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

RISK ANALYSIS & MANAGEMENT FOR PROPOSED ADDITIONS AND ALTERATIONS AT 55 ROBERTSON ROAD, SCOTLAND ISLAND

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

Development Application for _____
Name of Applicant

Address of site 55 ROBERTSON ROAD, SCOTLAND ISLAND

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 24/07/2013 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 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.

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

Geotechnical Report Details:

Report Title: RISK ANALYSIS & MANAGEMENT FOR PROPOSED ADDITIONS & ALTERATIONS AT **55 ROBERTSON ROAD, SCOTLAND ISLAND**
Report Date: 02/07/2013

Author : PETER THOMPSON

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

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

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 **55 ROBERTSON ROAD, SCOTLAND ISLAND**

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 ADDITIONS & ALTERATIONS AT **55 ROBERTSON ROAD, SCOTLAND ISLAND**

Report Date: 02/07/2013

Author: PETER THOMPSON

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

Please mark appropriate box

☒ Comprehensive site mapping conducted 02/07/2013 (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 02/07/2013

☒ 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 Peter Thompson

Name Peter Thompson

Chartered Professional Status MIE Aust CPEng

Membership No. 146800

Company Jack Hodgson Consultants Pty Ltd

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RISK ANALYSIS & MANAGEMENT FOR PROPOSED ADDITIONS & ALTERATIONS AT 55 ROBERTSON ROAD, SCOTLAND ISLAND

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 Sydney.

2. PROPOSED DEVELOPMENT.

2.1 Construct a boatshed, deck and stairway along the waterfront.

2.2 Details of the proposed development are shown on 4 drawings prepared by Jack Hodgson Consultants labelled job number 24417. The drawings are numbered A01-A04 Rev A and dated 28th June, 2013.

3. DESCRIPTION OF SITE & SURROUNDING AREA.

3.1 The site was inspected on the 2nd July, 2013.

3.2 The property has a northerly aspect and is accessed by boat. The land surface rises steeply from the waterfront at an average angle of some 35 degrees for ~ 10 metres before reducing to an angle of some 15 degrees and extending to the upper boundary. The slope extends above at similar grades and gradually increases towards the crest of the hill located ~ 160 metres from the upper boundary.

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3.3 A jetty in good condition extends into Pittwater from the middle of the block (Photo 1). Sandstone bedrock outcrops along the waterfront and shows no geological defects that could affect it's stability (Photo 2). An embankment rises steeply from the water's edge before easing at the house. Slumping has occurred near the middle of this bank (Photo 3). The slump is approximately 1.2 metres deep and 3.5 metres wide. A tree is located beside the slump and soil erosion has occurred beside the tree trunk (Photo 4). The tree appears to be dying and if it falls it will destabilize the surrounding area. Further investigation is to be undertaken to determine the condition of the tree. Access to the house is provided by a path that extends along the eastern side of the property. The slope is planted with deep rooted gum trees that stand vertical (Photo 5). A cut has been made underneath the house to accommodate a storage area. It is supported by a stable timber wall. The western side of the cut is unsupported but the batter angles appear stable (Photo 6). A paved area has been cut into the slope on the uphill side of the house. It is supported by a stable concrete block wall (Photo 7). A shed is located near the upper boundary. The cut batter to accommodate this shed rises to a maximum of approximately 0.6 metres. The cut batter stands at near vertical angles and is unsupported. We recommend a retaining wall be installed.

3.4 The two storey timber framed and clad house is in good condition. It is supported on a timber posts that show no signs of movement. Stormwater from the house was piped to water tanks beneath the house or discharged into Pittwater.

4. GEOLOGY OF THE SITE.

4.1 The site is underlain by interbedded sandstones, siltstones and shales of the Narrabeen Group that outcrop along the waterfront. 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 loam topsoil over sandy clays and clays with rock fragments and some floaters through out 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 1.0 to 1.5 metres.

