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Project 35470.08
26 August 2019
35470.08.R.001.Rev1
DEM:mm

Attention: Mr Stephen Girdis

Dear Sir

Geotechnical Assessment for New Boat Shed
967 Barrenjoey Road, Palm Beach

1. Introduction

This report presents the results of a geotechnical assessment carried out for a proposed new boatshed at 967 Barrenjoey Road, Palm Beach. The proposed work will include demolition of the existing boatshed and the construction of a new boat shed. The work was carried out at the request of Mr Stephen Girdis, on behalf of SMJ Investments Pty Ltd, owner of the property.

Douglas Partners Pty Ltd (DP) has previously undertaken a series of investigations and geotechnical assessments on 967 Barrenjoey Road since 2003. The results of a 2016 assessment are provided in our report 35470.05.R.001.Rev0 dated 5 April 2016. DP understands this report has been submitted to Northern Beaches Council in support of an approved Development Application (DA) for a proposed new residence (DA NO272/16 and Mod 2018/0387).

The current assessment comprised re-inspection of the site, a review of the previous geotechnical reports, and reference to the design drawings for the proposed boatshed. This report aims to provide information on subsurface conditions for the boatshed and for DA purposes, in accordance with requirements of Northern Beaches (Pittwater) Council's Geotechnical Risk Management Policy (GRMP) of December 2009.

2. Site Description and Geology

The site is located at 967 Barrenjoey Road Palm Beach, on the low, western side of the road and extends downslope to the Pittwater foreshore.

The allotment is an irregularly shaped area of 727 m^2 with a total frontage to Barrenjoey Road of approximately 24 m and a foreshore frontage of approximately 20 m. The site slopes steeply down to the Pittwater foreshore with a difference in elevation of approximately 18.7 m from the road kerb (21.0 AHD) to the paved terrace adjoining the timber deck at the foreshore (2.3 AHD).

The site is bounded by residential properties to the north (No.969) and south (No. 965). A drainage easement lies within a natural gully line beyond (north of) 969 Barrenjoey Road.

The site is occupied by a residence on the central part of the site with most of the site covered by the existing site developments. The existing structures comprise a dilapidated timber residence, steps, retaining walls and paved areas, with substantial sections of the site covered by sandstone flagging.

Earlier inspections of the site have identified highly weathered, open jointed sandstone outcropping behind the timber boatshed at the foreshore (much of this area of the site is now covered with thick vegetation). This outcrop extends upslope beside the pathway leading to the foreshore area. The outcrop also extends across the slope at the foreshore level, behind the boatshed on the adjoining southern property (965 Barrenjoey Road) where the rock is moderately weathered, open jointed sandstone with detached joint blocks and some large floaters (again, presently covered with thick vegetation).

Reference to the Sydney 1:100 000 Geological Series sheet indicates that the site is underlain by rocks of the Newport Formation which are the upper unit of the Narrabeen Group. These rocks are of Triassic age and typically comprise interbedded shale, laminite and lithic to quartz lithic sandstone.

3. Field Work and Site Observations

The field work upon which the current report is based comprised a re-inspection of the site on 16 August 2019, and earlier site inspections on 22 March 2016, 23 June 2015, 8 July 2013 and August 2008.

The main site observations from the recent re-inspection of the site as well as the salient points from previous site inspections and work are:

- the site slopes steeply from Barrenjoey Road to the Pittwater foreshore at an average slope angle of 30^{o}. Across 967 Barrenjoey Road, the slope comprises a series of brick and stone retaining structures, paved pathways and sandstone flagging faced batters;
- the sandstone flagging on the slope above the residence has slumped against the rear of the residence (the failure has occurred sometime between July 2013 and June 2015);
- most, if not all, of the remaining structures on 967 Barrenjoey Road exhibit evidence of minor downslope creep movement. The structures include: the existing residence (the foundations of which have moved with some pillars rotated), brick and sandstone garden retaining walls (which are cracked and rotated), paving (which has settled) and cracking of the sandstone flagging on the lower slope batters;
- there does not appear to have been any significant, additional creep movement or crack damage to the existing structures on the site since DP's previous inspection in 2016; and
- the existing, semi-completed sandstone block and concrete sea-wall appears to be in a satisfactory condition.

