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CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS
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RISK ANALYSIS & MANAGEMENT FOR PROPOSED VEHICLE CROSSING, CAR PLATFORM AND STORAGE ROOM AT 101 BUNGAN HEAD ROAD, NEWPORT

1. INTRODUCTION.

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

1.2 The definitions used in this Report are those used in the Geotechnical Risk Management Policy for 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 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 driveway and portion of existing garage

2.2 Construct new vehicle crossing and suspended driveway.

2.3 Construct new carport and storeroom underneath.

2.4 Various internal alterations.

2.5 Details of the proposed development are shown a series of architectural plans developed by North Shore Building Design Group, numbered 01616-01 - 01616-06 and dated 4th May 2016.

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3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on the 17th May, 2016.

3.2 The block is situated on the low side of the road and has a Northerly aspect. The property is situated toward the crest of a slope that rises from Pittwater to the crest of Bungan headland which runs along Myola Road. From the road frontage the slope falls across the property to the northern boundary at maximum average angles of 15 degrees.

3.3 Vehicular access to the property is via concrete driveway that descends from the road frontage and terminates in a garage as part of the main residence (Photo 1). Pedestrian access to the block is via a set of paver stairs that descend from the road frontage through a densely vegetated garden containing small shrubs and trees, before terminating in a paved courtyard that extends along the southern side of the residence (Photos 2 & 3). Access along the western side of the residence is via a paved set of stairs and paved courtyard (Photo 4). The cut for the stairs is supported by a stable timber crib retaining wall (Photo 4). A paved area extends along the northern side of the residence (Photo 5). A set of garden beds are located below the paved area and are supported by stable treated timber retaining walls (Photo 6). From the garden beds a lawn area gently falls toward the northern boundary (Photo 7). Access along the eastern side of the residence is via a concrete pathway (Photo 8).

3.4 The part-two storey masonry residence is in good condition for its age. It is supported on brick walls that show no evidence of cracking or significant movement that could be identified at the time of our inspection.

4. GEOLOGY OF THE SITE.

4.1 The site is underlain by the variable interbedded sandstones, siltstones and shales of the Narrabeen Group. 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 in origin at the surface and become residual with depth. They consist of topsoil over sandy clays and clays that merge into the weathered rock at depths varying from 0.50 to 1.5 metres or deeper where filling has been carried out.

5. SUBSURFACE INVESTIGATION.

5.1 Two Dynamic Cone Penetrometer (DCP) tests were put down to determine the nature of the subsurface profile. The locations of these tests are shown on the site plan provided and the results are as follows:

DEPTH (m)	NUMBER OF BLOWS - conducted with Pointed Tip	
	DCP1	DCP2
0.0 to 0.3	3-drop	10
0.3 to 0.6	26	20
0.6 to 0.9	10/	28
0.9 to 1.2		22
1.2 to 1.5		10/
	Refusal @ 0.70m on rock	Refusal @ 1.30m on rock

Notes:
DCP1: Refusal on weathered rock @ 0.70m. Fine grained red impact dust on dry tip. No evidence of water table.
DCP2: Refusal on weathered rock @ 1.30m. Fine grained red/orange impact dust on dry tip. No evidence of water table.

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.

7.2.1 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 (**HAZARD ONE**).

7.2.2 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

From the road frontage down to the waterfront the slope of the land falls across the property at maximum average angles of 15 degrees. No evidence of significant slope instability was identified at the time of our inspection. The likelihood of the slope failing 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:

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

8.2.2.1 Annual Probability
No evidence of significant slope instability was detected onsite.
$\mathbf{P_{(H)}}$ = 0.0001/annum

8.2.2.2 Probability of Spatial Impact
The house is situated towards the toe of a moderate slope.
$\mathbf{P_{(SH)}}$ = 0.2

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 failing and its likely velocity when it impacts the house, it is estimated that the vulnerability of a person to being killed when the slope fails is 0.01
$\mathbf{V_{(DT)}}$ = 0.01

8.2.2.5 Risk Estimation
$\mathbf{R_{(LoI)}}$ = 0.0001 x 0.2 x 0.83 x 0.01
= 0.000000166
$\mathbf{R_{(LoI)}}$ = 1.66 x 10^{-7}/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided the recommendations given in **Section 10** are followed.

8.2.3 <u>HAZARD TWO Qualitative Risk Assessment on Property</u>

The cut for the proposed lower ground floor storage room will reach maximum depths of approximately 1.7 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 x 10^{-6}).

