CROZIER GEOTECHNICAL CONSULTANTS

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Crozier Geotechnical Consultants a division of PJC Geo - Engineering Pty Ltd

Date: 31st March 2020
No. Pages: 1
Project No.: 2019-150

Development Officer
Northern Beaches Council.

Geotechnical Assessment for Section 4.55 modification to approved works at 190 Barrenjoey Road, Newport

We understand the client would like to make some design changes to the approved Development Application (DA 2020/0179) for the above site.

As a result we have reviewed the following documents:

1. Geotechnical Report titled "Risk Analysis & Management for proposed new garage and entrance at 190 Barrenjoey Road, Newport", Project No.: MS3132IC Jack Hodgson Consultants PTY LTD, Dated.: 29/03/2018
2. Architectural Design Drawings by GV Architecture, Project No.: 1511, Drawing No.: DA-0.0, DA1.0 to DA1.3, DA-1.7, DA2.0 to DA2.3, DA-SK, Dated.: 25/02/2020
3. "Geotechnical Assessment and Design recommendations for Stormwater Management plan for 190 Barrenjoey Road, Newport" by Crozier Geotechnical Consultants, Project No.: 2019-150, Dated: 9th January 2020

It is understood that the changes involve a cantilevered two storey extension to the south side of the house along with replacement, removal and installation of several windows and skylights on the south and west sides of the residence. Changes also include the extension of a flat roof off the south side and changes to the weatherboard on the south and west sides to match the existing style. No bulk excavation or significant ground work is required.

The proposed changes to the original design do not alter the geotechnical aspects of the proposed development or the site from those on which the original report or were based. As such we see no geotechnical reason for these changes not to be approved, provided all works are undertaken as per the recommendations of our reports.

Hope the above comments meet Council's requirements, if we can be of further assistance in regard to this matter please don't hesitate to contact the undersigned.

Yours faithfully,

Troy Crozier
Principal
MAIG. RPGeo.: Geotechnical and Engineering

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1 – To be submitted with Development Application

Development Application for _____
Name of Applicant

Address of site 190 BARRENJOEY ROAD NEWPORT

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

I, Peter Thompson (insert name) *on behalf of* Jack Hodgson Consultants Pty Ltd (Trading or Company Name)

on this the 24/10/2017 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.

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 paragraph 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy fro 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.

☐ Have examined the site and the proposed development/alteration is separate form and not affected by a Geotechnical Hazard and does not require a Geotechnical report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater – 2009 requirements

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

Geotechnical Report Details:

Report Title: RISK ANALYSIS & MANAGEMENT FOR PROPOSED GARAGE AND ENTRANCE AT 190 BARRENJOEY ROAD NEWPORT

Report Date: 24/10/2017

Author : PETER THOMPSON

Author's Company/Organisation : JACK HODGSON CONSULTANTS PTY LTD

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

architectural drawings developed by GV Architecture, Project 1708, Numbered DA-1.0 – DA.1.3, DA-2.1, DA.2.2 & DA.3.1, dated 6th September, 2017.

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 Peter Thompson

Name Peter Thompson

Chartered Professional Status MIE Aust CPEng

Membership No. 146800

Company Jack Hodgson Consultants Pty Ltd

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

Development Application for _____
Name of Applicant
Address of site **190 BARRENJOEY ROAD NEWPORT**

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: RISK ANALYSIS & MANAGEMENT FOR PROPOSED GARAGE AND ENTRANCE AT 190 BARRENJOEY ROAD NEWPORT

Report Date: 24/10/2017

Author: PETER THOMPSON

Author's Company/Organisation: JACK HODGSON CONSULTANTS PTY LTD

Please mark appropriate box

☒ Comprehensive site mapping conducted 18/10/2017 (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 .....
- ☒ Yes Date conducted 03/03/2012

☒ 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 P. Thompson
Name Peter Thompson
Chartered Professional Status MIE Aust CPEng
Membership No. 146800
Company Jack Hodgson Consultants Pty Ltd

Jack Hodgson Consultants Pty Limited
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS
ABN: 94 053 405 011

RISK ANALYSIS & MANAGEMENT FOR PROPOSED NEW GARAGE AND ENTRANCE AT 190 BARRENJOEY ROAD NEWPORT

1. INTRODUCTION.

1.1 This assessment has been prepared to accompany an application for development approval with Northern Beaches Council - Pittwater. The requirements of the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009 have been met.

