance with DP's proposal SYD181062 dated 1 November 2018 and acceptance received from Mr Michael Head, on behalf of Taronga Conservation Society of Australia. The work was carried out under DP's Conditions of Engagement. The report is provided for the use of the Taronga Conservation Society Australia for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

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

DPs advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

This report must be read in conjunction with all of the attached notes 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 a statement, interpretation, outcome or conclusion given 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 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.

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.

Copyright

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

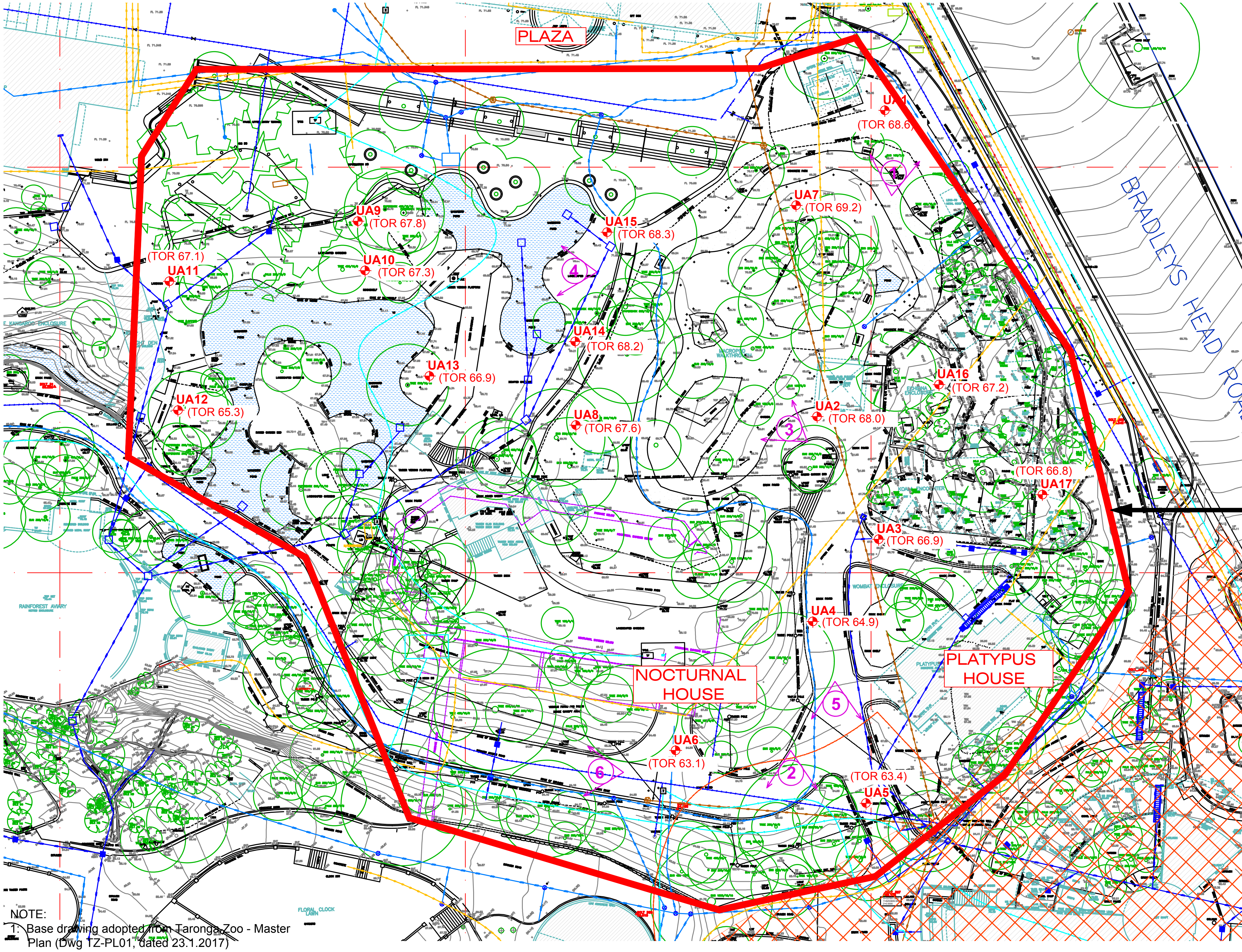
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate 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.

Appendix B

Drawing 1



Locality Plan

NOTE:
1: Base drawing adopted from Taronga Zoo - Master Plan (Dwg TZ-PL01, dated 23.1.2017)
2: Test locations are approximate only and are shown with reference to existing features.

0 5 10 15 20 30 40 50m

1:500 @ A3

LEGEND

- Borehole and DCP test location
- (TOR 66.8) Inferred level of top of rock
- (1) Photo number with direction of view

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Taronga Conservative Society Australia		TITLE: **Borehole Location Plan**	PROJECT No: 86625.00
OFFICE: Sydney	DRAWN BY: PSCH	**Upper Australia Habitat Development**	DRAWING No: 1
SCALE: 1:500 @ A3	DATE: 5.12.2018	**TARONGA ZOO**	REVISION: 0

Appendix C

Descriptive Notes and

Results of Field Work

Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

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

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

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

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

Rock Descriptions

Douglas Partners

Rock Strength

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

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

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

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

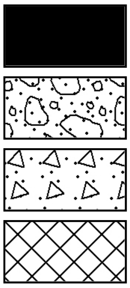
Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

