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Geotechnical Assessment, Proposed Swimming Pool and Spa
13a Ocean Road, Palm Beach

1. Introduction

This letter report presents a geotechnical assessment of the site of a proposed swimming pool and spa at 13a Ocean Road, Palm Beach by Douglas Partners Pty Ltd (DP). The work was carried out for Michele and Trevor Matthews, property owners, acting under instructions from MacCormick and Associates Architects.

It is understood that this report will accompany a Development Application (DA) to Northern Beaches Council and has therefore been compiled to comply with the Council's 'Geotechnical Risk Management Policy' (GRMP) dated July 2009 (Reference 1). The GRMP-2009 identifies the site as lying within Hazard Zone H1.

The assessment comprised a review of previous geotechnical inspections of the property and adjacent areas in between July 2016 and April 2019. Reference has also been made to the following documents:

- Design Drawings Project 1408, DA02.02, DA05.01 and DA05.02, (all Revision A dated 8 March 2019) by MacCormick and Associates Architects;
- Survey Plan Dwg 12212detail (Revision 4 dated 1 July 2016) by C.M.S. Surveyors Pty Ltd;
- DP reports and memos - Projects 11563, 11653B, 11653C and 11653D (dated between 1988 and 1993);
- DP Report 85471.01.R.001.Rev0 dated 2 August 2017, which accompanied a DA to Northern Beaches Council for a proposed secondary residence on the upper slope; and
- DP memos dated 25 February 2019 and 12 April 2019 which summarise site inspections of construction works for the secondary residence between December 2018 and April 2019.

Comments relating to geotechnical design issues and constraints are given below and are based on the results of our site inspections and the information shown in the above documents.

2. Site Description and Geology

The site is a trapezoid shaped residential lot (Lot 1 D.P. 121833), with major plan dimensions of around 55 m by 17 m. The site is located opposite the beachfront on the western (high) side of Ocean Road. It is bounded by residential lots to the south, south-west and north and by Sunrise Road to the west. The lower, eastern section of the lot to the north of the site is undeveloped and bush covered.

There is a total fall in elevation across the site to the east from the western boundary to the edge of the road reserve along Ocean Road in the order of 36 m (RL 42 m to RL 6 m AHD), resulting in an overall average slope angle of approximately 32°. Much of this fall in elevation occurs within a 10 m to 12 m high shotcrete covered face behind the existing residence near the Ocean Road frontage and within a 3 m to 4 m high, irregular sandstone cliff line which is located approximately mid-level on the site.

The shotcrete covered face is sub-vertical over its lowest 3 m, with a typical batter angle between 60^0 to 75^0 from horizontal above that height.

Current improvements comprise a one and two storey concrete block and steel clad residence with a metal roof which is located at the lower, eastern end of the lot (below the shotcrete covered face). Early site clearing and civil works for a proposed secondary dwelling on upper, western section of the site (mid-slope between the shotcrete covered face and Sunrise Road) have been underway since late 2018.

Reference to the Sydney 1:100 000 Geological Series Sheet 9130 indicates that the site is underlain by the Narrabeen Group of rocks but is close to the boundary with the overlying Hawkesbury Sandstone. Both formations are of Triassic age, the Narrabeen Group comprising interbedded sandstones, siltstones and shales and the Hawkesbury Sandstone generally comprising medium to coarse grained quartz sandstone.

The current and previous geotechnical investigations of the site have confirmed the geological mapping with medium grained sandstone exposed within the cliff-line on the upper (western) section of the site and as detached boulders on the upper slope. This rock is considered to be consistent with the Hawkesbury Sandstone. The description of interbedded sandstone, shale and siltstone reportedly encountered within the lower section of the excavated rock face (now covered in shotcrete) is considered to be consistent with Narrabeen Group rocks.