The locations of selected site features in the near-vicinity of the proposed boat shed are shown on Drawing 1.

4. Proposed Development

It is understood that the proposed boat shed development (to be built concurrently with the approved residence, swimming pool and landscaping) will comprise:

- demolition of existing boat shed;
- excavation into the hillside at the Pittwater foreshore to construct a new boat shed with a garden roof-top measuring approximately 5.5 m by 4 m in plan dimensions, and associated permanent retaining walls; and
- the retention and completion of the existing sandstone block and concrete sea-wall to support the shoreline and a new timber deck.

The maximum depth of excavation into the hillside required for the new boat shed is expected to be in the order of 4 m to 5 m below existing ground levels.

5. Comments

5.1 Geological Model

The interpreted geological model for the site comprises a steep slope with a surface mantle of colluvium and a residual clayey sand/sandy clay soil profile (typically ranging from less than 1 m to about 3 m deep, but locally deeper) underlain by very low then medium and high strength bedrock (which possibly steps down the slope).

Based on outcrops visible by the Pittwater foreshore, it is expected that at least the lower section of the excavation for the proposed boat shed will be in sandstone bedrock, possibly with some shale interbeds. Some overland stormwater flow would be expected to occur at or above the soil and rock interface following heavy or prolonged rainfall.

Refer to Drawing 2 for an inferred geological section through the location of the proposed new boat shed.

5.2 Stability and Slope Risk Assessment

Inspection of the general slope on the site indicated no evidence of significant natural slope instability in the recent past. There has however, been a slumping failure of the sandstone flagging covering the slope above the existing residence and other evidence of downslope creep movement of the near surface soils.

The presence of large floaters mid-slope on and adjoining the site indicate past detachment and movement of large sandstone joint blocks from further upslope (possibly from above Barrenjoey Road). However, it is considered that the likelihood of similar natural rock falls affecting the property in its existing condition is "rare to barely credible" for the life of the proposed structures.

There is evidence of ongoing settlement/consolidation of some areas of filling behind existing retaining structures, as well as ongoing creep of the upper level soils and colluvium, as evidenced by rotation of landscaping walls and cracking of sandstone flagging surfaces of the lower batters.

The site soils will be susceptible to erosion where disturbed and care will be required to ensure concentrated surface flows are not created. Recommendations for stormwater disposal are presented in Section 5.8.

The hazards above and on the site have been assessed for risk to property and life using the general methodology outlined by the Australian Geomechanics Society - Landslide Risk Management Subcommittee, 2007.

Identified hazards are summarised in Table 1, together with qualitative assessment of likelihood, consequence and slope instability risk to property after completion of construction (including appropriate engineering design and construction works). These hazards are the same as those previously assessed for the approved residential development for the site.

Table 1: Property Slope Instability Risk Assessment for Proposed Site Development (including proposed Boat Shed)

Hazard	Likelihood	Consequence	Risk
Overflow of stormwater onto the site from Barrenjoey Road and surface erosion	Rare, following construction of proposed retaining/slope protection measures and adequate road maintenance	Property - Minor	Very Low
Failure of temporary shoring during construction	Unlikely, for properly designed and constructed structure	Property – Medium	Low
Failure of final excavation support	Rare for properly designed and constructed structure	Property – Medium	Low
On-going creep of colluvium and soils	Unlikely, following construction of appropriate retaining walls and other landscaping measures	Property – Minor to Medium	Very Low to Low

For loss of life, the individual risk can be calculated from:

$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$

where:

$R_{(LoL)}$ *is the risk (annual probability of loss of life (death) of an individual)*

$P_{(H)}$ *is the annual probability of the hazardous event (erosion/ wall failure)*

$P_{(S:H)}$ *is the probability of spatial impact by the hazard (e.g. of the failure reaching the residence the taking into account the distance for a given event)*

$P_{(T:S)}$ *is the temporal probability (e.g. of the adjacent area being occupied by the individual) given the spatial impact*

V(D:T) *is the vulnerability of the individual (probability of loss of life of the individual given the impact*

The assessed individual risk to life (person most at risk) resulting from slope instability is summarised in Table 2.