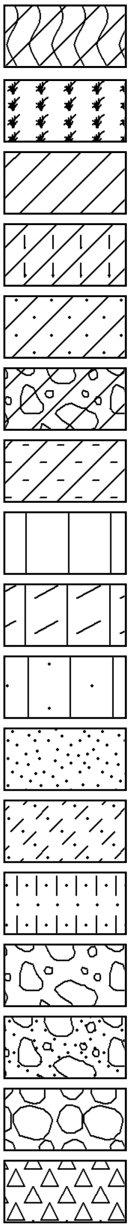
Graphic Symbols for Soil and Rock

General



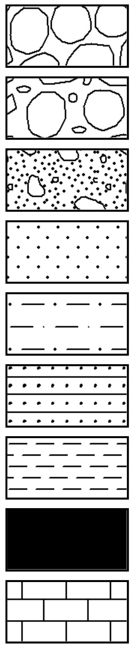
- Asphalt
- Road base
- Concrete
- Filling

Soils



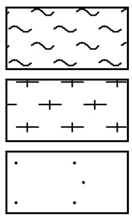
- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks



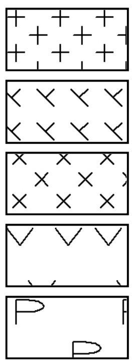
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks



- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks



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

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
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client Taronga Conservation Sociiety Australia | Project No. 86625.00

Project Upper Australia Habitat Redevelopment | Date 27/11/2018

Location Taronga Zoological Park, Bradleys Head Road, Mosman | Page No. 2

Test	UA12	UA13	UA14	UA15	UA16	UA17				
RL of Test (AHD)	66.3	68	69.2	69.4	67.9	67.3				
Depth (m)										
0 - 0.15	1	2	1	3	1	3				
0.15 - 0.30	1	3	1	4	1	6				
0.30 - 0.45	8	3	1	4	4	20				
0.45 - 0.60	27	11	2	6	4	25/100				
0.60 - 0.75	12	12	1	15	10/100	B				
0.75 - 0.90	21	6	2	13	B					
0.90 - 1.05	12/100	4	20/120	8						
1.05 - 1.20	B	13/100	B	5/40						
1.20 - 1.35		B		**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										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑ **Tested By** RB

AS 1289.6.3.3, Flat End Penetrometer ☐ **Checked By** PGH

Remarks R = Refusal, 24/110 indicates 25 blows for 110 mm penetration

B = Bouncing refusal

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
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client Taronga Conservation Sociiety Australia
Project Upper Australia Habitat Redevelopment
Location Taronga Zoological Park, Bradleys Head Road, Mosman

Project No. 86625.00
Date 26/11/2018

Test Location	UA2	UA3	UA4	UA5	UA6	UA7	UA8	UA9	UA10	UA11
RL of Test (AHD)	68.4	67.1	66.2	64	64.4	70	68.7	69.3	68	67.6
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	10	14	25	15/100	9	2	1	1	1	1
0.15 - 0.30	14	10/60	22	B	14	5	1	2	1	5/70
0.30 - 0.45	8/50	B	17		21	7	2	1	4	B
0.45 - 0.60	B		9		4/20	22	3	8	15	
0.60 - 0.75			14		B	13	13	8	21/100	
0.75 - 0.90			6			25/100	20	11	B	
0.90 - 1.05			6			B	12	10		
1.05 - 1.20			6				6/70	11		
1.20 - 1.35			18/130				B	14		
1.35 - 1.50			B					20		
1.50 - 1.65								21/60		
1.65 - 1.80								B		
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										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Flat End Penetrometer

Tested By RB
Checked By PGH

Remarks R = Refusal, 24/110 indicates 25 blows for 110 mm penetration
B = Bouncing refusal

BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 69.8 AHD
EASTING: 337499
NORTHING: 6253912
DIP/AZIMUTH: 90°/--

BORE No: UA01
PROJECT No: 86625.00
DATE: 26/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING: Brown coarse grained sand filling with some clay and gravel, damp		A/E	0.1–0.2				
70		1.1 m - some coarse grained gravel from 0.1 m to 0.2 m							
		0.4 m - becoming fine to medium grained sand filling		A/E	0.4–0.5				
	1			A/E	1.0–1.1		14/100 mm refusal		
71	1.2			A/E	1.1–1.2				
	1.25	SANDSTONE: low strength, moderately weathered, light brown, medium to coarse grained sandstone							
		Bore discontinued at 1.25m due to auger refusal							
72	2								
73	3								
	4								

RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Solid flight auger to 1.25 m
WATER OBSERVATIONS: No free ground water observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

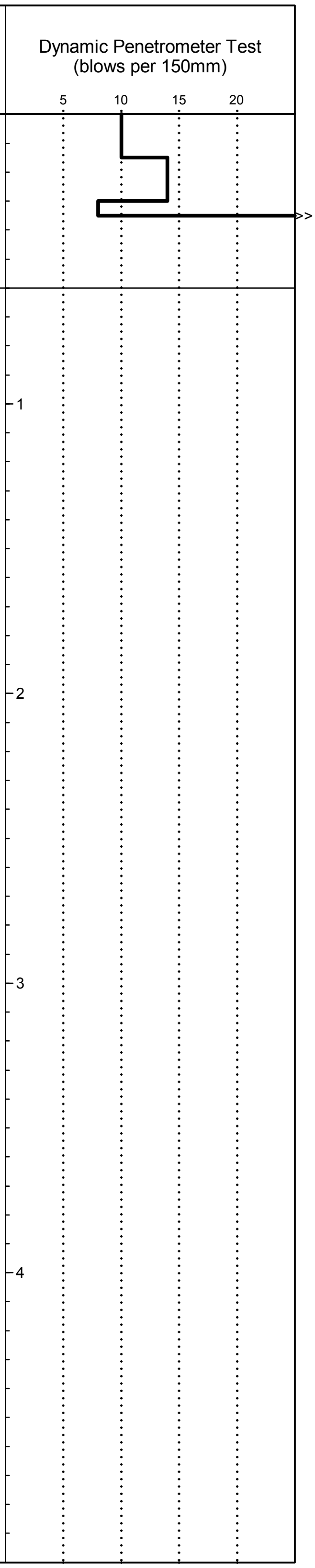
BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 68.4 AHD
EASTING: 337489
NORTHING: 6253871
DIP/AZIMUTH: 90°/--