3. Original Site Investigations and Slope Stabilisation Works

DP undertook a geotechnical assessment and a design review in relation to the construction of the existing residence and the stabilisation of the excavated face within the hillside. The work was undertaken for a former owner of the site between 1988 and 1993.

A review of the original structural design drawings held in our files infers that the existing residence was designed to be supported by pad footings which are founded on bedrock with an allowable bearing pressure (ABP) of 800 kPa, with the front eastern wall of the residence supported on piles to

bedrock. The drawings indicate that a retaining wall along the eastern site boundary is founded on a strip footing in 'clay' soils.

Geological mapping by DP at the time indicated that bedrock exposed within approximately the upper half of the excavated rockface behind the residence comprised a sandstone unit. Approximately half of the lower face was mapped as comprising interbedded sandstone, shale and siltstone (described on design drawings as 'shale').

Design drawings and notes held in our records indicate that the excavated rockface behind the residence has been protected with a 75 mm thick layer of reinforced shotcrete. The drawings and notes infer that the rockface (behind the shotcrete) has been stabilised with approximately thirty two permanent rock anchors and dowels. DP is not in possession of any 'work as executed' drawings for the anchors or dowels

A retaining wall and a dish drain are indicated to lie along the crest of the shotcrete covered face.

4. Field Work

The current area of proposed development above the shotcrete wall has been inspected by a senior engineering geologist on five occasions between 18 May 2016 and 12 April 2019.

The main site observations made during the inspections of the site were that:

- the 10 m to 12 m high, shotcrete covered face behind (west of) the residence appears to be in a satisfactory condition with no significant cracking observed within the visible sections;
- there was no evidence of fallen rock or shotcrete fragments along the toe of the shotcrete face;
- there was previously an extensive cover of coastal vine and weeds over the top 3 m to 4 m of the shotcrete face and over its full height at the southern corner. Much of the vine cover had been removed during the most recent inspection of the site;
- there are 20 mm diameter PVC pipe weep holes visible at 2 m to 3 m centres across the central section of the shotcrete face;
- there was no visible evidence of dowels or anchor heads protruding through the shotcrete face or obvious rust patches;
- there is some build-up of brown iron-oxide sludge in the open drains along the toe of the shotcrete face, although the drains and pits at the toe of the face appear to be functional;
- a 300 mm diameter, shotcrete covered pipe runs down the southern end of the face and discharges into a grated stormwater pit behind the south-western corner of the residence;
- there was no evidence of defects or cracking within the masonry sections of the residence that could be attributed to foundation or slope movement;
- the 'mid-level' area of the site, where the new swimming pool and spa is proposed, has a typical slope angle of around 20^0 to 25^0, whilst the slope angle of the uppermost section of the site is around 30^0 to 35^0, locally increasing to 45^0;

- the upper section of the site is characterised by numerous eroded sandstone boulders. Most of the boulders appear to have detached from in-situ bedrock and rotated or slid to their present positions on the slope;
- the detached boulders on the upper slope display no evidence of imminent instability in their current configurations;

5. Proposed Development

It is understood that the proposed new development will be located between the existing residence on Ocean Road and the secondary dwelling currently under construction on the upper slope, and will comprise:

- a new swimming pool and spa with a plant room, toilet and seating area;
- new stairs extending from Ocean Road to the swimming pool. This may require some excavation into the shotcrete covered face for footings or horizontal dowels to support the stairs;
- new stairs and a cable car extending from the swimming pool to a deck under the secondary residence; and
- general landscaping of the slope

The approximate footprints of the proposed new developments on site are shown on Drawing 1.

6. Comments

6.1 Geological Model

The interpreted geological model for the site comprises a moderate to steeply sloping site, which has been previously modified by the excavation into the lower slope to permit the construction of the existing residence. The available design drawings indicate that the excavated face has been stabilised by rock anchors and dowels and protected by reinforced shotcrete.

