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REPORT ON GEOTECHNICAL SITE INVESTIGATION

For

PROPOSED NEW INCLINATOR

at

4 NOTTING LANE, COTTAGE POINT, NSW

Prepared For

Garry Sexton

Project No.: 2012-228.1

November 2019

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GEOTECHNICAL REPORT FOR PROPOSED INCLINATOR
4 NOTTING LANE, COTTAGE POINT, NSW

1. INTRODUCTION:

This report details the results of a geotechnical investigation and assessment carried out for a proposed inclinator at 4 Notting Lane, Cottage Point, NSW. The investigation and assessment was undertaken by Crozier Geotechnical Consultants (CGC) at the request of the client Garry Sexton.

It is understood that the proposed works involve the installation of an inclinator that traverses the northern side of the property. The inclinator will run from the ground floor of the house to the lawn in front of the jetty at the foreshore. The works require no bulk excavation or retention and are considered ‘minor’ from a geotechnical perspective.

Northern Beaches Council (Warringah 2011 LEP and DCP) states that all building development applications must be accompanied by a geotechnical assessment. That developments within Class ‘A’, ‘B’ and ‘D’ landslip risk zone may only require a preliminary assessment as per the check list, see below, however Class ‘C’ and ‘E’ will generally require a full geotechnical report, see details in Section E10 Landslip Risk of Councils Policy.

This site is located within landslip risk Class ‘C’. Therefore it is expected that a Development Application will require a geotechnical report. As Crozier Geotechnical Consultants has previously completed a geotechnical investigation and report for the property (Job No.: 2012-228, Dated: 14th March 2013) for a DA application, the site was re-inspected to confirm site conditions and then the previous report was updated to the new Development Application and current Council Policy standards. This report includes a landslide risk assessment to the methods of AGS 2007 for the site and proposed works, plans, geological sections and provides recommendations for construction.

The inspection and reporting were undertaken as per the Tender: P19-383, Dated: 10th October 2019.

The fieldwork comprised:

a) Geotechnical inspection of the site to confirm conditions of the site and adjacent properties against the previous report observations.
b) A photographic record of conditions

The following plans and drawings were supplied for the work:

- Inclinator Plans unreferenced (provided by client on site on 29th October 2019)

2. SITE FEATURES:

2.1. Description:

The site is a trapezoidal shaped block within moderately south dipping topography. An aerial photograph of the site and its surrounds is provided below (Photograph 1), as sourced from NSW Government Six Map spatial data system. The site is located at the tip of a north-east striking ridge line that extends down to Cottage Point, Sydney NSW. It is located on the south-eastern side of the ridge, at the base of the slope adjacent to Coal & Candle Creek. The property is situated on the low eastern side of Notting Lane within moderate to steep east dipping topography down to the waterway.

Photograph 1: Aerial photo of site and surrounds

2.2. Geology:

Reference to the Sydney 1:100,000 Geological Series sheet 9130) indicates that the site is underlain by Newport Formation (Upper Narrabeen Group) rock (Rnn) which is of middle Triassic Age. The Newport Formation typically comprises interbedded laminite, shale and quartz to lithic quartz sandstones and pink clay pellet sandstones. The rock unit was identified and mapped on the site and adjacent properties.

Narrabeen Group rocks are dominated by shales and thin siltstone beds and often form rounded convex ridge tops with moderate angle (<20°) side slopes. These side slopes can be either concave or convex depending on geology, internally they comprise interbedded shale and siltstone beds with close spaced bedding partings that have either close spaced vertical joints or in extreme cases large space convex joints. The shale often forms deeply weathered silty clay soil profiles (medium to high plasticity) with thin silty colluvial cover.

3. FIELD WORK:

3.1. Methods:

The initial field investigation comprised a walk over inspection of the site and limited inspection of adjacent properties on the 17th October 2012. It involved the drilling of three hand auger boreholes along with Dynamic Cone Penetrometer (DCP) testing to investigate sub-surface geology.

A site inspection was conducted on 29th October 2019 to confirm site conditions.

Explanatory notes are included in Appendix: 1. Mapping information and test locations are shown on Figure: 1, along with detailed Borehole Log sheets and Dynamic Penetrometer Test Sheet in Appendix: 2. A geological model/section is provided as Figure: 2, Appendix: 2.

3.2. Field Observations:

The site contains two residences, a small cottage next to the western site boundary, with the main, larger house, further downslope to the east. From the roadway a concrete driveway accesses down along the southern boundary to a raised double car, weatherboard garage built on a concrete slab and supported up to approximately 3m above the ground on its eastern side by concrete piers.

The driveway in front of the cottage is supported by a rendered, concrete block wall up to approximately 4.30m high built on top of outcropping sandstone bedrock. The wall appeared to be in a good condition with only some minor cracks in the render and possible signs of seepage at the base of the wall. Tiled steps access down from the driveway, next to the garage towards the main house. The steps from the driveway then access down to a tiled patio level with entranceway to the main house from this level. Along the southern property boundary is a low sandstone block wall with a timber fence on top.