BORE No: UA02
PROJECT No: 86625.00
DATE: 26/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.05	PAVERS: Brick pavers 50 mm thick		A/E	0.0 – 0.1				
		FILLING: Dark brown sand filling with some silt, moist							
	0.4	SANDSTONE: low strength, moderately weathered, light brown , medium to coarse grained sandstone		A/E	0.4 – 0.5				
69	0.6	Bore discontinued at 0.6m due to auger refusal							
70	1								
71	2								
72	3								
	4								



RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Diatube to 0.05 m, Solid flight auger to 0.6 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

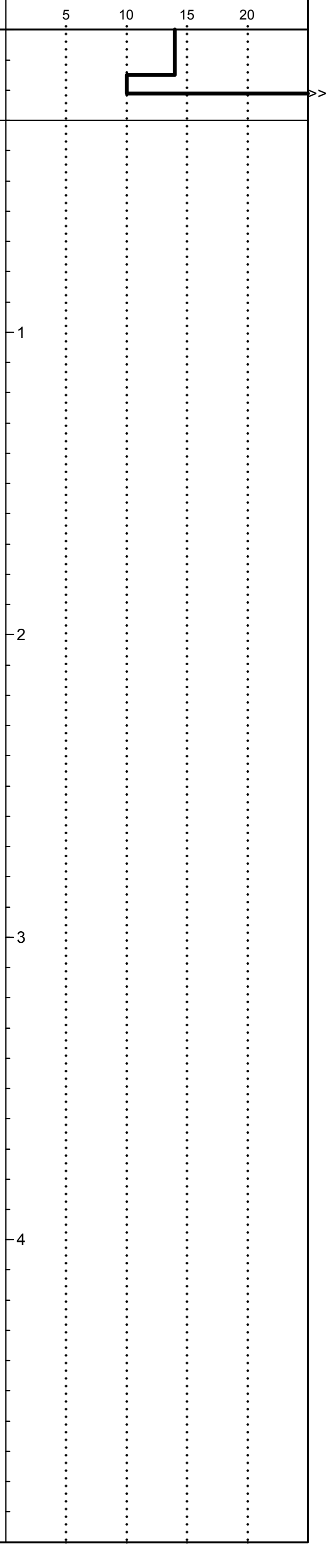
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 67.1 AHD
EASTING: 337500
NORTHING: 6253856
DIP/AZIMUTH: 90°/--

BORE No: UA03
PROJECT No: 86625.00
DATE: 26/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.05	PAVERS: Brick pavers 50 mm thick						
		FILLING: Dark grey, gravelly sand (medium to coarse grained) filling, moist		A/E	0.1			
	0.25			A/E	0.2			
	0.3	SANDSTONE: low strength, slightly weathered, light grey, medium to coarse grained sandstone			0.3			
		Bore discontinued at 0.3m due to auger refusal						
68	1							
69	2							
70	3							
71	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Diatube to 0.05 m, Solid flight auger to 0.3 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

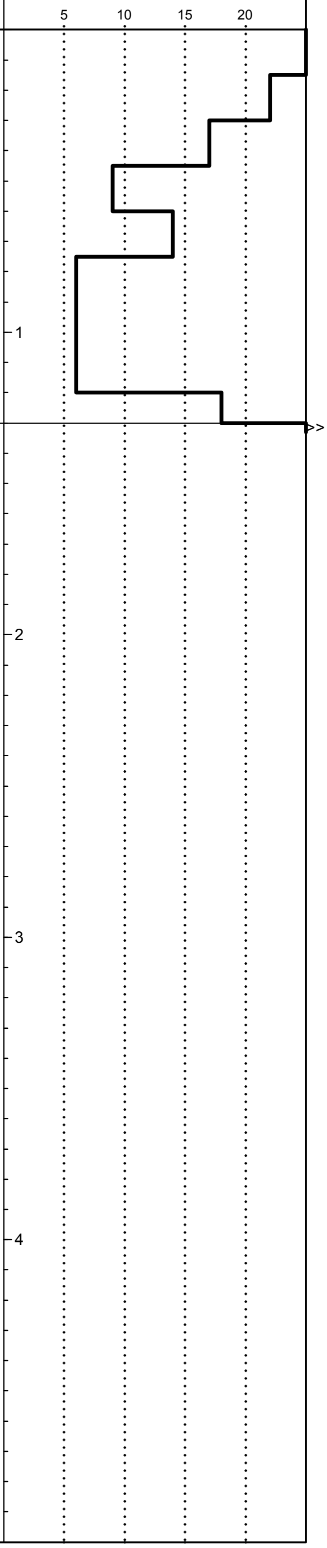
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 66.2 AHD
EASTING: 337495
NORTHING: 6253844
DIP/AZIMUTH: 90°/--

BORE No: UA04
PROJECT No: 86625.00
DATE: 26/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.05	PAVERS: Brick pavers 50 mm thick		A/E	0.0 – 0.1			
67	1	FILLING: Dark grey, gravelly sand filling		A/E	0.4 – 0.5			
				A/E	0.9 – 1.0			
	1.3	1.2 m: light brown sand filling (possible colluvium)						
		SANDSTONE: very low to low strength, moderately to slightly weathered, light brown, medium to coarse grained sandstone		A/E	1.35 – 1.45	BD1 - 20181126		
	1.6			A/E	1.5 – 1.6			
68	2	Bore discontinued at 1.3m due to auger refusal						
69	3							
70	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Diatube to 0.05 m, Solid flight auger to 1.3 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 64.0 AHD
EASTING: 337499
NORTHING: 6253825
DIP/AZIMUTH: 90°/--

