REGIONAL GEOTECHNICAL SOLUTIONS

Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS03414.1-AB

14 August 2024

Keith & Philippa Hogan
PO Box 1637
BATHURST NSW 2795

Dear Keith & Philippa

RE: Proposed Dwelling – 27 Maslin Close, Red Head
Geotechnical Assessment

1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical site investigation and slope stability assessment at 27 Maslin Close, Red Head (Lot 544 DP1280910).

Provided preliminary drawings indicate that parts of the site will be regraded by cuts of up to 3.6m which will be supported by structural retaining walls. It is anticipated the structure will be supported by a combination of piers, pad footings, strip footings, concrete slabs and block walls.

The aim of the assessment was to address the geotechnical issues relating to the development and to provide recommendations and advice on:

- Subsurface profile, including the presence of fill and the depth to weathered rock;
- Foundations, including foundation design parameters and depths, and site classification to *AS2870-2011 Residential slabs and footings;*
- Temporary and permanent cut and fill batters;
- Retaining wall design parameters;
- Risk of slope instability in accordance with the principles and protocols of the Australian Geomechanics Society publication '*Practice Note Guidelines for Landslide Risk Management*' (2007); and
- Site drainage.

2 METHODOLOGY

Field work for the assessment included:

- Observation of site features and surrounding features including measurement of slope angles relevant to the geotechnical conditions of the site;
- Four boreholes (BH1 to BH4) undertaken within the proposed building footprint;
- Four Dynamic Cone Penetrometer (DCP) tests undertaken adjacent to each borehole; and

- Collection of a representative sample of clay for assessment.

Engineering logs of the boreholes are attached. The locations of the boreholes are shown on Figure 1.

3 SITE CONDITIONS

3.1 Surface Conditions

The site is located within a new residential subdivision. It is situated within a region of moderately to steeply sloping terrain on the north facing slopes of a main east west oriented ridgeline. The property occupies approximately 700m2 and is bordered by Maslin Close to the north, a vacant residential lot to the east, a residential lot containing a recently constructed dwelling to the west and a residential lot containing a dwelling to the south. The site is vegetated with grass and contains small wattle trees in the northeast and southwest corners of the lot. Slopes generally grade down to the north at 10 – 13 degrees steepening to around 27 degrees on the northern end of the lot where a cutting batter associated with the construction of Maslin Close has been constructed. A shallow diversion drain has been constructed along the top edge of the batter which directs surface water in an easterly direction. Loose gravel fill was observed on the lot in some locations. Visual assessment indicates some fill may be present in the southwest corner of the lot beyond the proposed building footprint. A treated pine and hardwood timber retaining wall up to 1.1m in height is located along the southern boundary. Drainage of the lot is via minor infiltration and overland flow towards the street drainage system. The site was wet and slippery during fieldwork due to rain.

A satellite image that shows the location of the site and the site setting is reproduced in Plate 1.

Plate 1: *Satellite image obtained from the NSW Government 'MinView' website that illustrates the site location and setting at 27 Maslin Close. The approximate site boundaries are outlined in red.*

Site photographs are presented below:

Looking upslope to the south over the lot showing typical vegetation and slopes.

Looking downslope to north over lot showing typical vegetation and slope angles.

Section of timber retaining wall located along southern boundary.

Looking to west along steep batter on northern end of lot.

3.2 Subsurface Conditions

The 1:100,000 Bulahdelah Geology map indicates that the property is located within an area underlain by the Bundook Beds which comprise grey to brown lithic sandstone & siltstone, interbedded with massive greywackes & minor conglomerate. These formations are typically overlain by residual clay soil profiles derived from these rock types.

The subsurface conditions encountered during the investigation are summarised in Table 1.

Table 1: Summary of Subsurface Conditions Encountered in Boreholes

Material Name	Material Description	Depth to base of Material Layer (m)			
		BH1	BH2	BH3	BH4
Fill	Sandy Silty CLAY/ Gravelly Silty Clay, low plasticity	--	--	0.15	--
Topsoil	Silty CLAY, low plasticity.	0.1	0.15	--	0.1
Slopewash	Gravelly Silty CLAY, low plasticity, stiff.	--	0.25	--	--
Residual	CLAY/Gravelly CLAY, low to medium plasticity, gravel fine to coarse grained, stiff.	0.5	0.7	0.35	0.25
Extremely Weathered Siltstone	Gravelly CLAY, low to medium plasticity, very stiff to hard.	--	≥0.9*	≥0.5*	≥0.5*
Highly Weathered Siltstone	Moist, medium to high strength, highly fractured	≥1.1*	--	--	--

Notes: * indicates auger refusal on weathered siltstone
-- Indicates the material was not encountered at the test location
≥ indicates the base of the material layer was not encountered

