Geotechnical Investigation Report

Project

Proposed Golf Course Subdivision
2/4 Crackenback Drive, Thredbo NSW

Prepared for

Kosciuszko Thredbo Pty Ltd

Date

3 August 2023

Report No

14871-GR-1-1-Rev B

alliance
geotechnical & environmental solutions

Alliance Geotechnical Pty Ltd

Address: 8-10 Welder Road
Seven Hills, NSW

Phone: 1800 288 188
Office Email: info@allgeo.com.au
Web: www.allgeo.com.au

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B	3/08/2023	Report Update per Amendments to the Proposed Development	KN	MAG

	Author	Reviewer
Signature		
Name	Khue Nguyen	Mark Green
Title	Geotechnical Engineer	Principal Geotechnical Engineer

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APPENDICES

1 Introduction

This report presents the results of a Lot Classification for the proposed residential subdivision at the Thredbo Golf Course, Thredbo NSW (NSW) undertaken by Alliance Geotechnical Pty Ltd (Alliance). The investigation was commissioned by Kosciuszko Thredbo Pty Ltd (the client) and was undertaken in accordance with Alliance's Estimate No. 6393, dated 15 March 2022.

The objective of this geotechnical investigation was to address the subsurface conditions encountered, field and laboratory testing results, and provide comments and recommendations regarding:

- The site general geology, subsoil profile, and groundwater conditions; and
- Site classification in accordance with AS 2870:2011 Residential Slabs and Footings.

The investigation comprised drilling six boreholes and in-situ testing, followed by laboratory testing of selected samples, engineering analysis, and reporting. Details of the field and laboratory results are presented in this report, together with comments and recommendations relating to design and construction practice.

Previously, the geotechnical investigation was carried out in April 2022 and the findings are provided in Alliance's report, ref.: 14871-GR-1-1 Rev A, dated 24/2/2023. However, in July 2023, Alliance has been advised that additional changes are proposed as part of the development and a review of the new design is required.

2 Proposed Development

Alliance has been provided with a request for fee proposal, prepared by the client, dated 8 March 2022 which includes:

- An outline of the proposed subdivision; and
- Subdivision concept plan, prepared by djrd, ref.:19413 A1.001 Rev E, dated 7/09/2021.

On 28/7/2023, the client has provided additional / updated documents as following:

- Subdivision concept plan, prepared by djrd, ref.:19413 A1.001 Rev F, dated 13/07/2023;
- Parking layout plan, prepared by djrd, ref.: 19413 A1.003 , dated 16/05/2023;
- Staging area plan, prepared by djrd, ref.:19413 A1.003, dated 16/05/2023;
- Proposed additional water storage tank layout, prepared by KOS, dated 18/07/2023;
- Proposed civil works plans, prepared by CLM Civil, ref.: U-183-E, Sheet 1-12, dated 27/07/2023; and
- Proposed extend of golf course works drawings, prepared by Dawson Design Golf + Resorts Ptd Ltd, ref.: 2115 Issue F, dated 16/09/2023.

Based on the supplied documents, it is understood that the development would comprise:

- The redesign of the existing nine-hole golf course;
- The construction of 19 separate buildings lots with areas vary between 533m^2 and 1,310m^2;
- The construction of a new concrete road off Crackenback Drive with total length of approximately 425m as well as an emergency service road to the Crackenback Ridge subdivision; and
- The construction of municipal infrastructure such as water, sewer, gas, and telecommunication/data infrastructure.

Alliance understands that each newly subdivided lot will house accommodation facilities with footprint areas varied between 170m^2 (6 beds) and 470m^2 (20 beds). In addition, an additional water tank storage adjacent to the existing water tank, located approximately 400m north of the proposed subdivision is proposed.

Earthworks for the new roads, lodge estate, the wat and other infrastructure is required, though it is anticipated that the excavation for the development will not extend more than 1m bgl.

3 Site Description & Regional Geology

The site is located at the Thredbo Golf Course, known as 2/4 Crackenback Drive within Thredbo Village, Thredbo NSW 2625 which covers an area of approximately 12ha. The Golf Course is bounded by Crackenback Drive at the northeast and surrounded by vegetation. Along the northwest and southeast boundaries lies Thredbo River which joins Jindabyne Lake, some 30km to the northeast. Figure 1 below shows the site location with its surroundings. During the site walkover as part of the investigation, granodiorite boulders were observed across the site, particularly at the northwest section.