BORE No: UA05
PROJECT No: 86625.00
DATE: 26/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 100mm)
64	0.05	PAVERS: Brick pavers 50mm thick		A/E	0.0–0.1				15 then >>
		FILLING: Grey sandy gravel filling - 0.3 m: becoming light brown medium grained sand filling with some fine gravel		A/E	0.4				
	0.6			A/E	0.5–0.6				
	0.65	SANDSTONE: very low and low strength, slightly weathered, light grey, medium to coarse grained sandstone							
		Bore discontinued at 0.65m due to auger refusal							
65	1								
66	2								
67	3								
68	4								

RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Diatube to 0.05 m, Solid flight auger to 0.65 m
WATER OBSERVATIONS: No free ground water 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)

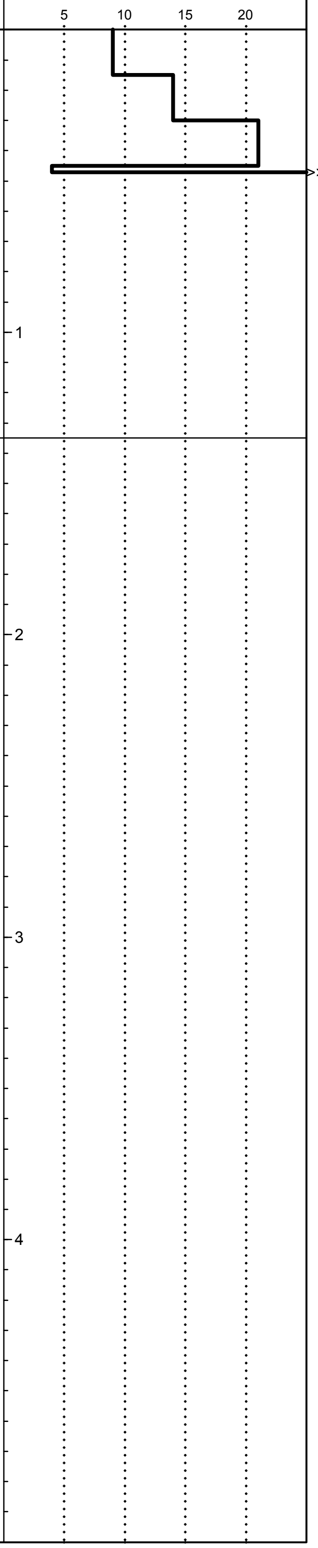
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT:	Taronga Conservative Society Australia	**SURFACE LEVEL:**	64.4 AHD	**BORE No:**	UA06
PROJECT:	Upper Australia Habitat Redevelopment	**EASTING:**	337478	**PROJECT No:**	86625.00
LOCATION:	Taronga Zoological Park, Bradleys Head Road, Mosman	**NORTHING:**	6253829	**DATE:**	26/11/2018
		DIP/AZIMUTH:	90°/--	**SHEET**	1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.05	PAVERS: Brick pavers 50 mm thick		A/E	0.0–0.1			
		FILLING: grey and light brown, medium grained sand filling with some sandstone gravel, moist		A/E	0.4–0.5			
65								
	1			A/E	0.9–1.0			
	1.3			A/E	1.2–1.3			
	1.35	SANDSTONE: low strength, slightly weathered , ligh grey, medium to coarse grained sandstone						
		Bore discontinued at 1.35m due to auger refusal						
66	2							
67	3							
68	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Bobcat **DRILLER:** George Marino **LOGGED:** Roshan Bhetwal **CASING:** -

TYPE OF BORING: Diatube to 0.05 m, Solid flight auger to 1.35 m

WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

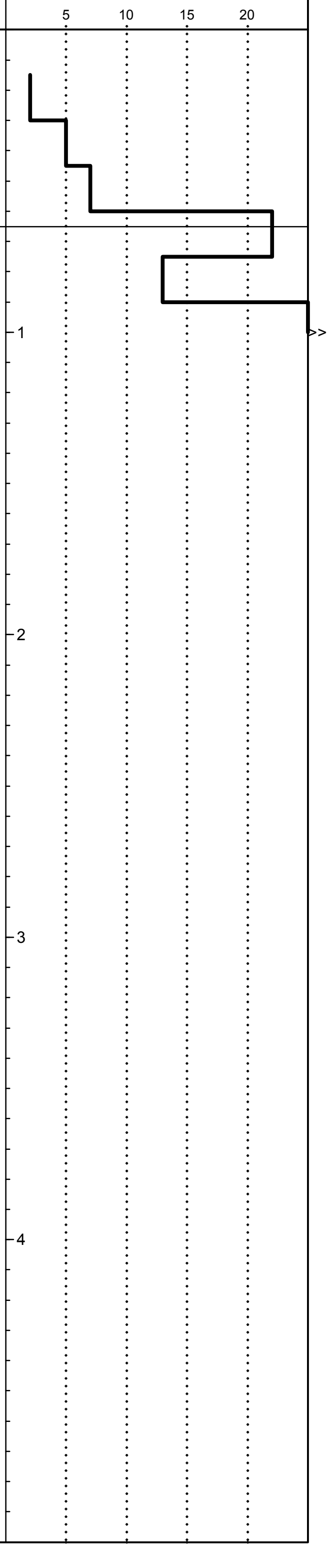
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 70.0 AHD
EASTING: 337487
NORTHING: 6253890
DIP/AZIMUTH: 90°/--

BORE No: UA07
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
70		FILLING: Dark brown sandy clay filling with some rootlets and wood chips, damp		A/E	0.0–0.1			
	0.15	FILLING: Clay filling with some gravel		A/E	0.4–0.5			
				A/E	0.6–0.65			
	0.65	Bore discontinued at 0.65m due to hand-auger refusal						
71	1							
72	2							
73	3							
74	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.65 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