5. SUBSURFACE INVESTIGATION.

Four Dynamic Cone Penetrometer (DCP) tests were conducted in the approximate locations shown on the Site Plan. The results of these tests are as follows:

DEPTH (m)	NUMBER OF BLOWS – conducted with Pointed Tip			
	DCP1	DCP2	DCP3	DCP4
0.0 to 0.3	9	4	6	4
0.3 to 0.6	19	1(drop)	8	6
0.6 to 0.9	14	5	9	24
0.9 to 1.2	23	18	16	17
1.2 to 1.5	36	24	32	#
	Refusal on rock @ 1.35m	Refusal on rock @ 1.5m	End of test @ 1.5m	Refusal on rock @ 1.0m

Notes:
DCP 1: Refusal on rock @ 1.35m, yellow rock fragments on tip.
DCP 2: Refusal on rock @ 1.5m, clean tip.
DCP 3: End of Test @ 1.5m, DCP still slowly going down, orange rock fragments on tip.
DCP 4: Refusal on rock @ 1.0m, clean tip.

6. DRAINAGE OF THE SITE.

6.1 ON THE SITE.

The site is naturally well drained.

6.2 SURROUNDING AREA.

Particularly during heavy storms excess surface flow will enter the property from the adjoining upside slope.

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 The land slump that has occurred along the waterfront bank is a potential hazard **(HAZARD ONE)**.

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 properties beside the site are at similar elevations and have similar geomorphology to the subject property. The house and grounds of the properties beside the site were in good condition as observed from 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

An embankment rises steeply from the water's edge. Slumping has occurred near the middle of this bank. The slump is approximately 1.2 metres deep and 3.5 metres wide. The soil profile consists of 0.2m of organic topsoil over firm clay with bedrock encountered at ~ 1.0m. A tree is located beside the slump and soil erosion has occurred underneath the tree trunk. The tree appears to be dying and if it falls it will destabilize the surrounding area. The likelihood of further slumping impacting on the jetty is assessed as 'Likely' (10^{-2}). The consequences to property of such a failure are assessed as 'Minor' (5%). The risk to property is 'Medium' (5×10^{-4}).

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
Slumping has already occurred and the soil profile indicates further slumping is likely.
$\mathbf{P_{(H)}} = 0.01$/annum

8.2.2.2 Probability of Spatial Impact
The jetty is located below the land slump.
$\mathbf{P_{(SH)}} = 0.5$

8.2.2.3 Possibility of the Location Being Occupied During Failure
The average jetty is taken to be occupied by 2 people. It is estimated that 1 person will be on the jetty 2 hours a day, 7 days a week. It is estimated the other person will be on the jetty 1 hour a day, 4 days a week.
For the person most at risk:

$$\frac{2}{24} x \frac{7}{7} = 0.083$$

$\mathbf{P_{(TS)}} = 0.083$

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 jetty, it is estimated that the vulnerability of a person to being killed in the house when this occurs is 0.05
$\mathbf{V_{(DT)}} = 0.05$

8.2.2.5 Risk Estimation
$\mathbf{R_{(Lol)}} = 0.01 \times 0.5 \times 0.083 \times 0.05$
$= 0.0000208$
$\mathbf{R_{(Lol)}} = 2.08 \times 10^{-5}$/annum **NOTE:** This level of risk is **'UNACCEPTABLE'**. This level of risk can be brought to **'ACCEPTABLE'** if further investigation is undertaken to determine the condition of the tree and large boulders are placed across the base of the slump and stepped up the slope to stabilize this area.

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 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 suitable.

10.2. EXCAVATIONS.

10.2.1 An excavation to a maximum depth of 2.0 metres is required to accommodate the proposed boathouse. The soil profile consists 0.2m of organic topsoil over firm clay with sandstone bedrock encountered in the range of 1.0m to 1.5m. Provided the entire cut is kept dry it will stand unsupported for short periods.

10.2.2 As the land surface above the cut face rises steeply, a Geotechnical Engineer is to inspect the cut at 1.0 metre intervals during excavation to ensure temporary support is not required.

10.2.3 The retaining wall to support the cut for the proposed boathouse is to be installed as soon as possible after the excavation is complete. The cut batter of the fill and clay portion is 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 depending upon the material encountered in the cuts, the likelihood of heavy rain and the length of period before permanent support is installed.

10.3. FILLS.

No fills are shown on the plans.

10.4. FOUNDATION MATERIALS AND FOOTINGS.

10.4.1 It is recommended that the footings for the proposed additions be supported on the underlying bedrock using piers as necessary. The design ultimate bearing pressures are 1.2 MPa for spread footings or shallow piers.