The proposed 19 lots are situated at the middle of the golf course towards the southwestern area which the proposed road connected to Crackenback Drive with a total area of almost 15,000m^2.

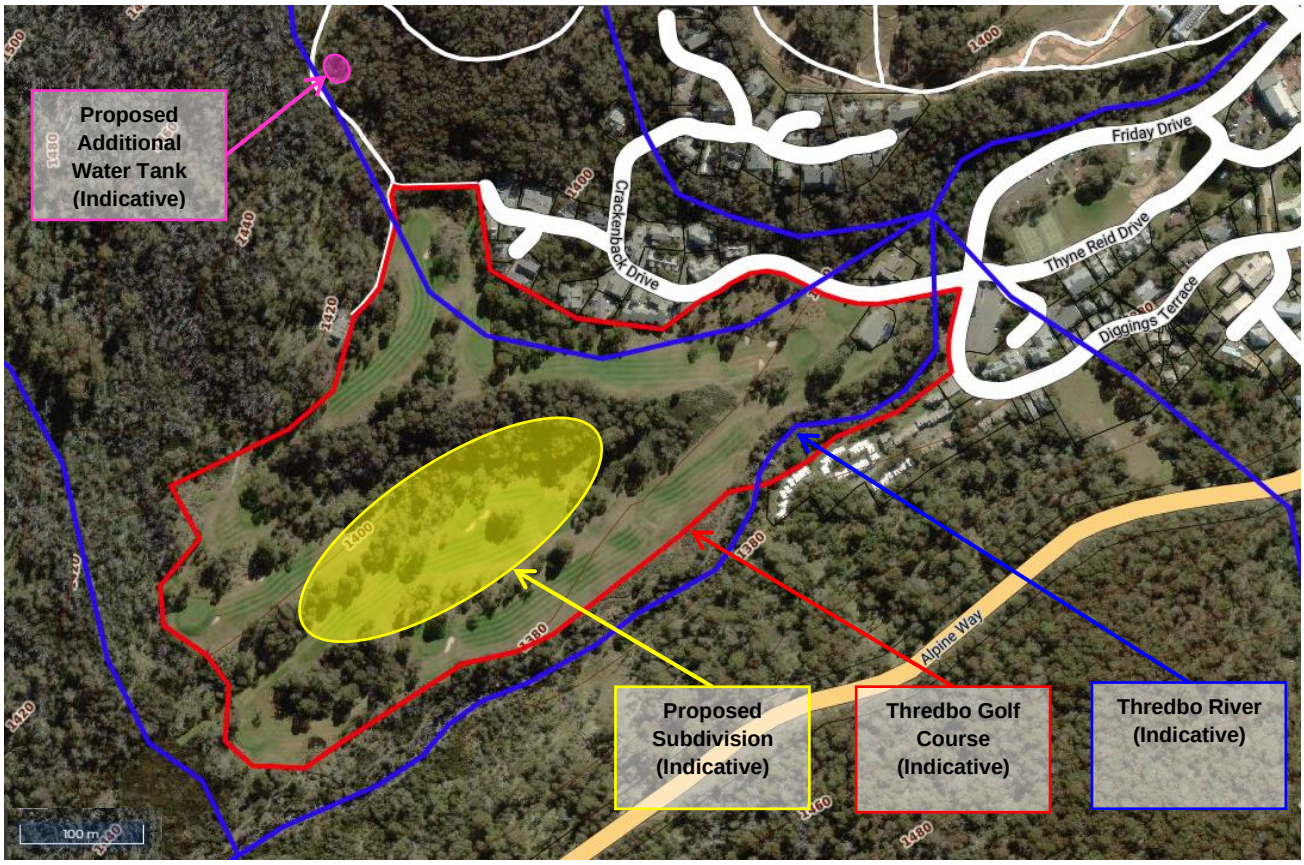

Figure 1 - The Site Location

At the time of preparing this report, the site detailed survey plan has not been provided. Based on the regional topography, the site lies within a valley with slightly steep inclines of less than 20° and 30° towards the northwest and southeast direction, respectively.