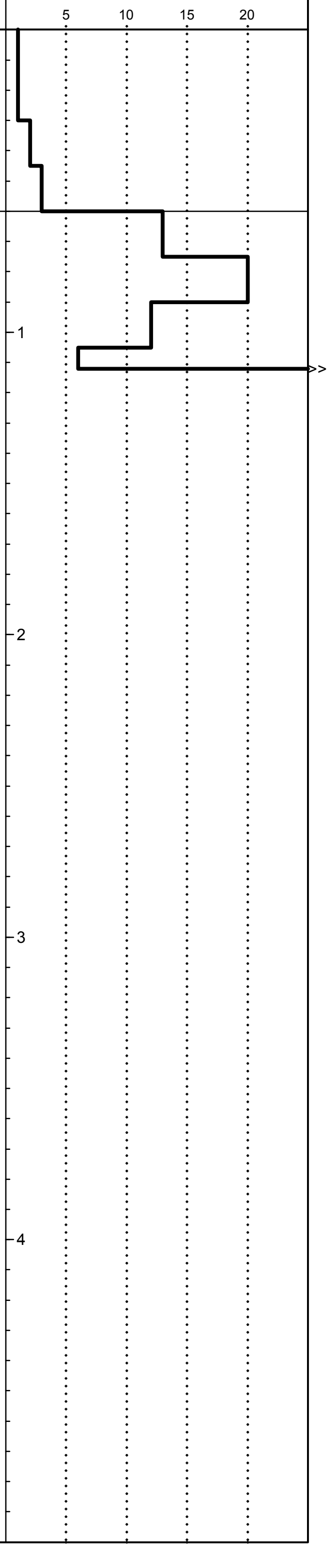
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 68.7 AHD
EASTING: 337472
NORTHING: 6253877
DIP/AZIMUTH: 90°/--

BORE No: UA08
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type (Sampling & In Situ Testing)	Depth	Sample	Results & Comments	Water
		FILLING: Dark brown silty sand filling with some woodchips, organics and plastic, damp		A/E	0.0–0.1			
69				A/E	0.4–0.5			
	0.6	Bore discontinued at 0.6m due to hand-auger refusal		A/E	0.6			
70	1							
71	2							
72	3							
	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.6 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

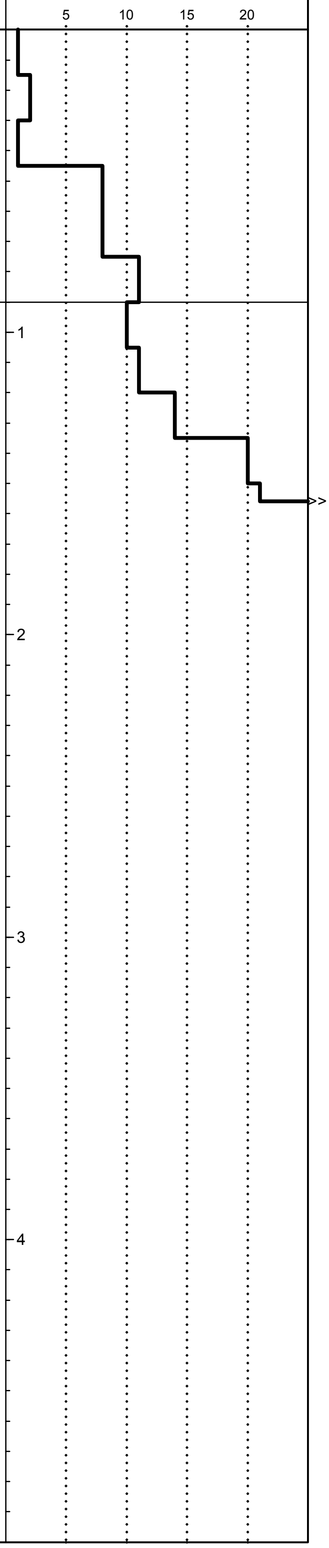
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 69.3 AHD
EASTING: 337439
NORTHING: 6253893
DIP/AZIMUTH: 90°/--

BORE No: UA09
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING: dark brown silty snd filling with rootlets, organics, moist		A/E	0.0 – 0.1		BD220181127	
				A/E	0.4 – 0.5			
70		at 0.9m: brick fragment and sandstone gravel		A/E	0.8 – 0.9			
	0.9	Bore discontinued at 0.9m due to hand-auger refusal						
71	1							
72	2							
73	3							
	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.9 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

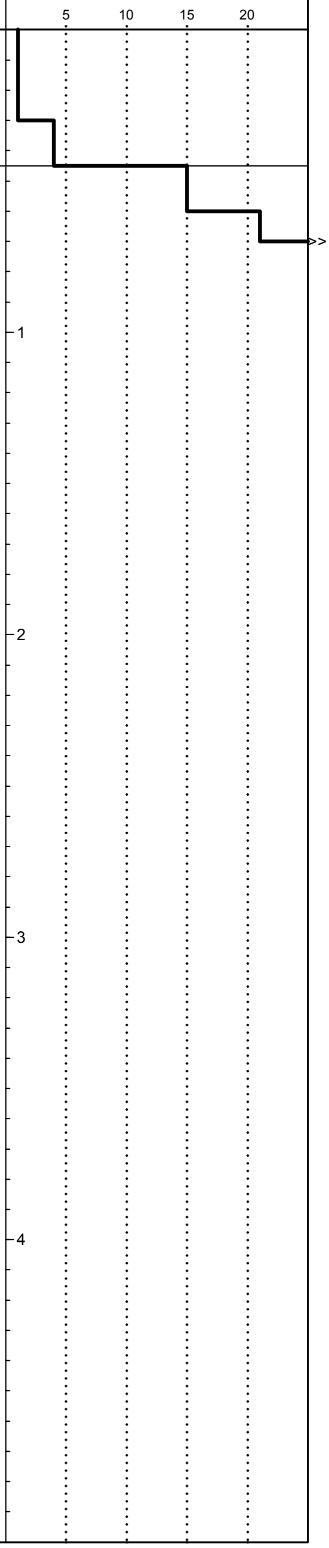
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 68.0 AHD
EASTING: 337426
NORTHING: 6253890
DIP/AZIMUTH: 90°/--