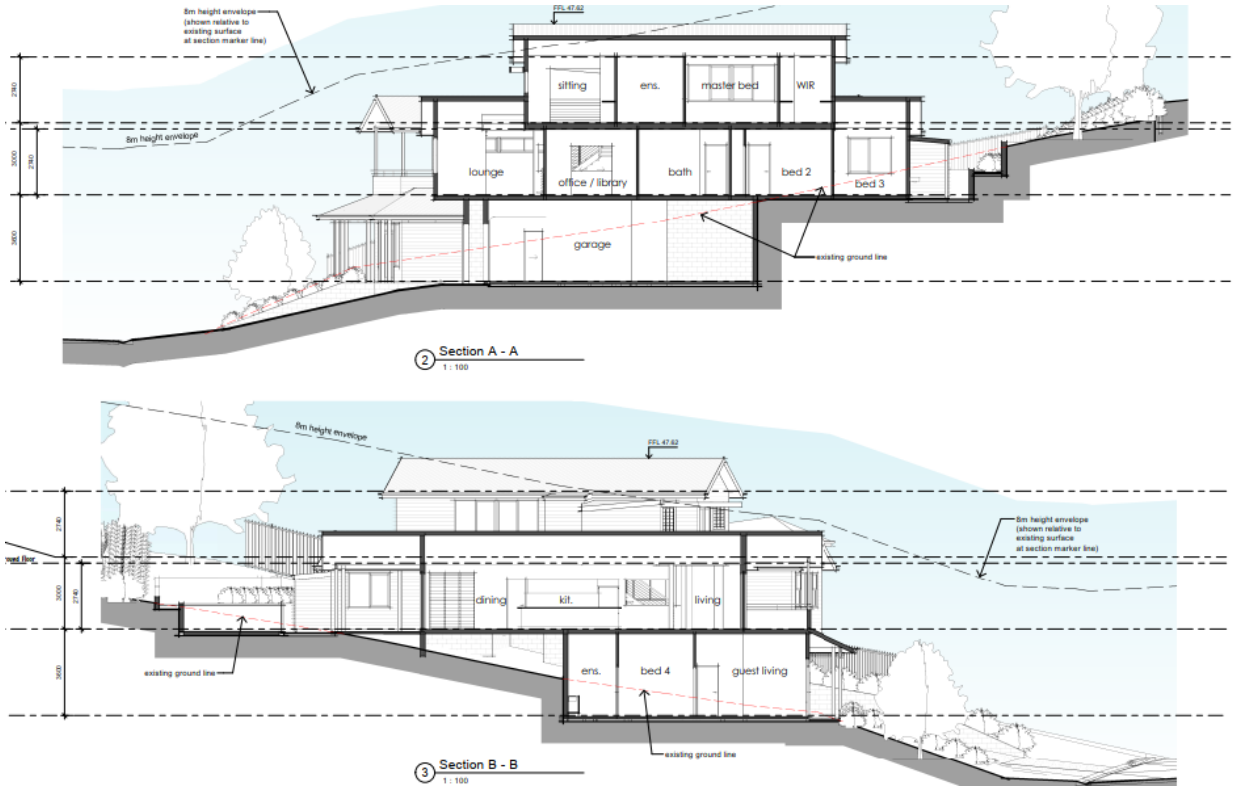
Groundwater was not encountered in the boreholes. Groundwater levels fluctuate as a result of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of the assessment.

RGS has undertaken laboratory testing on numerous samples of residual clay from within the subdivision and testing has revealed shrink swell index (Iss) values of between 2.5 – 3.3%.

Further details of the subsurface profiles are provided on the attached Engineering Logs.

4 PROPOSED DEVELOPMENT

The drawings provided indicate a four-bedroom three storey dwelling and pool are proposed at the site and that up to 3.6m of cut earthworks will be undertaken which will be supported by structural retaining walls. It is generally recommended that developments be designed to accommodate the natural slope and minimise the requirement for cut to fill earthworks. Some details from concept plans are provided in the figure below:



East and West Elevation Sections of proposed development as per drawings provided to RGS

5 SLOPE STABILITY

5.1 Risk Assessment

The risk of slope instability has been assessed using the principles and procedures of the Australian Geomechanics Society publication Practice Note Guidelines for Landslide Risk Management, 2007. This methodology represents the currently accepted state of practice for landslide risk assessment in Australia.

The slope risk assessment process involves identification of a potential slope failure event, or hazard, followed by an estimation of the likelihood of the event occurring, and the potential consequences should the event occur.

The terms used in the risk assessment process are defined below:

Hazard: A condition with the potential for causing an undesirable consequence.

Likelihood: The estimated probability that the hazardous event will occur.