1.2 The definitions used in this Report are those used in the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009.

1.3 The methods used in this Assessment are based on those described in Landslide Risk Management March 2007, published by the Australian Geomechanics Society and as modified by the Geotechnical Risk Management Policy for Northern Beaches Council - Pittwater, 2009.

1.4 The experience of Jack Hodgson Consultants spans a time period over 40 years in the Pittwater area and greater Sydney region.

2. PROPOSED DEVELOPMENT.

2.1 Demolish existing garage, driveway and terraced landscaping at western side of block.

2.2 Construct new garage complex, driveway entrance and landscaping.

2.3 Details of the proposed development are shown on a series of architectural drawings developed by GV Architecture, Project 1708, Numbered DA-1.0 – DA.1.3, DA-2.1, DA.2.2 & DA.3.1, dated 6th September, 2017.

3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on the 18th October, 2017 and previously by this firm on the 3rd of March, 2012, 14th March 2011 and numerous occasions during 2008 and 2009.

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3.2 The property is located on the low side of the road and has an easterly aspect. The upper boundary of the property is on the crest of the hill and the block extends over the eastern slope. The slope of the land surface across the property falls gently at an average angle of 10 degrees. The slope gradually increases in gradient down the property until it reaches a coastal scarp. The scarp drops steeply to the dunes at Bungan Beach.

3.3 From the road frontage a sandstone paved driveway provides access to a garage (Photo 1). The natural slope is filled and terraced to the entrance of the house (Photo 2). The terraces are supported by well-constructed concrete block retaining walls (Photo 3). The uphill side of the house is cut into the slope and is supported by another of these walls. There are two walkways down either side of the house that provide access to the rear of the block and to tiled patio, level lawn area and a concrete inground swimming pool situated beyond the eastern side of the house (Photo 4). Immediately below the pool the site has been levelled into a lawn covered fill (Photo 5). The fill merges into the natural slope (Photo 6). The slope has been planted with natives shrubs. The average grade of the scarp is some 50 degrees with a bedrock face outcropping approximately halfway down. No evidence of significant slope instability was observed on the property.

3.4 The existing three storey residence is in excellent condition for its age. The house is supported on concrete slabs. No evidence of significant cracking or movement was identified at the time of our inspection.

4. GEOLOGY OF THE SITE.

4.1 The Sydney geological series sheet, at a scale of 1:100,000 indicate that is underlain by interbedded sandstones, siltstones and shales of the Upper Narrabeen Group that outcrop on the cliff at the eastern boundary of property. The Narrabeen Group Rocks are Late Permian to Middle Triassic in age with the early rocks not outcropping in the area under discussion. The materials from which the rocks were formed consist of gravels, coarse to fine sands, silts and clays. They were deposited in a riverine type environment with larger floods causing fans of finer materials. The direction of deposition changed during the period of formation. The lower beds are very variable with the variations decreasing as the junction with the Hawkesbury Sandstones is approached. This is marked by the highest of persistent shale beds over thicker sandstone beds which are similar in composition to the Hawkesbury Sandstones.

4.2 The slope materials are colluvial at the surface and residual at depth. They consist of sandy clays and clays with rock fragments and some floaters throughout the profile. The sandy clays and clays merge into the weathered zone of the under lying rocks at depths expected to be in the range 0.9 to 2.4 metres.