The house is a raised one and two storey residence of weatherboard and concrete block construction with sandstone and concrete block footings. Due to the ground slope the house is single storey on its western side and two storey on its eastern side. The roof is guttered with downpipes discharging to a subsurface disposal system. It is estimated at 40 years old and a brief inspection revealed it to be in a reasonable structural condition with no obvious cracking or signs of differential settlement.

The north boundary is formed by a timber fence. It contains a series of dry stacked sandstone block walls and outcropping sandstone bedrock and boulders between the house and boundary fence.

To the east of the house are terraced lawns supported by sandstone block walls up to 2.50m high and access down to the water, with a sandstone boulder outcropping through one of the walls. These walls appear in good condition with no signs of significant settlement or cracking. Along the water's edge is a lawn terrace with a small weatherboard boatshed near the south property boundary and a timber jetty that leads out to a pontoon in the middle of the block. Towards the north boundary a sandstone block seawall supports the lawn area. The wall is up to 1.50m high and constructed on top of outcropping sandstone bedrock at its base. The outcropping sandstone bedrock is visible as a terrace before dropping down into the creek about 4.40m from the wall. Another timber jetty extends out from the lawn next to the northern site boundary.

The neighbouring property to the north, No. 3a Notting Lane, consists of a 2 and 3 storey weatherboard house stepping down the slope. The house is relatively new and in a good condition. The property is at a similar ground level as the site along the common boundary with the remainder of the block having a similar topography to the site. The house is located within 1.00m of the common boundary.

The neighbouring property to the south, No. 5 Notting Lane, consists of a 2 storey concrete and weatherboard residence with the house walls extending no closer than 2.50m from the shared property boundary. The house is approximately 10 years of age and in a good condition. At the east side of this block are sandstone block retaining walls supporting sloping lawn terraces and near the shared property boundary large sections of outcropping sandstone bedrock.

The neighbouring properties and structures were inspected from the site or road reserves, however visible aspects showed no indications of geotechnical hazard that may impact the site.

3.3. Test Results:

Three hand augered boreholes (BH1, BH1a & BH2) were undertaken across the site. Engineering logs of boreholes BH1 to BH2 with explanatory notes are attached within Appendix: 1. Borehole test locations are shown on Figure: 1 attached.

In general, the boreholes & DCP tests encountered clay fill overlying insitu clay soils. Bedrock was observed to be outcropping in this site and neighbouring areas.

Borehole 1 was drilled underneath the stairs that access down towards the water through a raised lawn area. This borehole intersected sandy clay fill from the surface to 0.55m depth where the auger refused on a sandstone boulder within the fill. A Dynamic Cone Penetrometer (DCP) test carried out adjacent to the borehole indicates that there is soft to firm fill material from the surface to at least 1.20m depth where the test was discontinued. Since the DCP test was able to extend deeper than the borehole another borehole was attempted at an additional adjacent location at BH1a.

BH1a also intersected clay fill soils from the surface to 0.40m depth where the auger again refused on a sandstone boulder within the fill. A DCP test carried out at this location indicates soft to firm fill material from the surface to at least 1.20m depth where the test was discontinued.

Borehole 2 was drilled through the lawn area next to the cottage and the entrance to the driveway. This borehole intersected sandy gravelly fill from the surface to 0.25m depth where insitu clay soils were found. This clay contained ironstone gravels and extended to 0.75m depth where the auger refused on a thicker band of these gravels. A DCP test carried out adjacent to the borehole found stiff material from the surface to 1.20m depth where the test was discontinued.

No freestanding ground water table was noted in any of the boreholes.

4. COMMENTS:

4.1. Geotechnical Assessment:

In general there are no signs of features within the site, where the proposed inclinator is to take place, or surrounding slopes that could be attributed to significant slope instability. The investigation found shallow layers of clay fill soils overlying insitu clay soils with sandstone bedrock below. Previous construction activity in the adjacent property to the south was inspected by Crozier Geotechnical Consultants. This work identified sandstone bedrock at relatively shallow depth except where modified by previous development. Outcropping sandstone bedrock was visible across the bottom half of the property and on the high side of Notting Lane. Several sandstone boulders are present across the hill slope also.

The recommendations and conclusions in this report are based on an investigation restricted to the use of hand tools, therefore, some minor variation to the interpreted sub-surface conditions is possible. However, these results of the investigation provide a reasonable basis for the analysis of Development Application.

4.2. Site Specific Risk Assessment:

Based on our site investigation we have identified the following geological/geotechnical landslip hazards which need to be considered in relation to the existing site and the proposed works. The hazard is:

A. Landslip (Rockslide/topple $<1m^3$) due to unsafe footing excavation methods

A qualitative assessment of risk to life and property related to these hazards is presented in Table A and B, Appendix: 3, and is based on methods outlined in Appendix: C of the Australian Geomechanics Society (AGS) Guidelines for Landslide Risk Management 2007. AGS terms and their descriptions are provided in Appendix: 4.

The Risk to Life from the hazards was estimated to be up to $\mathbf{1.04 \times 10^{-7}}$, whilst the Risk to Property was considered to be **'Low'**.

The risk in relation to the existing site and the proposed works is within 'Acceptable' levels when assessed against the criteria of the AGS. As such the project is considered suitable for the site provided the recommendations of this report are implemented.