The NSW Seamless Geology version 2.1, published online in 2013, indicates that most of the site is underlain by Silurian aged Mowambah Granodiorite which may contain medium-grained mafic biotite-rich granodiorite, strong foliation defined by quartz and biotite crystals plus aligned xenoliths, muscovite flakes accentuate foliation, and metasedimentary xenoliths include banded cordierite gneiss. The geology map identifies a fault system, Crackenback Fault, along the site southeast boundary that follows the line of Thredbo River.

The site overlaying NSW Seamless Geology map with 10m contours are presented in Figure 2 below.

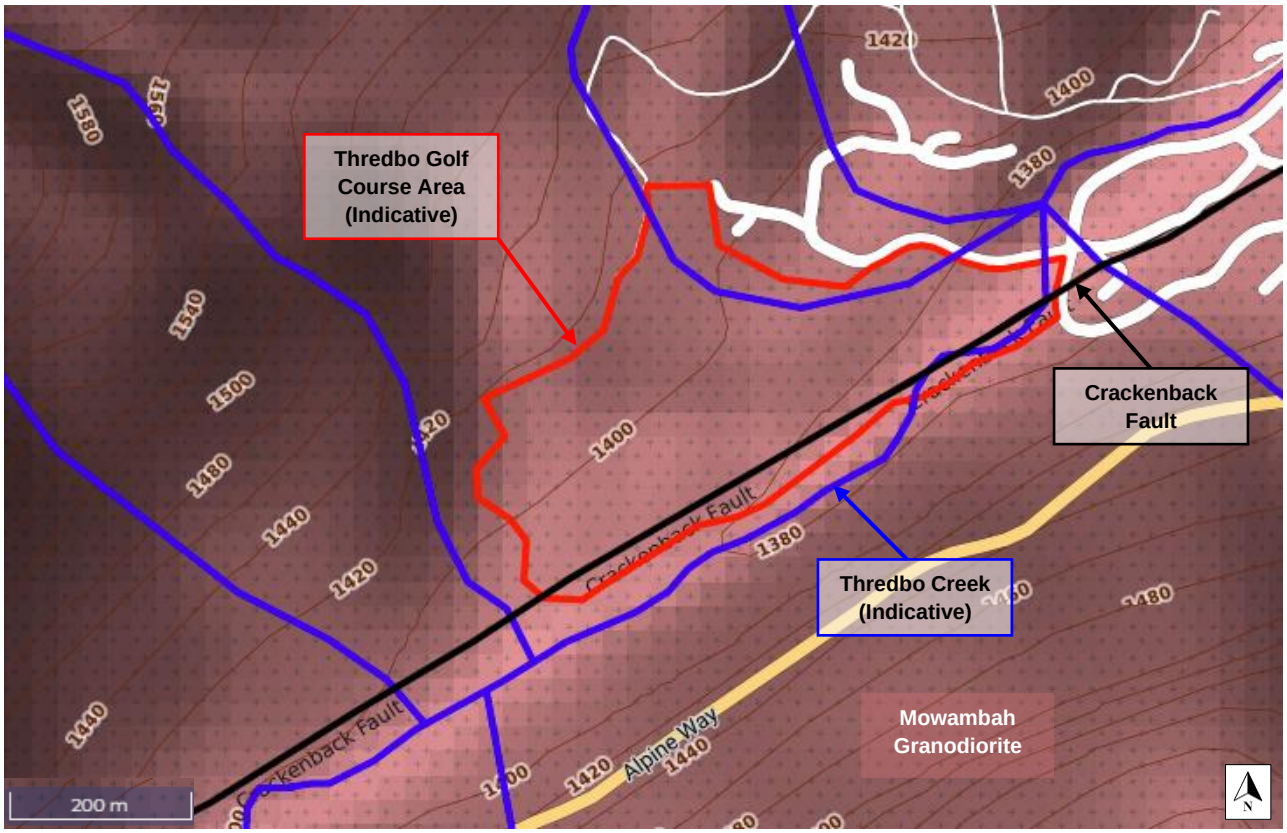

Figure 2 - The Site Location with NSW Seamless Geology and 10m Contours

4 Fieldwork

4.1 Methods

The geotechnical site investigation was carried out on 27 April 2022 and commenced with a site walkover and inspection aby an Alliance geotechnical engineer. During the walkover, geological and topographical features of the site were documented.