The upper section is underlain by sandstone bedrock with some outcropping ledges and a cliff line, with soils depths away from outcrop expected to be typically less than 1 m to 1.5 m. There are detached sandstone boulders on the upper section of the site that have evidently slid or rotated to their present positions during geological time. The base of the sandstone bedrock reportedly extends partially down the excavated rockface (which is now shotcrete covered).

The lower section of the excavated rockface and the area occupied by the existing residence is reportedly underlain by interbedded siltstone, shale and sandstone bedrock. The existing residence was designed to be supported by spread or pile footings founded on bedrock.

6.2 Stability Assessment

Inspection of the general slope on the site indicated no evidence of defects attributable to significant slope instability since the construction of the shotcrete wall and the existing residence.

6.3 Slope Risk Analysis

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

For the purposes of this assessment, an acceptable level of geotechnical risk for property is “Low” while an accepted annual probability of loss of life is 1×10^{-6}.

Identified hazards within and adjacent to the site are summarised in Table 1, together with qualitative assessments of likelihood, consequence and slope instability risk to the existing and proposed residential structures after completion of construction which has had appropriate engineering design and construction methodologies.

Table 1: Property Slope Instability Risk Assessment for Existing and Proposed Developments

Hazard	Likelihood	Consequence	Risk
Collapse of the existing shotcrete stabilised rock face during construction of the proposed developments	Unlikely – provided that regular geotechnical advice is sought in relation to disposal of stormwater generated by the new development	Medium	Low
Downhill creep or rapid failure of footings supporting the proposed new works	Rare – if footings are founded on strata assessed by geotechnical personnel to appropriate with respect bearing pressure and stability	Medium to Major	Low
Rapid collapse of the large detached sandstone boulders on the ‘mid-level’ or ‘upper section’ of the site	Rare – if trial excavations are undertaken around the base of any boulders to be disturbed and the boulders are either underpinned or removed as necessary	Major	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 occurring (failure of the residence footings)
- $P_{(S:H)}$ is the probability of spatial impact by the hazard (e.g. of the failure reaching the residence, taking into account the distance of a given event from the residence)
- $P_{(T:S)}$ is the temporal probability (e.g. of the residence being occupied by the individual) at the time of 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 Existing and Proposed Developments

Hazard	$P_{(H)}$ (1)	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	Risk $R_{(LoL)}$
Collapse of the existing shotcrete stabilised rock face during construction of the proposed developments	10^{-4}	0.5	0.25	0.05	6.25×10^{-7}
Downhill creep or rapid failure of footings supporting the proposed new works	10^{-5}	1	0.25	0.2	5×10^{-7}
Rapid collapse of the large detached sandstone boulders on the 'mid-level' or 'upper section' of the site	10^{-5}	1	0.25	0.2	5×10^{-7}

Note: (1) – $P_{(H)}$ is subject to the same conditions outlined for the likelihood of each hazard in Table 1 above

When compared to the requirements of the Northern Beaches Council and the AGS, it is considered that the existing site and the proposed development meet 'Acceptable Risk Management' criteria with respect to property and life under current and foreseeable conditions.

Provided construction is undertaken in accordance with the recommendations contained in this report, construction of the proposed new residence, garage and retaining walls is not expected to affect the overall stability of the site or negatively influence the geotechnical hazards identified in Tables 1 and 2.

6.4 Site Preparation

Based on the records held by our office, it is expected that any of the excavation into the shotcrete covered face for footings or anchor points will be within sandstone, siltstone or shale bedrock. It is possible that any excavation behind or through the shotcrete could intersect rock anchors or dowels that have been installed into the rock face behind the shotcrete.

Care will be required if rock anchors are encountered to ensure that the anchors have been destressed prior to the cutting of any strands. Additional slope support measures may be required to support the shotcrete wall and these will need to be installed progressively as the existing support measures are removed.

Any anchors/dowels or shotcrete reinforcement mesh that are uncovered but are not removed during the site works will need to be assessed structurally and either replaced or protected to prevent future corrosion.