8.2.4 <u>HAZARD TWO Quantitative Risk Assessment on Life</u>

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 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
$\mathbf{V_{(DT)}}$ = 0.1

8.2.4.5 Risk Estimation
$\mathbf{R_{(LoI)}}$ = 0.0001 x 0.3 x 0.36 x 0.1
= 0.00000108
$\mathbf{R_{(LoI)}}$ = 1.08 x 10^{-6}/annum **NOTE:** This level of risk is **'ACCEPTABLE'** provided appropriate support to the existing structure is installed before the excavation commences and 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.

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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 The excavations required to install the proposed lower ground floor storage room will extend to an approximate maximum depth of 1.7m. The cut is expected to be through medium stiff to stiff clays before Narrabeen Group Bedrock is encountered. Bedrock is expected to be encountered at depths between 0.5 to 1.5 metres.

10.2.2 Provided any soil portions of the cut for the pool are battered back and kept dry the underlying materials will stand unsupported for short periods until permanent support is in place.

10.2.3 Where sandstone on the property is too hard to be excavated with a bucket, we recommend the excavation be carried out using equipment that results in minimal vibration so as not to impact on the existing structures or neighbouring properties. A Rock Saw is ideally suited for this purpose. If hydraulic picks are to be used the energy input per blow should not exceed 500 Joules. A 300kg Rock Breaker produces 250 to 600 Joules depending on the type (brand) of breaker. This should be confirmed with the manufacturer. Rock breaking should be carried out in short bursts to prevent amplification of vibration.

10.2.4 Any retaining walls to support the cut are to be installed as soon as possible after the excavation is complete. The cut batters are to be covered to prevent loss of moisture in dry weather and to prevent access of moisture in wet weather. Any potential 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.

10.2.5 All excavated material is to be removed from the site.

10.3. FILLS.

10.3.1 If minor 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 the underlying weathered rock using piers as necessary. The design ultimate bearing pressures are 800 kPa for spread footings or shallow piers. It is expected that weathered rock will be encountered between 0.5m and 1.5m from current surface levels. All footings are to be founded on material of equal consistency to prevent differential settlement.

10.5. STORM WATER DRAINAGE.

Storm water generated from any new works is to be piped to the existing stormwater system for the block through any water tanks or onsite detention 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 and pipe 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 will be sufficient.

10.7. INSPECTIONS.

It is essential that the foundation materials of all footing excavations be inspected and approved before 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 MR 30611 dated 17th May, 2016.

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 MR 30611 dated 17th May, 2016.

The Geotechnical Engineer inspected and approved the foundation material of all footing excavations.

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%)	'Minor' (5%)
RISK TO PROPERTY	'Low'(5×10^{-6})	'Low (5×10^{-6})
RISK TO LIFE	1.6×10^{-7}/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 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