Consequence: Loss or damage resulting from a hazard event.

Risk: A term combining the likelihood and consequence of an event in terms of adverse effects to property or the environment.

5.2 Hazard Identification

In terms of slope stability, the following potential hazards were assessed in relation to the site and the proposed development:

Hazard 1 – Translational failure caused by sliding of the soil or rock profile over a plane of weakness such as a clay seam, zone of water concentration within the exposed rock mass, or on the soil-rock/soil – fill interface. Should such a failure occur it could potentially cause moderate structural damage;

Hazard 2 – Rotational failure or toppling failure within unsupported excavations or fill batters. If such a failure was to occur it could potentially cause moderate structural damage to a structure. It is noted structural retaining walls are proposed.

Hazard 3 – Soil creep. Creep is an imperceptibly slow movement that takes place on sloping soil sites. It is an ongoing, natural slope process involving the progressive downslope migration of soils over the underlying rock profile;

The identified hazards are shown in Figure 2.

5.3 Risk Evaluation for Existing Site Conditions

Table 2 assesses the risk of slope instability for each of the hazards identified, using the risk assessment matrix provided in Appendix C of the Australian Geomechanics Society (AGS) publication Practice Note Guidelines for Landslide Risk Management, 2007.

A copy of the risk matrix from the AGS document is attached.

Table 2. Slope Risk Assessment Based on AGS2007 Method

Hazard	H1 Translational slide over defect or soil-rock interface	H2 Instability within unsupported cuts and fills (Future Works)	H3 Soil Creep
Slope height	Up to about 1m	Up to about 3.6m	Whole slope
Cause or trigger	Slope deterioration(10yr) followed by extreme rainfall event (1 in 10,000yr) event. Leaking underground services and poor drainage.	Cut steeper than angle of repose, unsupported, high rainfall (1 in 10yr event) Leaking underground services, poor drainage, application of a load or surcharge (traffic, construction, etc) at crest of cut or fill.	Ongoing process
Proportion of slope affected	Up to 0.2	0.2	1
Element(s) at Risk	Footings, structures on property	Site occupants or structures nearby	Post development structures
Risk assessment without management or treatment			
Estimated annual probability	10^{-4}	10^{-2}	10^{-1}
Likelihood	Unlikely	Likely	Almost Certain
Consequence	Medium	Medium	Insignificant
Risk	Low	High	Low
Risk assessment with management as proposed			
Proposed treatment	Employ good hillside construction practice	All cut and fill support to be engineer designed for the slope conditions	No specific treatment proposed – minimise disturbance to existing slope and employ good hillside construction practice
Estimated annual probability	10^{-5}	10^{-5}	10^{-1}
Likelihood	Rare	Rare	Almost certain
Consequence	Medium	Medium	Insignificant
Risk	Low	Low	Low

5.4 Evaluation of Risk Level

The assessment presented in Table 2 indicates that there is a **Low** risk of slope instability for the site provided the development is undertaken in accordance with general good hillside practice (refer to attachment) and by adopting the recommendations of this report regarding maximum unsupported cut heights, batter angles, and retaining wall design.

A **Low** risk rating would normally be considered acceptable for hillside development in Australia and can be maintained by implementing good surface drainage at the site and good hillside construction practices as recommended herein. Site drainage associated with the proposed development should be designed to avoid concentrated flows in the vicinity of any proposed cuttings, fill embankments and foundations. Drainage measures should include a diversion drain or swale upslope of the development that diverts upslope runoff around the proposed building area, to discharge in a controlled manner that limits erosion downslope of the development or to the site stormwater drainage system.

All cuts and fills must be appropriately benched and battered, supported by temporary shoring or by an engineered retaining wall. All retaining walls should include an allowance for adequate drainage behind the wall in accordance with AS4678-2002 that either discharges into the site stormwater system or further downslope from the proposed dwelling.

5.5 Recommendations in Relation to Slope Risk Management

The Australian Geomechanics Society published a series of documents providing guidelines for Landslide Risk Management in 2007. The documents included recommendations on Good Hillside Practice. It is recommended that development at this site be undertaken in accordance with good hillside practice as summarised in the attached document and the specific recommendations of this report.

Type of Structure

The drawings provided indicate that the site will be regraded by cut of up to 3.6m which will be supported by structural retaining walls. It is anticipated the structure will be supported by a combination of piers, pad footings, strip footings, concrete slabs and block walls. It has been assumed that the performance expectations of *AS2870-2011* are acceptable for the proposed structure. The proposed development should be founded in accordance with the recommendations of this report.