5. SUBSURFACE INVESTIGATION.

5.1 Three Dynamic Cone Penetrometer (DCP) tests were put down to determine the nature of the ground materials. The tests were conducted to the Australian Standard for ground testing: AS 1289.6.3.2 – 1997. The locations of these tests are shown on the site plan provided and the results of these tests are as follows:

DEPTH (m)	NUMBER OF BLOWS - Conducted using a 9kg hammer, 510mm drop and conical tip.		
	DCP1	DCP2	DCP3
0.0 to 0.3	3	1	5
0.3 to 0.6	9	2	6
0.6 to 0.9	9	21	27
0.9 to 1.2	26	37	#
1.2 to 1.5	10	#	#
1.5 to 1.8	11	#	#
1.8 to 2.1	28	#	#
2.1 to 2.4	40	#	#
	End of test @ 2.4m	Refusal @ 1.1m	Refusal @ 0.9m

Notes: DCP 1 – Still was moving down slowly through shale. Wet from 0.9m. Rock fragments washed off wet tip.
DCP 2 – Refusal @ 1.1m, Maroon shale fragments on dry tip.
DCP 3 – Refusal @ 0.9m, Maroon shale fragments on wet tip. Wet from 0.6m

One hand auger hole was put down in the approximate location shown on the Site Plan. The logs of this test is as follows:-

AUGER HOLE 1.

0.0 to 0.1 Brown clayey topsoil
0.1 to 0.5 Brown stiff clay
0.5 to 0.9 Yellow-Brown, firm to stiff clay with maroon rock fragments. Wet from 0.5 metres.
0.9 to 1.0 Grey to mottled maroon, stiff to hard clay (weathered shale).
Hand auger refusal at 1.0 metre.

5.2 The equipment chosen to undertake ground investigations provides the most cost effective method for understanding the subsurface conditions. Our interpretation of the subsurface conditions is limited to the results of testing undertaken and the known geology in the area. While every care is taken to accurately identify the subsurface conditions on-site, variation between the interpreted model presented herein, and the actual conditions onsite may occur. Should actual ground conditions vary from those anticipated, we would recommend the geotechnical engineer be

informed as soon as possible to advise if modifications to our recommendations are required.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The block is naturally well drained.

6.2 SURROUNDING AREA.

Overland stormwater flow entering the site from the adjoining properties was not evident. Normal overland runoff could enter the site from above during heavy or extended rainfall.

7. GEOTECHNICAL HAZARDS.

7.1 ABOVE THE SITE.

No geotechnical hazards likely to adversely affect the subject property were observed above the site.

7.2 ON THE SITE.

By reference to Pittwater Councils Geotechnical Hazard mapping, the block is classified as a H1 Hazard zone. The slope of the land surface that falls across the property is considered a potential hazard (**HAZARD ONE**).

The excavations required for the proposed development are considered a potential hazard (**HAZARD TWO**).

7.3 BELOW THE SITE.

No geotechnical hazards likely to adversely affect the subject property were observed below the site.

7.4 BESIDE THE SITE.

The areas beside the site are also classed slip affected hazard areas. These blocks have similar elevation and geomorphology to the subject property. No significant geotechnical hazards likely to adversely affect the subject property were observed beside the site at the time of our inspection.

8. RISK ASSESSMENT.

8.1 ABOVE THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed above the site, no risk analysis is required.

8.2 ON THE SITE.

8.2.1 HAZARD ONE Qualitative Risk Assessment on Property

The slope of the land surface rises across the property at average angles of approximately 10 degrees toward the east before steepening significantly as the coastal scarp is approached. No evidence of significant slope instability was identified at the time of our inspection. The likelihood of the slope failing and impacting on the house is assessed as 'Unlikely' (10^{-4}). The consequences to property of such a failure are assessed as 'Medium' (20%). The risk to property is 'Low' (5×10^{-6}).

8.2.2 HAZARD ONE Quantitative Risk Assessment on Life

For loss of life risk can be calculated as follows:
$\mathbf{R_{(Loll)} = P_{(H)} \times P_{(SH)} \times P_{(TS)} \times V_{(DT)}}$ (See Appendix for full explanation of terms)

8.2.2.1 Annual Probability
No evidence of significant slope instability was identified at the time of inspection.
$\mathbf{P_{(H)}} = 0.0001$/annum

8.2.2.2 Probability of Spatial Impact
The house is situated toward the crest of moderate to steep slope.
$\mathbf{P_{(SH)}} = 0.1$