Selected photographs taken during the fieldwork are presented in Appendix A and the approximate borehole locations are shown on the Geotechnical Investigation Plan (Drawing 14871-GR-1-A) presented in Appendix B.

The investigation locations were marked out on site by client representative prior to the fieldwork and checked against dial before you dig (DBYD) plans before drilling commencement.

Six boreholes were drilled to tungsten carbide bit (TC-bit) refusal at depths between 1.4m and 2.4m below ground level (bgl). The boreholes were drilled using a trailer-mounted rig operated by an accredited subcontractor. Drilling through the soil was advanced with solid flight augers fitted with a tungsten carbide (TC-bit). Standard penetration tests (SPTs) were performed inside each borehole at 1.5m depth intervals except for boreholes BH01 and BH02 due to time constraints.

At boreholes BH03, BH04, and BH05, NMLC coring was initiated upon TC-bit refusal and terminated at target depths between 2.6m and 4.9m bgl.

Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to each borehole location to assess the near surface soil consistency. The penetrometer tests commenced at the existing surface level and terminated at refusal depths between 0.4m and 1.1m bgl on inferred granodiorite boulders.

The encountered soil profiles were documented in accordance with AS1726 - 2017 Geotechnical Site Investigation and recovered soil samples were transported to Alliance's NATA accredited laboratory for further testing and storage.

At completion, the boreholes were backfilled with drilling spoils and made flush with the surrounding surface. The site condition was reinstated to its original condition.

The borehole locations were surveyed as part of the fieldwork using a Trimble Positioning Device with GNSS and positioning Ranger.

A summary of the coordinates and reduced levels (RLs) in relation to Australian Height Datum (AHD)) as well as investigation depth at each borehole location is presented in Table 1 below.

Table 1 – Summary of Boreholes and Potholes Coordinates and RLs

Location	Easting	Northing	Surface RLs	Termination Depth	Termination Level
Unit	m MGA20 (±1.0m)	m MGA20 (±1.0m)	m AHD (±0.1m)	m bgl	m AHD
BH01	616227	5958982	1382.6	1.6	1381.0
BH02	616194	5958952	1386.1	1.4	1384.7
BH03	616133	5958932	1388.2	4.0	1384.2
BH04	616133	5958903	1388.1	1.9	1386.2
BH05	616010	5958864	1391.2	2.6	1388.6
BH06	616142	5958868	1386.3	4.9	1381.4

4.2 Results

The borehole logs, core box photos, and the DCP test results are attached in Appendix D. These log sheets should be read in conjunction with the attached Explanatory Notes, which explain the terms, abbreviations and symbols used, together with the interpretation and limitation of the logging procedure.

Table 1 above summarises the termination depths of all investigations that were carried out, and the summary of the encountered subsurface profile and interpreted geotechnical units are provided in Table 2.

Table 2 - Summary of Subsurface Profile

Ground Profile	Consistency/ Strength	Depth to top of unit	Level to top of unit	Thickness*
Unit	-	m bgl	m AHD	m
Fill Clayey SILT/ Silty CLAY	Moderately to well compacted	0.0	1381.2 – 1391.5	0.2 – 0.5
Extremely weathered granodiorite Recovered as Gravelly SAND	Medium dense to dense	0.4 – 0.5	1382.2 – 1385.6	0.9 – 1.2
Colluvium Silty CLAY / CLAY / Gravelly CLAY	Firm to stiff	0.2 – 0.6	1386.0 – 1390.9	1.2 – 1.7
(Residual) Clayey SAND	Medium dense to dense	1.8	1386.4 – 1386.6	0.6
Granodiorite boulder	Low to medium strength	1.7 – 2.4	1384.4 – 1389.5	0.2 – 0.6
Granodiorite boulder	Medium to high strength	2.6 – 2.4	1383.8 – 1385.6	0.2 – 0.4

*Inferred based on terminated depth at some units

The site subsurface profile comprised poorly to moderately compacted fill up to 0.5m bgl at borehole BH03 underlain by colluvium consisting of firm to stiff silty clay, clay, or gravelly clay followed by residual soils consisting of medium dense to dense clayey sand.

Extremely weathered granodiorite, recovered as gravelly sand, was encountered at borehole BH01 and BH02 below the fill layer with a proven thickness of 1.2m (BH01) and 0.9m (BH02).