Table 2: Life Risk Assessment for Proposed Development (including proposed Boat Shed)

Hazard	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	Risk $R_{(LoL)}$
Overflow of stormwater onto the site from Barrenjoey Road and surface erosion	1×10^{-5}	0.5	0.5	0.05	1.25×10^{-7}
Catastrophic failure of final excavation support	1×10^{-6}	1.0	0.75	1.0	7.5×10^{-7}
Movement of retaining walls or foundations supporting proposed structures	5×10^{-5}	0.2	0.5	0.01	5×10^{-8}
On-going creep of colluvium and soils.	5×10^{-5}	0.2	0.5	0.01	5×10^{-8}

When compared to the requirements of the AGS, it is considered that the proposed development meets 'Acceptable Risk Management' criteria with respect to both property and life under current and foreseeable conditions.

Provided the construction is undertaken in accordance with the recommendations contained in this report, the construction of the proposed boat shed would be expected to not adversely affect the overall stability of the site or negatively influence the geotechnical hazards identified in Tables 1 and 2.

5.3 Excavation Conditions

Inspection and investigation has indicated that the excavation for the proposed boat shed is expected to encounter both colluvial and residual soils, together with the underlying bedrock.

The upper colluvium and soil materials, down to the level of low to medium strength sandstone, should be readily excavated using conventional earthmoving equipment; however, any large sandstone floaters encountered would most likely to require the use of rock breaking equipment to break the boulders down to a manageable size for removal from site. Medium and high strength sandstone

bedrock, if encountered, would require the use of rock sawing, rotary milling head or rock breaking equipment to remove the rock.

The previous field work did not encounter any groundwater during auger drilling of the bores and the use of drilling fluid when coring thereafter precluded subsequent observation. However, it is anticipated that seepage will be present through the upper soils, at the upper soil/rock surface and from jointing within the bedrock. Seepage will be present both during the excavation work and for the life of the structure. During construction any seepage should be readily controlled by the use of strategically sited sumps and intermittent pumping.

Under current practice for the disposal of excavated materials, it is likely that environmental testing of the excavated material for waste classification purposes will be required to determine the suitability of the material for disposal at a licensed landfill, or for re-use on third party sites.

5.4 Excavation Vibration

It is possible that vibration monitoring may be required to ensure that vibrations generated during the proposed excavation are reduced to limit potential damage to structures on adjacent properties. It is suggested that a dilapidation survey of structures on adjacent properties be carried out to document the existing condition and any damage present before excavation commences. Any dilapidation survey of adjacent structures which may be affected, should be carried out prior to commencement of site preparation, demolition and excavation works.

Provisional Allowed Vibration Limit

From current information, it is considered likely that the residence on the adjacent southern site can withstand vibration levels higher than those required to maintain the comfort of the occupants. A human comfort criterion is therefore indicated and the peak particle velocity in any direction i (PPVi), is proposed as the control parameter. It is recommended that a Provisional Allowed Vibration Limit of 8.0 mm/sec PPVi be set during normal working hours, measured at foundation level of the potentially affected building.

Excavation Plant

DP maintains a database of vibration trial results which can provide guidance for the selection of plant. Trial data is dependent on site conditions and equipment, hence actual vibration levels may differ from predictions and a specific trial is recommended at the commencement of rock excavation. The database suggests that buffer distances within the ranges shown below should be maintained between excavation plant and the adjacent buildings. These estimates should be examined in relation to the distances between adjacent building(s) and the proposed excavation footprint, in order to select suitable plant.

Table 3: Approximate Buffer Distances for Excavation Plant

Provisional Allowed Vibration Limit:	8 mm/s PPVi	
Excavation Plant	Buffer Distance[1]	
	(from trial maxima) [1]	(from trial averages)
Rock Saw on Excavator[2]	0.8 m	0.4 m
Ripper on 20t Excavator	2.5 m	0.9 m
Rock Hammer < 500 kg operating weight	5.6 m	2.2 m
Rock Hammer 501 - 1000 kg operating weight	6.3 m	2.6 m
Rock Hammer 1001 - 2000 kg operating weight	9.7 m	4.3 m

1. Smaller distances can generally be determined from individual trials, as indicated by those from trial averages.
2. Loading effects from buildings may reduce vibration levels, to enable boundary saw cuts with few exceedances.