10.4.2 Bedrock is expected to be encountered in the range of 1.0m to 1.5m. All footings are to be founded on the same material to prevent differential settlement. We recommend that all footings be inspected by the Geotechnical Engineer.

10.5. STORM WATER DRAINAGE.

10.5.1 All roof stormwater runoff from the proposed boathouse is to be piped to Pittwater.

10.6. SUBSURFACE DRAINAGE.

10.6.1 All 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.

10.7. INSPECTIONS.

10.7.1 During the excavation process the cut batter is to be inspected at 1.0 metre intervals to ensure that temporary support is not required.

10.7.2 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 VS 24417 dated 2nd July, 2013.

The Geotechnical Engineer is to inspect the cut batter during the excavation process at 1.0 metre intervals to ensure no temporary support is required.

The Geotechnical Engineer is to inspect and approve the foundation materials of all footings 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 VS 24417 dated 2nd July, 2013.

The Geotechnical Engineer has inspected the cut batter during the excavation process at 1.0 metre intervals and specified whether or not temporary support is required.

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

13. RISK ANALYSIS SUMMARY.

HAZARDS	Hazard One
TYPE	The land slump that has occurred along the waterfront bank is a potential hazard (Photo 3 & 4)
LIKELIHOOD	'Likely' (10^{-2})
CONSEQUENCES TO PROPERTY	'Minor' (5%)
RISK TO PROPERTY	'Medium' (5×10^{-4}).
RISK TO LIFE	2.08×10^{-5}/annum
COMMENTS	**NOTE:** This level of risk is **'UNACCEPTABLE'**. This level of risk can be brought to **'ACCEPTABLE'** if further investigation is undertaken to determine the condition of the tree and large boulders are placed across the base of the slump and stepped up the slope.

JACK HODGSON CONSULTANTS PTY. LIMITED.