Boreholes BH01, BH02, and BH04 were terminated upon TC-bit refusal at depth between 1.4m and 1.9m bgl on inferred granodiorite boulders.

At boreholes BH03, BH05, and BH06, NMLC coring was initiated upon TC-bit refusal and granodiorite was encountered at depth between 1.7m and 2.4m bgl with thickness varied between 0.3m and 1.6m. Significant core loss between 0.3m and 2.0m occurred at these boreholes indicating the boulders were underlain by extremely weathered material or residual soils and inferring that coherent solid rock was not encountered. Rock coring was terminated at target depths 2.6m and 4.9m bgl on inferred soils.

4.3 Groundwater

Groundwater was not observed during the fieldwork and long-term groundwater monitoring was not carried out. It should be noted that groundwater seepage condition is subject to the soil permeability, seasonal and

climatic conditions and it may vary across the site. It is expected the groundwater seepage occurs through the interface between soil and rock boulders.

5 Laboratory Testing

5.1 Field Moisture Content

Five samples were selected for field moisture content testing and the tests were completed by Alliance NATA accredited laboratory in accordance with AS 1289 2.1.1:2005. The summary of the results is included in the table below Table 3 and with the full laboratory report is provided in Appendix D.

Table 3 - Field Moisture Content Results

Samples Location	Sample Depth (m)	Material	Moisture Content (%)
BH01	1.0 – 1.5	Gravelly SAND	12.8
BH02	1.0 – 1.4	Gravelly Clayey SAND	13.5
BH03	1.5 – 1.7	Silty CLAY	25.3
BH04	0.5 – 0.7	CLAY	21.0
BH05	0.5 – 1.0	Gravelly CLAY	12.6

5.2 Shrink-Swell Index

Three relatively undisturbed samples (U50) were collected at boreholes BH03, BH04, and BH06 for shrink-swell index testing. However, due to high presence of gravel in the sample collected from BH06 between 1.5m and 1.7m, the sample was opted for Atterberg Limit with linear shrinkage testing.

The two shrink-swell index tests were completed by Alliance NATA accredited laboratory testing facility in accordance with AS1289.7.1.1:2003. The results presented in below with test certificates are included in Table 4 Appendix D.

Table 4 – Shrink-Swell Index Results

Samples Location	Depth	Material	Shrinkage	Swell	Shrink-Swell Index
	m	-	%	%	%
BH03	1.5 – 1.7	Silty CLAY	2.4	-0.1	1.6
BH04	0.5 – 0.7	CLAY	1.8	-0.1	1.0

5.3 Atterberg Limit with Linear Shrinkage

Four Atterberg limit (four-point liquid limit) with linear shrinkage tests were completed on selected samples in accordance with AS1289 3.1.1, 3.2.1, and 3.3.1:2008 by Alliance NATA accredited laboratory. The results are summarised in Table 5 below with laboratory test certificates provided in Appendix D.

Table 5 - Atterberg Limit Results

Samples Location	Depth	Material	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage
	m	-	%	%	%	%
BH03	2.0 – 2.5	Clayey SAND	Not obtainable	Not obtainable	Non-plastic	-
BH04	1.5 – 1.9	Gravelly CLAY	46	31	15	7.5
BH05	0.5 – 1.0	Gravelly CLAY	35	29	6	4.5
BH06	1.5 – 1.7	Gravelly CLAY	36	24	12	4.0

6 Recommendations

6.1 Excavation Conditions and Vibration Control

Based on the subsurface condition encountered discussed in Section 4.2, bulk or footing excavations are expected to encounter sandy soils of medium dense to dense, clayey soils of firm to stiff, and granodiorite boulders of low to medium high strength.

Excavation through the fill material and natural sandy or clayey soil is expected to be achievable using conventional earthwork equipment such as a tracked excavator with tiger-tooth bucket. Vibration from excavation within soil is expected to be negligible.

Excavatability through rock boulders and hard materials can be based on method published by Pettifer and Fookes (1994) as shown in Figure 3 where the rock point load index ($I_{s(50)}$) and fracture spacing is considered. The excavatability categories range from easy to hard digging, through easy to hard ripping, to blasting.

Excavation through the medium to high strength granodiorite boulders encountered at the site may require the use of rock breaking hammers or other easy to hard ripping equipment. Low vibration equipment will be required at locations where vibration could impact on adjacent structures. Alternatively, blocks of cut rock mass can be dislodged using small rock hammers and lifted out without generating large vibration.