The builder should excavate trial pits around the sides of the large detached boulder that is lying on the mid-level area of the site. Underpinning of the boulder to in-situ bedrock may be required if the pits indicate that it is currently bearing in soil.

All site works will need to be the subject of regular geotechnical inspections.

6.5 Foundations

All new foundations for the new swimming pool, staircases and retaining walls should be socketed into in in situ weathered sandstone, siltstone or shale bedrock of at least low strength and proportioned for a maximum allowable bearing capacity of 800 kPa. An allowable shaft adhesion of 150 kPa (compression) and 100 kPa (uplift) for sockets greater than 500 mm long is recommended in the same strata.

Based on the results of the site inspection, it is expected that in-situ bedrock will probably be encountered with around 0.5 m to 1 m of the surface on the upper section of the site. Subject to geotechnical inspection, it may be possible to leave some of the smaller detached boulders in place and locate footings for the new structures between the boulders. It is probable that a combination of spread and pile footings may be required to minimise the potential for differential settlement across the new structures.

It may also be necessary to move some of the boulders to elsewhere on the slope if the proposed excavations would otherwise remove a significant proportion of the boulder's mass and potentially destabilise it.

All excavations for new footings should be inspected by an engineering geologist prior to placement of reinforcement and concrete pouring, so as to confirm that intact strata of sufficient bearing capacity and stability has been reached.

6.6 Retaining Structures

Engineer-designed retaining walls should be used to retain all soils, filling or weathered bedrock where space within the boundaries or the prevailing slope angle does not permit permanent batter slopes of 2:1 (H:V) and/or the vertical soil/EW rock face to be retained is more than 1 m in height. The following retaining wall design parameters are suggested where the top of backfill is horizontal:

Table 3: Recommended Retaining Wall Design Parameters

Material	Earth Pressure Coefficient		Bulk Density
	Short term	Long term	
Filling or sandy soils	0.3	0.4	20 kN/m^3
Siltstone or Sandstone - very low to low strength	0.1	0.15	22 kN/m^3
Siltstone or Sandstone – medium strength or stronger	0.0	0.1	22 kN/m^3

It should be noted that no provision has been made in the above design parameters for surcharge loading from sloping backfill or from existing or proposed structures (both on the subject lot or adjacent lots). Similarly, the above design parameters do not allow for water pressures acting on the walls or for adversely orientated jointing within bedrock. Drainage measures such as free draining backfill and discharge points through the wall should be incorporated in any wall design.

6.7 Stormwater Disposal and Site Drainage

There is a potential for significant groundwater seepage from all levels of the hillside, particularly during and following extended periods of wet weather. Some of the soils within the current development footprint have been saturated during previous site inspections along with seepage down the shotcrete covered face.

Therefore, it will be necessary to provide adequate sub-soil drainage on the slope to minimise moisture build-up around the new and existing developments.

It is recommended that all stormwater generated from the new developments on the site and seepage intercepted on the slope be piped to the Council system along Ocean Road. The builder and designers should, as a minimum, expose and assess the functionality of the existing pits and pipe work which are above and down the shotcrete covered face. Modification or replacement of the existing stormwater system may be required if it be deemed to be deficient for the stormwater volumes from the new development.

A long term build-up of orange-brown gelatinous sludge has been observed within the existing drains at the base of the shotcrete covered face where iron oxides have precipitated out of groundwater upon exposure to the atmosphere. This natural phenomenon is particularly common from groundwater or seepage emanating from shales or siltstones. Therefore, provision should be made in any new or existing drainage lines on this site for access ports to allow for periodic cleaning or flushing out (or “rodding”).

7. Conditions Relating to Design and Construction Monitoring

To comply with Council conditions and to enable the completion of Forms 2B and 3, required as part of the construction, building and post-construction certificate requirements of the GRMP, it will be necessary for Douglas Partners Pty Ltd to:

Form 2B

- review the geotechnical content of all structural drawings.