Peter Thompson

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

Photo 1

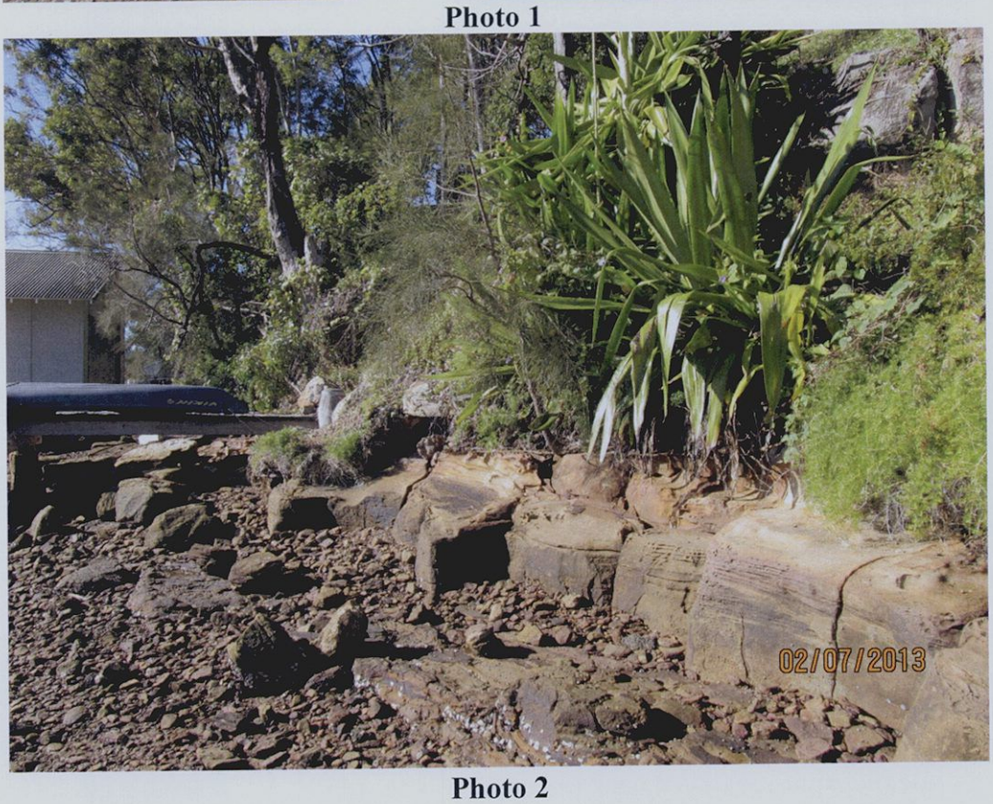