BORE No: UA10
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
68	0.01	FILLING: dark brown sandy clay filling with some rootlets, organics, damp		PID	0.0 / 0.01			
		at 0.02m: becoming brown gravelly sand with some rootlets, damp		A/E	0.2 / 0.3			
		at 0.35m: sandstone gravel and glass fragments		A/E	0.4			
		Bore discontinued at 0.45m due to hand-auger refusal						
69	1							
70	2							
71	3							
72	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -

TYPE OF BORING: Hand auger to 0.45 m

WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

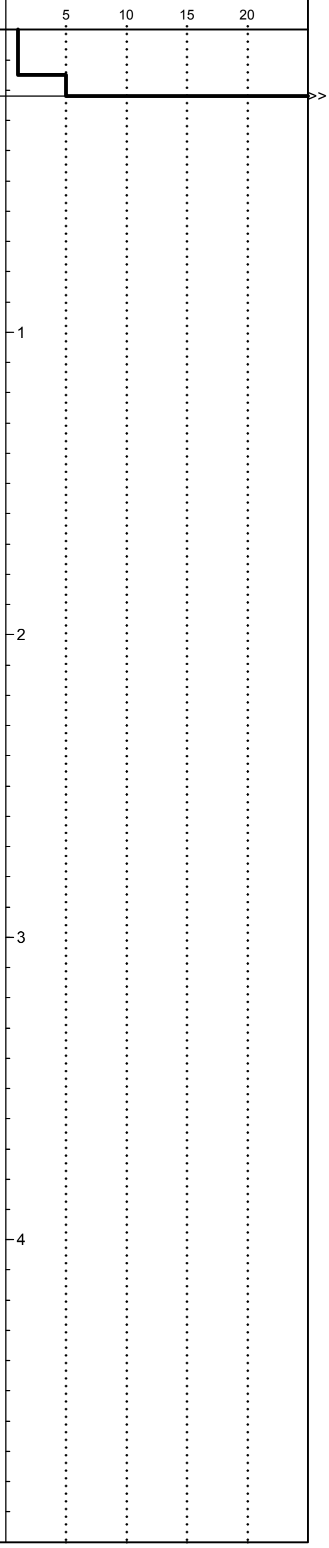
BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 67.6 AHD
EASTING: 337413
NORTHING: 6253883
DIP/AZIMUTH: 90°/--

BORE No: UA11
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: dark grey silty sand filling with some rootlets, organics, damp		A/E	0.0 – 0.2				
	0.22	Bore discontinued at 0.22m due to hand-auger refusal							



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.22 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

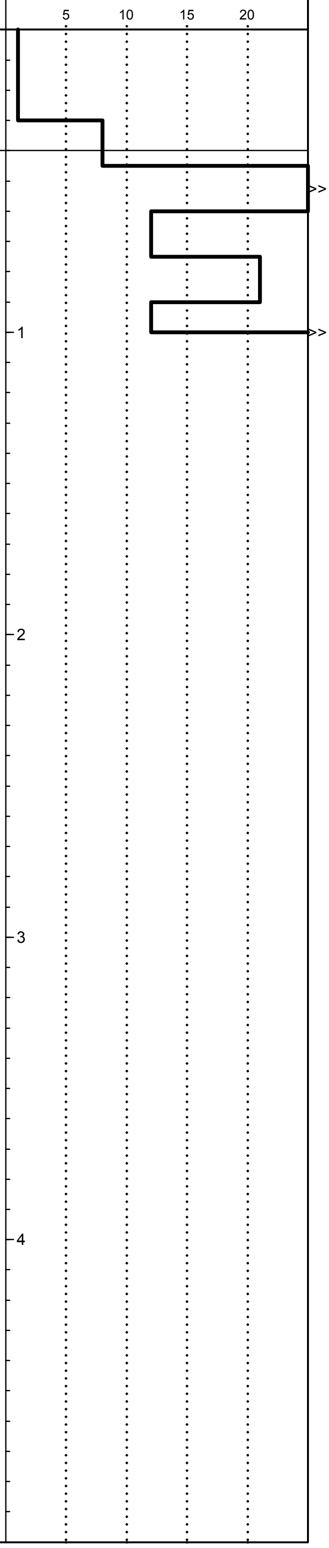
BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 66.3 AHD
EASTING: 337411
NORTHING: 6253871
DIP/AZIMUTH: 90°/--

BORE No: UA12
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING: dark brown silty sand filling with rootlets, organics, damp		A/E	0.0–0.2		BD320181127		
	0.4	Bore discontinued at 0.4m due to hand-auger refusal							



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.4 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

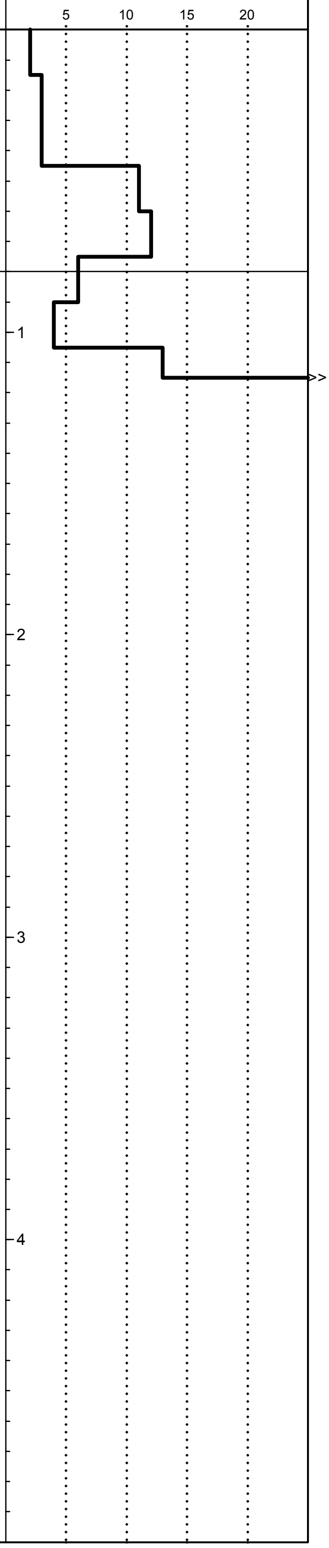
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 68.0 AHD
EASTING: 337445
NORTHING: 6253873
DIP/AZIMUTH: 90°/--