Excavations and Filling

Excavations and filling should be limited where possible to reduce the potential for instability of cuts and fills. Unsupported cut or fill batters up to 1.5m should not exceed 2H:1V for permanent slopes, or 1V:1H for temporary (ie during construction) batters. All cuts or fills exceeding 1m in height should be supported by engineer-designed retaining walls. Temporary batters for retaining wall construction could be cut with an overall batter grade of no more 1V:1H for heights no greater than 3.6m. Where cuts encountered soil over rock the upper soil portion of the cut should be no steeper than 1.5H:1V and the lower portion within very low to low strength rock could be cut no

steeper than 0.75H:1V. Cuts within medium to high strength rock can be cut no steeper than 0.5H:1V.

Steeper batters could be achievable within competent weathered rock, however, geotechnical assessment will be required during excavation to assess for the presence of potentially destabilizing features such as outwardly dipping joint sets or seams. If such features are identified flatter batters or alternative support measures may be required.

It should be noted that excavations for the construction of retaining walls result in a temporary reduction in the stability of the slope until the construction of an appropriately engineered retaining wall is complete. In areas where the above recommended batters cannot be achieved it is recommended the excavations be undertaken in stages of not more than 2m depth with each 2m stage supported prior to excavation of the subsequent stage.

Construction of retaining walls sometimes require site personnel to access the area immediately in front of the excavation face. Retaining walls should not be constructed without some temporary support measures being installed to prevent localised instability of the cut face from affecting site personnel involved in constructing the walls. The gap between the excavation face and the back of the walls must be backfilled with approved angular drainage aggregate or no fines concrete, with a slotted ag drain or similar behind the base of the wall discharging to the site stormwater system.

Any fill placed on the site must be placed on a foundation that has been benched into the slope to provide a level surface to avoid a sloping interface that could facilitate instability. The use of fill on this site should be avoided where possible.

All excavations on site must comply with the Safework Australia '*Excavation Work Code of Practice*' (2020 or latest edition). Vertical batters should not be undertaken without appropriate engineer designed support measures.

Retention

All retaining walls should be designed in accordance with AS4678-2002 and must take into account surcharge loading associated with slopes, future traffic, or structures above the wall. Retaining walls must be provided with free draining backfill and a slotted subsoil drain behind the wall that discharges to the site stormwater system, or else discharges well beyond the wall foundations.

Gravity or cantilever retaining walls can be designed on the basis of a triangular lateral earth pressure distribution using the parameters provided in Table 3.

Table 3. Retaining Wall Design Parameters

Material Type	Bulk Unit Weight (kN/m3)	Angle of Internal Friction (Φ)	Cohesion (kPa)	Active earth pressure coefficient (Ka)	Passive earth pressure coefficient (Kp)	Allowable base bearing pressure (kPa)
Fill	18	22°	2	0.50	2.2	--
Topsoil	18	20^0	--	0.49	2.1	--
Slopewash	18	22^0	2	0.45	2.2	--
Residual Clay	19	25^0	5	0.41	2.5	100
EW to HW Siltstone	22	35^0	15	0.28	3.6	400

The earth pressure coefficients detailed in Table 3 have been calculated using Rankine's Theory. The retaining wall designer should ensure that the use of this method is appropriate for the individual retaining wall.

Maintenance of retaining structures is recommended including reduction of vegetation growing within retaining walls, and regular maintenance of groundwater weep structures.

Drainage

Runoff water should be directed to an onsite stormwater drainage system that pipes the water away from the proposed building area to discharge either to the inter allotment or street front drainage system. All runoff should be controlled and discharge downslope of all fill and retaining structures in a controlled manner that limits erosion. Drainage systems should be 'self flushing' where possible, to reduce blockages from leaves and other debris.

Regular maintenance of groundwater weep points should be undertaken.

6 FOUNDATION AND SITE CLASSIFICATION

The site classification presented herein is provided on the basis that the performance expectations of AS2870-2011 are acceptable. In assessing the estimated characteristic surface movement (ys) values the following has been adopted:

- Suction change at ground surface of pf 1.2;
- Depth of suction change of 1.5m;
- Crack depth multiplication factor of 0.5;
- Characteristic Iss of 2.5 – 3.3% for the residual clay;
- Footings will extend through any areas of uncontrolled fill; and
- There are two wattle trees located on the site.

Due to the presence of nearby trees and their potential influence on the soil moisture profile, producing abnormal moisture conditions as defined by AS2870-2011, the site is classified as **Class P**. Footings therefore require design on the basis of engineering principles.

Based on the conditions encountered during fieldwork and laboratory test results, slabs and footings for the site can be designed for a **Class 'M'** (Moderately Reactive) site in accordance with AS2870-2011 with a characteristic free surface movement of up to 30mm. Some additional shrink / swell related characteristic free surface movement (Yt) from the drying effects of nearby trees has been calculated and included in the predicted movement.