5.5 Excavation Support and Retaining Structures

It is recommended that all proposed retaining walls be engineer designed in accordance with the following suggested parameters.

Table 4: Summary of Retaining Wall Design Parameters

Material	Coefficient of Active Earth Pressure (Ka) *	"At rest" Coefficient of Earth Pressure (Ko) *	Unit Weight (kN/m^3)
Filling - uncompacted - compacted	0.4 0.3	0.6 0.45	20
Colluvium/sandy clay	0.35	0.5	20
Extremely to Highly Weathered Bedrock - very low strength	0.2	0.3	22

* Allowance will need to be incorporated to accommodate the slope of the site and any additional surcharge loads.

All retaining structures will need to be designed taking into consideration additional loads due to any adjoining structures and any surcharges due to external loads. They should be founded on in situ bedrock and should be designed to incorporate free draining backfill material behind the structure and appropriate subsoil drainage to discharge all seepage and groundwater collected within the backfill material and to prevent water pressure building up behind the wall.

5.6 Acid Sulphate Soil (ASS) Considerations

Reference to the Broken Bay Acid Sulphate Soil Risk Map (Department of Land and Water Conservation - Edition 2, dated December 1997) indicates the bottom estuarine sediments within the adjacent area of Pittwater to have a “high risk” of ASS.

All bulk and detailed footing excavations proposed for the proposed boat shed will be located well upslope (east) of the existing seawall. It is therefore not expected that the proposed excavations will intersect any estuarine soils along the Pittwater foreshore.

Accordingly, it is considered that preparation of an Acid Sulphate Management plan is not required for the proposed development.

5.7 Foundations

Based on the results of the previous investigations, it is expected that the deepest section of the excavation into the hillside for the proposed boatshed will probably reach bedrock of at least low to medium strength.

It is recommended that all foundations be taken down and socketed into insitu bedrock of uniform strength to minimise the potential for differential settlement across the proposed structures and top resist downhill creep of the near surface soils.

Suggested design parameters for new footings are provided in Table 5 below.

Table 5: Recommended Design Parameters for Bored Piles and Spread Footings

Strata	Allowable (Serviceability)	
	End Bearing Pressure (kPa)	Shaft Adhesion (kPa)
Low strength bedrock	1500	150
Medium to high strength bedrock	3500	350

For uplift loads it is recommended that the shaft adhesion values given in Table 5 should be reduced by 0.75, and if short piles are used then a check should be made for a potential cone failure in uplift.

It is recommended that all foundation excavations be inspected by an experienced engineering geologist to confirm the actual conditions on site are in accordance with the interpretations and assumptions made in this report.

5.8 Drainage and Stormwater Control

It is recommended that the proposed works include stormwater and subsoil drainage control measures. Such measures are very important to the maintenance and improvement of the stability of

the site, particularly of the colluvium and soils remaining on the slope, as well as the amenity of below ground sections of the boat shed.

Appropriately sized grate-covered surface drainage should be installed with lined catch drains at the crest of slopes and batters with subsoil drains behind all retaining walls. All collected water should be directed by pipe-work to approved and controlled discharge points (most likely located along the Pittwater foreshore). All pipes and drainage lines should include inspection ports to permit periodic maintenance and cleanout by the owners.

6. Conditions Relating to Design and Construction Monitoring

To comply with Northern Beaches (Pittwater) Council conditions and to enable the completion of Pittwater Forms 2b and 3 (which are required as part of the construction, building and post-construction certificate requirements of the GRMP), it will be necessary for DP to:

- review the geotechnical content of all structural drawings (Form 2b requirement); and
- progressively inspect all new footing excavations and bulk excavations into the slope to confirm compliance to design with respect to allowable bearing pressure and stability, and inspect retaining wall drainage measures (Form 3 requirement).

7. Design Life and Requirement for Future Geotechnical Assessments

Douglas Partners Pty Ltd interprets the reference to design life requirements specified within the GRMP to refer to structural elements designed to retain the subject slope and maintain the risk of instability within acceptable limits.