BORE No: UA13
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
68		FILLING: dark brown silty sand filling with rootlets, organics, damp		A/E	0.0–0.15			
		at 0.3m: becoming gravelly sand filling, damp		A/E	0.4–0.5			
				A/E	0.7–0.8			
	0.8	Bore discontinued at 0.8m due to hand-auger refusal						
69	1							
70	2							
71	3							
72	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.8 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

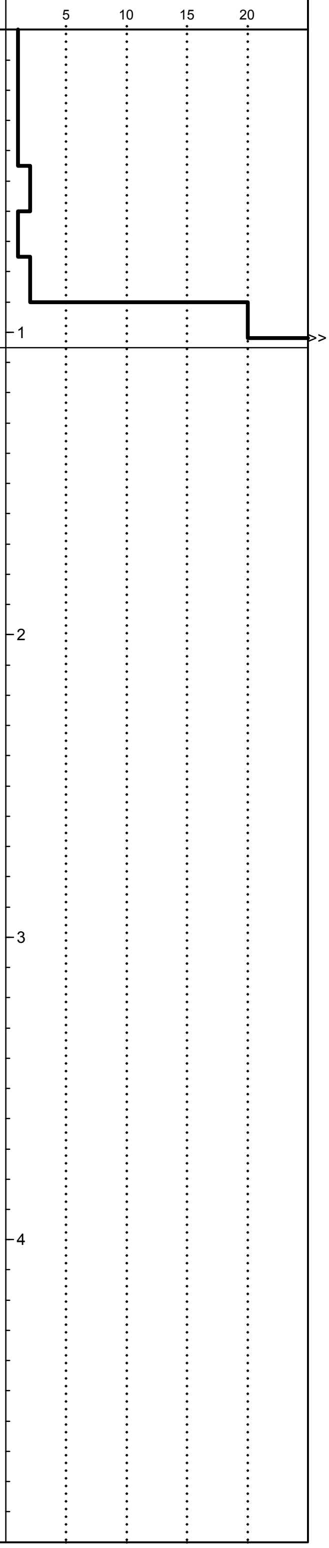
SURFACE LEVEL: 69.2 AHD
EASTING: 337466
NORTHING: 6253879
DIP/AZIMUTH: 90°/--

BORE No: UA14
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING: dark brown silty sand filling with rootlets and organics, damp		A/E	0.0–0.1			
		at 0.1m: becoming brown sand with some clay and silt and rootlets, damp		E	0.2–0.3			
				A/E	0.4–0.5			
70		at 0.75m: dark grey silty sand filling, wet						▼ (0.75m)
	1			A/E	0.9–1.0			
	1.05	Bore discontinued at 1.05m due to hand-auger refusal						

RL scale: 70, 71, 72, 73. Depth scale: 1, 2, 3, 4.

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 1.05 m
WATER OBSERVATIONS: Groundwater observed at 0.75m
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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

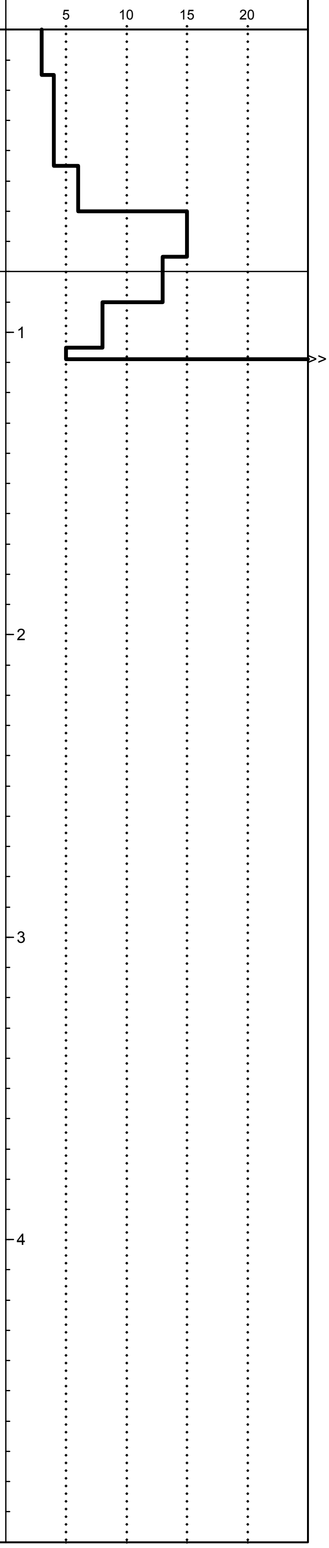
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 69.4 AHD
EASTING: 337473
NORTHING: 6253891
DIP/AZIMUTH: 90°/--

BORE No: UA15
PROJECT No: 86625.00
DATE: 27/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING: dark brown silty sand filling with rootlets, organics, damp		A/E	0.0–0.1			
70				A/E	0.4–0.5			
	0.8	- at 0.7m: some sandstone gravel		A/E	0.7–0.8			
		Bore discontinued at 0.8m due to hand-auger refusal						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.8 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