The founding of structures in differing materials is not recommended as differential movements, including shrink-swell related movements and settlement related movements can result in damage to the building. These movements can be accommodated by extending all footings to found within weathered rock.

Shrink-swell related movements can be affected by alterations to the soil profile by cutting and filling, and by the suction related effects of trees close to the building area. The effects of any such cutting, filling, tree planting, or tree removal should be taken into account when selecting design values for differential movement across the building.

The planting of trees and shrubs in the vicinity of the building will affect the moisture profile in the vicinity of the footings. Trees or shrubs should not be planted within a distance from the building equivalent to 1 times the final height of the tree, measured from the nearest footing. Garden beds directly adjacent to footings will cause abnormal moisture conditions under the footings and should also be avoided.

If any further earthworks are undertaken at the site, reclassification may be required.

7 FOOTINGS, CONSTRUCTION AND SITE MAINTENANCE CONSIDERATIONS

All structural footings should be founded as follows:

- All footings should be founded within controlled fill, residual soil or weathered rock below all topsoil, slopewash or uncontrolled fill;
- Footings founded within at least stiff residual soil or fill placed under Level 1 construction monitoring and testing to AS3798-2007 can be designed on the basis of a maximum allowable base bearing pressure of **100kPa**;
- Footings founded within weathered rock can be designed based on a maximum allowable base bearing pressure of **400kPa**;
- All footings should be founded on similar materials and outside or below the zones of influence resulting from existing or future service trenches and other subsurface structures.
- Site drainage associated with the proposed development should be designed to avoid concentrated flows in the vicinity of any proposed cuttings and foundations and to discharge water downslope of the development in a controlled manner that limits erosion;
- The soils and rocks in the Red Head area are prone to fretting and softening on exposure to air and water. It is therefore recommended that concrete be poured as soon as possible after footing excavation. In the event that wet weather occurs prior to pouring of concrete, the base of footing excavations should be checked for the presence of loose or softened material, which should be removed prior to pouring concrete.

- Any foundations located within areas where tree removals, earthworks or demolition works have previously been carried out or will occur in the future will need to be taken through the disturbed ground to be founded on the undisturbed natural ground beneath. All organic root material should be removed from within the building footprint; and
- Where lot filling works are proposed, all fill for the support of structures should be placed and compacted in accordance with the recommendations outlined in AS3798-2007 *Guidelines on Earthworks for Residential and Commercial Developments*, under Level 1 supervision, for it to be considered Controlled Fill as defined in *AS2870-2011*. The founding of structures on fill that is not placed in accordance with Level 1 requirements is not recommended.

Site maintenance must comply with the recommendations and advice provided in CSIRO Sheet BTF18 "*Foundation Maintenance and Footing Performance: A Homeowners Guide* "a copy of which is which is available from the CSIRO website http://www.publish.csiro.au/pid/7076.htm