8.2.2.3 Possibility of the Location Being Occupied During Failure
The average household is taken to be occupied by 4 people. It is estimated that 1 person is in the house for 20 hours a day, 7 days a week. It is estimated 3 people are in the house 12 hours a day, 5 days a week.
For the person most at risk:

$$\frac{20}{24} x \frac{7}{7} = 0.83$$

$\mathbf{P_{(TS)}} = 0.83$

8.2.2.4 Probability of Loss of Life on Impact of Failure

Based on the volume of land sliding and its likely velocity when it fails, it is estimated that the vulnerability of a person to being killed in the house when a landslide occurs is 0.01

$\mathbf{V_{(DT)}} = 0.01$

8.2.2.5 Risk Estimation

$\mathbf{R_{(LoI)}} = 0.0001 \times 0.1 \times 0.83 \times 0.01$

$= 0.000000083$

$\mathbf{R_{(LoI)}} = 8.3 \times 10^{-8}$/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided the recommendations provided in **Section 10** are followed.

8.2.3 HAZARD TWO Qualitative Risk Assessment on Property

The cuts for the proposed garage complex will reach maximum depths of approximately 3.0 metres. Provided the recommendations given in Section 10 are undertaken the likelihood of the cut failing and impacting on the worksite is assessed as 'Unlikely' (10^{-4}). The consequences to property of such a failure are assessed as 'Minor' (5%). The risk to property is 'Low' (5×10^{-6}).

8.2.4 HAZARD TWO Quantitative Risk Assessment on Life

For loss of life risk can be calculated as follows:

$\mathbf{R_{(LoI)}} = \mathbf{P_{(H)}} \times \mathbf{P_{(SH)}} \times \mathbf{P_{(TS)}} \times \mathbf{V_{(DT)}}$ (See Appendix for full explanation of terms)

8.2.4.1 Annual Probability

Provided any soil portions of the cut are battered back and kept dry, batter failure is considered unlikely.

$\mathbf{P_{(H)}} = 0.0001$/annum

8.2.4.2 Probability of Spatial Impact

People will be working below the cut.

$\mathbf{P_{(SH)}} = 0.3$

8.2.4.3 Possibility of the Location Being Occupied During Failure

The average domestic worksite is taken to be occupied by 5 people. It is estimated that 1 person is below the cut for 10 hours a day, 6 days a week. It is estimated 4 people are below the cut 7 hours a day, 5 days a week.

For the person most at risk:

$$\frac{10}{24} x \frac{6}{7} = 0.36$$

$\mathbf{P_{(TS)}} = 0.36$

8.2.4.4 Probability of Loss of Life on Impact of Failure
Based on the volume of land failing and its likely velocity when it hits the work area, it is estimated that the vulnerability of a person to being killed below the cut when the batter fails is 0.1
$V_{(DT)} = 0.1$

8.2.4.5 Risk Estimation
$R_{(LoI)} = 0.0001 \times 0.3 \times 0.36 \times 0.1$
$= 0.00000108$
$R_{(LoI)} = 1.08 \times 10^{-6}$/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided the recommendations given in **Section 10** are undertaken.

8.3 BELOW THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed below the site, no risk analysis is required.

8.4 BESIDE THE SITE.

As no geotechnical hazards likely to adversely impact upon the subject site were observed beside the site, no risk analysis is required.

9. SUITABILITY OF DEVELOPMENT FOR SITE.

9.1 GENERAL COMMENTS.

The proposed development is considered suitable for the site.

9.2 GEOTECHNICAL COMMENTS.

No geotechnical hazards will be created by the completion of the proposed development in accordance with the requirements of this Report and good engineering and building practice.

9.3 CONCLUSIONS.

The site and the proposed development can achieve the Acceptable Risk Management criteria outlined in the Pittwater Geotechnical Risk Policy provided the recommendations given in **Section 10** are undertaken.

10. RISK MANAGEMENT.

10.1. TYPE OF STRUCTURE.

The proposed structures are considered suitable.

