RISK ANALYSIS & MANAGEMENT FOR PROPOSED NEW RESIDENCE AT 139 HEADLAND ROAD NORTH CURL CURL

1. INTRODUCTION.

1.1 This assessment has been prepared to accompany an application for development approval.

1.2 By reference to Clause E10 of Warringah DCP and the WLEP Landslip Risk Map, the site is located in land that is subject to Area B classification. The methods used in this Assessment are based on those described in Landslide Risk Management March 2007, published by the Australian Geomechanics Society.

1.3 The experience of Jack Hodgson Consultants spans a time period over 40 years in the Northern Beaches Council area and Greater Sydney region.

2. PROPOSED DEVELOPMENT.

2.1 Demolish existing residence.

2.2 Construct new residence including swimming pool and car parking.

2.3 Details of the proposed development are as per architectural drawings prepared by Angela Steyn & Co, Dwg No: SK-PLA001 to SK-PLA003, SK-SEC001 to SK-SEC005, Revision Q and dated 24th September, 2018.

3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on 19th November 2018 for purpose of this assessment.

3.2 This property is located on a moderate to steep slope that falls steeply from the road frontage towards the existing residence where the slope becomes moderate and has a southerly aspect. Outcropping sandstone was visible on all parts of the site. The average

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3. DESCRIPTION OF SITE & SURROUNDING AREA. (Continued)

slope above the existing residence is steep moderate averaging approximately 17.0 degrees with the average slope for the rest of the site being at approximately 12.0 degrees.

3.3 Vehicle access to the property is via a strip concrete driveway that leads to a single car space in the road reserve adjacent the front boundary, Photo 1. Pedestrian access is also via the driveway and a pathway to the main entrance. Exposed sandstone bedrock was visible at the front of the property, Photo 2. Access to the rear of the property is via a pathway on the western side of the existing residence, Photo 3. Access is also possible to the rear yard on the eastern side of the existing residence but is not a paved pathway. Sandstone bedrock was also visible at the top of the access, Photo 4 & 5. An existing rear deck area is at the lower ground level of the existing residence, Photo 6. Sandstone bedrock was visible in the upper lawn area of the rear yard, Photo 7. The rear lawn area flattens out to a gentle slope, Photo 8.

3.4 The multistorey timber and masonry house is in fair to good condition. The supporting brick walls and piers show no signs of movement. No evidence of significant cracking or movement was observed at the time of our inspection.

4. GEOLOGY OF THE SITE.

4.1 Referencing the Sydney 1:100,000 Geological Series Sheet 9130 indicates the site is underlain by Hawkesbury Sandstones of the Wianamatta Group. These sandstones are of Middle Triassic age and were probably laid down in braided streams. The sand grains are mainly quartz with some sand grade claystone fragments. There are lenticular deposits of mudstones and laminites which are thought to have been deposited in abandoned channels of the main streams. The sandstones generally have widely spaced sub vertical joints with some current bedding. The joint directions are approximately north/south and east/west. The beds vary in thickness from 0.5 to in excess of 5 metres.

4.2 The slope materials are colluvial at the surface and residual at depth. Where not exposed at the surface, sandstone bedrock is expected to be encountered at depths of approximately 0.5 to 1.5 metres across the subject property or deeper where filling has been undertaken.

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION.

5.1 Three Dynamic Cone Penetrometer (DCP) test was conducted in the location shown on the site plan. The test was conducted to the Australian Standard for ground testing: AS 1289.6.3.2 – 1997 (R2013). The results of these tests are as follows:

NUMBER OF BLOWS - Conducted using a 9kg hammer, 510mm drop and conical tip -			
DEPTH (m)	**DCP#1**	**DCP#2**	**DCP#3**
0.0 to 0.3	2	3	3
0.3 to 0.6	4	2	7
0.6 to 0.9	5	**26/0.210**	19
0.9 to 1.2	16		25
1.2 to 1.5	12		**11/0.060**
1.5 to 1.8	16		
1.8 to 2.1	23		
2.1 to 2.4	**26/0.240**		
	End of Test @ 2.340m	**End of Test @ 0.810m**	**End of Test @ 1.260m**
~ Top RL	**36.60**	**38.20**	**40.20**
~ EOT RL	**34.26**	**37.39**	**38.94**