8 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

James Dowling

Senior Technical Officer

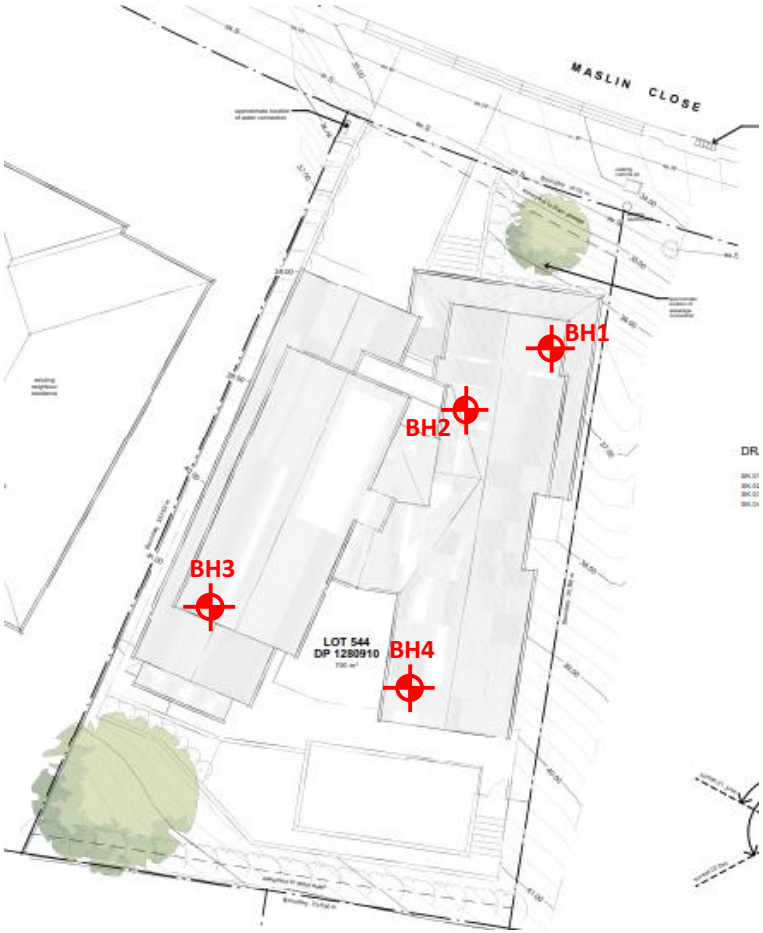
Reviewed by

Adam Holzhauser

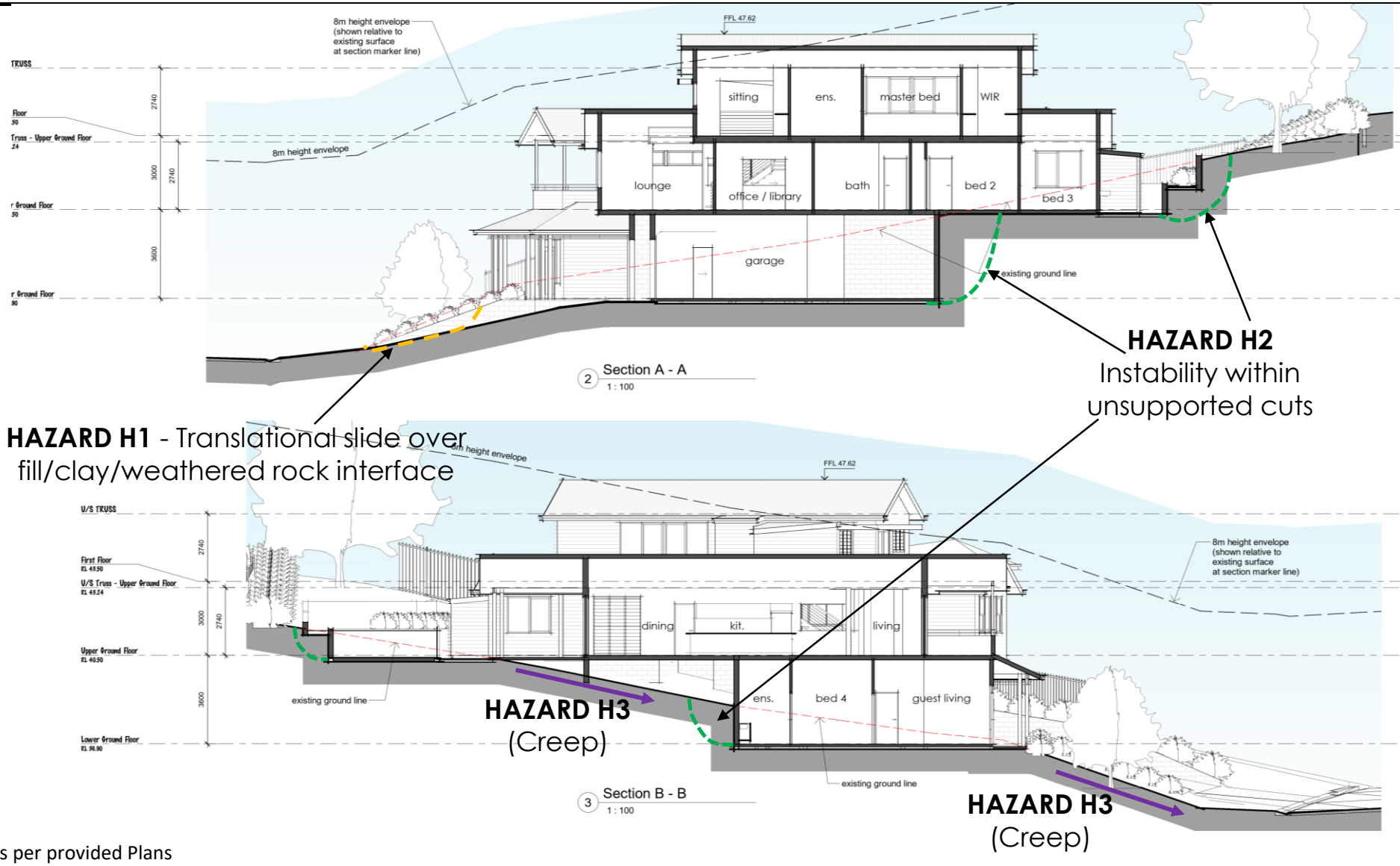
Associate Geotechnical Engineer

Figures and Attachments:

Figure 1 - Borehole Location Plan
Figure 2 - Cross Section
Results of Field Investigations
Slope matrix and information on hillside development



REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Keith & Philippa Hogan	Job No. RGS03414.1
	Project:	Proposed Dwelling 27 Maslin Close, Redhead	Drawn By: JD Scale: NTS Date: 14-Aug-24
	Title:	Borehole Location Plan	Drawing No. **Figure 1**



*As per provided Plans

REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	Keith & Philippa Hogan	Job No.	RGS03414.1
	Project:	Proposed Dwelling 27 Maslin Close, Redhead	Drawn By:	JD
			Scale:	NTS
			Date:	14-Aug-24
	Title:	Cross section with examples of identified hazards	Drawing No.	**Figure 2**

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH1

CLIENT: Keith and Phillipa Hogan
PAGE: 1 of 1
PROJECT NAME: Proposed Dwelling
JOB NO: RGS03414.1
SITE LOCATION: 27 Maslin Close, Red Head
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 2/7/24

DRILL TYPE: RGS Ute Mounted Drill Rig
EASTING: 456475 m
SURFACE RL:
BOREHOLE DIAMETER: 100 mm
INCLINATION: 90°
NORTHING: 6452864 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Encountered			0.2		CL	**TOPSOIL:** Silty CLAY, dark brown, trace of sand and gravel, fine to medium grained, trace of grass roots	M > w_P		DCP (0.00-0.50m)	2	TOPSOIL
							0.10m					
						Cl	**CLAY:** Medium plasticity, pale brown, brown, trace to some gravel, fine to medium grained, sand, fine to medium grained		St		2	RESIDUAL
				0.4							2	HP=130kPa
											3	
											3	HP=170kPa
							0.50m					
				0.6			**SILTSTONE:** Pale brown, pale orange-brown, pale grey, moist, medium to high strength, highly fractured, highly weathered	M				HIGHLY WEATHERED SILTSTONE DCP=18/80mm Bouncing
				0.8								
				1.0								
							1.10m					
				1.2			Hole Terminated at 1.10 m					
				1.4								
				1.6								
				1.8								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH2

CLIENT: Keith and Phillipa Hogan
PAGE: 1 of 1
PROJECT NAME: Proposed Dwelling
JOB NO: RGS03414.1
SITE LOCATION: 27 Maslin Close, Red Head
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 2/7/24

DRILL TYPE: Hand Auger
EASTING: 456474 m
SURFACE RL:
BOREHOLE DIAMETER: 0.75 mm
INCLINATION: 90°
NORTHING: 6452854 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
HA	Not Encountered			0.2		CL	**TOPSOIL:** Silty CLAY, low plasticity, dark brown, trace of sand and gravel, fine to medium grained, trace of grass roots	M > w_P		DCP (0.00-1.10m)	2	TOPSOIL
							0.15m				3	
						CL	**Gravelly Silty CLAY:** Low plasticity, brown, dark brown, gravel, fine to medium grained, trace sand, fine to medium grained		St			SLOPEWASH
							0.25m				4	
				0.4		CL	**Gravelly CLAY:** Low to medium plasticity, brown, pale brown, grey, gravel, fine to coarse grained, trace sand, fine to medium grained		St - VSt			RESIDUAL
											4	HP=140kPa
											4	
				0.6							5	
											3	HP=180kPa
							0.70m					
				0.8		CL	**Gravelly CLAY:** Low to medium plasticity, pale grey, pale brown, pale orange-brown	M < w_P			6	HIGHLY WEATHERED SILTSTONE DCP=15/70mm Bouncing at 1.1m
							0.90m				10	
							Hole Terminated at 0.90 m Practical Hand Auger Refusal				13	
				1.0							14	
				1.2								
				1.4								
				1.6								
				1.8								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH3

CLIENT: Keith and Phillipa Hogan
PAGE: 1 of 1
PROJECT NAME: Proposed Dwelling
JOB NO: RGS03414.1
SITE LOCATION: 27 Maslin Close, Red Head
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 2/7/24

DRILL TYPE: Hand Auger
EASTING: 456466 m
SURFACE RL:
BOREHOLE DIAMETER: 0.75 mm
INCLINATION: 90°
NORTHING: 6452848 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
HA	Not Encountered	0.15m D 0.35m		0.2 0.4		CL CL Cl CL	0.05m **FILL:** Sandy Silty CLAY, low plasticity, dark brown, sand, fine to medium grained, trace gravel, fine to medium grained, trace of grass roots 0.15m **Gravelly Silty CLAY:** Low plasticity, brown, gravel, fine to coarse grained, trace sand, fine to medium grained **Gravelly CLAY:** Medium plasticity, brown, pale brown, grey, gravel, fine to coarse grained, trace sand, fine to medium grained 0.35m **Gravelly CLAY:** Low to medium plasticity, pale brown, pale grey, gravel, fine to coarse grained, trace of sand, fine to medium grained Becoming highly weathered from 0.5m 0.50m	M > w_P M < w_P	St VSt - H	DCP (0.00-0.40m)	2 3 2 6	FILL SLOPEWASH RESIDUAL HP=130kPa EXTREMELY WEATHERED SILTSTONE DCP=10/30mm Bouncing
				0.6 0.8 1.0 1.2 1.4 1.6 1.8			Hole Terminated at 0.50 m Practical Hand Auger Refusal					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH4