10.2. EXCAVATIONS.

10.2.1 All excavation recommendations as outlined below should be read in conjunction with Safe Work Australia's *'Excavation Work – Code of Practice'*, published October, 2013.

10.2.2 The cuts required for the construction of the garage complex will reach an approximate maximum depth of ~ 3.0 metres from current surface levels. The bulk of the cut is expected to be through competent Narrabeen Group rocks, with sandy loam topsoil and sandy clays in some areas overlying interbedded bedrock.

10.2.3 We would recommend that a detailed construction methodology/excavation management plan be developed, reviewed and approved before bulk excavations commence. This management plan should include contingency planning for temporary support, shotcreting or similar support if deemed necessary.

10.2.4 It is suggested that the geotechnical engineer inspect the excavation face at hold points of 1.5m drops to ensure the competency of the cut face/rock strata and advise if any temporary or permanent support is required.

10.2.5 We recommend that any excavation through rock that cannot be readily achieved with a bucket excavator or ripper should be carried out initially using a rock saw to minimise the vibration impact and disturbance on the adjoining properties and adjacent structures. Any rock breaking must be carried out only after the rock has been sawed and in short bursts (2-5 seconds), to prevent the vibration amplifying. The break in the rock from the saw must be between the rock to be broken and the closest adjoining structure.

10.2.6 We would recommend the retaining structure to support the proposed cut is to be installed as soon as possible after the excavation is complete. The cut batter of any unconsolidated portion of the cut, if exposed for an extended period, is to be covered to prevent loss of moisture in dry weather and to prevent excess moisture in wet weather. Upslope runoff must be diverted from the cut faces by sandbag mounds or similar diversion works. Temporary support may be necessary depending upon the material encountered in the cuts, the likelihood of heavy rain and the length of period before permanent support is installed.

10.2.7 All excavated material is to be removed from the site in accordance with current Office of Environment and Heritage (OEH) regulations.

10.3. FILLS.

10.3.1 If filling is required, all fills are to be placed in layers not more than 250 mm thick and compacted to not less than 95% of Standard Optimum Dry Density at plus or minus 2% of Standard Optimum Moisture Content.

10.3.2 The fill batters are to be not steeper than 1 vertical to 1.7 horizontal or they are to be supported by properly designed and constructed retaining walls.

10.4. FOUNDATION MATERIALS AND FOOTINGS.

It is recommended that all footings be supported on and potted into the underlying weathered bedrock, using piers as necessary. The design allowable bearing pressures are 800 kPa for spread footings or piers. All footings are to be founded on material of similar consistency to minimise potential for differential settlement.

Note: The local geology is comprised of highly variable interbedded clays, shales and sandstones, with abundant detached joint blocks and sandstone floaters at surface and in the upper profile. Subsequently ground conditions on site may alter significantly across short distances. This variability should be anticipated and accounted for in the design and construction of any new foundations.

10.5. STORM WATER DRAINAGE.

Any storm water generated from any new works is to be piped to the storm water system for the block through any water tanks, onsite detention or dispersion systems that may be required by the regulating authorities.

10.6. SUBSURFACE DRAINAGE.

Any retaining walls are to be back filled with non-cohesive free draining material to provide a drainage layer immediately behind the wall. The free draining material is to be separated from the ground materials by geotextile fabric. Standard under pool drainage is acceptable

10.7. INSPECTIONS.

10.7.1 We would recommend the geotechnical engineer meet on site with the building contractor and the excavation contractor to discuss and approve construction methodology and equipment used before bulk excavations commence.

10.7.2 It is recommended that the geotechnical engineer inspect the cut face at hold points of approximately 1.5m drops.

10.7.3 It is recommended that the foundation materials of all footing excavations be inspected and approved before steel reinforcement or concrete is placed.

11. GEOTECHNICAL CONDITIONS FOR ISSUE OF CONSTRUCTION CERTIFICATE.

It is recommended that the following geotechnical conditions be applied to the Development Approval:-

The work is to be carried out in accordance with the Risk Management Report MS 31321 dated 24th October, 2017.

The Geotechnical Engineer is to meet with the building and excavation contractors onsite before bulk excavations commence.