DCP TESTING NOTES:

DCP#1	26 Blows for 0.240m then 8 blows for 0.020m. Double bounce. Refusal on rock. Possible trench in rock or natural drop or joint. Further investigation would be required to determine. Tip – Wet last 900mm with orange/red fragments.
DCP#2	26 Blows for 0.210m then 8 blows for 0.015m. Double bounce. Refusal on rock. Tip - Wet last 300mm with brown/red fragments.
DCP#3	11 Blows for 0.060m then 8 blows for 0.020m. Double bounce. Refusal on rock. Tip - Wet last 300mm with brown sandy fragments.
Further Notes	When ringing bouncing rock is not encountered, end of test occurs when there is less than 0.02m of penetration for 8 blows or danger of equipment damage is imminent. No significant standing water table was identified in our testing.

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

5. SUBSURFACE INVESTIGATION AND SITE CLASSIFICATION. (Continued)

recommend the geotechnical engineer be informed as soon as possible to advise if modifications to our recommendations are required.

5.3 SITE CLASSIFICATION

We would recommend the site be classified as 'Class A' as outlined in AS 2870. Class A is most sand and rock sites with little or no ground movement from moisture changes.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The site is naturally well drained.

6.2 SURROUNDING AREA.

Overland stormwater flow entering the site from the adjoining properties was not evident. During heavy prolonged rain fall water may enter from this property. Normal overland flow may enter the property from the slope above.

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.

The slope that rises across the site is considered a potential hazard (**HAZARD ONE**).

The proposed depth of the excavation of the proposed residence and swimming pool is considered a potential hazard, **(HAZARD TWO)**.

7. GEOTECHNICAL HAZARDS. (Continued)

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 geotechnical hazards likely to adversely affect the subject property were observed beside the site.

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 average slope above the existing residence is steep moderate averaging approximately 17.0 degrees with the average slope for the rest of the site being at approximately 12.0 degrees. The existing residence was found to display no evidence of significant cracking or movement. No evidence of significant slope instability was observed on the site. 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 'Minor' (5%). 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:
$\mathbf{R_{(LoL)} = P_{(H)} \times P_{(SH)} \times P_{(TS)} \times V_{(DT)}}$ (See Appendix for full explanation of terms)

8. RISK ASSESSMENT. (Continued)

8.2.2.1 Annual Probability
No evidence of significant movement was observed on the site.
$\mathbf{P_{(H)}} = 0.0001$/annum

8.2.2.2 Probability of Spatial Impact
The existing residence is situated toward the upper half of the 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 hits the house, it is estimated that the vulnerability of a person to being killed in the house when a landslide hits is 0.01
$\mathbf{V_{(DT)}} = 0.01$

8.2.2.5 Risk Estimation
$\mathbf{R_{(LoI)}} = 0.0001 \text{ x } 0.1 \text{ x } 0.83 \text{ x } 0.01$
$= 0.000000083$
$\mathbf{R_{(LoI)}} = 8.3 \text{ x } 10^{-8}$/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided the recommendations given in **Section 10** are undertaken.

8.2.3 HAZARD TWO Qualitative Risk Assessment on Property

The excavation for the proposed residence and swimming pool will require a maximum depth of excavation to be approximately 2.5m. Provided good engineering and building practices are followed and the recommendations given in **Section 10** are undertaken the likelihood of the cut failing and impacting on the worksite is assessed as 'Rare' (10^{-5}). The consequences to property of such a failure are assessed as 'Medium' (20%). The risk to property is 'Low' ($2 \text{ x } 10^{-6}$).

8. RISK ASSESSMENT. (Continued)

8.2.4 HAZARD Two Quantitative Risk Assessment on Life

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

8.2.4.1 Annual Probability
Provided recommendations in Section 10 are followed and any soil portions of the cut are battered back and kept dry, batter failure is considered unlikely.
$\mathbf{P_{(H)}} = 0.00001$/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 0.2
$\mathbf{V_{(DT)}} = 0.2$

8.2.4.5 Risk Estimation
$\mathbf{R_{(LoI)}} = 0.00001 \times 0.3 \times 0.36 \times 0.2$
$= 0.000000216$
$\mathbf{R_{(LoI)}} = 2.16 \times 10^{-7}$/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided the recommendations given in **Section 10** are undertaken.

