

REPORT ON GEOTECHNICAL ASSESSMENT

for

LANDSCAPING / ALTERATIONS

at

2 TRENTWOOD PARK, AVALON BEACH, NSW

Prepared For

Michelle Dunn and Graeme Lowry-Jones

Project No.: 2025-201

Document Revision Record

Issue No	Date	Details of Revisions
0	12 November 2025	Original issue

Copyright

© This Report is the copyright of Crozier Geotechnical Consultants. Any unauthorised reproduction or usage by any person other than the addressee is strictly prohibited.

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

Development Application for _____

Name of Applicant

Address of site _____ 2 Trentwood Park, Avalon Beach

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, Troy Crozier on behalf of Crozier Geotechnical Consultants 13 November 2025 certify that I am a geotechnical engineer or engineering geologist or ~~coastal engineer~~ as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least \$2million.

I:

- ☐ have prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ☐ am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ☐ have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.
- ☐ have examined the site and the proposed development/alteration in detail and I am of the opinion that the Development Application only involves Minor Development/Alteration that does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.
- ☒ have examined the site and the proposed development/alteration is separate from and is not affected by a Geotechnical Hazard and does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.
- ☐ have provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: Geotechnical Report for Demolition and Proposed Subdivision

Report Date: 12 November 2025 **Project No.:** 2025-201

Author: T. Crozier

Author's Company/Organisation: Crozier Geotechnical Consultants

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

Architectural Drawings (including survey) – Gartner Trovato Architects, Project No.: 2529, Drawing No.: DA01 – DA05, Dated: 31.10.2025

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature 

Name ...Troy Crozier.....

Chartered Professional Status...RPGeo (AIG)

Membership No. ...10197.....

Company... Crozier Geotechnical Consultants

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1(a) - Checklist of Requirements For Geotechnical Risk Management Report for Development Application

Development Application for _____	Name of Applicant _____
Address of site ____ 2 Trentwood Park, Avalon Beach _____	

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

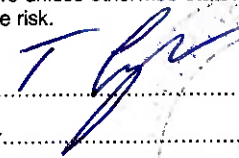
Geotechnical Report Details:

Report Title: Geotechnical Report for Demolition and Proposed Subdivision	Project No.: 2025-201
Report Date: 12 November 2025	Author: T. Crozier
Author's Company/Organisation: Crozier Geotechnical Consultants	

Please mark appropriate box

- ☒ Comprehensive site mapping conducted ____ 10 November 2025 ____
(date)
- ☐ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
- ☐ Subsurface investigation required
 - ☒ No JustificationMinor works.....
 - ☐ Yes Date conducted
- ☐ Geotechnical model developed and reported as an inferred subsurface type-section
- ☐ Geotechnical hazards identified
 - ☐ Above the site
 - ☐ On the site
 - ☐ Below the site
 - ☐ Beside the site
- ☐ Geotechnical hazards described and reported
- ☐ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
 - ☐ Consequence analysis
 - ☐ Frequency analysis
- ☐ Risk calculation
- ☐ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☐ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☐ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
- ☒ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
- ☒ Design Life Adopted:
 - ☒ 100 years
 - ☐ Other specify
- ☐ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified
- ☒ Additional action to remove risk where reasonable and practical have been identified and included in the report.
- ☐ Risk assessment within Bushfire Asset Protection Zone.

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature 

Name ...Troy Crozier.....

Chartered Professional Status...RPGeo (AIG)

Membership No. ...10197.....

Company... Crozier Geotechnical Consultants



Date: 12 November 2025

Project No: 2025-201

Pages: 8

**GEOTECHNICAL ASSESSMENT FOR PROPOSED ALTERATIONS AND ADDITIONS
2 TRENTWOOD PARK, AVALON BEACH, NSW**

1. INTRODUCTION:

This report details the results of a landslip assessment required by Northern Beaches Council for proposed alterations and additions at 2 Trentwood Park, Avalon Beach, NSW. The assessment was undertaken by Crozier Geotechnical Consultants (CGC) at the request of Gartner Trovato Architects on behalf of the clients Michelle Dunn and Graeme Lowry-Jones.

It is understood that the proposed works involve minor alterations and additions to the existing landscaping at the front of the site along with removal of the existing garage and construction of a new carport and storage room slightly further east. The proposed works appear to require only minor and isolated excavation to modify landscaping and to construct new footings.