Specific structures that may affect the maintenance of site stability in relation to the proposed development on this site are considered to comprise:

- existing (and any proposed) stormwater surface drains and buried pipes leading to the stormwater disposal system; and
- existing and proposed retaining walls on the site.

In order to attain a structural life of 100 years as required by the Council Policy, it will be necessary for the structural engineer to incorporate appropriate construction detailing and for the property owner to adopt and implement a maintenance and inspection program. A typical program for developments on sloping sites is given in Table 6.

Table 6: Recommended Maintenance and Inspection Program

Structure	Maintenance/Inspection Task	Frequency
Drainage lines	Inspect to ensure lines are flowing and not blocked.	Every 2 years or following each significant rainfall event.
Drainage pits	Inspect to ensure that pits are free of debris and sediment build-up. Clear surface grates of vegetation/litter build-up.	During normal grounds maintenance and following each significant rainfall event.
Retaining walls	Inspect walls for the presence of cracking or rotation from vertical, or as-constructed condition	Every 5 years or following each significant rainfall event.
General slopes	Inspect slopes and batters for indications of movement which may comprise tension cracks, backscarps of freshly exposed soil.	Every 2 years or following each significant rainfall event.

Where changes to site conditions are identified during the maintenance and inspection program, reference should be made to a relevant professional (e.g. structural engineer or geotechnical engineer).

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 967 Barrenjoey Road, Palm Beach in accordance with the email request received from Mr Stephen Girdis of SMJ Investments Pty Ltd on 14 August 2019. The work was carried out under DP Conditions of Engagement and this report is provided for the exclusive use of SMJ Investments Pty Ltd for the specific project and purpose as described in the report. It should not be used by or relied upon for other projects or purposes on the same or another site or by a third party.

The results provided in the report are considered to be indicative of the sub-surface conditions on the site only to the depths observed, and only at the time the work was carried out. DP's advice is based on observations, measurements and derived interpretations. The accuracy of the advice provided by DP in this report is limited by unobserved features and variations in ground conditions across and beyond the site boundaries or by variations with time. The advice may be limited by restrictions in the observations which were able to be carried out, as well as by the amount of data that could be collected given the project and site constraints.

Actual ground conditions and materials behaviour observed or inferred may differ from those which may be encountered elsewhere on the site. If variations in subsurface conditions are encountered, then additional advice should be sought from DP and, if required, amendments made.

The contents of this report do not constitute formal design components, such as are required by Health and Safety Legislation and Regulations to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. This report does, however, identify hazards associated with the geotechnical aspects of development and presents the results of risk assessment associated with the management of these hazards. It is suggested that the developer's principal design company may wish to include the geotechnical hazards and risk assessment information contained in this report, in their own Safety Report. If the principal design company, in the preparation of its project Design Report, wishes to undertake such inclusion by use of specific extracts from this subject DP report, rather than by appending the complete report, then such inclusion of extracts should only be undertaken with DP's express agreement, following DP's review of how any such extracts are to be utilised in the context of the project Safety Report. Any such review shall be undertaken either as an extension to contract for the works associated with this subject DP report or under additional conditions of engagement, with either option subject to agreement between DP and the payee

This report must be read in conjunction with the attached notes "About This Report" and any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions from review by others of this report or test data, which are not otherwise supported by an expressed statement, interpretation, outcome or conclusion stated in this report. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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.

We trust that these comments are sufficient for your present requirements. If further assistance is required, please do not hesitate to contact the undersigned.

Yours faithfully
Douglas Partners Pty Ltd

David Murray
Senior Associate/Senior Engineering Geologist

Reviewed by

Fiona MacGregor
Principal

Attachments: Notes "About this Report"
Drawings 1 and 2
AGS Appendix C "Landslide Risk Management Concepts and Guidelines"
Pittwater Council Geotechnical Forms 1 and 1A

About this Report

Douglas Partners

Introduction

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

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

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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.

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

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.