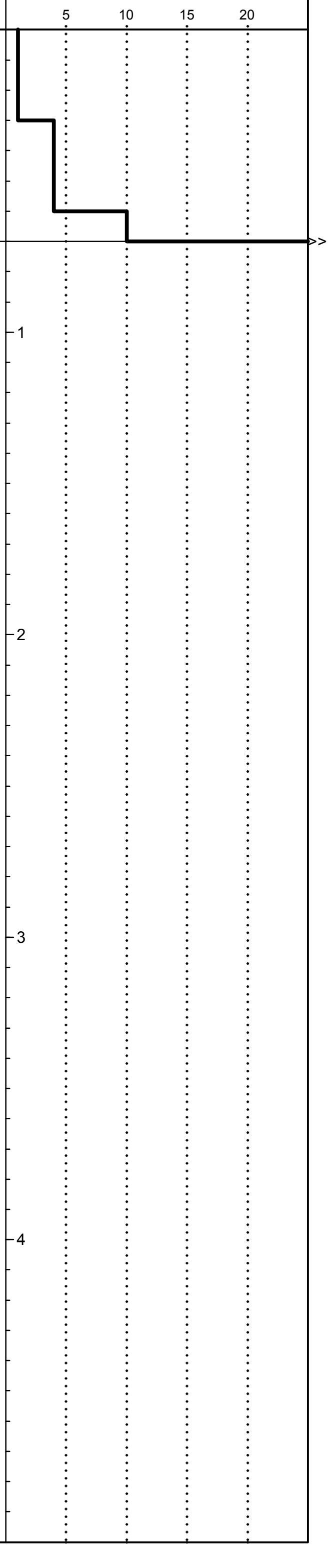
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 67.9 AHD
EASTING: 337508
NORTHING: 6253876
DIP/AZIMUTH: 90°/--

BORE No: UA16
PROJECT No: 86625.00
DATE: 29/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
68		FILLING: dark grey sandy clay filling with some silt, rootlets, wood chips, organics, damp - at 0.3m: becoming dark brown gravelly sand		A/E	0.0 0.1			
				A/E	0.5 0.6			▼
	0.7	Bore discontinued at 0.7m due to hand-auger refusal						
69	1							
70	2							
71	3							
	4							

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.7 m
WATER OBSERVATIONS: Groundwater observed at 0.65m
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)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

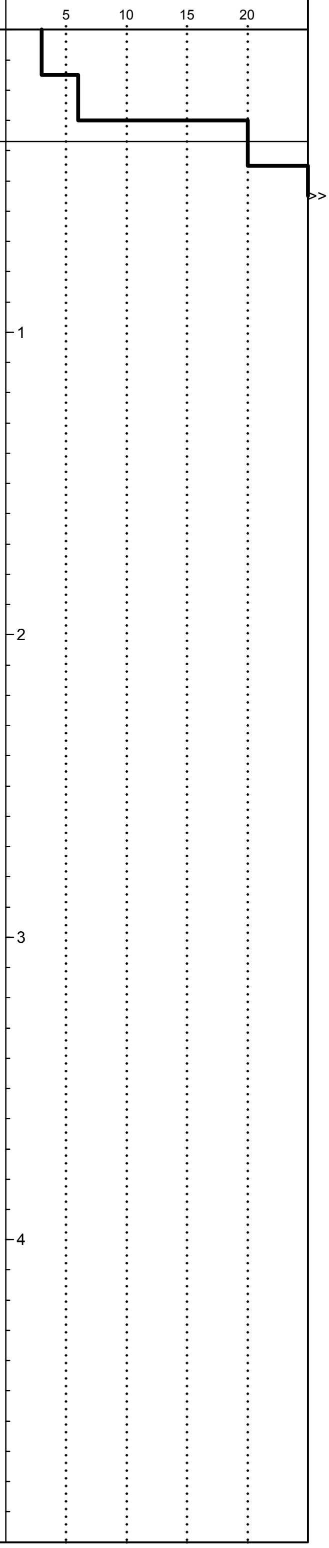
CLIENT: Taronga Conservative Society Australia
PROJECT: Upper Australia Habitat Redevelopment
LOCATION: Taronga Zoological Park, Bradleys Head Road, Mosman

SURFACE LEVEL: 67.3 AHD
EASTING: 337521
NORTHING: 6253866
DIP/AZIMUTH: 90°/--

BORE No: UA17
PROJECT No: 86625.00
DATE: 29/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING: brown sand filling with some clay and a trace of fine grained gravel, moist - at 0.15m: dark brown silty sand with some clay and a trace of sandstone gravel, humid		A/E	0.0–0.15			
				A/E	0.25–0.35			
	0.37	Bore discontinued at 0.37m due to hand-auger refusal						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **DRILLER:** Roshan Bhetwal **LOGGED:** Roshan Bhetwal **CASING:** -
TYPE OF BORING: Hand auger to 0.37 m
WATER OBSERVATIONS: No free ground water 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)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix D

Photo Plates

Photo 1: Drilling of borehole UA1

Photo 2: Excavation of sandstone in the Taronga House development

Photo 3: Sandstone floaters within the gardens of the Marsupial enclosure

Photo 4: Retaining wall between the wetlands and the Plaza

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Taronga Conservation Society Australia		TITLE: **Geotechnical Investigation: Photos 1 - 4**	PROJECT No: 86625.00
	OFFICE: Sydney	DRAWN BY: PGH	**Upper Australia Habitat Redevelopment**	PLATE No: 1
	SCALE: N/A	Dec-18	**Taronga Zoo, Bradleys Head Road, Mosman**	REVISION: 0

Photo 5: Paved pathway near the Koala exhibit

Photo 6: Asphalt pathway near the Nocturnal House

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Taronga Conservation Society Australia		TITLE: **Geotechnical Investigation: Photos 5 - 6**	PROJECT No: 86625.00
	OFFICE: Sydney	DRAWN BY: PGH	**Upper Australia Habitat Redevelopment**	PLATE No: 2
	SCALE: N/A	Dec-18	**Taronga Zoo, Bradleys Head Road, Mosman**	REVISION: 0