The front western edge of the site is located within the H1 (highest category) landslip hazard zone as identified within Northern Beaches Councils precinct (Geotechnical Risk Management Policy for Pittwater – 2009) - Geotechnical Hazard Map - Sheet GTH_016.

To meet the Councils Policy requirements for land classified as H1, a Geotechnical Report which meets the requirements of Paragraph 6.5 of that policy is required for Development Application submission. The proposed works are relatively minor from a geotechnical perspective and following an inspection are considered not to be affected by a geotechnical hazard. As such the reporting has been reduced in line with Paragraph 6.2 and 6.3 of the Councils Policy.

The investigation comprised:

- a) A detailed geotechnical inspection and mapping of the site and adjacent properties by an Engineering Geologist.
- b) Review of geological maps and CGC database on local geotechnical conditions

The following plans were supplied and relied upon for the work:

- Architectural Drawings (including survey) – Gartner Trovato Architects, Project No.: 2529, Drawing No.: DA01 – DA05, Dated: 31.10.2025

2. SITE FEATURES:

2.1. Description:

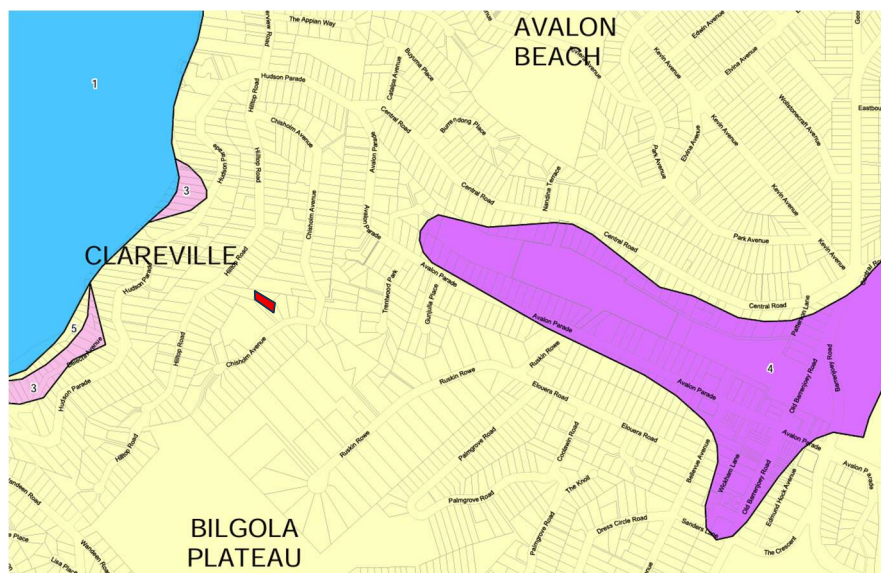
The site is trapezoidal shaped block of land situated on the low eastern side of the road within gently north-east dipping topography at the base of a north plunging ridge line. Site levels vary broadly from a high of approximately RL 31.0m in the front south-west corner to a low of approximately RL25.0 in the rear north-east corner.

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 that tend to deep weathering and produce a weak rock mass containing clay bands and fracturing.

2.3. Acid Sulfate Soils:

Reference to Northern Beaches (Pittwater Council's Local Environment Plan (LEP) 2014) the site is defined as being within Class 5 Acid Sulfate Soils hazard zone and is <50m from a Class 4 hazard zone to the north-east.



- Class 1: Acid sulfate soils in a class 1 area are likely to be found on and below the natural ground surface.
- Class 2 : Acid sulfate soils in a class 2 area are likely to be found below the natural ground surface.
- Class 3: Acid sulfate soils in a class 3 area are likely to be found beyond 1 metre below the natural ground surface.
- Class 4: Acid sulfate soils in a class 4 area are likely to be found beyond 2 metres below the natural ground surface.
- Class 5: Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres on adjacent class 1,2,3 or 4 land.

3. FIELD WORK:

3.1. Methods:

The field investigation comprised a walk over inspection of the site and limited inspection of adjacent properties on the 10 November 2025 by an Engineering Geologist which included a photographic record of site conditions as well as geological/geomorphological mapping of the site and adjacent land including assessment of structures.

Explanatory notes are included in Appendix: 1.