Form 3

- inspect all new footing and bulk excavations for the new works to confirm compliance to design with respect to allowable bearing pressure and stability.

8. Design Life and Requirement for Future Geotechnical Assessments

Douglas Partners Pty Ltd interprets the reference to design life requirements specified within the IGRMP 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:

- proposed stormwater surface drains and buried pipes leading to the Council stormwater disposal system on Ocean Road;
- existing and proposed retaining walls on the site (including an assessment of the retaining system associated with the shotcrete covered face).

In order to attain a structure 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 4.

Note that the program given in Table 4 is provisional and is subject to review or deletion at the conclusion of construction.

Table 4: Recommended Maintenance and Inspection Program

Structure	Maintenance/Inspection Task	Frequency
Stormwater drains, subsoil drains, pipes and pits	Owner to inspect to ensure that the drains, pipes and pits are free of debris and sediment build-up. Clear surface grates of vegetation/litter build-up.	Every year or following each significant rainfall event.
Existing or proposed retaining walls	Owner to check wall for deviation from as-constructed condition.	Every two to three years or following each significant rainfall event.
Shotcrete covered rockface	Owner to inspect shotcrete for any signs of deterioration of the concrete cover or of rust stains.	At least every two years. If there are any signs of deterioration or particularly rust stains they should be inspected by a geotechnical professional or structural engineer to provide advice on any remedial measures required.

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).

9. References

1. Pittwater Council's Geotechnical Risk Management Policy (2009)
2. Australian Geomechanics Society (AGS), Practice Note Guidelines for Landslide Risk Management

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this letter report for this project at 13a Ocean Road, Palm Beach in accordance with our proposal SydProp 190312 dated 26 March 2019 and instructions received from MacCormick and Associates Architects. The work was carried out under DP Conditions of Engagement. This report is provided for the exclusive use of MacCormick and Associates Architects and their agents 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.

Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the conditions on the site and only to the depths investigated, and then only at the time the work was carried out. Site conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field observations have been completed.

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

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 an expressed statement, interpretation, outcome or conclusion stated in this report.

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

The 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. If a 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.

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

Reviewed by

Fiona MacGregor
Principal

Attachments: Notes about this report
"Landslide Risk Management Concepts and Guidelines"
Drawings 1 and 2
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.