8. RISK ASSESSMENT. (Continued)

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 types of structures are considered suitable for the proposed development.

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 Landslide Risk Management March 2007, published by the Australian Geomechanics Society, provided the recommendations given in **Section 10** are undertaken.

10. RISK MANAGEMENT.

10.1. TYPE OF STRUCTURE.

The proposed structures are considered suitable for the site.

10. RISK MANAGEMENT. (Continued)

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 March, 2015.

10.2.2 The foundations for the proposed residence and swimming pool will require excavation up to 2.5 metres below natural ground levels. This is expected to be through the soil and clay material that is above the underlying rock. All foundations are to be taken to the underlying rock.

10.2.3 Temporary/permanent structural support will be required during the excavation and construction phase of the project. This is to be designed, approved and supervised by the structural engineer. Temporary cuts are to be battered at 45 degrees or permanently at 1.0 V:1.7 H in soil and clay material. Cuts in the sandstone, after inspection by the geotechnical engineer, can be temporarily vertical or permanently at 0.25 H: 1.0 V. Some joints or weathered areas may need support these areas to be confirmed during the excavation by the geotechnical engineer. Weathered shales and rocks are able to stand near vertical for short periods time in dry weather and if unaffected by groundwater.

10.2.4 Any new or replaced retaining walls are to be installed as soon as possible after the excavations are complete. The cut batters for the dwelling footings are to be covered to prevent loss of moisture in dry weather and to prevent access of 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 on the cut batters for the footings, depending upon the material encountered in the cuts, the likelihood of heavy rain and the length of period before permanent support is installed. The design Coefficient of Lateral Pressure is 0.6.

10.2.5 It is recommended that detailed dilapidation reporting be undertaken on the adjacent structures before demolition or excavation work commences.

10.2.6 Given bulk excavations are required through what is expected to be low to medium strength sandstone and the proximity to neighbouring occupied residential buildings it would be considered prudent to monitor and limit vibration effects on the adjacent structures.

The Australian Standard AS2670.2-1990 "Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings

(1-80 Hz)" suggests a day time limit of 8 mm/s component PPV for human comfort is acceptable.

We would suggest allowable vibration limits be set at 5mm/s PPV. It is expected that rock hammers with an approximate weight of 600-800kg will be adequate to operate within these tolerances.

10.2.7 We recommend that any excavation through rock be carried out initially using a rock saw to minimise the vibration impact and disturbance on the adjoining residence. Any rock breaking must be carried out only after the rock has been sawed and in small bursts 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. The energy input per blow of hydraulic picks should not exceed 600 Joules. A 300kg rock breaker produces ~600 Joules. It should be noted the input per blow varies between types of hammers so this is to be confirmed with the manufacturer.

10.2.8 All excavated materials left onsite will need to comply with the conditions in **Section 10.3** or be retained by an engineer designed retaining wall or structure.

10.2.9 All excavated material removed from site 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.

10.3.3 New retaining walls will be required to contain the fill in some parts of the proposed development. These retaining walls are to be designed by the structural engineer with any foundations support by piers and footings taken to the rock material.

10. RISK MANAGEMENT. (Continued)

10.4. FOUNDATIONS, FOOTINGS

10.4.1 It is recommended that footings for the proposed works are to be taken to and where applicable potted into the underlying rock, using piers as necessary. The design allowable bearing pressures are 1000 kPa for spread footings or piers. All footings are to be founded on material of similar consistency to minimise potential for differential settlement. It is expected that this material where already not at the surface will be encountered at approximate depths of 0.5 to 1.5m, though may be deeper where filling has been carried out.

10.5. STORM WATER DRAINAGE.

Any storm water generated from any new works is to be piped to the new storm water system for the block through any water tanks, onsite detention or dispersion systems that may be required by the regulating authorities. No easement for stormwater shown on the prepared survey. Council's stormwater policy for low level properties will be applied.