The Geotechnical Engineer is to inspect the cut face at regular 1.5m hold points.

The Geotechnical Engineer is to inspect and approve the foundation material of all footing excavations before concrete is placed.

12. GEOTECHNICAL CONDITIONS FOR ISSUE OF OCCUPATION CERTIFICATE.

The Geotechnical Engineer is to certify the following geotechnical aspects of the development:-

The work was carried out in accordance with the Risk Management Report MS 31321 dated 24th October, 2017.

The Geotechnical Engineer met with the building and excavation contractors onsite before bulk excavations commenced.

The Geotechnical Engineer inspected and approved the cut face at regular 1.5m hold points.

The Geotechnical Engineer inspected and approved the foundation material of all footing excavations before concrete was placed.

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13. RISK ANALYSIS SUMMARY.

HAZARDS	Hazard One	Hazard Two
TYPE	By reference to Pittwater Councils Geotechnical Hazard mapping, the block is identified as an H1 Hazard Zone. The slope of the land surface that falls across the property is considered a potential hazard.	The excavations required for the proposed development are considered a potential hazard.
LIKELIHOOD	'Unlikely' (10^{-4})	'Unlikely (10^{-4})
CONSEQUENCES TO PROPERTY	'Minor' (5%)	'Medium' (20%)
RISK TO PROPERTY	'Low'(5×10^{-6})	'Low (5×10^{-6})
RISK TO LIFE	8.3×10^{-8}/annum	1.08×10^{-6}/annum
COMMENTS	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.	This level of risk is **'ACCEPTABLE'** provided mechanical drilling is undertaken before excavations commence and the conditions in **Section 10** are followed.

JACK HODGSON CONSULTANTS PTY. LIMITED.