0 1 2 3 4 5 7.5 10m

1:100 @ A3

PROPOSED SMALLER TREES (Banksia integrifolia, Tristaniopsis laurina, Plum Pine)

DEMOLITION OF POOL APPROVED BY CROWN LANDS

RETAINIG WALLS AND TREES AS APPROVED IN MOD2018/0387

EXISTING SANDSTONE BLOCK AND CONCRETE SEA WALL APPEARS TO BE IN A SATISFACTORY CONDITION

APPROVED POOL OUTLINE MOD2018/0387

(15.4m²) By Lease

JETTY HINGE LOCATION

APPROX. LINE OF TOE OF BATTERED SEAWALL

(23.8m²) By Lease

(11m²) By

POOL

NOT

TIMBER PILE

R=0.35

EXISTING DECKING

TIMBER PILE

2.5

TIMBER SHED

FIBROUS CEMENT ROOF

MEAN HIGH SHED

PROPOSED BOATSHED

GARDEN ROOF TOP

METAL ROOF

CONCRETE BATTER

METAL POOL

CONCRETE POOL

WATER

SURROUND

BOTTOM

TOP

STONE BATTER

BANK

PAVING

CONCRETE STAIRS

TREE D:0.7 S:6 H:5

TREE D:0.6 S:8 H:5

STONE PAVE SHELF

PEBBLE CRETE POOL

FENCE

TOP OF BANK

NOT FENCED

TIMBER DECKING

A

A'

NOTE:
1: Base drawing from Blue Sky Building Design Pty Ltd (Proj. 2018074, dated 12.6.2019)

LEGEND

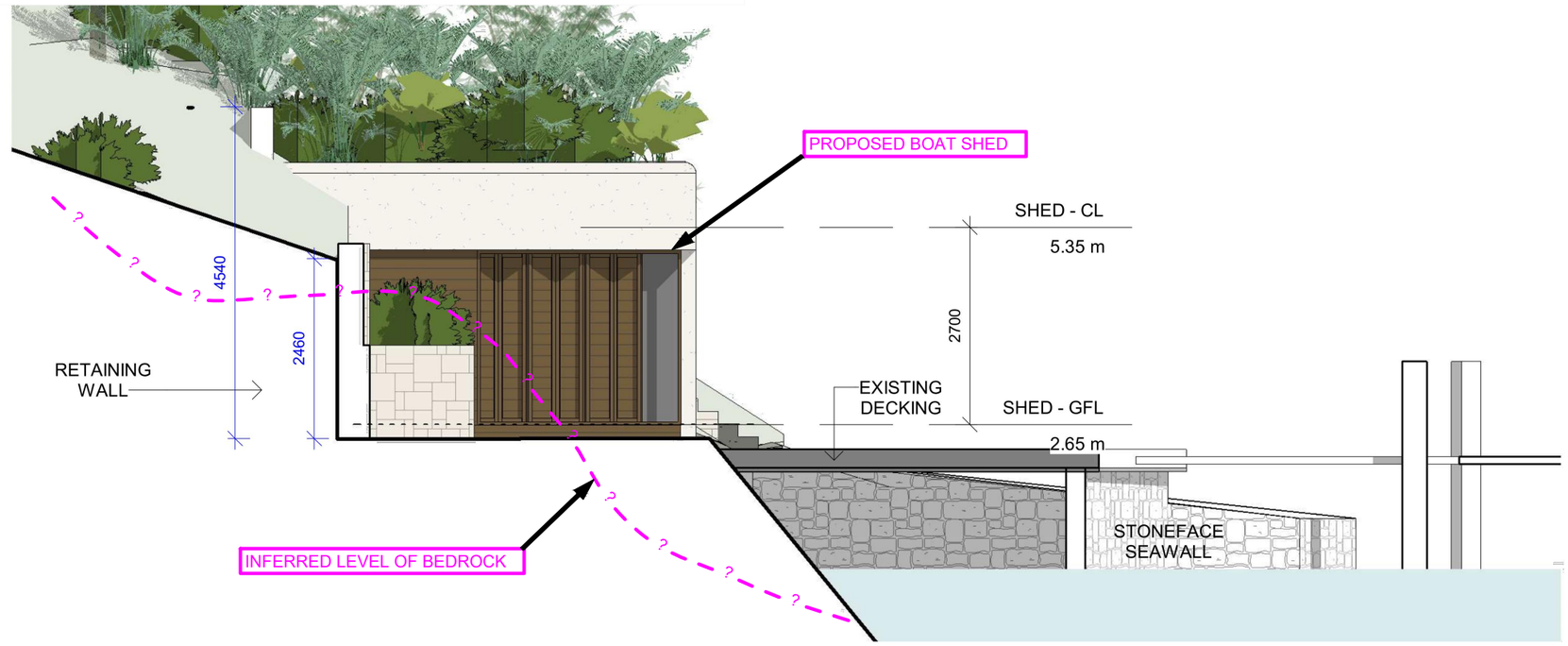
Bedrock outcrop

Cross Section A-A' (refer to Drawing 1)