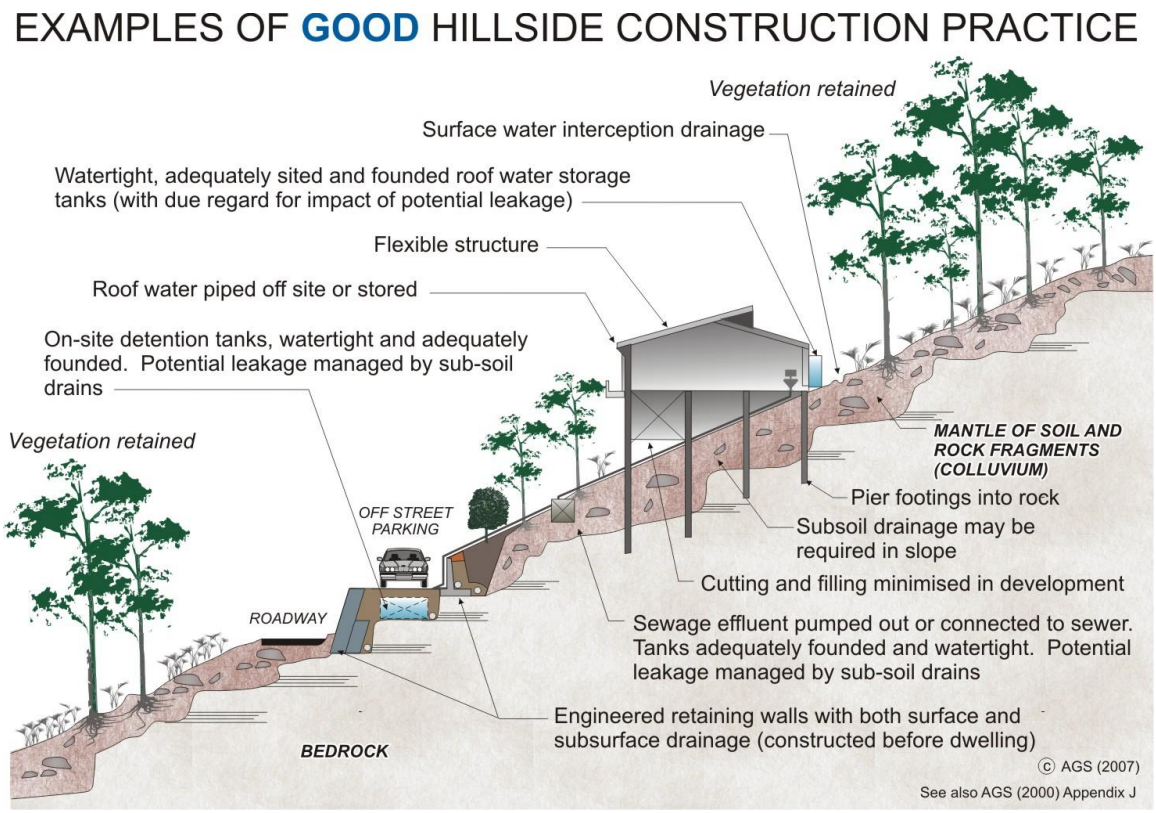
Site Inspection

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.

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

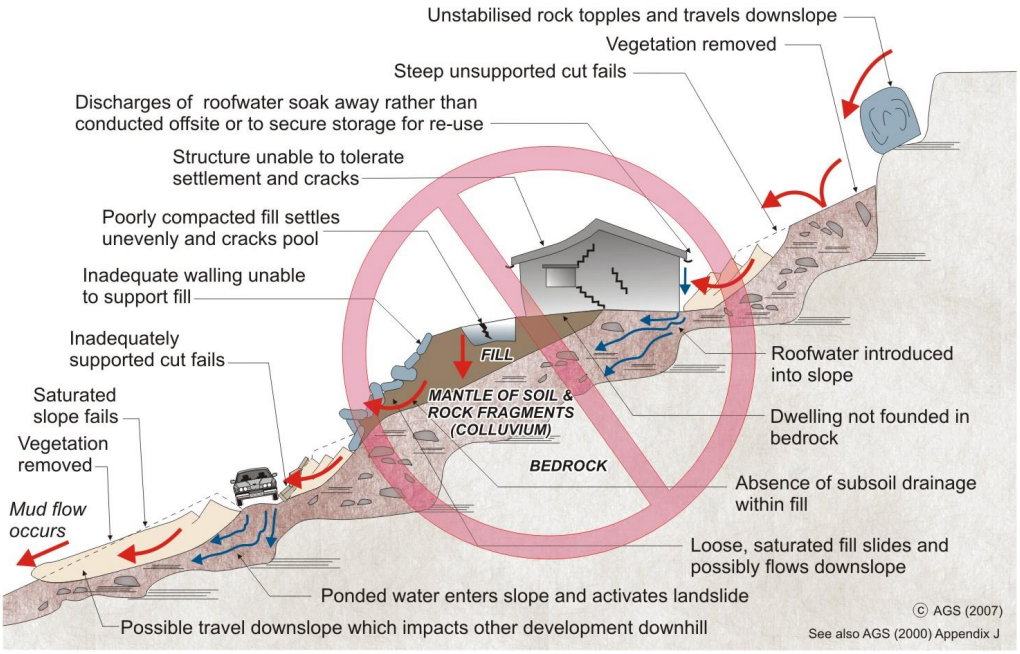
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF **POOR** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