Peter Thompson MIE Aust CPEng
Member No. 146800
Civil/Geotechnical Engineer

Photo 1

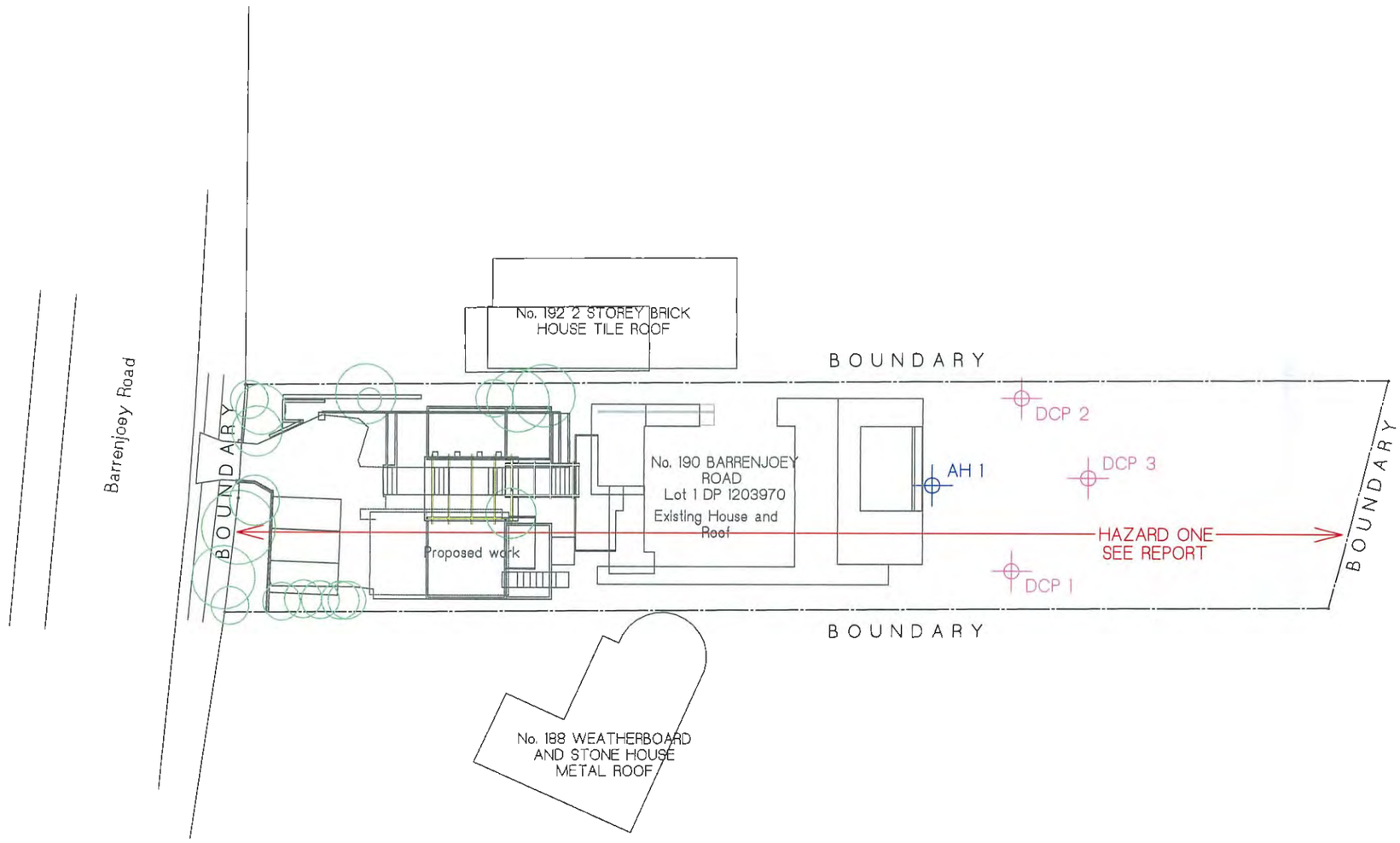
Photo 2

Photo 3

Photo 4

Photo 5

Photo 6



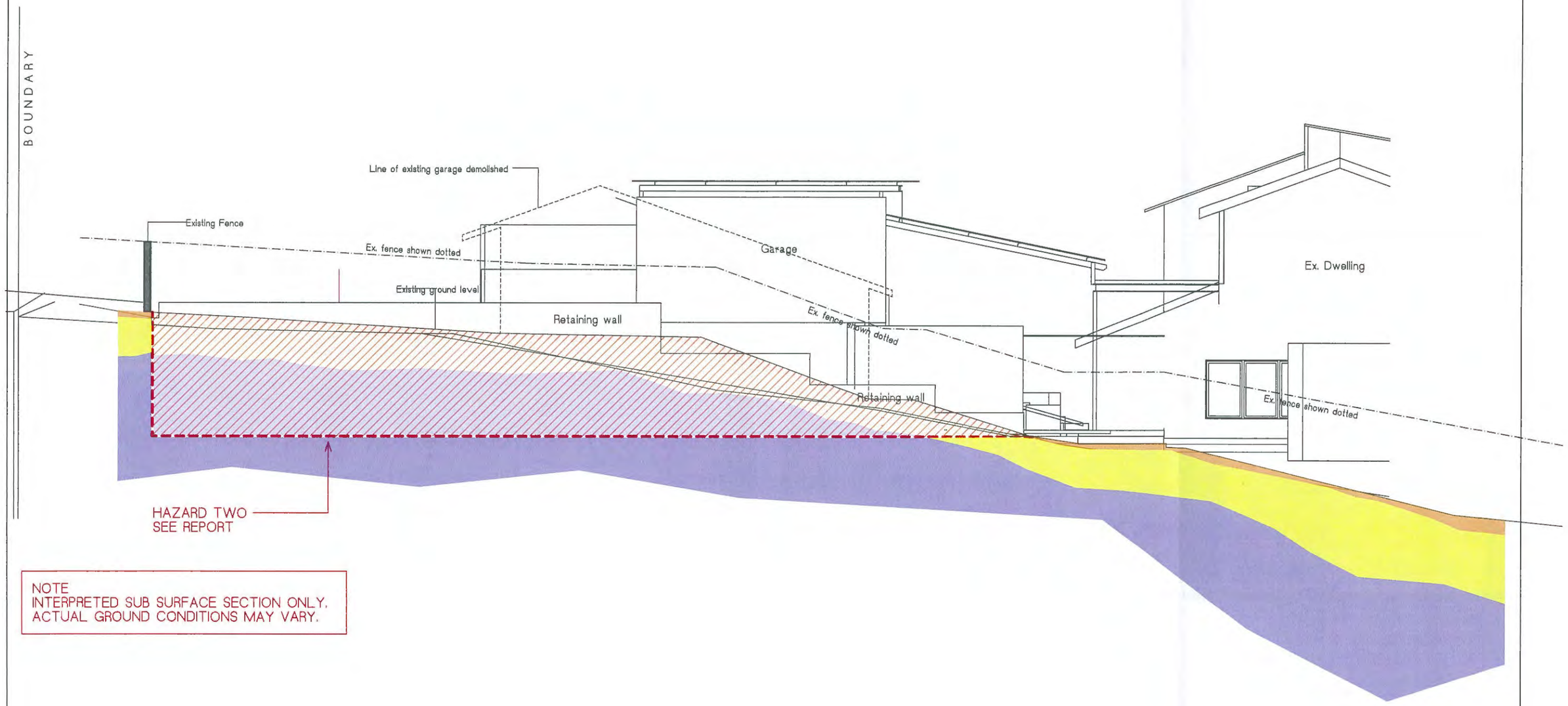
AH = AUGER LOCATION

DCP = DCP LOCATION

ABN 94 053 405 011
Jack Hodgson Consultants Pty Limited
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS

SITE PLAN – HAZARD,DCP, AUGER LOCATIONS

Job No	Address
MS 31321	190 BARRENJOEY ROAD
Scale	NEWPORT
NTS	NSW



NOTE
INTERPRETED SUB SURFACE SECTION ONLY.
ACTUAL GROUND CONDITIONS MAY VARY.

ABN: 94 053 405 011
Jack Hodgson Consultants Pty Limited
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS

TYPE SECTION

Job No	Address
MS 31321	190 BARRENJOEY ROAD
Scale	NEWPORT
NTS	NSW

Strata Profile Legend

- Sandy Topsoil
- Sandy Clay
- Narrabeen Group Rocks

7 RISK ESTIMATION

7.1 QUANTITATIVE RISK ESTIMATION

Quantitative risk estimation involves integration of the frequency analysis and the consequences.
For property, the risk can be calculated from:
$R_{(Prop)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(Prop:S)} \times E$ (1)

Where
$R_{(Prop)}$ is the risk (annual loss of property value).

$P_{(H)}$ is the annual probability of the landslide.

$P_{(S:H)}$ is the probability of spatial impact by the landslide on the property, taking into account the travel distance and travel direction.

$P_{(T:S)}$ is the temporal spatial probability. For houses and other buildings $P_{(T:S)}$= 1.0. For Vehicles and other moving elements at risk $1.0 < P_{(T:S)} > 0$.

$V_{(Prop:S)}$ is the vulnerability of the property to the spatial impact (proportion of property value lost).

E is the element at risk (e.g. the value or net present value of the property).
For loss of life, the individual risk can be calculated from:

$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$ (2)
Where

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

$P_{(H)}$ is the annual probability of the landslide.

$P_{(S:H)}$ is the probability of spatial impact of the landslide impacting a building (location) taking into account the travel distance and travel direction given the event.

$P_{(T:S)}$ is the temporal spatial probability (e.g. of the building or location being occupied by the individual) given the spatial impact and allowing for the possibility of evacuation given there is warning of the landslide occurrence.

$V_{(D:T)}$ is the vulnerability of the individual (probability of loss of life of the individual given the impact).
A full risk analysis involves consideration of all landslide hazards for the site (e.g. large, deep seated landsliding, smaller slides, boulder falls, debris flows) and all the elements at risk.

For comparison with tolerable risk criteria, the individual risk from all the landslide hazards affecting the person most at risk, or the property, should be summed.

The assessment must clearly state whether it pertains to 'as existing' conditions or following implementation of recommended risk mitigation measures, thereby giving the 'residual risk'.