10.6. SUBSURFACE DRAINAGE.

10.6.1 All retaining walls new and replaced are to have adequate back wall drainage.

10.6.2 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 materials by geotextile fabric ground.

10.7. INSPECTIONS.

10.7.1 It is essential that the foundation materials of all footing excavations be inspected and approved before concrete is placed. This includes retaining wall footings. Failure to advise the geotechnical engineer for these inspections could delay the issuance of relevant certificates.

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 MT 31618 dated 27th November, 2018.

The Geotechnical Engineer is to inspect and approve the foundation materials of any additional 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 MT 31618 dated 27th November, 2018.

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

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13. RISK ANALYSIS SUMMARY.

HAZARDS	HAZARD ONE	HAZARD TWO
TYPE	The slope that rises across the property is considered a potential hazard	The excavations required for the proposed development are considered a potential hazard.
LIKELIHOOD	'Unlikely' (10^{-4})	'Rare' (10^{-5})
CONSEQUENCES TO PROPERTY	'Minor' (5%)	'Medium' (20%)
RISK TO PROPERTY	'Low' (5×10^{-6})	'Low'(2×10^{-6})
RISK TO LIFE	8.3×10^{-8}/annum	2.16×10^{-7}/annum
COMMENTS	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.	This level of risk is **'ACCEPTABLE'** provided the conditions in **Section 10** are followed.

JACK HODGSON CONSULTANTS PTY. LIMITED.

Peter Thompson

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

Photo 1

Photo 2

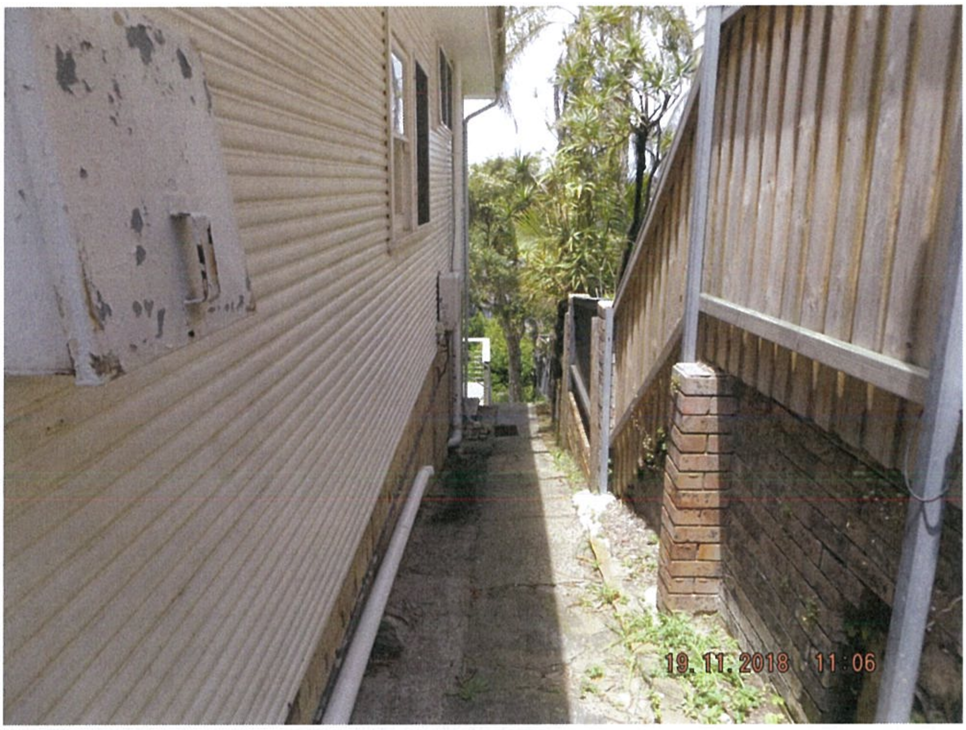


Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

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) x **P**(S:H) x **P**(T:S) x **V**(Prop:S) x **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 risk1.0< **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) x **P**(S:H) x **P**(T:S) x **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.