CLIENT: Keith and Phillipa Hogan
PAGE: 1 of 1
PROJECT NAME: Proposed Dwelling
JOB NO: RGS03414.1
SITE LOCATION: 27 Maslin Close, Red Head
LOGGED BY: RW
TEST LOCATION: Refer to Figure 1
DATE: 2/7/24

DRILL TYPE: Hand Auger
EASTING: 456473 m
SURFACE RL:
BOREHOLE DIAMETER: 0.75 mm
INCLINATION: 90°
NORTHING: 6452847 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (Not measured)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
HA	Not Encountered			0.2		CL	**TOPSOIL:** Silty CLAY, low plasticity, brown, dark brown, trace of sand and gravel, fine to medium grained, trace of grass roots	M > w_P		DCP (0.00-0.80m)	2	TOPSOIL
						CL	0.10m **Gravelly Silty CLAY:** Low plasticity, brown, gravel, fine to medium grained, trace sand, fine to medium grained	M < w_P	St		2	RESIDUAL HP=160kPa
				0.4		CL	0.25m **Gravelly CLAY:** Low to medium plasticity, brown, pale brown, pale grey, gravel, fine to coarse grained, trace of sand, fine to medium grained Becoming highly weathered from 0.5m		VSt - H		2 4	EXTREMELY WEATHERED SILTSTONE
				0.6			0.50m Hole Terminated at 0.50 m Practical Hand Auger Refusal on highly weathered siltstone				4 15	
				0.8							15	
				1.0							22	
				1.2								
				1.4								
				1.6								
				1.8								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

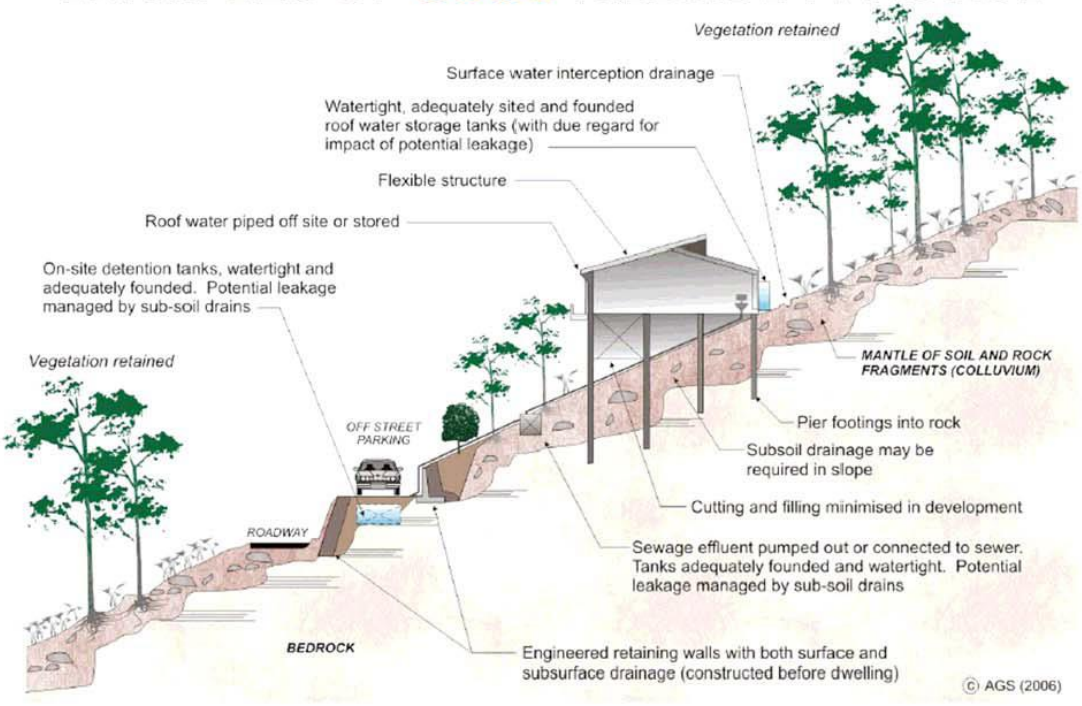
Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE