Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Proposed Perisher View Ski Lodge
Lot 1, DP1192372, Perisher Valley, NSW

Prepared for
Geoanalysis Pty Ltd

NSW Government
Department of Planning
and Environment

Issued under the Environmental Planning and Assessment Act 1979

Approved Application No DA 21/11288

Granted on the 23 June 2023

Signed M Brown

Sheet No 4 of 44

Project 94499.00
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Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		23 June 2020
Reviewer		23 June 2020

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Report on Geotechnical Investigation
Proposed Perisher View Ski Lodge
Lot 1, DP1192372, Perisher Valley, NSW

1. Introduction

This report presents the results of a geotechnical investigation carried out by Douglas Partners Pty Ltd (DP) for the proposed perisher view ski lodge at Lot 1, DP1192372, Perisher Valley, NSW. The investigation was commissioned in an email dated 21 May 2020 by Mr Steven House of Geoanalysis Pty Ltd and was undertaken in accordance with DP proposal CAN200142 dated 19 May 2020.

It is understood that the ski lodge would be a three to four level building, the lower level in cut at its upslope side. No structural details are known to DP.

The NSW Department of Infrastructure, Planning and Natural Resources (DIPNR, 2003) requires that a Geotechnical Report be prepared for building developments in designated “G” zones (hillside areas prone to slope instability) within the Kosciuszko Alpine Resorts area. Lot 1, DP1192372 is within the Perisher Valley “G” zone.

The aim of the investigation was to assess the subsurface conditions at the site to provide:

- a geotechnical model for the site;
- an assessment of the geotechnical suitability of the site for the proposed development;
- a risk assessment of any potential slope hazards and advice for removal or mitigation of the risk;
- site classification in accordance with the requirements of AS2870:2011;
- advice on site preparation and earthworks including excavation conditions and support;
- advice for basement level retaining wall;
- advice on building footing systems including allowable bearing pressures; and
- comments on the site drainage.

The field investigation included the excavation of seven test pits and a walkover assessment. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

This report must be read in conjunction with the notes “About this Report” included in Appendix A.

2. Site Location and Description

The site is located along Burramys Road in Perisher Front Valley. It is immediately upslope of the Alpine Church and downslope of Celmisia staff accommodation lodge at the other side of Burramys Road. The locality is shown in Figure 1 below.

Figure 1: Locality Plan

The Lot 1 DP1192372 site is presently undeveloped. At the time of the investigation, the partly snow-covered site surface had a lush cover of tussock grass and sedges and some small bushes. Numerous flattish-topped granodiorite boulders to about a maximum 1.5 m size in plan dimension were also present, some deeply embedded, others sitting on the ground surface.

The site is on the eastern end of a hilly spur which strikes and rises westward of this area. Surface slopes are relatively uniform at 8º to 10º all the way down from the spur ridgeline which is about 350 m upslope of the site. Much of the upslope area is cleared of trees and has a scattering of ski lodges. Numerous granodiorite boulders (and possible rock outcrop) are also present and some large broken tor clusters are present outside the northern side of the site. Perisher Creek is located about 125 m further downslope of the Lot 1 site.

An aerial view of the Lot 1 site is presented as Drawing 1 in Appendix B. Figures 2 to 4 below show views of the site taken at the time of the investigation.

Figure 2: View north across Lot 1.

Figure 3: View north-west diagonally from south-east corner of Lot 1.

Figure 4: View south-east toward the church outside Lot 1 rear boundary.

Figure 5: View west across upslope portion of Lot 1 adjacent to Burramys Road.

3. Local Geology

The Perisher Valley area is underlain by intrusive granodiorite rock of Devonian age (NSW Dept of Mines, 1951). The granodiorite is a medium to coarse grained igneous rock comprised of mainly white feldspar, quartz and black biotite mica. The rock weathers underground as air and moisture enter a typically open blocky joint structure which eventually leads to the formation of spheroidal shaped corestones to massive boulder size left in a groundmass of extremely weathered granodiorite or residual soil. Once the more weathered material is eroded away, the corestones are left as tors on the ground surface.

4. Field Work Methods

The fieldwork for the investigation was conducted by DP on 26 May 2020 and included:

- Excavation and logging of seven test pits (Pits 1 to 7);
- Dynamic cone penetrometer (DCP) testing of the ground adjacent to each of the test pits to assess the relative density condition of the strata; and
- Walkover inspection and photographing of the surface conditions generally, including upslope and downslope of the Lot 1 site.

The test pits were excavated by mini-excavator to 3 m depth except for Pit 3 which encountered high strength granodiorite (possibly a corestone rather than insitu rock) at 0.6 m depth and Pit 7 which encountered a buried small tunnel-like structure of brick, concrete and corrugated iron (possibly a stormwater drain) at 0.5 m depth.

The locations of the test pits and the suspected alignment of the tunnel structure are shown on Drawing 2 in Appendix B.

5. Field Work Results

5.1 Surface Conditions

Surface features of a geotechnical context noted during our site walkover of the Lot 1 area are as follows:

- The areas upslope and downslope of Lot 1 are mostly developed, containing lodges, meandering streets, access driveways and some open space in between;
- Immediately downslope of Lot 1 is the single-storey Alpine Church. The single-storey Celmisia staff accommodation lodge is located upslope at the other side of Burramys Road;
- The open spaces in the area are thickly grass vegetated and show no sign of land instability such as might otherwise be seen in the form of erosion, slippages or displaced vegetation;
- Granodiorite tors are common in the area, ranging from small to massive boulder size. These are mostly well embedded and stable, with no obvious undermining from erosion or animal digs. One mostly snow-covered wombat borrow was noted within the northern side boundary;
- There is no evidence of soil piled up against the upslope side of the snow gums to suggest any creep instability in the soil mantle; and
- There are no scour lines in the surrounding slopes to indicate past slippages or boulder runs.

5.2 Subsurface Conditions

The test pits logs including the results of the DCP tests, are presented in Appendix C together with notes that define classification methods and descriptive terms.

The subsurface profile at Lot 1 appears to be mostly in its natural state with minor presence of fill along the Burramys Road edge. The natural profile can be summarised as follows:

TOPSOIL – dark brown Silty CLAY to 0.2 m depth, contains granodiorite gravel and cobbles, numerous rootlets, moist/wet, soft or firm.

RESIDUAL SOIL– brown, grey-brown Sandy CLAY to 0.6 m to 0.9 m depth, low plasticity, fine to coarse sand, some granodiorite gravel and cobbles, moist/wet, firm or stiff.

RESIDUAL SOIL/GRANODIORITE – grey, brown-grey Clayey SAND to varying depth between about 1.2 m to greater than 3 m, fine to coarse sand, some extremely weathered (EW) granodiorite gravel, trace granodiorite cobbles, moist, medium dense.

GRANODIORITE – grey, yellow-grey and brown-grey, mostly extremely weathered (EW) or extremely/highly weathered (EW/HW), extremely low and very low strength to moderately weathered and high strength. Occasional cobble and small boulder-sized corestone of less weathered, higher strength granodiorite.

The physical difference between the sandy residual soil and the EW granodioite (from which the residual soil is a product) is slight, the latter being slightly tighter and denser with the more frequent presence of corestones.

Fill containing minor construction debris including plastic and metal was encountered to about 0.45 m depth in Pit 1 located near the upslope corner of Lot 1. Clayey sand fill was present over the small tunnel-like structure encountered at about 0.5 m depth in Pit 7.

Groundwater seepage was encountered in the sandy residual strata and/or EW granodiorite at depths of 2.3 m, 2.4 m and 1.6 m in Pits 1, 4 and 6 respectively, and was present in the tunnel-like structure at Pit 7. It was not encountered in the other three pits. It should be noted that groundwater presence is affected by weather conditions, soil permeability and other factors, and may vary with time.

6. Proposed Development

As indicated, it is understood the ski lodge would be a three to four level building, the lower level in cut at its upslope side.

Based on preliminary conceptual architectural plans provided by the client, it can be anticipated that excavation to a possible maximum 2 m to 3 m depth could be required for the lower level at the upslope side of the building.

Excavations for the lodge building, including for lower level floor footings and inground services, can impact on the geotechnical stability condition of the site, and therefore requirements for excavation side support must be carefully considered in design and construction.

7. Geotechnical Model

A conceptual geotechnical model of the Lot 1 site based on the subsurface conditions encountered in the test pits is presented in Table 1. The profile across the Lot 1 site appears to be quite consistent. The main uncertainty is the extent both vertically and horizontally in the profile of high strength corestones in the otherwise residual soil and mainly soil-like EW and EW/HW granodiorite.

Table 1: Estimated Geotechnical Properties of Strata

Stratum	Depth to Base of Stratum (m)	Drained Cohesion, c' (kPa)	Drained Internal Friction Angle, Φ' (degrees)	Undrained Shear Strength, S_u (kPa)	Bulk Unit Weight, γ (kN/m^3)
Sandy CLAY (Residual)	0.6 – 0.9	10	25	50	16
Clayey SAND (Residual/EW Rock)	1.2 - >1.3	5	35	0	18
EW and EW/HW Granodiorite Rock	>3.0	5	40	150	22

8. Slope Stability Assessment

In an assessment of the slope stability condition of a site, and of a potentially increased risk in construction of the proposed lodge, existing site features such as bedrock geology, soil type and depth, steepness of slope, vegetative cover, disturbed ground and groundwater conditions are among factors that are considered. The possible disturbance of the site due to excavations for the lodge is an important consideration.

DP has qualitatively assessed the site with reference to the Australian Geomechanics Society guidelines for “Practice Note Guidelines for landslide Risk Management 2007” (AGS, 2007). This has involved an assessment of the likelihood of occurrence, and of the damage consequences to the proposed lodge development, of various identified potential slope hazard types. The assessed likelihood and consequences levels for each identified hazard are combined by means of a risk matrix to obtain a qualitative risk level (very low, low, moderate, high or very high) for each hazard. A summary of qualitative terminology used for the current assessment is presented in Appendix C along with general information on landslide risk AGS (2007b).

The assessment has taken account of the site subsurface conditions and of the surface conditions which include (i) an existing relatively gentle (geotechnically) 10° hill slope, (ii) the absence of any sign of land instability, (iii) no large upstanding boulder outcrops upslope of the lot and (iv) no obvious sign of any damage to existing nearby lodges and infrastructure. The potential instability mechanisms considered included soil creep, small and deep-seated slippage failures and rolling tors. Fall-outs of large corestones from excavation faces and failure of retaining walls are two other slope hazards considered. Table 2 provides our assessment of the risk level to property for each of the identified potential hazards.

Table 2: Assessed Slope Instability Risk for Proposed New Lodge

Potential Hazard	Likelihood of Hazard Occurring	Consequences to Lodge Structure	Overall Risk Level
Creep of soil mantle	Unlikely	Minor	Low
Small scale slump	Unlikely	Minor	Low
Rolling Tors/Boulders	Possible	Minor	Moderate
Deep-seated slide	Rare	Major	Low
Construction excavation collapse	Possible	Minor	Moderate
Failure of Retaining Wall	Possible	Medium	Moderate
Corestone fall-outs from excavation faces	Likely	Minor	Moderate

DIPNR (2003) advocates that an acceptable risk level in terms of property damage is “Low” or “Very Low”. These are considered acceptable risk levels that people are normally prepared to accept and any action to reduce the risk level is normally not required. Regular maintenance of the slope condition however would still be required, and this might include checking that surface and subsurface drains are not blocked, that natural stabilising vegetation is being retained, and that any unnecessary excavation is being avoided. A “Moderate” risk level is defined as tolerable and “*is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if practical”* (AGS, 2007). Practical measures that can be implemented to reduce the risk level of damage to property for the current development to an acceptable “Low” or “Very Low” level is provided in Section 9 of this report.

The risk of loss of life for persons in the proposed lodge is considered very low or low, primarily because of the likely limited vulnerability (exposure) of persons at risk and that excavations and retaining systems for the proposed lodge would be properly engineered.

9. Recommendations

9.1 Hillside Construction

A pamphlet on good practice guidelines for hillside construction (AGS, 2007c) is provided in Appendix D. Typical matters to be considered include minimising any vegetation clearing, minimising depths of cut and/or fill and the retention of these with structural retaining walls, and providing suitable surface and subsurface drainage, and founding footings in rock.

9.2 Excavations Conditions and Support

The site soils and EW and EW/HW rock, present within an expected 2 m to 3 m maximum excavation depth for the ski lodge, can be excavated by backhoe or small excavator.

Some high or very high strength boulder-sized corestones could be present in the otherwise diggable strata. These can be large, and along with any surface tors that cannot be readily dug around and pushed/levered out, may require rock hammering to break up for removal, or else split apart by use of drilled holes filled with expanding chemical or cementitious grout, or by means of mechanical jacking. Wherever possible, deeply embedded corestones should be left in place as their removal may increase the risk of ground instability.

Groundwater seepages, possibly temporary during the period of construction, could be encountered in excavation. The seepage water should be controllable by draining it to a temporary sump in the excavation floor from where it can be pumped or led off to the local stormwater system.

Temporarily unsupported excavation sides should be formed at batters no steeper than 2(H):1(V). For their permanent state, they should be backfilled against appropriately engineered retaining walls or structurally competent basement walls. For cuts less than 1 m in height, these be battered at no steeper than 3(H):1(V) and their surfaces protected against erosion, or retained by pervious non-structural walls such as stacked rock. Walls and batters should have lined catch drains at their toe to collect and re-direct seepage water and runoff into the stormwater system.

9.3 Retaining Walls

Gravity and cantilever type retaining walls less than about 3 m in height can be designed on the basis of a lateral earth/rock pressure distribution given as follows:

$$p_z = K.\gamma.z + K.q$$

where p_z = horizontal earth pressure at depth z (kPa)
K = earth/rock pressure coefficient
= 0.3 (where wall is unrestrained at top and free to deflect slightly)
= 0.5 (where wall is restrained at top, preventing rotation)
γ = unit weight of retained soil/rock (kN/m^3)
= 18 kN/m^3 (soil backfill)
= 22 kN/m^3 (rockfill and intact rock)
z =depth below top of retained ground (m)
q = uniformly distributed surcharge pressure on ground surface behind wall (kPa)

The afore-mentioned earth pressure distribution can be used for ground slopes as steep as 10^o behind the wall. It must be noted that the distribution takes no account of hydrostatic pressure as the wall backfill zone must be provided suitable backfill drains.

Table 3 provides ultimate values of foundation resistance parameters for use in stability checks on retaining walls. These are appropriate for structurally competent walls that have a structurally integrated reinforced concrete footing.

Table 3: Foundation Resistance Parameters – Ultimate Values

Resistance Parameter	Recommended Ultimate Resistance Value
	EW or EW/HW Rock
Friction Factor on Base of Wall Footing	tan δ = 0.4
Adhesion on Base of Wall Footing	c = 5 kPa
Passive Pressure at Front of Wall Footing	p = 50.d (kPa)

Notes: d is the depth of embedment of the retaining wall footing

9.4 Existing Buried Tunnel-like Structure

The estimated alignment of the buried small tunnel-like structure exposed at Pit 7 location is shown on Drawing 2. We could not ascertain whether it is still operational or not. As it is within about 0.5 m depth of current surface level, and within the proposed building envelope, it will need to be re-routed or else removed and capped upstream.

9.5 Site Classification

Due to the absence of soil with significant shrink-swell volume change potential, and the presence of rock at shallow depth, Lot 1 DP1192372 would be a Class S (slightly reactive) site in respect of AS2870:2011 “Residential Slabs and Footings” guidelines. However, because of the sloping ground conditions, the possible presence of high strength corestones at varying depth, and the advice given in Section 9.6 below that strip or beam type footings should not be aligned across the slope, the standard deemed-to-comply Class “S” footing footings provided in AS2870:2011 would not be appropriate here. Instead, we suggest the site be regarded as Class “P” (problem). This will require the footing system to be designed by a structural engineer taking account of the recommendations given below.

9.6 Footing Systems

Design of building footing systems on hillside sites should follow guidelines presented by AGS (2007c). The principal requirements are that footings are founded in rock below the soil mantle and that continuous strip or beam type footings be avoided, especially across the slope, so that they do not impede the natural flow of downslope groundwater seepage.

As a guide, footings founded a minimum 500 mm embedment length in EW or EW/HW rock (to resist sliding movement) can be based on an allowable end bearing pressure of 200 kPa and a skin friction value of 20 kPa.

9.7 Site Drainage

Subsoil drains in drainage gravel must be installed behind all retaining walls, including basement walls. Minor non-structural walls should be either pervious (such as stacked stone walls) or provided with backfill drains or weep holes. All intercepted water should be directed into the piped stormwater system.

9.8 Site Maintenance

To mitigate the slope hazard risk level to the proposed lodge and its occupants, regular inspections, preferably annually, should be made of the lodge surrounds to check for any changed conditions that could impact on the site stability condition. As a minimum, we would suggest that:

- Surface drains be checked and cleared of any blockages;
- Surface water be discharged downslope in a controlled manner and not permitted to erode the slope;
- A walkover of the slope above and downslope of the lodge be undertaken to look for any evidence of erosion or instability including whether boulders (tors) remain embedded in the slope and are not becoming undermined by animal diggings or erosion effects. Should boulders appear to be becoming undermine or unstable, they may need to be broken up and removed or else stabilised by concrete underpins; and
- The presence of any noted changes to vegetation, the shape of the slope, presence of springs and of cracks in the ground be bought to the attention of a geotechnical engineer.

9.9 Slope Hazard Risk Reduction

Should the recommendations provided in Section 9 of the report be implemented in the design and construction off the proposed ski lodge, including those in respect of maintenance and annual inspections, then we consider a revision of the hazard risks given in Table 2 is justified. Table 4 provides our assessment of the risk levels under these conditions.

Table 4: Slope Instability Risk Assessment – Damage to Property
(Where Recommended Design, Construction and Slope Maintenance Works Adopted)

Potential Hazard	Likelihood of Hazard Occurring	Consequences to Lodge Structure	Overall Risk Level
Creep of soil mantle	Unlikely	Minor	Low
Small scale slump	Unlikely	Minor	Low
Rolling Tors/Boulders	Unlikely	Minor	Low
Deep seated slide	Rare	Major	Low
Construction excavation collapse	Unlikely	Minor	Low
Failure of Retaining Wall	Unlikely	Medium	Low
Corestone fall-outs from excavation faces	Unlikely	Minor	Low

9.10 DIPNR Requirements

Based on the results of the assessment described above, and on the basis the designer and constructor heeds the advice provided, DP considers the site to be suitable for the proposed ski lodge development.

The Geotechnical Policy (DIPNR, 2003) requires the geotechnical consultant who prepares the Geotechnical Report to complete "Form 1". This form is included in Appendix E and its contents verified by a DP chartered geotechnical engineer. The geotechnical policy also requires the geotechnical consultant to complete "Form 2" after examining the final design drawings and to complete Form 3 after an inspection of the excavations for the new footings.

10. References

AGS (2007), *Practice Note Guidelines for Landslide Risk Management 2007*, Australian Geomechanics Society, Extract from Journal and news of the AGS Vol.42, No.1 March 2007.

AGS (2007b), *The Australian GeoGuides for Slope Management and Maintenance, Australian Geoguide LR7 (Landslide Risk)*, Australian Geomechanics Society.

AGS (2007c), *The Australian GeoGuides for Slope Management and Maintenance, Australian Geoguide LR8 (Construction Practice) – Hillside Construction Practice*, Australian Geomechanics Society.

AS2870:2011, *Residential Slabs and Footings*, Standards Australia.

DIPNR (2003), *Geotechnical Policy, Kosciuszko Alpine Resorts*, NSW Department of Infrastructure, Planning and Natural Resources.

NSW Dept of Mines (1951), *Snowy Mountains Area, Geological Reconnaissance, Kosciusko Sheet*.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 1, DP1192372, Perisher Valley, NSW in accordance with DP's proposal dated 19 May 2020 and acceptance received from Mr Steven House of Geoanalysis Pty Ltd dated 21 May 2020. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Geoanalysis Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations 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.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report 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 or excavation. 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 and test pits 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 or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements 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 advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP 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 conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations 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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

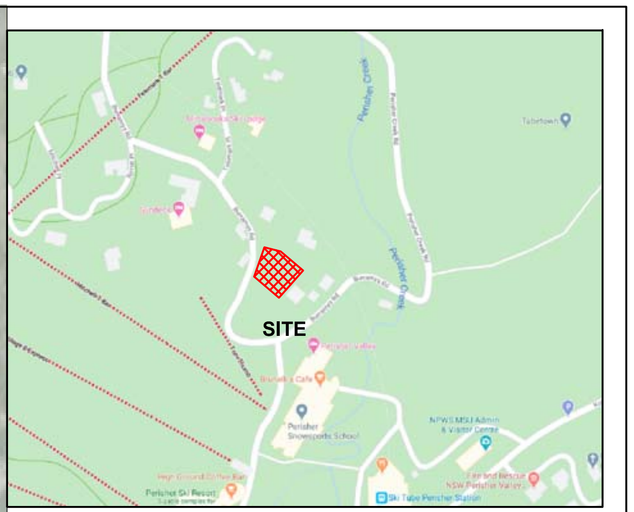
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP 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 and environmental 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 B

Drawings



Locality Plan

LEGEND

🟥 Approximate Site Boundary

⊞ Approximate Test Pit Location

⊞ Approximate Abandoned Test Pit Location

0 5 10 15 20 25

1:500 @ A3

NOTE: Base drawing from maps.six.nsw.gov.au
(dated 27 January 2011)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Geoanalysis Pty Ltd

OFFICE: Canberra

DRAWN BY: SDG

SCALE: As Shown

DATE: 02.06.2020

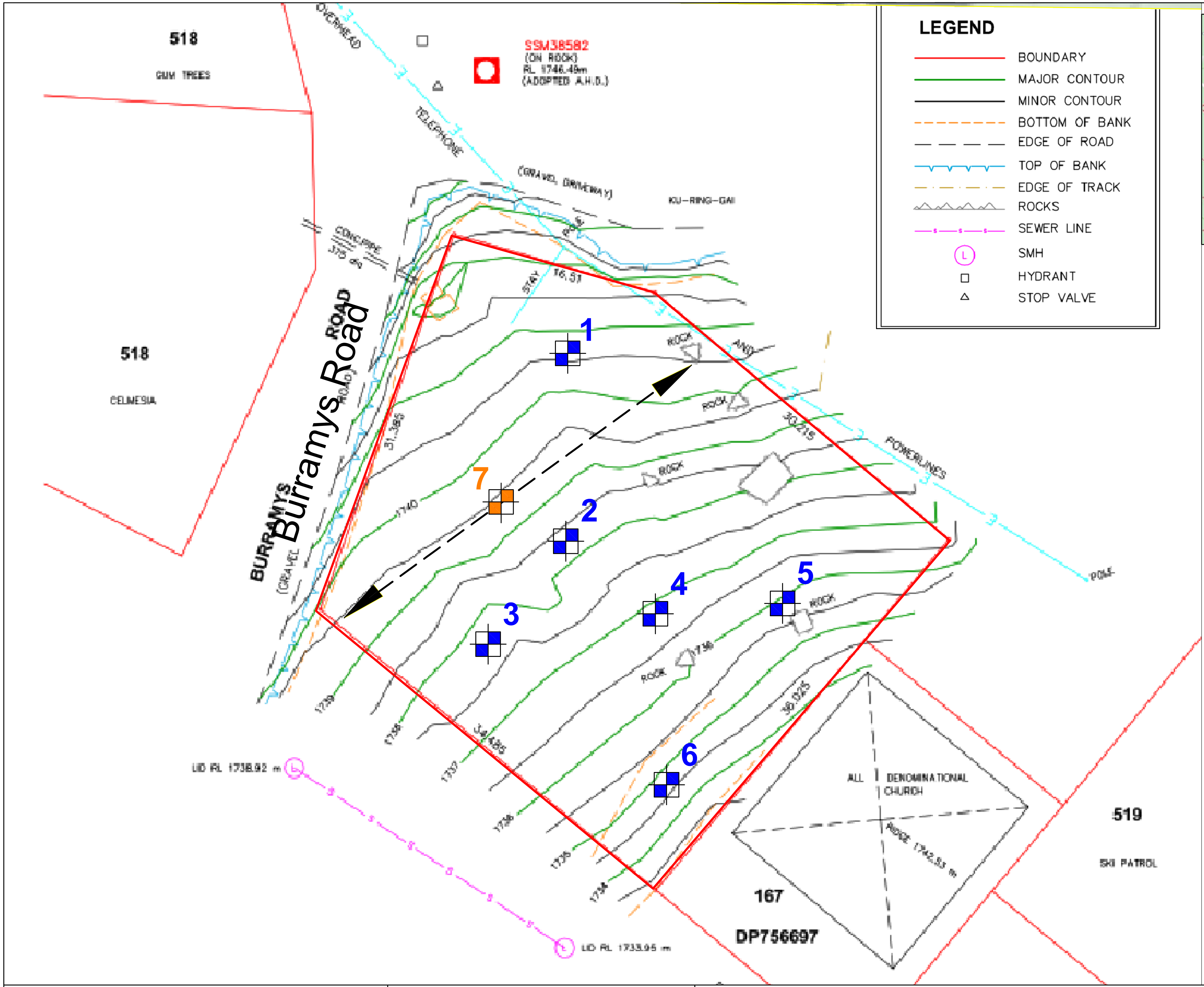
TITLE: **Site Layout and Test Location Plan**
Proposed Perisher View Ski Lodge
Lot 1 DP1192372, Perisher Valley, NSW

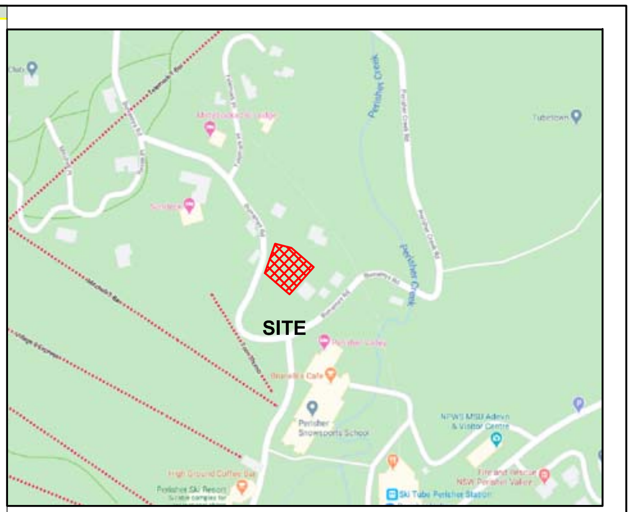
N

PROJECT No: 94499.00

DRAWING No: 1

REVISION: 0





Locality Plan

LEGEND

- 🟥 Approximate Site Boundary
- ▨ Approximate Test Pit Location
- ▨ Approximate Abandoned Test Pit Location
- ↔ Approximate Location and Direction of Unearthed Structure

0 3 6 9 12 15

1:300 @ A3

NOTE: Base drawing from maps.six.nsw.gov.au (dated 27 January 2011)

Douglas Partners

Geotechnics / Environment / Groundwater

CLIENT: Geoanalysis Pty Ltd		TITLE:	**Test Location and Contour Plan** **Proposed Perisher View Ski Lodge** **Lot 1 DP1192372, Perisher Valley, NSW**
OFFICE: Canberra	DRAWN BY: SDG		
SCALE: As Shown	DATE: 02.06.2020		

N

PROJECT No:	94499.00
DRAWING No:	2
REVISION:	0

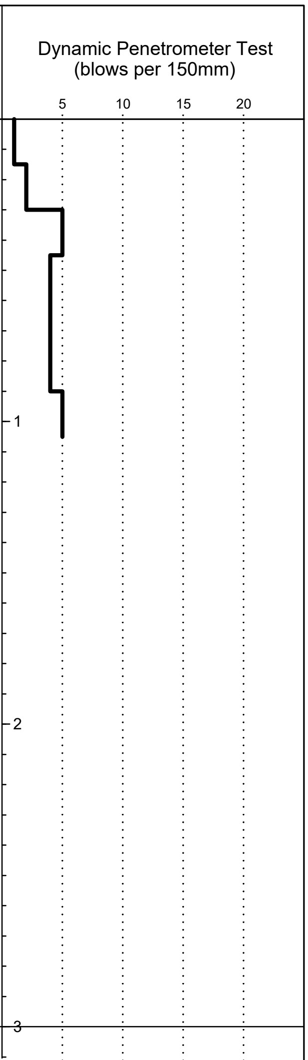
Appendix C

Test Pit Logs

TEST PIT LOG

CLIENT: Geoanalysis Pty Ltd	**SURFACE LEVEL:** 1741.0 AHD	**PIT No:** 1
PROJECT: Proposed Perisher View Ski Lodge	**EASTING:** 626462	**PROJECT No:** 94499.00
LOCATION: Lot 1, DP1192372, Perisher Valley	**NORTHING:** 5970448	**DATE:** 26/5/2020
		SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
1741		TOPSOIL FILL/Silty CLAY (CL): low plasticity, brown, with rootlets, moist, w~PL, soft, TOPSOIL FILL	⊠					
	0.2	FILL/Silty CLAY (CI): medium plasticity, brown, trace cobbles, plastic, metal. moist, w~PL, firm to stiff, FILL	⊠					
	0.45	Sandy CLAY (CL): low plasticity, grey, fine to coarse grained sand with silt, moist to dry, w<PL, stiff, residual/extremely weathered granodiorite	▨	D	0.5			
1740	1							
	1.2	GRANODIORITE: fine to coarse grained, grey, moist, very low strength, highly weathered, with clayey sand/sandy clay seams (extremely weathered granodiorite)	+	D	1.9			
1739	2							▷
1738	3	Pit discontinued at 3.0m -limit of investigation						
1737	4							



RIG: Bobcat E45, fitted with a 450mm bucket **LOGGED:** SDG **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: Groundwater observed at 2.3m, slow flow

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

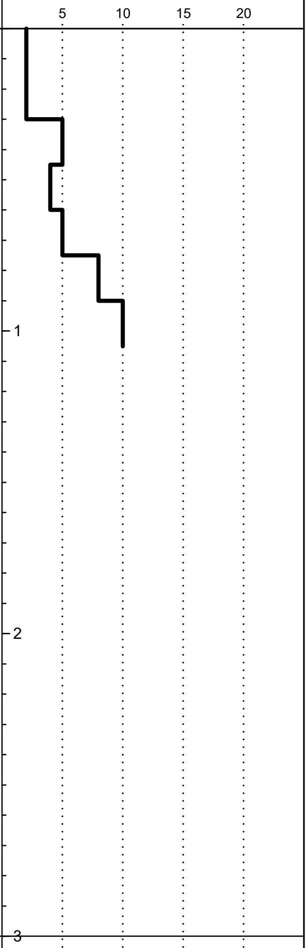
CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1738.5 AHD
EASTING: 626461
NORTHING: 5970435

PIT No: 2
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL/Silty CLAY (CL): low plasticity, dark brown, with fine to coarse grained sand, rootlets, trace granodiorite cobbles, moist, w~PL, firm, TOPSOIL						
1738	0.7	Sandy CLAY (CL): low plasticity, brown/grey-brown, fine to coarse grained sand, moist, w~PL, firm to stiff residual		D	0.5			
1737	1.7	Clayey SAND (SC): fine to coarse grained, grey, low to medium plasticity clay, with angular quartz gravel up to 15mm in size, trace granodiorite cobbles, moist, medium dense to dense, residual		D	1.5			
1736	3.0	GRANODIORITE: fine to coarse grained, grey, moist, very low strength, highly weathered, and medium to high strength core stones, with clayey sand/sandy clay seams, (extremely weathered granodiorite)		D	2.5			
1735 1734		Pit discontinued at 3.0m -limit of investigation						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Bobcat E45, fitted with a 450mm bucket
LOGGED: SDG
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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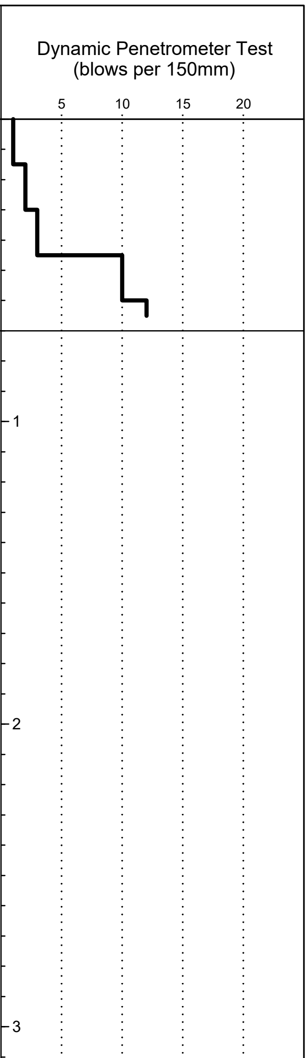
TEST PIT LOG

CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1738.0 AHD
EASTING: 626458
NORTHING: 5970430

PIT No: 3
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
1738		TOPSOIL/Silty CLAY (CL): low plasticity, dark brown, with fine to coarse grained sand, rootlets, with irrigation pipe across some pit, moist, w~PL, topsoil						
	0.2	Sandy CLAY (CL): low plasticity, brown, fine to coarse grained sand, moist, w~PL, firm to stiff, residual		D	0.5			
	0.6	GRANODIORITE: fine to coarse grained, grey, dry, high strength, slightly weathered						
	0.7	Pit discontinued at 0.7m -refusal		D	0.7			
1737	1							
1736	2							
1735	3							
1734	4							



RIG: Bobcat E45, fitted with a 450mm bucket

LOGGED: SDG

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

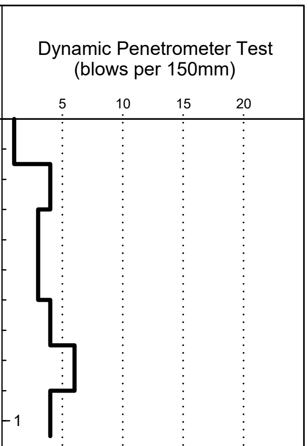
CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1736.0 AHD
EASTING: 626467
NORTHING: 5970432

PIT No: 4
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)
1736	
1735	1
1734	2
1733	3
1732	4

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
0.2	TOPSOIL/Silty CLAY (CL): low plasticity, dark brown, with fine to coarse grained sand, rootlets, trace granodiorite cobbles, moist, w~PL, soft, TOPSOIL					
0.6	Silty CLAY (CL): low plasticity, brown, with fine to coarse grained sand, rootlets, moist, w~PL, stiff, residual	D	0.5			
2.3	Sandy CLAY (CL): low plasticity, grey, fine to coarse grained sand with silt and angular quartz gravel up to 15mm in size, moist, w<PL, stiff, residual/extremely weathered granodiorite -from 1.5m, very stiff	D	1.5			
3.0	GRANODIORITE: fine to coarse grained, grey, very low strength, highly weathered, with clayey sand/sandy clay seams (extremely weathered granodiorite)					▷
	Pit discontinued at 3.0m -limit of investigation					



RIG: Bobcat E45, fitted with a 450mm bucket

LOGGED: SDG

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater observed at 2.4m, slow flow

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

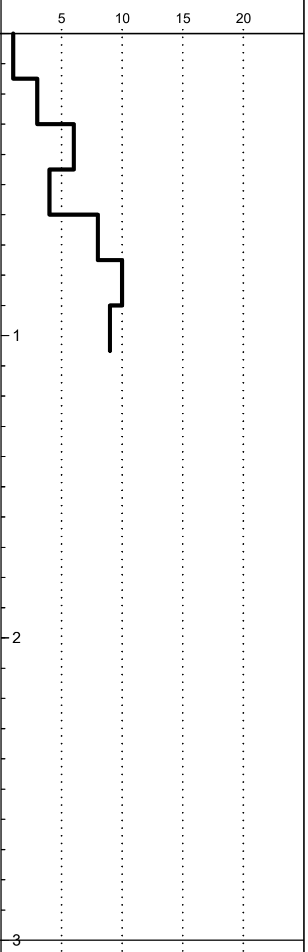
CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1735.5 AHD
EASTING: 626476
NORTHING: 5970434

PIT No: 5
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
1735	0.2	TOPSOIL/Silty CLAY (CL): low plasticity, dark brown, with fine to coarse grained sand, rootlets, trace granodiorite cobbles, moist, w~PL, soft, TOPSOIL					
	0.6	Silty CLAY (CL): low plasticity, brown, with fine to coarse grained sand, rootlets, moist, w~PL, stiff to very stiff, residual	D	0.5			
	0.9	Silty CLAY (CL/CI): low to medium plasticity, grey, with fine to coarse grained sand, moist, w~PL, stiff to very stiff, residual					
1734	2.0	Clayey SAND (SC): fine to coarse grain, grey, low to medium plasticity clay, with angular quartz gravel up to 15mm in size, trace granodiorite cobbles, moist, medium dense, residual	D	1.5			
1733	3.0	GRANODIORITE: fine to coarse grained, grey, very low strength, highly weathered, with clayey sand/sandy clay seams (extremely weathered granodiorite) -from 2.5m, some low strength core stones	D	2.5			
1732 1731		Pit discontinued at 3.0m -limit of investigation					

Dynamic Penetrometer Test (blows per 150mm)



RIG: Bobcat E45, fitted with a 450mm bucket **LOGGED:** SDG **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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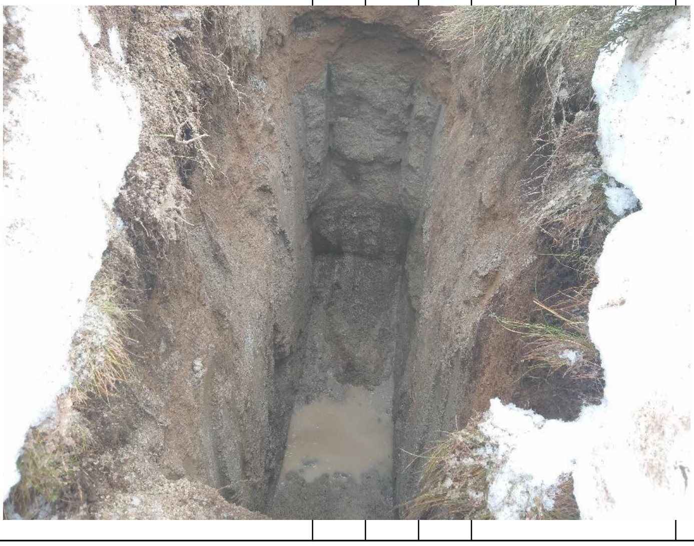
TEST PIT LOG

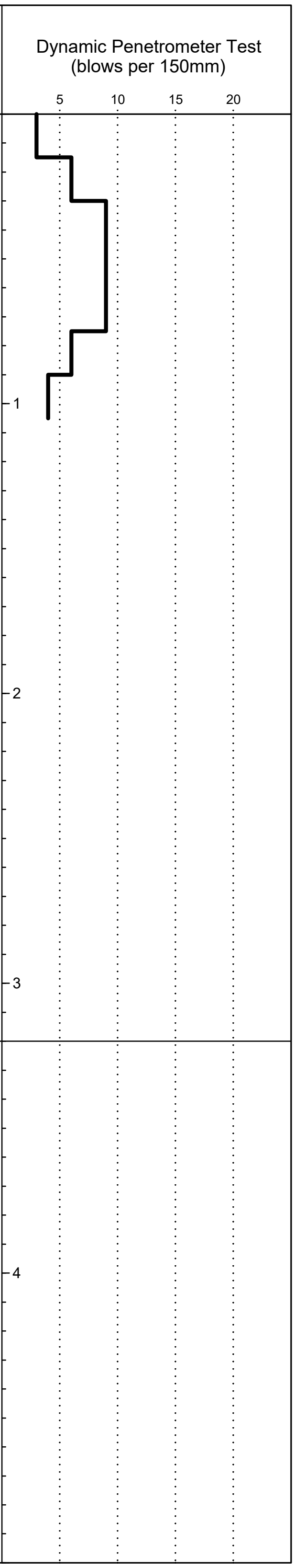
CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1734.0 AHD
EASTING: 626468
NORTHING: 5970419

PIT No: 6
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
1734		TOPSOIL/Silty CLAY (CL): low plasticity, dark brown, with fine to coarse grained sand, with granodiorite cobbles, rootlets, moist, w~PL, firm, TOPSOIL					
	0.2	Clayey SAND (SC): fine to coarse grained, brown, low plasticity clay, with angular quartz gravel up to 15mm in size, moist, loose to medium dense, residual	D	0.5			
	0.7	Clayey SAND (SC): fine to coarse grained, grey, low to medium plasticity clay, with angular quartz gravel up to 15mm in size, trace granodiorite cobbles, moist, medium dense, residual					
1733	1		D	1.5			
	1.6	GRANODIORITE: fine to coarse grained, grey, very low strength, highly weathered, with clayey sand/sandy clay seams (extremely weathered granodiorite)					▷
1732	2 2.0	Clayey SAND (SC): fine to coarse grained, grey, low to medium plasticity clay, with angular quartz gravel up to 15mm in size, trace granodiorite cobbles, moist, medium dense, extremely weathered granodiorite	D	2.5			
1731	3						
	3.2	Pit discontinued at 3.2m -limit of investigation					
1730	4						





RIG: Bobcat E45, fitted with a 450mm bucket
LOGGED: SDG
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater observed at 1.6m, medum to fast flow

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Geoanalysis Pty Ltd
PROJECT: Proposed Perisher View Ski Lodge
LOCATION: Lot 1, DP1192372, Perisher Valley

SURFACE LEVEL: 1739.5 AHD
EASTING: 626456
NORTHING: 5970442

PIT No: 7
PROJECT No: 94499.00
DATE: 26/5/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		TOPSOIL FILL/Silty CLAY (CL): low plasticity, brown, with rootlets, moist, w~PL, soft, TOPSOIL FILL	☒						
1739	0.2	FILL/Clayey SAND (SC): fine to coarse grained, grey-brown, low plasticity clay, with sub-angular granodiorite gravel up to 60mm in size, moist, loose to medium dense, FILL -from 0.5m, an underground structure comprised of bricks, corrugated iron and concrete was uncovered	☒						
	0.9	Pit discontinued at 0.9m - abandoned due to underground structure							
1738	1								1
1737	2								2
1736	3								3
1735	4								

RIG: Bobcat E45, fitted with a 450mm bucket
LOGGED: SDG
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Sampling Methods

Sampling

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

Disturbed samples taken during drilling provide 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 it to obtain 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.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) 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 samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud 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 the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure 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 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Description and Classification Methods

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

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Descriptions

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

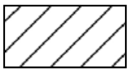
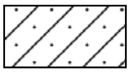
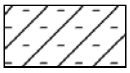
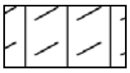
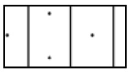
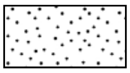
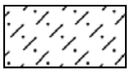
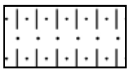
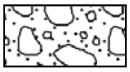
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

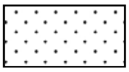
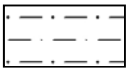
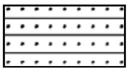
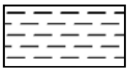
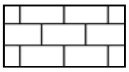
General

■	Asphalt
	Road base
	Concrete
	Filling

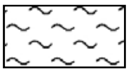
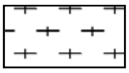
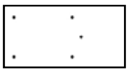
Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

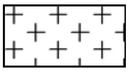
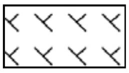
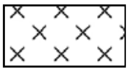
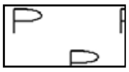
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
■	Coal
	Limestone

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Appendix D

Slope Instability Risk Literature

AUSTRALIAN GEOGUIDE LR7 (LANDSLIDE RISK)

LANDSLIDE RISK

Concept of Risk

Risk is a familiar term, but what does it really mean? It can be defined as *"a measure of the probability and severity of an adverse effect to health, property, or the environment."* This definition may seem a bit complicated. In relation to landslides, geotechnical practitioners (GeoGuide LR1) are required to assess risk in terms of the likelihood that a particular landslide will occur and the possible consequences. This is called landslide risk assessment. The consequences of a landslide are many and varied, but our concerns normally focus on loss of, or damage to, property and loss of life.

Landslide Risk Assessment

Some local councils in Australia are aware of the potential for landslides within their jurisdiction and have responded by designating specific "landslide hazard zones". Development in these areas is often covered by special regulations. If you are contemplating building, or buying an existing house, particularly in a hilly area, or near cliffs, go first for information to your local council.

Landslide risk assessment must be undertaken by a geotechnical practitioner. It may involve visual inspection, geological mapping, geotechnical investigation and monitoring to identify:

- potential landslides (there may be more than one that could impact on your site)
- the likelihood that they will occur
- the damage that could result
- the cost of disruption and repairs and
- the extent to which lives could be lost.

Risk assessment is a predictive exercise, but since the ground and the processes involved are complex, prediction tends to lack precision. If you commission a landslide risk assessment for a particular site you should expect to receive a report prepared in accordance with current professional guidelines and in a form that is acceptable to your local council, or planning authority.

Risk to Property

Table 1 indicates the terms used to describe risk to property. Each risk level depends on an assessment of how likely a landslide is to occur and its consequences in dollar terms. "Likelihood" is the chance of it happening in any one year, as indicated in Table 2. "Consequences" are related to the cost of repairs and temporary loss of use if a landslide occurs. These two factors are combined by the geotechnical practitioner to determine the Qualitative Risk.

TABLE 2: LIKELIHOOD

Likelihood	Annual Probability
Almost Certain	1:10
Likely	1:100
Possible	1:1,000
Unlikely	1:10,000
Rare	1:100,000
Barely credible	1:1,000,000

The terms "unacceptable", "may be tolerated", etc. in Table 1 indicate how most people react to an assessed risk level. However, some people will always be more prepared, or better able, to tolerate a higher risk level than others.

Some local councils and planning authorities stipulate a maximum tolerable level of risk to property for developments within their jurisdictions. In these situations the risk must be assessed by a geotechnical practitioner. If stabilisation works are needed to meet the stipulated requirements these will normally have to be carried out as part of the development, or consent will be withheld.

TABLE 1: RISK TO PROPERTY

Qualitative Risk		Significance - Geotechnical engineering requirements
Very high	VH	**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 the value of the property.
High	H	**Unacceptable** without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable level. Work would cost a substantial sum in relation to the value of the property.
Moderate	M	**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 possible.
Low	L	**Usually acceptable** to regulators. Where treatment has been needed to reduce the risk to this level, ongoing maintenance is required.
Very Low	VL	**Acceptable**. Manage by normal slope maintenance procedures.

AUSTRALIAN GEOGUIDE LR7 (LANDSLIDE RISK)

Risk to Life

Most of us have some difficulty grappling with the concept of risk and deciding whether, or not, we are prepared to accept it. However, without doing any sort of analysis, or commissioning a report from an "expert", we all take risks every day. One of them is the risk of being killed in an accident. This is worth thinking about, because it tells us a lot about ourselves and can help to put an assessed risk into a meaningful context. By identifying activities that we either are, or are not, prepared to engage in we can get some indication of the maximum level of risk that we are prepared to take. This knowledge can help us to decide whether we really are able to accept a particular risk, or to tolerate a particular likelihood of loss, or damage, to our property (Table 2).

In Table 3, data from NSW for the years 1998 to 2002, and other sources, is presented. A risk of 1 in 100,000 means that, in any one year, 1 person is killed for every 100,000 people undertaking that particular activity. The NSW data assumes that the whole population undertakes the activity. That is, we are all at risk of being killed in a fire, or of choking on our food, but it is reasonable to assume that only people who go deep sea fishing run a risk of being killed while doing it.

It can be seen that the risks of dying as a result of falling, using a motor vehicle, or engaging in water-related activities (including bathing) are all greater than 1:100,000 and yet few people actively avoid situations where these risks are present. Some people are averse to flying and yet it represents a lower risk than choking to death on food. Importantly, the data also indicate that, even when the risk of dying as a consequence of a particular event is very small, it could still happen to any one of us any day. If this were not so, no one would ever be struck by lightning.

Most local councils and planning authorities that stipulate a tolerable risk to property also stipulate a tolerable risk to life. The AGS Practice Note Guideline recommends that 1:100,000 is tolerable in newly developed areas, where works can be carried out as part of the development to limit risk. The tolerable level is raised to 1:10,000 in established areas, where specific landslide hazards may have existed for many years. The distinction is deliberate and intended to prevent the concept of landslide risk management, for its own sake, becoming an unreasonable financial burden on existing communities. Acceptable risk is usually taken to be one tenth of the tolerable risk (1:1,000,000 for new developments and 1:100,000 for established areas) and efforts should be made to attain these where it is practicable and financially realistic to do so.

TABLE 3: RISK TO LIFE

Risk (deaths per participant per year)	**Activity/Event Leading to Death** (NSW data unless noted)
1:1,000	Deep sea fishing (UK)
1:1,000 to 1:10,000	Motor cycling, horse riding , ultra-light flying (Canada)
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1:32,000,000	Lightning strike

More information relevant to your particular situation may be found in other AUSTRALIAN GEOGUIDES:

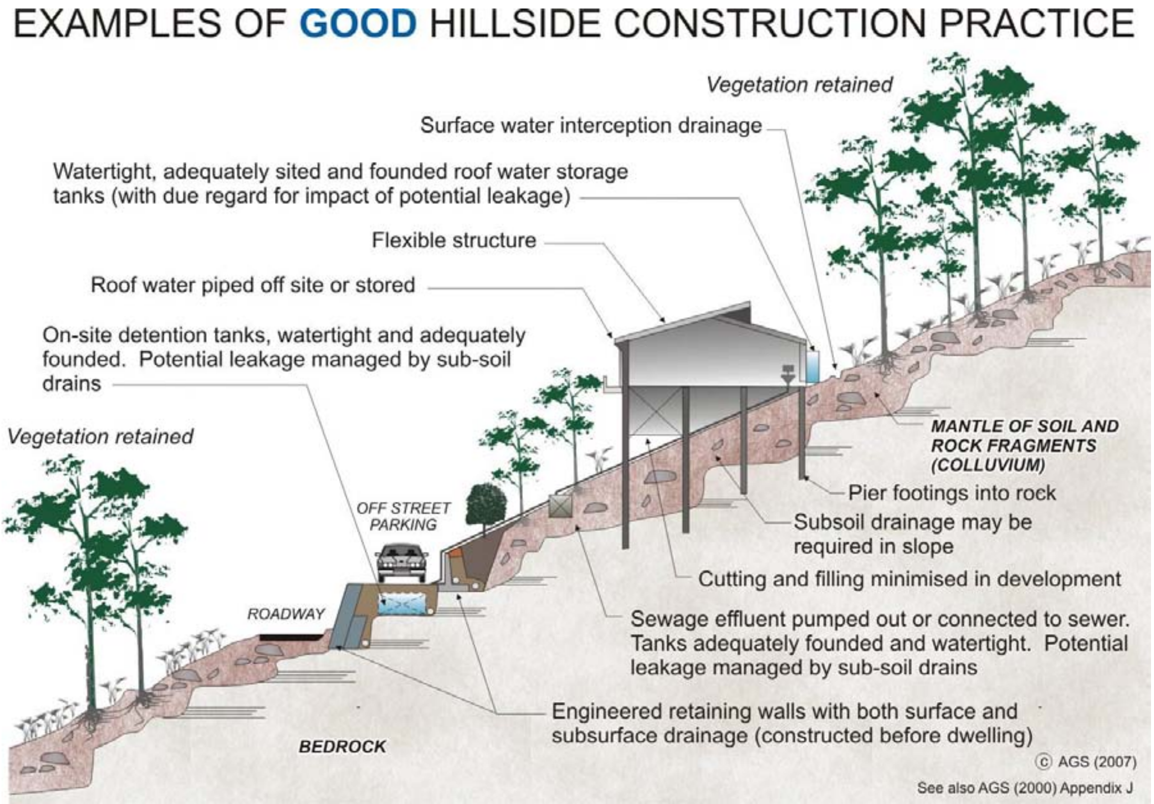
- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
  GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

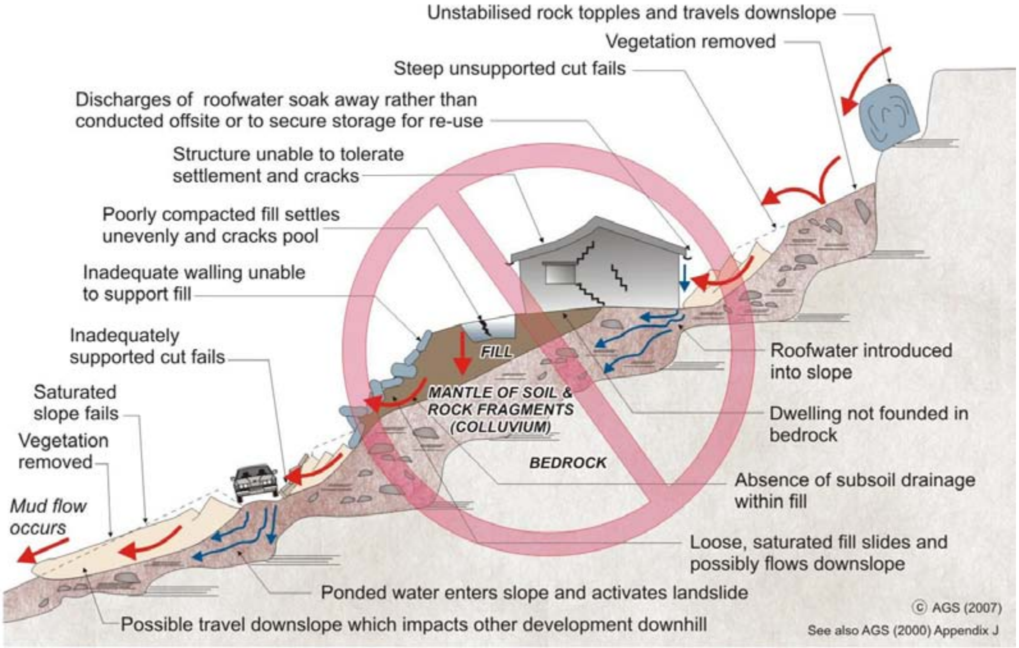
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
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Appendix E

DIPNR Geotechnical Policy “Form 1”

Department of Planning and Environment

Issued under the Environmental Planning and Assessment Act 1979

Approved Application No DA 21/11288

Granted on the 23 June 2023

Signed M Brown

Sheet No 5 of 44

Geotechnical Policy – Kosciuszko Alpine Resorts Form 1 – Declaration and certification made by geotechnical engineer or engineering geologist in a geotechnical report.

Date received: ____/____/____

DA no: ______________

To be submitted with a development application

You can use Form 1 to verify that the author of a geotechnical report is a geotechnical engineer or engineering geologist as defined by DIPNR Geotechnical Policy. Alternatively, where a geotechnical report has been prepared by a professional person not recognised by DIPNR Geotechnical Policy, then form 1 may be used as technical verification of the geotechnical report if signed by a geotechnical engineer or engineering geologist as defined by the DIPNR Geotechnical Policy.

Please contact the Alpine Resorts Assessments Team in Jindabyne for further information. Phone 02 6456 1733.

To complete this form, please place a cross in the boxes ☐ and fill out the white sections.

1. Declaration made by geotechnical engineer or engineering geologist as part of a geotechnical report

I,

Mr ☒ Ms ☐ Mrs ☐ Dr ☐ Other

Gary Edward

Family name
Renfrey

OF

Company/organisation
Douglas Partners Pty Ltd

on this the 23 day of June 2020,

certify that I am a geotechnical engineer or engineering geologist as defined by the "Policy" and I; (tick appropriate box)

☑ prepared the geotechnical report referenced below in accordance with the AGS 2000 and DIPNR Geotechnical Policy – Kosciuszko Alpine Resorts.

☐ am wiling to technically verify that the Geotechnical Report referenced below has been prepared in accordance the AGS 2000 and the Geotechnical Policy – Kosciuszko Alpine Resorts.

2. Geotechnical Report Details

Report Title
Proposed Perisher View Ski Lodge, Lot 1, DP1192372, Perisher Valley

Author
Gary Renfrey

Dated
23 June 2020

DA Site Address
Lot 1, DP 1192372, Perisher Valley, NSW.

DA Applicant

I am aware that the Geotechnical Report I have either prepared or am technically verifying, (referenced above) is to be submitted in support of a development application for the proposed development site (referenced above), and it's findings will be relied upon by the Consent Authority in determining the development application.

3. Checklist of essential requirements to be contained in a geotechnical risk assessment report to be submitted with a development application

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Report. This checklist is to accompany the report.

Please tick appropriate box

- ☑ Risk assessment of all identifiable geotechnical hazards in accordance with AGS 2000, as per 6.1 (a) of the policy.
- ☑ Site plans with key hazards identified and other information as per 6.1 (b)
- ☑ Details of site investigation and inspections as per 6.1 (c)
- ☑ Photographs and/or drawings of the site as per 6.1 (d)
- ☑ Presentation of geotechnical model as per 6.1 (e)
- ☑ A specific conclusion as to whether the site is suitable for the development proposed on the above site, if applicable, subject to the following conditions;
  - ☐ Conditions to be provided to establish design parameters,
  - ☑ Conditions to be incorporated into the detailed design to be submitted for the construction certificate,
  - ☑ Conditions applying to the construction phase,
  - ☑ Conditions relating to ongoing management of the site/structure.

4. Signatures

Signature

Chartered professional status: CPEng MIEAust Member No. 258028

Name: Gary Edward Renfrey

Date: 23 June 2020

5. Contact details

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