4.3. Design & Construction Recommendations:

Design and construction recommendations are tabulated below:

4.3.1. New Footings:	
Site Classification as per AS2870 – 2011 for new footing design	- Class 'A' for footings founded within bedrock
Type of Footing	Pad or Pier
Sub-grade material and Maximum Allowable Bearing Capacity	- Very Low Strength Sandstone – 800kPa* - Low Strength Sandstone: 1000kPa* - Medium Strength Sandstone: 2000kPa*
Site sub-soil classification as per *Structural design actions AS1170.4 – 2007, Part 4: Earthquake actions in Australia*	B_e – Rock site
*where proved by geotechnical investigation/inspection to a sufficient depth underlying any new footings **Remarks:** All permanent structure footings should be founded off material of similar strength to reduce the potential for differential settlement and provide lateral resistance unless designed for by the structural engineer. All new footings must be inspected by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata. This is mandatory to allow them to be 'certified' at the end of the project.	

4.4. Conditions Relating to Design and Construction Monitoring:

To allow certification at the completion of the project it will be necessary for Crozier Geotechnical Consultants to:

1. Review and approve the structural design drawings, including the retaining structure design and construction methodology, for compliance with the recommendations of this report prior Construction Certificate.
2. Inspect all new footings and earthworks to confirm compliance to design assumptions with respect to allowable bearing pressure, basal cleanness and the stability prior to the placement of steel or concrete,

Crozier Geotechnical Consultants cannot provide certification for the Occupation Certificate if it has not been called to site to undertake the required inspections.

4.5. Design Life of Structure:

We have interpreted the design life requirements specified within Council□s Risk Management Policy to refer to structural elements designed to support the existing structures, control stormwater and maintain the risk of instability within acceptable limits. Specific structures and features that may affect the maintenance and stability of the site in relation to the proposed and existing development are considered to comprise:

- stormwater and subsoil drainage systems,
- retaining walls and instability,
- maintenance of trees/vegetation on this and adjacent properties.

Man-made features should be designed and maintained for a design life consistent with surrounding structures (as per AS2870 □2011 (100 years)). It will be necessary for the structural and geotechnical engineers to incorporate appropriate design and inspection procedures during the construction period. Additionally, the property owner should adopt and implement a maintenance and inspection program.

If this maintenance and inspection schedule are not maintained the design life of the property cannot be attained. A recommended program is given in Table: C in Appendix: 3 and should also include the following guidelines.

- The conditions on the block don□t change from those present at the time this report was prepared, except for the changes due to this development.
- There is no change to the property due to an extraordinary event external to this site
- The property is maintained in good order and in accordance with the guidelines set out in;
    a) CSIRO sheet BTF 18
    b) Australian Geomechanics □Landslide Risk Management□Volume 42, March 2007.
    c) AS 2870 □2011, Australian Standard for Residential Slabs and Footings

Where changes to site conditions are identified during the maintenance and inspection program, reference should be made to relevant professionals (e.g. structural engineer, geotechnical engineer or Council). Where the property owner has any lack of understanding or concerns about the implementation of any component of the maintenance and inspection program the relevant engineer should be contacted for advice or to complete the component. It is assumed that Council will control development on neighbouring properties, carry out regular inspections and maintenance of the road verge, stormwater systems and large trees on public land adjacent to the site so as to ensure that stability conditions do not deteriorate with potential increase in risk level to the site. Also, individual Government Departments will maintain public utilities in the form of power lines, water and sewer mains to ensure they don□t leak and increase either the local groundwater level or landslide potential.

5. CONCLUSION:

The site has been investigated by CGC in 2012 and was re-assessed as part of this report update. There were no signs of previous or impending landslip instability whilst the proposed works involve no excavation or filling and therefore are not anticipated to create any landslip hazards.

The existing site has been assessed as per the Northern Beaches (Warringah Council DCP 2011) and all existing landslip hazards identified achieve the □Acceptable□Risk to Life and □Acceptable□Risk to Property criteria. The site is therefore considered suitable for the proposed development and can achieve the □Acceptable□risk criteria over the design life of the house required by Council□s Policy provided that any recommendations outlined in this report are followed.

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6. REFERENCES:

1. Australian Geomechanics Society 2007, Landslide Risk Assessment and Management Australian Geomechanics Journal Vol. 42, No 1, March 2007.
2. Geological Society Engineering Group Working Party 1972, The preparation of maps and plans in terms of engineering geology Quarterly Journal Engineering Geology, Volume 5, Pages 295 - 382.
3. Australian Standard AS 3798 2007, Guidelines on Earthworks for Commercial and Residential Developments.
4. Australian Standard AS 2870 1996, Residential Slabs and Footings Construction
5. Australian Standard AS1170.4 2007, Part 4: Earthquake actions in Australia

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Appendix 1

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. Sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very soft	Less than 12
Soft	12 - 25
Firm	25 – 50
Stiff	50 – 100
Very stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300mm)	CPT Cone Value (Qc – MPa)
Very loose	less than 5	less than 2
Loose	5 – 10	2 – 5
Medium dense	10 – 30	5 -15
Dense	30 – 50	15 – 25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

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Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling to allow information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Drilling Methods

The following is a brief summary of drilling methods currently adopted by the company and some comments on their use and application.

Test Pits – these are excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descent into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) – the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling – the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers – the hole is advanced using 90 – 115mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPT's or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling – similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. From SPT).

Continuous Core Drilling – a continuous core sample is obtained using a diamond-tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedures is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150mm of say 4, 6 and 7
  as 4, 6, 7 then N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm then as 15, 30/40mm.

The results of the test can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50mm diameter thin wall sample tubes in clay. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch Cone – abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australia Standard 1289, Test 6.4.1.

In tests, a 35mm diameter rod with a cone-tipped end is pushed continually into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separte 130mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected buy electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) their information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: -

- Cone resistance – the actual end bearing force divided by the cross-sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0 – 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0 – 50 MPa) is less sensitive and is shown as a full line. The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios 1% - 2% are commonly encountered in sands and very soft clays rising to 4% - 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range: -

Qc (MPa) = (0.4 to 0.6) N blows (blows per 300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range: -

Qc = (12 to 18) Cu

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculations of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Dynamic Penetrometers

Dynamic penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer – a 16mm diameter flattened rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test 6.3.3). The test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289, Test 6.3.2). The test was developed initially for pavement sub-grade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is generally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Borehole Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Details of the type and method of sampling are given in the report and the following sample codes are on the borehole logs where applicable:

D	Disturbed Sample	E	Environmental sample	DT	Diatube
B	Bulk Sample	PP	Pocket Penetrometer Test		
U50	50mm Undisturbed Tube Sample	SPT	Standard Penetration Test		
U63	63mm " " " " "	C	Core		

Ground Water

Where ground water levels are measured in boreholes there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made. More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. A three-storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty-storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions – the potential for this will depend partly on bore spacing and sampling frequency,
- changes in policy or interpretation of policy by statutory authorities,
- the actions of contractors responding to commercial pressures,

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

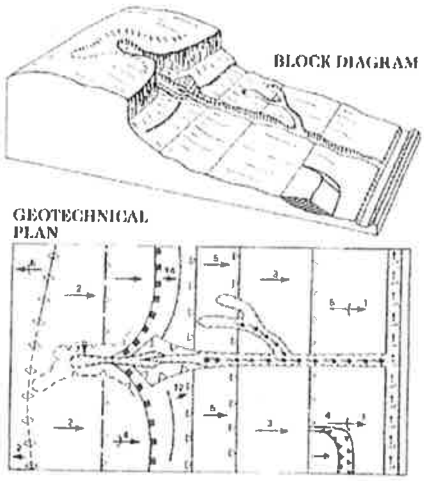
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

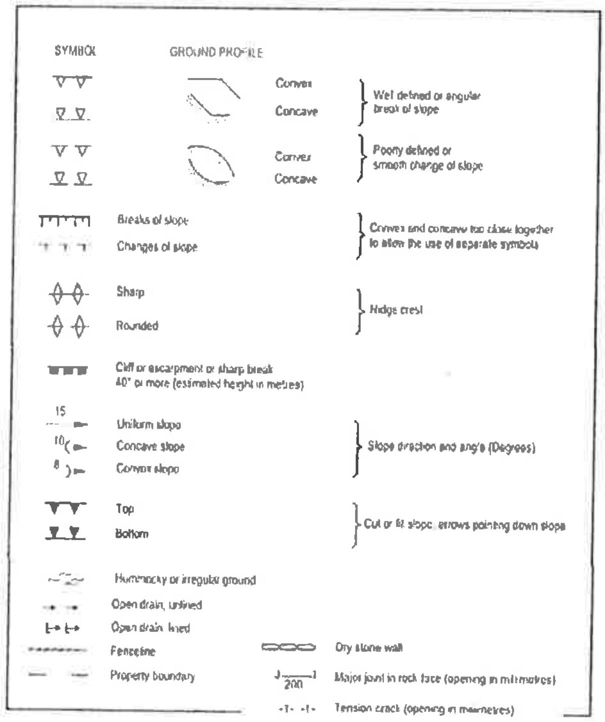
Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a special ally edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

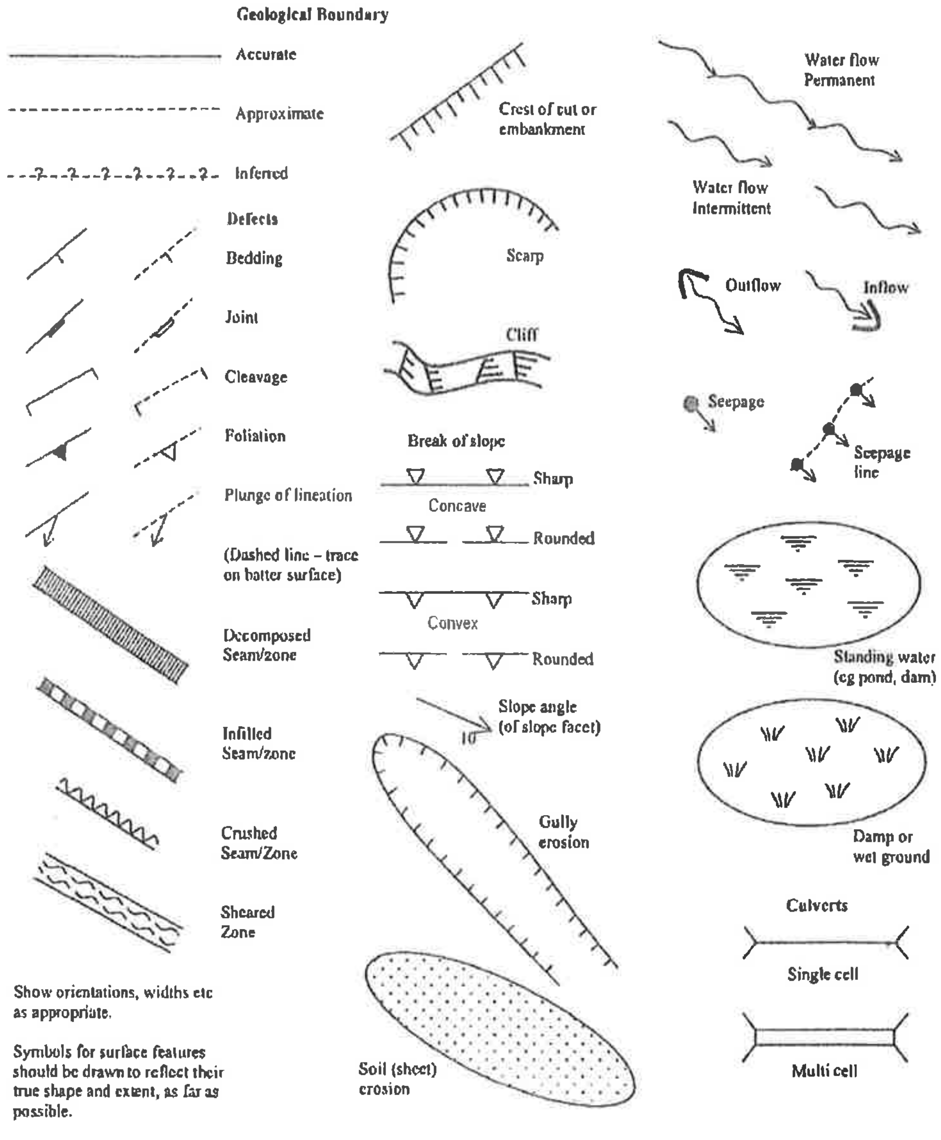




Example of Mapping Symbols

(after V Gardiner & R V Dackombe (1983).Geomorphological Field Manual. George Allen & Unwin).

APPENDIX E - GEOLOGICAL AND GEOMORPHOLOGICAL MAPPING SYMBOLS AND TERMINOLOGY



Examples of Mapping Symbols (after Guide to Slope Risk Analysis Version 3.1 November 2001, Roads and Traffic Authority of New South Wales).

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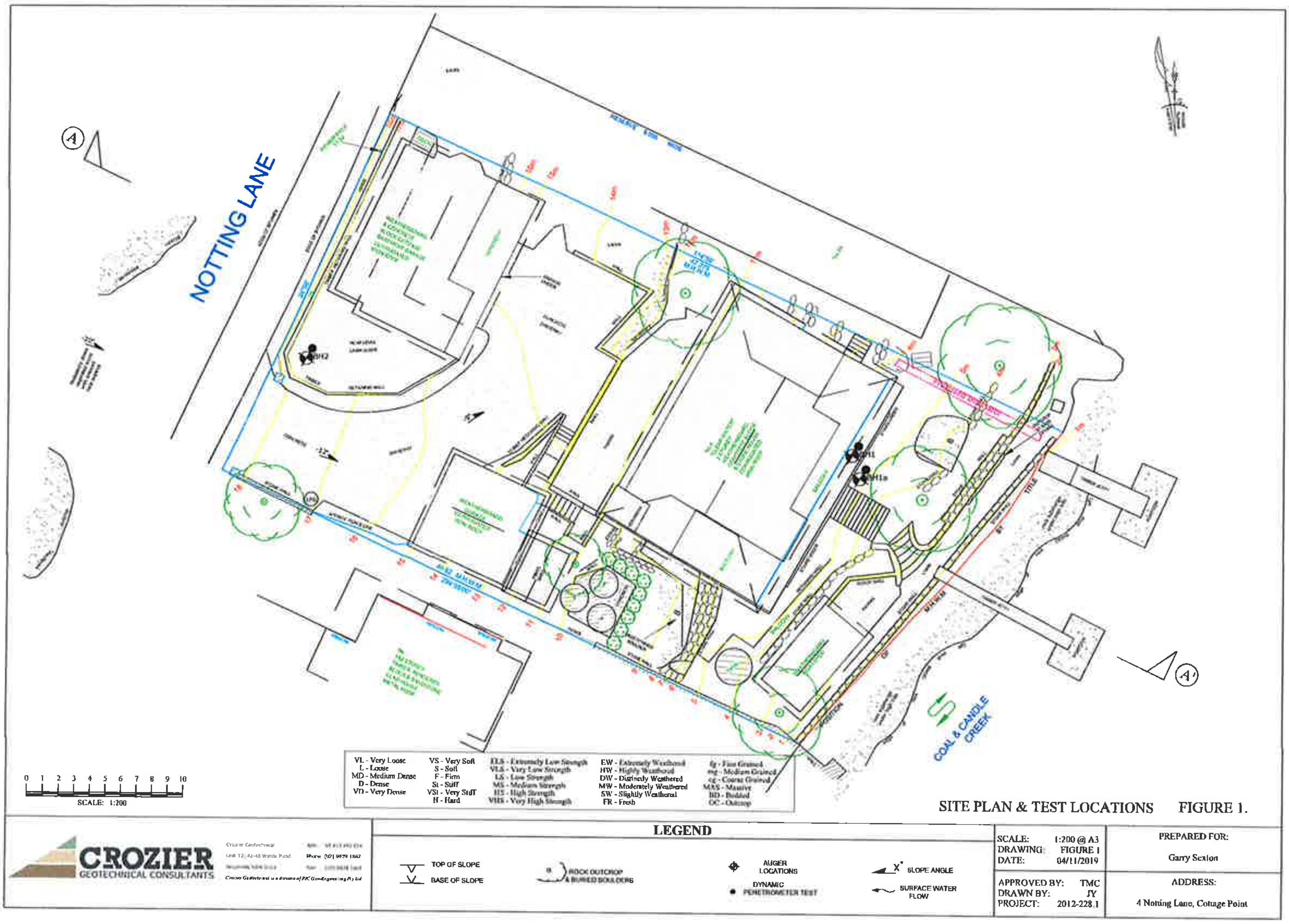
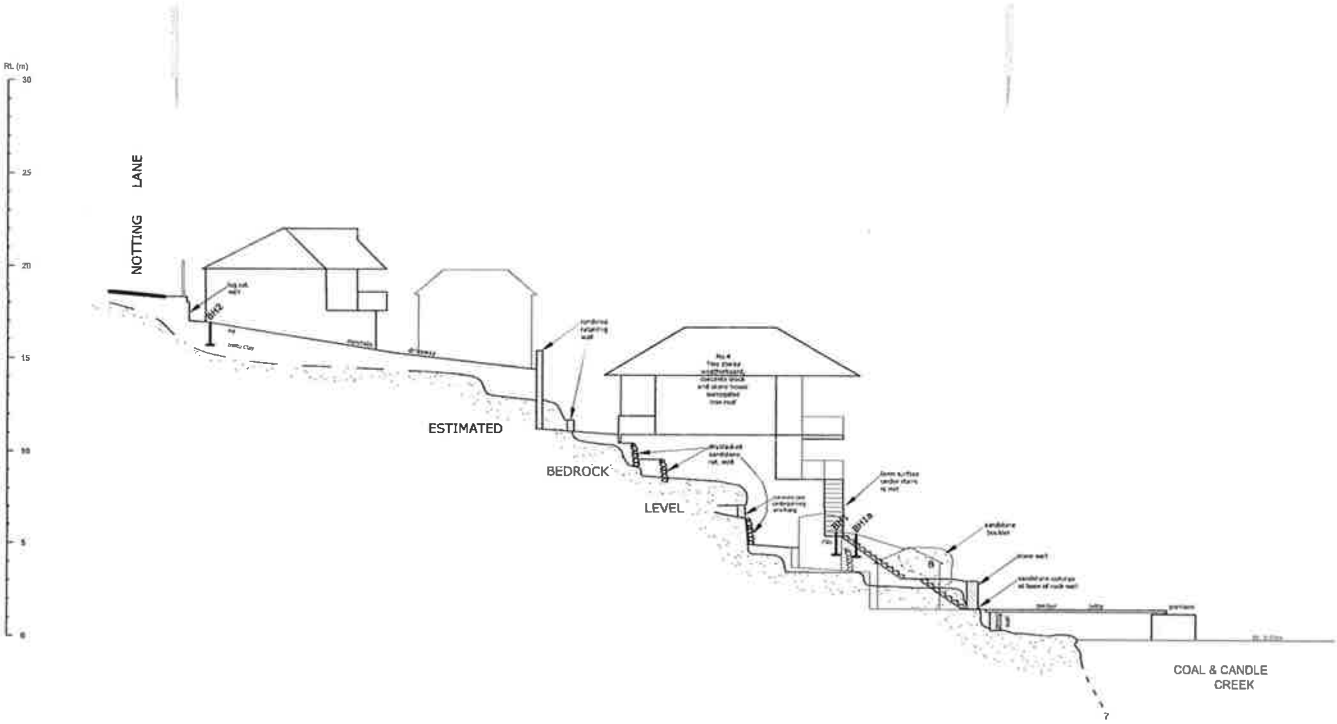
Appendix 2



SITE PLAN & TEST LOCATIONS FIGURE 1.



0 1 2 3 4 5 6 7 8 9 10
SCALE: 1:200

VL - Very Loose	VS - Very Soft	ELS - Extremely Low Strength	EW - Extremely Weathered	fg - Fine Grained
L - Loose	S - Soft	VLS - Very Low Strength	HW - Highly Weathered	mg - Medium Grained
MD - Medium Dense	F - Firm	LS - Low Strength	DW - Distinctly Weathered	cg - Coarse Grained
D - Dense	St - Stiff	MS - Medium Strength	MW - Moderately Weathered	MAS - Massive
VD - Very Dense	VSt - Very Stiff	HS - High Strength	SW - Slightly Weathered	BD - Bedded
	H - Hard	VHS - Very High Strength	FR - Fresh	OC - Outcrop

NB. FOR LOCATION OF SECTION A-A', PLEASE REFER TO FIGURE 1. SITE PLAN AND TEST LOCATIONS

GEOLOGICAL MODEL FIGURE 2.

LEGEND

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SCALE:	1:200 @ A3	PREPARED FOR:	Garry Sexton
DRAWING:	FIGURE 2		
DATE:	04/11/2019		
APPROVED BY:	TMC	ADDRESS:	4 Notting Lane, Cottage Point
DRAWN BY:	JY		
PROJECT:	2012-228.1		

TEST BORE REPORT

CLIENT: Garry & Dawn Sexton **DATE:** 17/10/2012 **BORE No.:** 1

PROJECT: Alterations & Additions **PROJECT No.:** 2012-228 **SHEET:** 1 of 4

LOCATION: 4 Notting Lane, Cottage Point **SURFACE LEVEL:** RL □5.10m

Depth (m)	Description of Strata PRIMARY SOIL - strength/density, colour, grainsize/plasticity, moisture, soil type incl. secondary constituents, other remarks	Sampling		In Situ Testing	
		Type	Depth (m)	Type	Results
0.00	LAWN FILL: Brown, low plasticity, wet, sandy clay fill with gravel and tree roots.				
0.30	FILL: Orange-brown, low plasticity, moist, sandy clay fill with sandstone gravel				
0.55	HAND AUGER REFUSAL at 0.55m on sandstone boulder within the fill				
1.00					
2.00					

RIG: None DRILLER: AW LOGGED: JB

METHOD: Hand Auger

GROUND WATER OBSERVATIONS: Nil

REMARKS: CHECKED: TMC

TEST BORE REPORT

CLIENT: Garry & Dawn Sexton **DATE:** 17/10/2012 **BORE No.:** 1a

PROJECT: Alterations & Additions **PROJECT No.:** 2012-228 **SHEET:** 2 of 4

LOCATION: 4 Notting Lane, Cottage Point **SURFACE LEVEL:** RL □5.10m

Depth (m)	Description of Strata PRIMARY SOIL - strength/density, colour, grainsize/plasticity, moisture, soil type incl. secondary constituents, other remarks	Sampling		In Situ Testing	
		Type	Depth (m)	Type	Results
0.00	LAWN FILL: Brown, low plasticity, wet, silty clay fill with some sand and gravel				
0.30	FILL: Orange-brown and red-brown, low plasticity, moist, sandy clay fill with sandstone gravel				
0.40	HAND AUGER REFUSAL at 0.40m on sandstone boulder within the fill				
1.00					
2.00					

RIG: None

DRILLER: AW LOGGED: JB

METHOD: Hand Auger

GROUND WATER OBSERVATIONS: Nil

REMARKS:

CHECKED: TMC

TEST BORE REPORT

CLIENT: Garry & Dawn Sexton **DATE:** 17/10/2012 **BORE No.:** 2

PROJECT: Alterations & Additions **PROJECT No.:** 2012-228 **SHEET:** 3 of 4

LOCATION: 4 Notting Lane, Cottage Point **SURFACE LEVEL:** RL □16.95m

Depth (m)	Description of Strata PRIMARY SOIL - strength/density, colour, grainsize/plasticity, moisture, soil type incl. secondary constituents, other remarks	Sampling		In Situ Testing	
		Type	Depth (m)	Type	Results
0.00	LAWN				
0.10	FILL: Brown, fine to coarse grained, dry, clayey sand with sandstone gravel				
0.25	FILL: Brown and orange-brown, fine to coarse grained, gravelly sand fill				
	CLAY: Light brown and orange-brown, medium plasticity, moist clay with ironstone gravel	D	0.50		
0.75	HAND AUGER REFUSAL at 0.75m depth on ironstone gravel band within the insitu clay				
1.00					
2.00					

RIG: None DRILLER: AW LOGGED: JB

METHOD: Hand Auger

GROUND WATER OBSERVATIONS: Nil

REMARKS: CHECKED: TMC

DYNAMIC PENETROMETER TEST SHEET

CLIENT: Garry & Dawn Sexton **DATE:** 17/10/12

PROJECT: Alterations & Additions **PROJECT No.:** 2012-228

LOCATION: 4 Notting Lane, Cottage Point **SHEET:** 4 of 4

TEST LOCATION	PENETRATION RESISTANCE BLOWS / 150 mm							
	DCP1	DCP1a	DCP2					
Depth (m)								
0.00 - 0.15	1	1	4					
0.15 - 0.30	1	2	6					
0.30 - 0.45	7	4	12					
0.45 - 0.60	3	3	12					
0.60 - 0.75	2	4	7					
0.75 - 0.90	1	1	5					
0.90 - 1.05	1	1	5					
1.05 - 1.20	3	1	8					
1.20 - 1.35	END	END	END					
1.35 - 1.50								
1.50 - 1.65								
1.65 - 1.80								
1.80 - 1.95								
1.95 - 2.10								
2.10 - 2.25								
2.25 - 2.40								
2.40 - 2.55								
2.55 - 2.70								
2.70 - 2.85								
2.85 - 3.00								

TEST METHOD: AS 1289. F3.2, CONE PENETROMETER

REMARKS:

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Appendix 3

<u>**TABLE : A**</u>

Landslide risk assessment for Risk to life

HAZARD	Description	Impacting	Likelihood	Spatial Impact		Occupancy	Evacuation	Vulnerability	Risk to Life
A	Landslip (Rockslide/topple <1m³) due to unsafe footing excavation methods		Footings need to be socketed into rock	a)footing excavation adjacent to boundary, stair along boundary, impact 10% of stairs b)footing excavation adjacent to house, impact 5% of structure		a) Person in stairs 1hrs/day avg b) Persons in house 10hrs/day avg	a) Unlikely to not evacuate b) Possible to not evacuate	a) Person in open space and not buried, b) Person in building, minor damage	
				Prob. Of Impact	Impacted				
		a) stair in No. 3a	Unlikely 0.0001	0.25	0.1	0.0417	0.25	0.1	**1.04E-08**
		b) undermining house footings	Unlikely 0.0001	0.25	0.05	0.4167	0.5	0.1	**1.04E-07**

* hazards considered in current condition and/or without remedial/stabilisation measures
* likelihood of occurrence for design life of house (considered 100years)
* considered for person most at risk
* evacuation scale from Almost Certain to <u>not</u> evacuate (1.0), Likely (0.75), Possible (0.5), Unlikely (0.25), Rare to not evacuate (0.01)
* vulnerability assessed using Appendix F - AGS Practice Note Guidelines for Landslide Risk Management 2007

TABLE : B

Landslide risk assessment for Risk to Property

HAZARD	Description	Impacting	Likelihood		Consequences		Risk to Property
A	Landslip (Rockslide/topple <$1m^3$) due to unsafe footing excavation methods	a) stair in No. 3a	Possible	The event could occur under adverse conditions over the design life.	Insignificant	Little Damage, no significant stabilising required, no impact to neighbouring properties.	Very Low
		b) undermining house footings	Unlikely	The event might occur under very adverse circumstances over the design life.	Minor	Limited Damage to part of structure or site requires some stabilisation, insignficant damage to neighbouring properties.	Low

* hazards considered in current condition, without remedial/stabilisation measures and during construction works.
* qualitative expression of likelihood incorporates both frequency analysis estimate and spatial impact probability estimate as per AGS guidelines.
* qualitative measures of consequences to property assessed per Appendix C in AGS Guidelines for Landslide Risk Management.

TABLE: C

Recommended Maintenance and Inspection Program

Structure	Maintenance/ Inspection Item	Frequency
Stormwater drains.	Owner to inspect to ensure that the drains, and pipes are free of debris & sediment build-up. Clear surface grates and litter.	Every year or following each major rainfall event.
Retaining Walls. or remedial measures	Owner to inspect walls for deveation from as constructed condition.	Every two years or following major rainfall event.
Large Trees on or adjacent to site	Arbourist to check condition of trees and remove branches as required.	Every five years

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Appendix 4

APPENDIX A

DEFINITION OF TERMS

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES WORKING GROUP ON LANDSLIDES, COMMITTEE ON RISK ASSESSMENT

Risk – A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form.

Hazard – A condition with the potential for causing an undesirable consequence (*the landslide*). The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the likelihood of their occurrence within a given period of time.

Elements at Risk – Meaning the population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

Probability – The likelihood of a specific outcome, measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between 0 and 1, with 0 indicating an impossible outcome, and 1 indicating that an outcome is certain.

Frequency – A measure of likelihood expressed as the number of occurrences of an event in a given time. See also Likelihood and Probability.

Likelihood – used as a qualitative description of probability or frequency.

Temporal Probability – The probability that the element at risk is in the area affected by the landsliding, at the time of the landslide.

Vulnerability – The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

Consequence – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

Risk Analysis – The use of available information to estimate the risk to individuals or populations, property, or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.

Risk Estimation – The process used to produce a measure of the level of health, property, or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis, and their integration.

Risk Evaluation – The stage at which values and judgements enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.

Risk Assessment – The process of risk analysis and risk evaluation.

Risk Control or Risk Treatment – The process of decision making for managing risk, and the implementation, or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.

Risk Management – The complete process of risk assessment and risk control (*or risk treatment*).

Individual Risk – The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide; or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.

Societal Risk – The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of a landslide causing a number of deaths, injuries, financial, environmental, and other losses.

Acceptable Risk – A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.

Tolerable Risk – A risk that society is willing to live with so as to secure certain net benefits in the confidence that it is being properly controlled, kept under review and further reduced as and when possible.

In some situations risk may be tolerated because the individuals at risk cannot afford to reduce risk even though they recognise it is not properly controlled.

Landslide Intensity – A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area.

Note: Reference should also be made to Figure 1 which shows the inter-relationship of many of these terms and the relevant portion of Landslide Risk Management.

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.