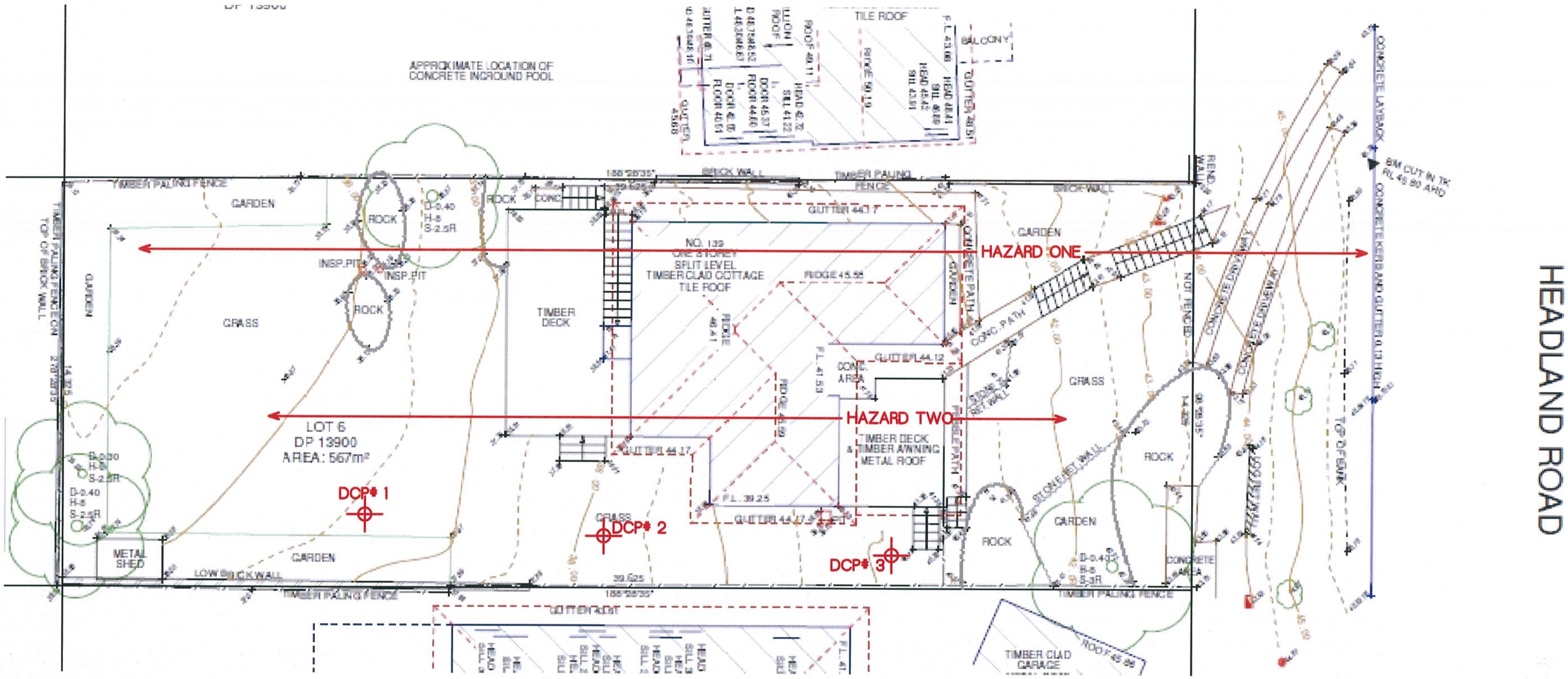
P(T:S) is the temporal spatial probability (e.g. of the building or location being occupied by the individual)
given the spatial impact and allowing for the possibility of evacuation given there is warning of the landslide occurrence.

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.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

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'.



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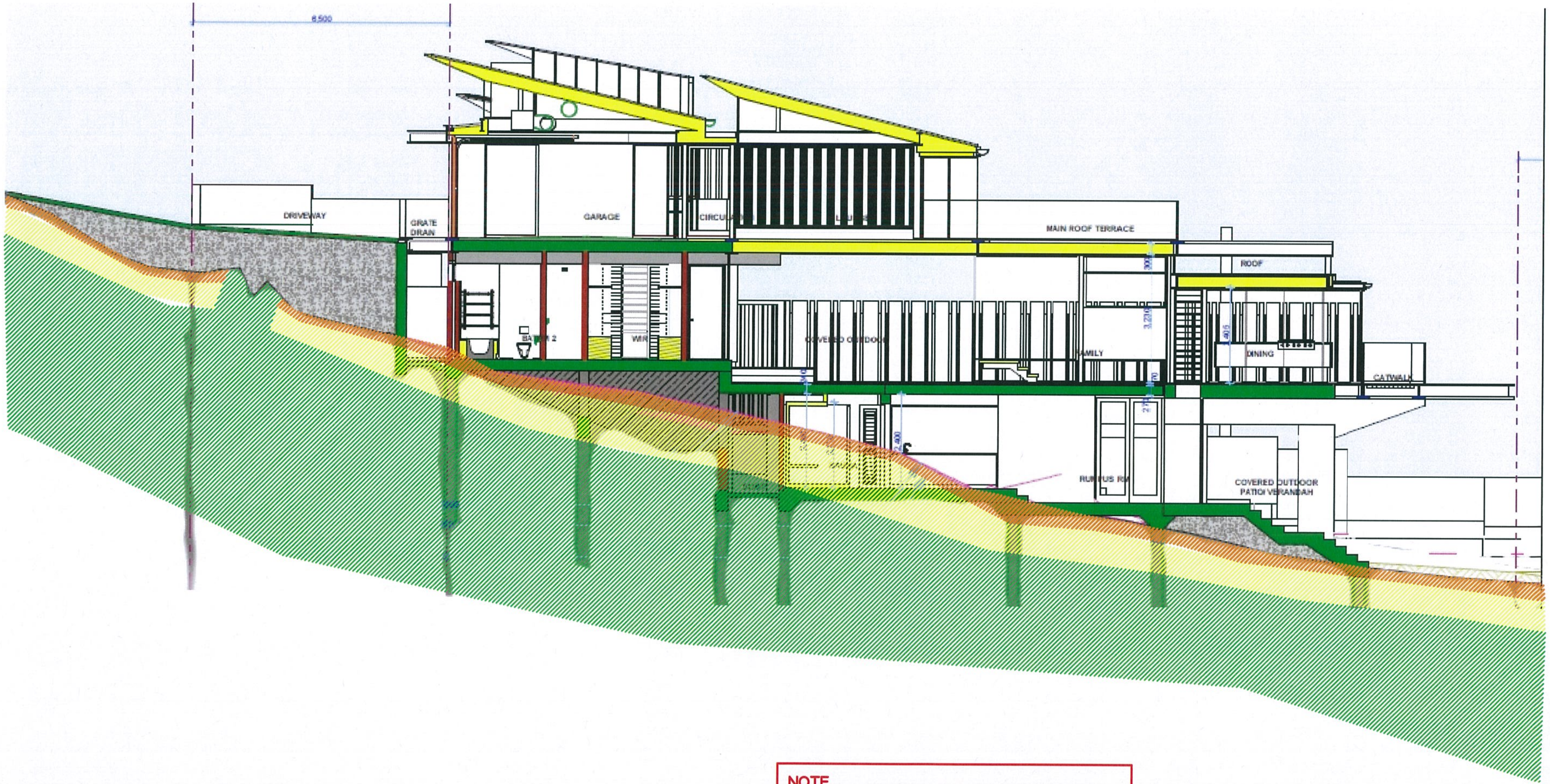
SITE PLAN - DCP LOCATIONS & HAZARDS

Job No	Address
MT 31618	139 HEADLAND ROAD NORTH CURL CURL NSW
Scale	
NTS	



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

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TYPE SECTION	
Job No MT 31618	Address 139 HEADLAND ROAD NORTH CURL CURL NSW
Scale NTS	

STRATA PROFILE LEGEND	
Fill	Narrabeen Group Rocks
Sandy Topsoil	Hawkesbury Sandstone
Sandy Clay	