Photo 2

Photo 3

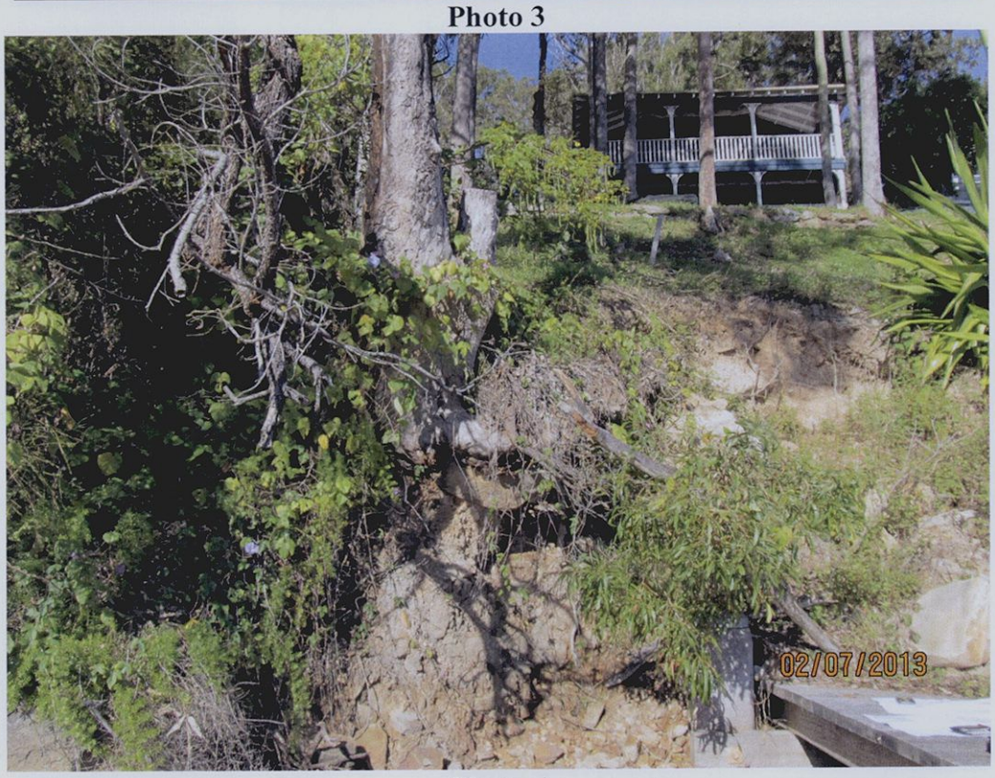


Photo 4

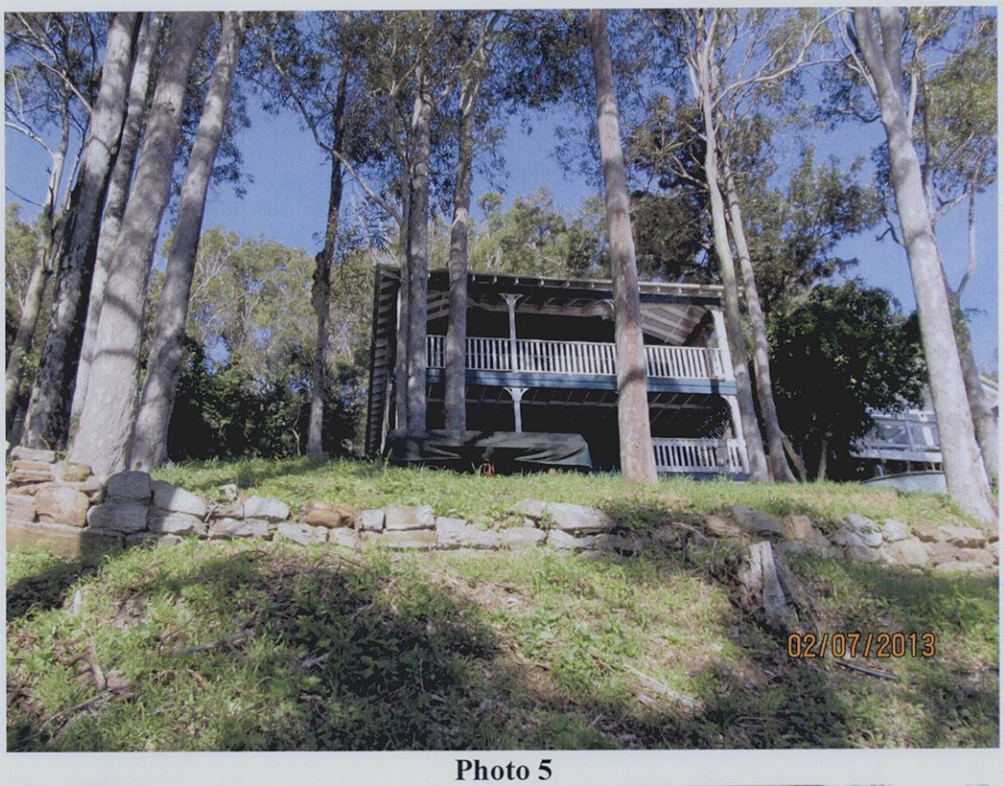


Photo 5