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

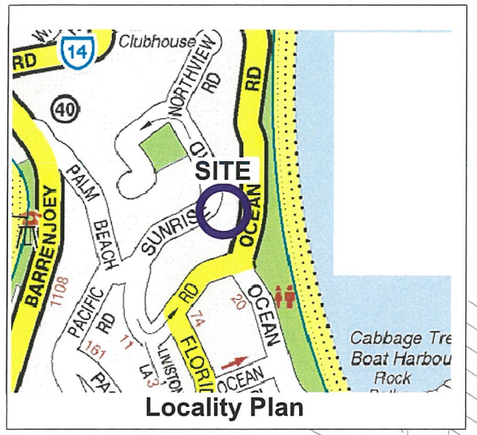
LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY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



10-12m high shotcrete covered face

Outline of secondary residence (under construction)

PROPOSED SWIMMING POOL & SPA

PROPOSED STAIRS

EXISTING RESIDENCE

OCEAN

ROAD

SUNRISE

PROPOSED CABLE CAR

PROPOSED STAIRS

3m to 4m irregular sandstone cliff line

Large detached sandstone boulders

Shotcrete covered 300mm pipe down face

Approximate location of proposed stairway (under construction)

0 1 2 3 4 5 6 7 8 9 10

NOTE:
1: Base drawing from C.M.S. Surveyors Pty Ltd (Dwg 12212detail, dated 16.2.2016)
2: See Drawing 2 for Cross Section A-A'