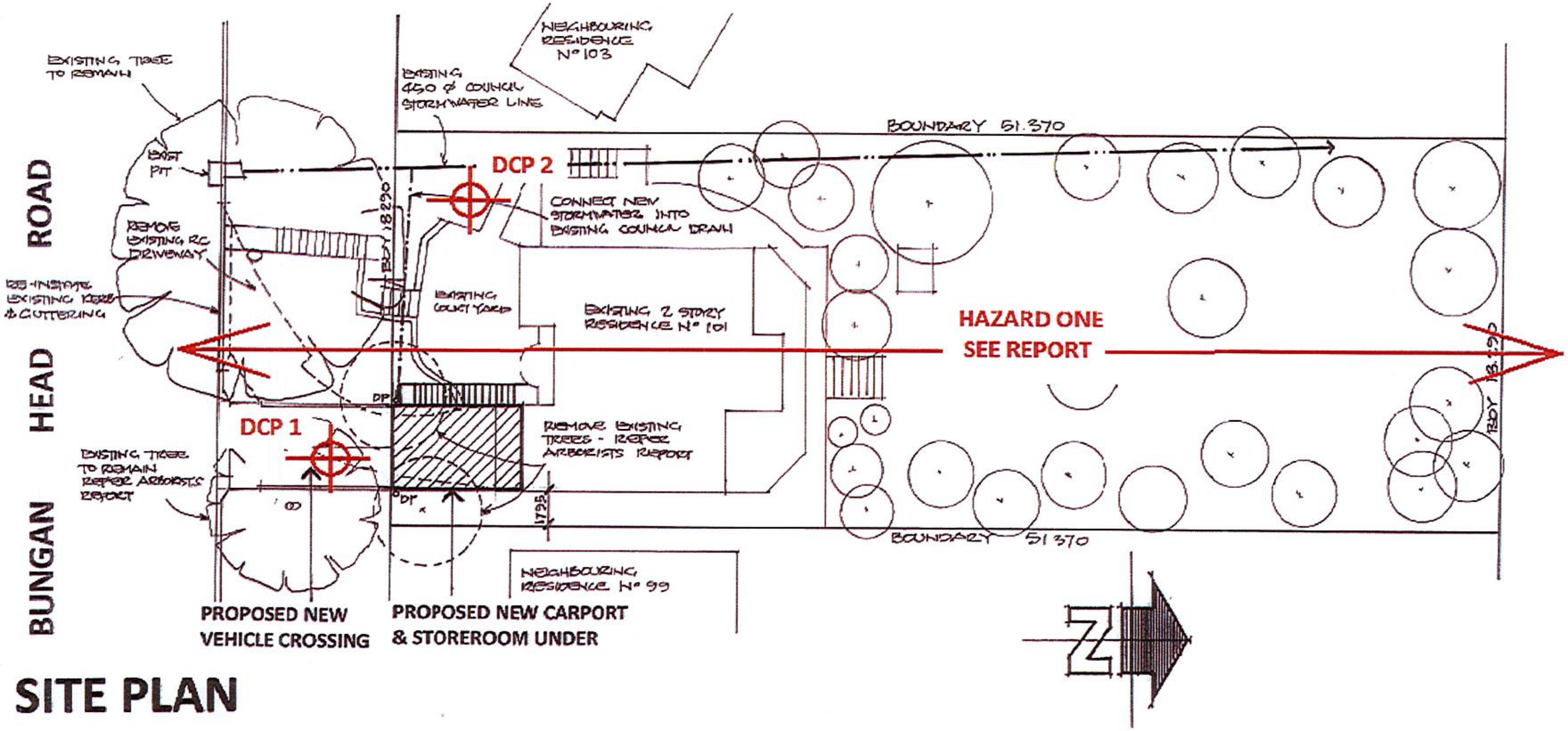
Photo 4

Photo 5

Photo 6

Photo 7

Photo 8



SITE PLAN

= DCP LOCATION

SITE PLAN - HAZARD AND DCP LOCATIONS

Job No	Address
MR 30611	101 BUNGAN HEAD ROAD NEWPORT NSW
Scale	
NTS	

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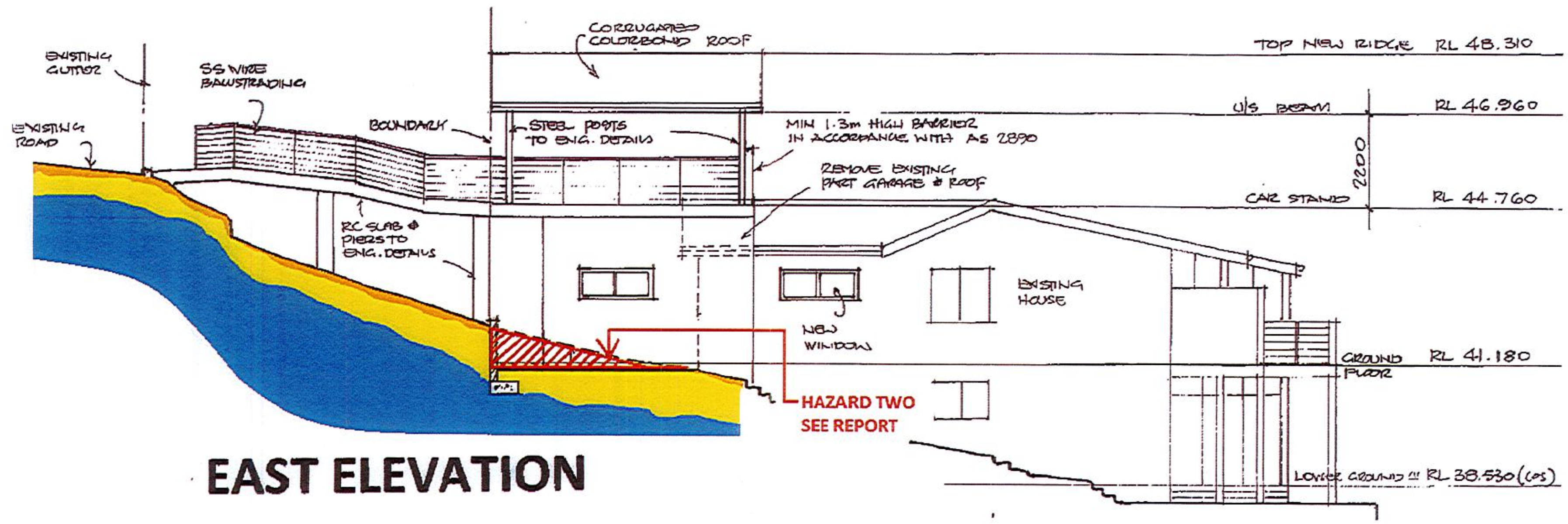

EAST ELEVATION

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

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TYPE SECTION	
Job No MR 30611	Address 101 BUNGAN HEAD ROAD NEWPORT NSW
Scale NTS	

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'.