Photo 6

Photo 7

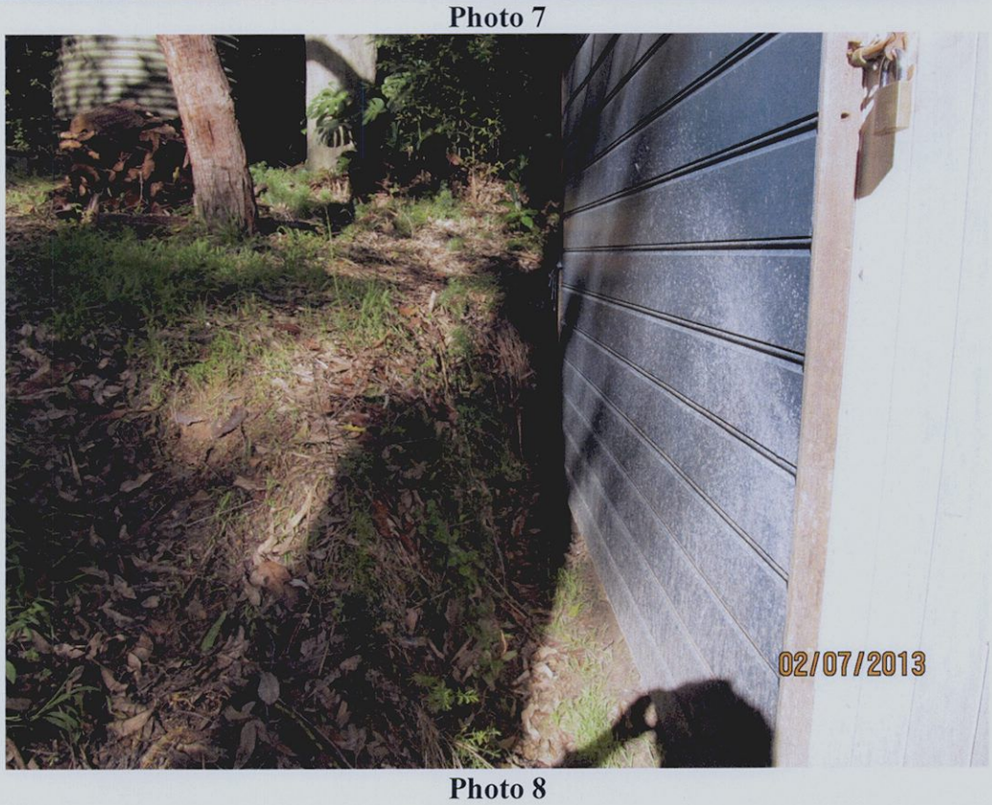
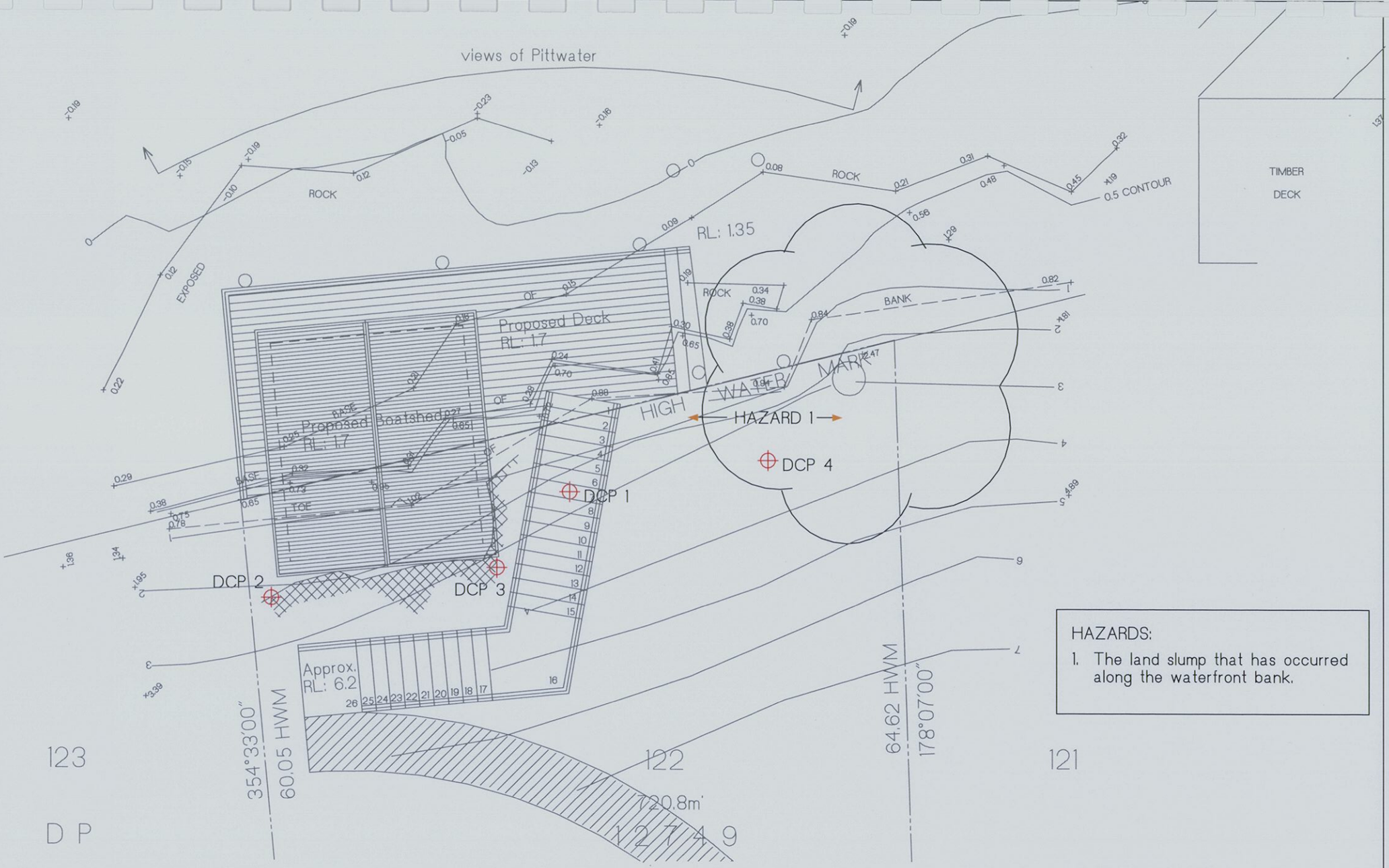


Photo 8



HAZARDS:

1. The land slump that has occurred along the waterfront bank.

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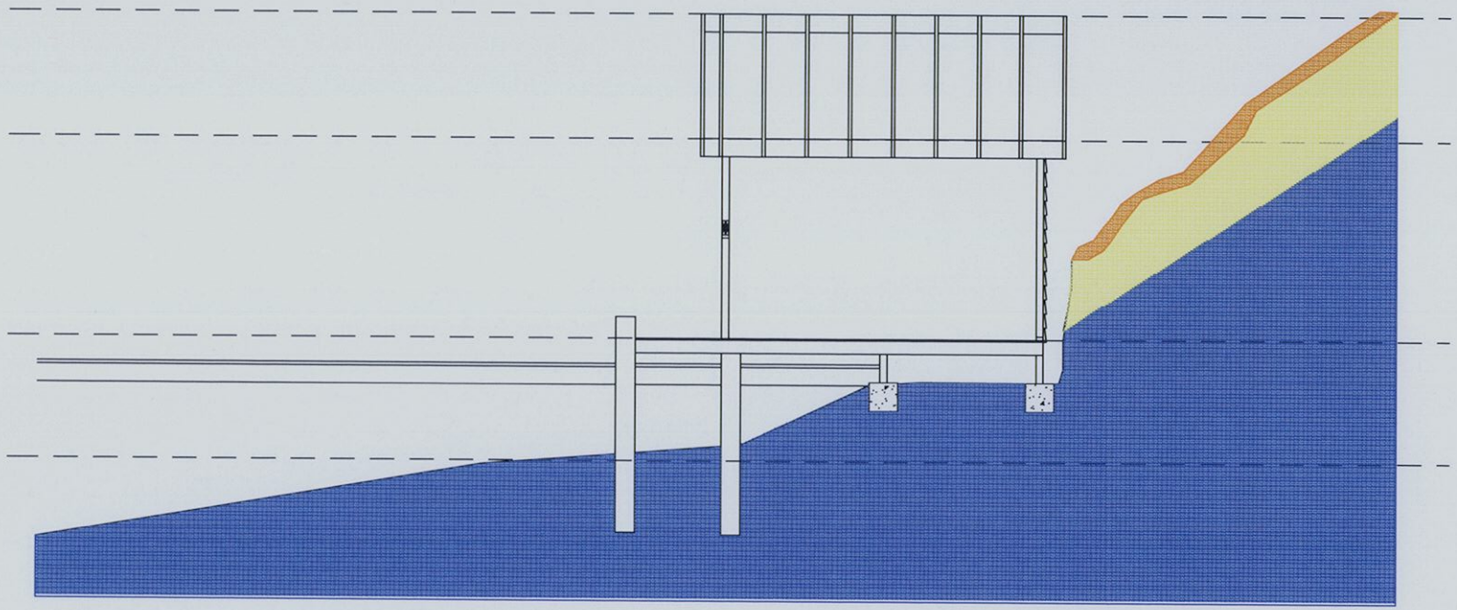
CONSULTING CIVIL, GEOTECHNICAL AND STRUCTURAL ENGINEERS

SITE PLAN – DCP LOCATIONS

Job No	Address
VS 24417	55 ROBERTSON ROAD
Scale	SCOTLAND ISLAND
1:100	NSW



SECTION LOOKING EAST

ABN: 94 053 405 011
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TYPE SECTION

Job No	Address
VS 24417	55 ROBERTSON ROAD SCOTLAND ISLAND NSW
Scale 1:100	

Strata Profile Legend

- Fill
- Sandy Topsoil
- Sandy Clay
- Narrabeen Group Rocks (can resemble a mottled stiff to hard clay)
- Hawkesbury Sandstone

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:
$\mathbf{R}_{(Prop)} = \mathbf{P}_{(H)} \times \mathbf{P}_{(S:H)} \times \mathbf{P}_{(T:S)} \times \mathbf{V}_{(Prop:S)} \times \mathbf{E}$ **(1)**

Where
$\mathbf{R}_{(Prop)}$ is the risk (annual loss of property value).

$\mathbf{P}_{(H)}$ is the annual probability of the landslide.

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

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

$\mathbf{V}_{(Prop:S)}$ 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:

$\mathbf{R}_{(LoL)} = \mathbf{P}_{(H)} \times \mathbf{P}_{(S:H)} \times \mathbf{P}_{(T:S)} \times \mathbf{V}_{(D:T)}$ **(2)**
Where

$\mathbf{R}_{(LoL)}$ is the risk (annual probability of loss of life (death) of an individual).

$\mathbf{P}_{(H)}$ is the annual probability of the landslide.

$\mathbf{P}_{(S:H)}$ 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.

$\mathbf{P}_{(T:S)}$ 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.

$\mathbf{V}_{(D:T)}$ 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'.