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Mr Stephen Girdis	TITLE: **Geotechnical Features**	PROJECT No: 35470.08
	OFFICE: Sydney / DRAWN BY: PSCH	**Proposed Boat Shed**	DRAWING No: 1
	SCALE: 1:100 @ A3 approx. / DATE: 21.8.2019	**967 Barrenjoey Road, PALM BEACH**	REVISION: 0

A

A'



NOTE:
1: Base drawing from Blue Sky Building Design Pty Ltd
(Proj. 2018074, dated 12.6.2019)
2: Refer to Drawing 1 for location of Cross Section A-A'

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Mr Stephen Girdis		TITLE: **Cross Section A-A'**	PROJECT No: 35470.08
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Boat Shed**	DRAWING No: 2
SCALE: 1:75 @ A3 approx.	DATE: 21.8.2019	**967 Barrenjoey Road, PALM BEACH**	REVISION: 0

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

PITTWATER COUNCIL

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1 – To be submitted with Development Application

Development Application for MR Stephen Girdis
Name of Applicant

Address of site 967 Barrenjoey Road Palm Beach

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, Fiona MacGregor *on behalf of* Douglas Partners Pty Ltd
(Insert Name) (Trading or Company Name)

on this the 22 August 2019 certify that I am a geotechnical engineer or engineering geologist or coastal engineer as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $2million.
I have:

Please mark appropriate box

☐ Prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☑ I am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☐ Have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.

☐ Have examined the site and the proposed development/alteration in detail and am of the opinion that the Development Application only involves Minor Development/Alterations that do not require a Detailed Geotechnical Risk Assessment and hence my report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements for Minor Development/Alterations.

☐ Provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: Geotechnical Assessment - Proposed Boat Shed
Report Date: 22 August 2019 - Project 35470.08
:
Author: David Murray
Author's Company/Organisation: Douglas Partners

Documentation which relate to or are relied upon in report preparation:

Drawings A101 - 103, A111 by Blue Sky Design

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ..F MacGregor.....
Name Fiona MacGregor
Chartered Professional Status CPEng
Membership No. 370757
Company Douglas Partners Pty Ltd

PITTWATER COUNCIL

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1(a) - Checklist of Requirements For Geotechnical Risk Management Report for Development Application

Development Application for Mr Stephen Girdis
Name of Applicant

Address of site 967 Barrenjoey Road, Palm Beach

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Geotechnical Assessment - Proposed Boat Shed
Report Date: 22-8-19 Project 35470.08
Author: David Murray
Author's Company/Organisation: Douglas Partners

Please mark appropriate box

- ☑ Comprehensive site mapping conducted 16-8-19, 2016, 2015, 2013, 2008 (date)
- ☑ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
- ☑ Subsurface investigation required
  - ☑ No Justification ..... Previous investigations + outcrop
  - ☐ Yes Date conducted .....
- ☑ Geotechnical model developed and reported as an inferred subsurface type-section
- ☑ Geotechnical hazards identified
  - ☑ Above the site
  - ☑ On the site
  - ☐ Below the site
  - ☐ Beside the site
- ☑ Geotechnical hazards described and reported
- ☑ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
  - ☑ Consequence analysis
  - ☑ Frequency analysis
- ☑ Risk calculation
- ☑ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
- ☑ Design Life Adopted:
  - ☑ 100 years
  - ☐ Other ..... specify
- ☑ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified
- ☑ Additional action to remove risk where reasonable and practical have been identified and included in the report.
- ☐ ~~Risk assessment within Bushfire Asset Protection Zone.~~

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ..... MacGregor
Name ..... Fiona MacGregor
Chartered Professional Status ..... CPEng
Membership No. 370757
Company ..... Douglas Partners Pty Ltd.