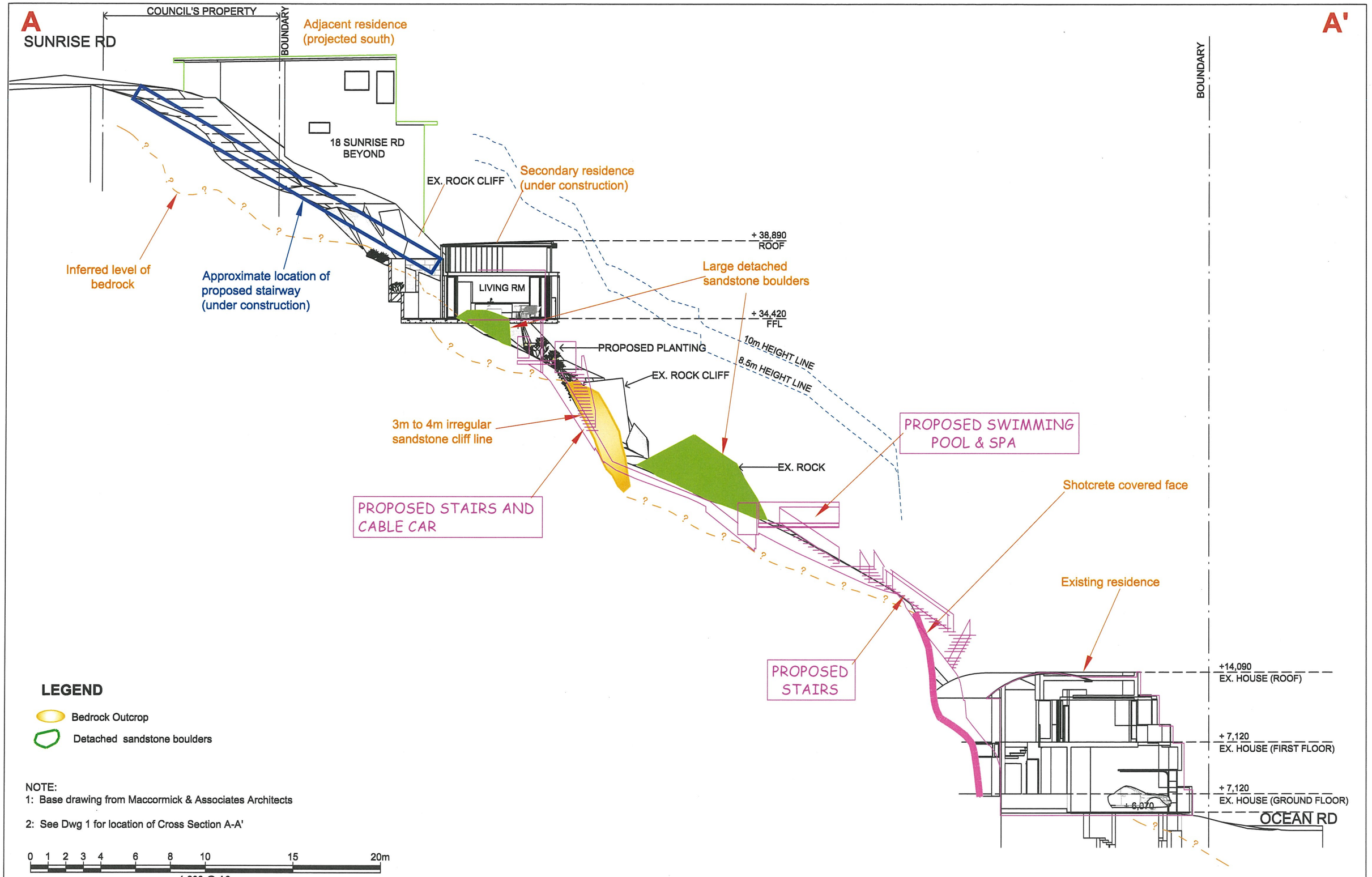
LEGEND

- Bedrock Outcrop
- A — A' Geotechnical Cross Section A-A'
- Detached sandstone boulders

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Michele and Trevor Matthews		TITLE: **Geotechnical Features**
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Swimming Pool and Spa**
SCALE: 1:200 @ A3	DATE: 23.4.2019	**13A Ocean Road, PALM BEACH**

PROJECT No: 85471.02
DRAWING No: 1
REVISION: 0



LEGEND

- Bedrock Outcrop
- Detached sandstone boulders

NOTE:
1: Base drawing from Maccormick & Associates Architects

2: See Dwg 1 for location of Cross Section A-A'

0 1 2 3 4 6 8 10 15 20m
1:200 @ A3

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Michele and Trevor Matthews		TITLE: **Cross Section A-A'** **Proposed Swimming Pool** **13A Ocean Road, PALM BEACH**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:200 @ A3	DATE: 23.4.2019	

PROJECT No:	85471.02
DRAWING No:	2
REVISION:	0

PITTWATER COUNCIL

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

Development Application for Trevor + Michele Matthews
Name of Applicant

Address of site 13A Ocean 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 (Insert Name) on behalf of Douglas Partners Pty Ltd (Trading or Company Name)

on this the 23 April 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: Proposed Swimming Pool + Spa
Report Date: 23/4/19 Project 85471.02.R.001.Rev0
Author: David Murray
Author's Company/Organisation: Douglas Partners Pty Ltd

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

- Dwgs DA02.02, DA05.01, DA05.02 (Rev A - 8/3/19) by MacCormick + Associates
- Survey Dwg 12212 (Rev 4 - 1-7-16) by CMS

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 ..... FMacGregor .....
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 Trevor + Michele Matthews
Name of Applicant

Address of site 134 Ocean Rd, 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: Proposed Swimming Pool + Spa
Report Date: 23/4/19 Rept 85471.02.R.001. Rev0
Author: David Murray
Author's Company/Organisation: Douglas Partners Pty Ltd

Please mark appropriate box

☐ Comprehensive site mapping conducted x 5 (2016 - 2019)
(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 reports + current inspections
- ☐ 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 F MacGregor
Name Fiona MacGregor
Chartered Professional Status CP Eng
Membership No. 370757
Company Douglas Partners Pty Ltd