3.2. Field Observations:

Trentwood Park road reserve contains a gently north dipping bitumen pavement with concrete kerbs and gutters to either side. A narrow lawn and vegetated garden occupy the reserve between the kerb and the sites front western boundary. The garden has a gently slope to the north-east into the site.



Photograph: 1 – showing Trentwood Park road reserve, looking south.



Photograph: 2 – showing front western end of site as viewed from Trentwood Park road reserve.

The front of the site contains a near level lawn in the upper south-west corner surrounded by gently sloping gardens and low sandstone rock and timber retaining walls that step down towards the north east and also to the east to the existing residential development on the site.

The north-west portion of the site contains a gently sloping concrete driveway that leads to a two car garage/shed with access pathway around its southern side leading to the house. To the rear of the garage is a small terrace area with vegetated on-grade garden beds extending down the northern side boundary.



Photograph: 3 and 4 – showing lawns and gardens at south-west corner of site.



Photograph: 5 and 6 – showing existing driveway, garage and low timber retention around its southern side.

The existing dwelling on site is a single storey brick and timber structure that is aligned close to the south side boundary and is formed within a near level terrace slightly excavated into the hill slope.



Photograph: 7 and 8 – showing retaining walls around its western and southern sides respectively.

The neighbouring property to the north (No. 1 Trentwood Park) contains a one and two storey masonry dwelling setback from the shared boundary by approximately 1.0m. The property is slightly down slope and appears excavated into the hillslope adjacent the boundary, with rendered masonry retention systems of up to 1.0m in height supporting the boundary. The visible aspects of the structures appeared in good condition with no signs of cracking or excessive settlement to indicate any impending geotechnical concern.

The neighbouring property to the south (No. 3 Trentwood Park) contains a two storey residential dwelling that is generally formed at ground surface levels and extends to within approximately 1.0m of the common boundary. The front and rear of the property contain gardens adjacent the boundary with a driveway to garage formed on the south-west corner. The visible aspects of the structures appeared in good condition with no signs of cracking or excessive settlement to indicate any impending geotechnical concern.

The neighbouring buildings and properties were only inspected from within the site or from the road reserve however the visible aspects did not show any signs of large-scale slope instability or other major geotechnical concerns which would impact the site.

4. COMMENTS:

4.1. Geotechnical Model:

Based on previous investigations nearby, the sub-surface conditions within the site are expected to comprise predominantly minor fill and colluvial soils over residual soils with bedrock at depths in excess of 2.00m however variability can be high within the local geological sequence.

4.2. Geotechnical Assessment:

The geotechnical inspection did not identify any signs of previous or impending large scale or deep-seated landslide instability within the site or adjacent properties. The existing main residential structure appears to be >20 years of age and shows no signs of slope movement whilst there are no indications of excess surface stormwater flow, groundwater seepage or erosion within the site.

The proposed works involve relatively minor alterations to the front yard of the site only with no bulk excavation or filling proposed.

4.3. Slope Stability & Risk Assessment:

Based on our site mapping no credible geological/geotechnical landslip hazards were identified which need to be considered in relation to the existing site whilst the proposed development will not create any new stability hazards.

As such, a risk assessment is not required as the works are considered separate from, and not affected by, a geotechnical landslip hazard.

The entire site and surrounding slopes have been assessed as per the Pittwater Council Geotechnical Risk Management Policy 2009 and no credible landslip hazards were identified, therefore the site is considered to meet the 'Acceptable' risk management criteria for a design life of 100 years, provided the property is maintained as per the recommendations of this report.

4.4. Design Life of Future Development:

We have interpreted the design life requirements specified within Councils Risk Management Policy to refer to structural elements designed to support the slopes, excavations and fills, 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 development are considered to comprise:

- stormwater and subsoil drainage systems,
- retaining walls and soil slope erosion 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 (50 years)). In order to attain an "Acceptable Risk Management Criteria" for a design life of 100 years as detailed by the Councils Risk Management Policy, it will be necessary for the property owner to adopt and implement a maintenance and inspection program.

If a maintenance and inspection schedule are not implemented the design life of the property may not be attained. A recommended program is given in Table: 1 below 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 new development.
- There is no change to the property due to an extraordinary event external to this site, and 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

Table 1: Recommended Maintenance and Inspection Program for Future Developments

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 deviation from as constructed condition or for excess deterioration/rotation or signs of soil settlement/erosion or significant cracking adjacent to crest.	Every two years or following major rainfall events. Replace existing non-engineered walls as required.
Large Trees on or adjacent to site	Arborist to check condition of trees and remove branches and dead trees as required	Every five years

N.B. Provided the above schedule is maintained the design life of the property should conform AS2870 and Councils 100 years stability criteria

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).

It is assumed that Northern Beaches 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 levels or landslide potential.

5. CONCLUSION:

The inspection and assessment identified no obvious significant slope movement, excess surface stormwater flow or seepage, erosion or instability within the site or adjacent properties. The entire site and surrounding slopes have been assessed as per the Pittwater Council Geotechnical Risk Management Policy 2009 and no credible landslide hazards were identified.

The proposed developments involve landscaping and limited ancillary structures with only minor isolated excavation expected for pavements and footings.

The proposed works are therefore relatively minor from a geotechnical perspective and should not create any new instability. As such, the proposed works are separate from and not affected by a geotechnical hazard, and no further geotechnical assessment or reporting is required as part of this DA.

It is considered that the site will meet the 'Acceptable' risk management criteria for the design life of the development taken as 100 years from the proposed works provided the property is maintained as per the recommendations of this report.

The site works will not involve bulk excavation and, as such no impact or lowering to the groundwater table will occur. Therefore, no further assessment is required into Acid Sulfate Soils and there is no requirement for a management plan, as per the guidelines of the Acid Sulfate Soils Manual 1998.

Prepared by:



Troy Crozier
Principal
MIE Aust, CPEng (NER)
MAIG. RPGeo; 10197

6.0. REFERENCES:

1. Australian Geomechanics Society 2007, "Landslide Risk Assessment and Management", Australian Geomechanics Journal Vol 42, No 1, March 2007.
2. Geotechnical Risk Management Policy for Pittwater, 2009.

Appendix 1

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:

<u>Soil Classification</u>	<u>Particle Size</u>
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:

<u>Classification</u>	<u>Undrained Shear Strength kPa</u>
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:

<u>Relative Density</u>	<u>SPT</u> "N" Value (blows/300mm)	<u>CPT</u> 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.

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 separate 130mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by 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: -

$$Q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) N \text{ blows (blows per 300mm)}$$

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

$$Q_c = (12 \text{ to } 18) C_u$$

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.

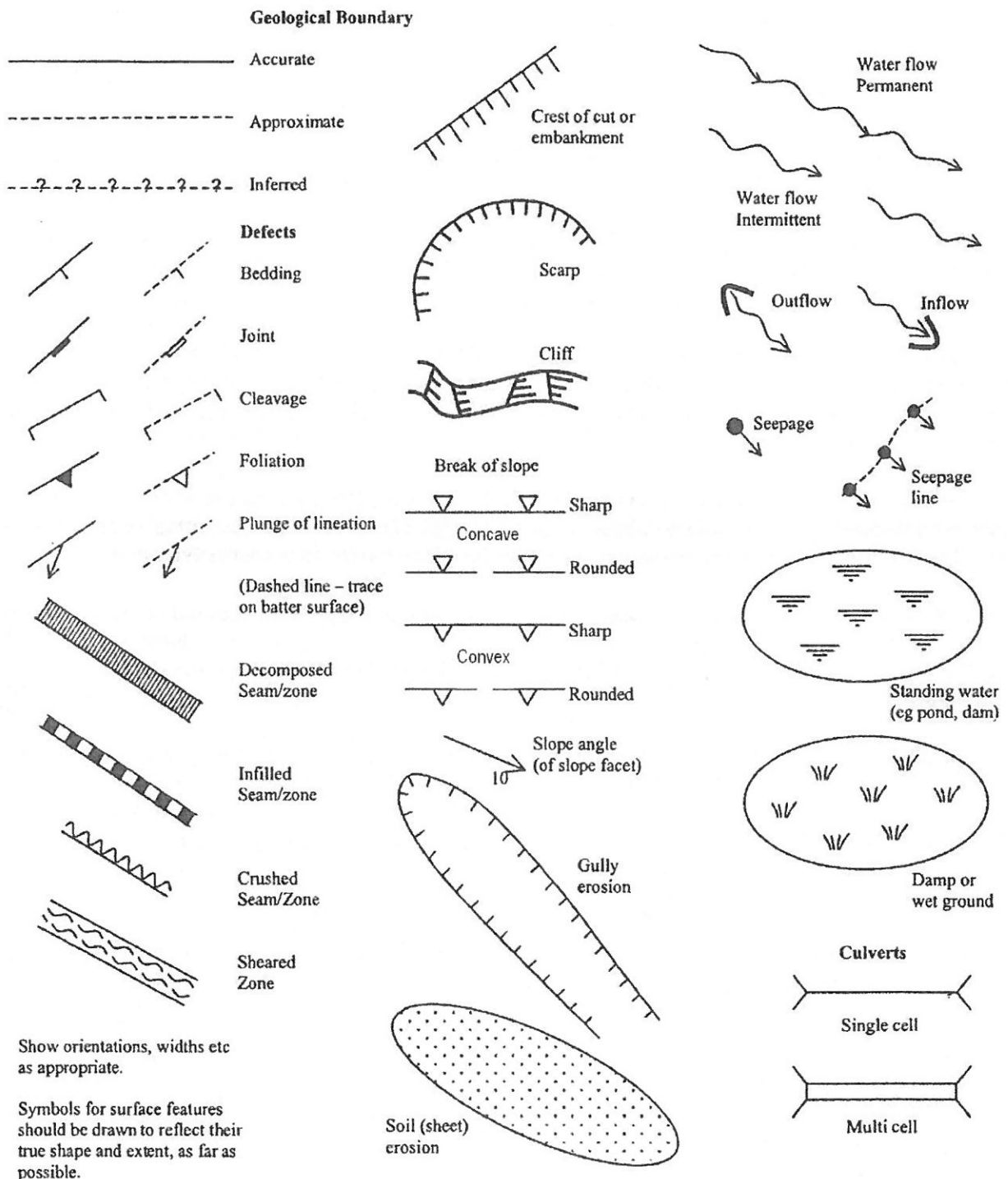
Reproduction of Information for Contractual Purposes

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

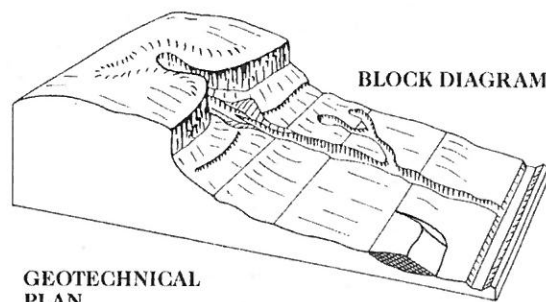
The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

APPENDIX E - GEOLOGICAL AND GEOMORPHOLOGICAL MAPPING SYMBOLS AND TERMINOLOGY

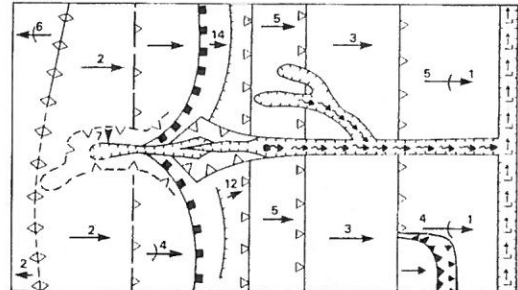


Examples of Mapping Symbols (after Guide to Slope Risk Analysis Version 3.1 November 2001, Roads and Traffic Authority of New South Wales).

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007



GEOTECHNICAL
PLAN



SYMBOL	GROUND PROFILE	
		Convex
		Concave
		Convex
		Concave
	Breaks of slope	} Convex and concave too close together to allow the use of separate symbols
	Changes of slope	
	Sharp	} Ridge crest
	Rounded	
	Cliff or escarpment or sharp break 40° or more (estimated height in metres)	
	Uniform slope	} Slope direction and angle (Degrees)
	Concave slope	
	Convex slope	
	Top	} Cut or fill slope, arrows pointing down slope
	Bottom	
	Hummocky or irregular ground	
	Open drain, unlined	
	Open drain, lined	
	Fenceline	
	Property boundary	
	Dry stone wall	
	Major joint in rock face (opening in millimetres)	
	Tension crack (opening in millimetres)	

Example of Mapping Symbols

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