Generally, the peak particle velocity during any demolition, excavation, and construction should be limited to 5mm/s. A minimum distance of from 1.5m to 2.0m is recommended between the operation point (hand-operated jack hammer at 100% maximum operating capacity) and the adjacent structure.

If the encountered ground conditions are not in line with the finding of this geotechnical investigation, the project geotechnical engineer should be informed prior to advancing the construction works.

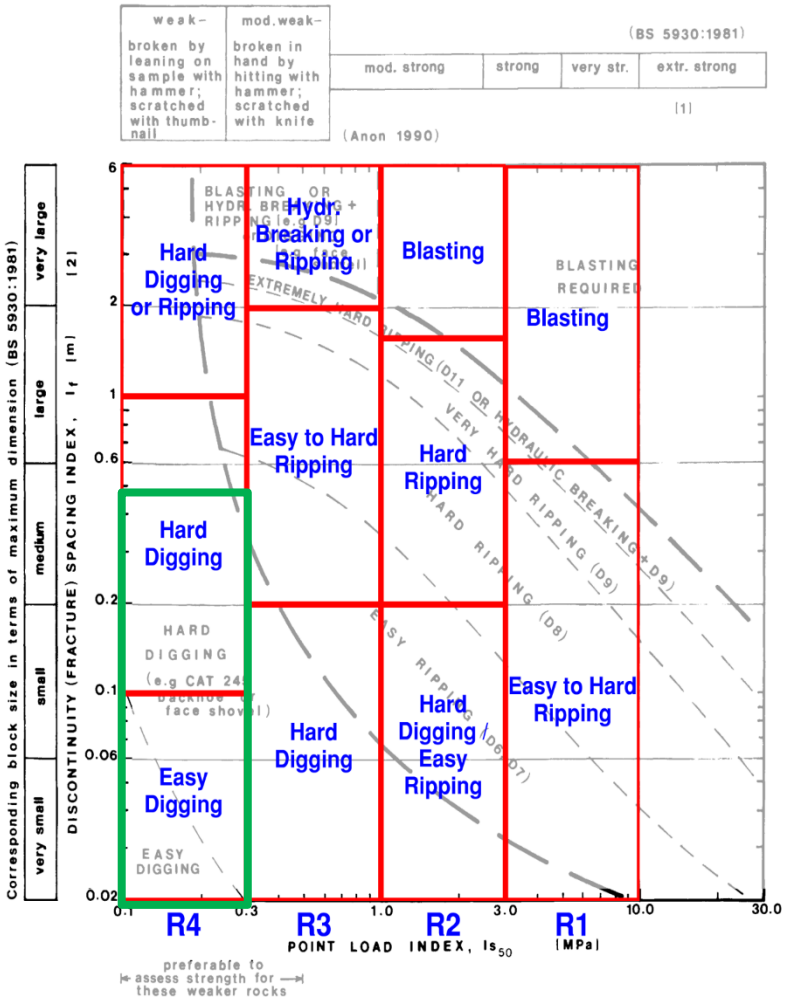

Figure 3: Excavatability Nomogram (Extracted from Pettifer and Fookes, 1994)

6.2 Earthwork Construction Recommendations

It is understood that some fill placement and compaction will be required for the construction of the proposed development. Subgrade preparation works will however first need to be undertaken prior to fill placement, as detailed below. It is noted that site classification may require to be re-undertaken if major filling is placed across the site.

6.2.1 Subgrade Preparation for Ground Slabs and Pavements

The following recommendations are provided for subgrade preparation for earthworks, pavements, and slab-on-ground (if required) construction:

- Strip existing fill and topsoil. Remove unsuitable materials from the site (e.g., material containing deleterious matter). Stockpile remainder for re-use as landscaping material or remove from site.

- If natural soils need to be excavated, stockpile for re-use as fill or remove as spoil.

- Areas which show visible heave under compaction equipment should be over-excavated a further 0.3m and replaced with approved fill. The replaced select fill layers (following moisture conditioning, if required) shall be compacted with a roller until a minimum standard dry density ratio of 95% SMDD is achieved, and the in-situ moisture content of the layer is within ± 2% of standard optimum at the time of carrying out the field density testing.

- For the pavement subgrade, after excavation to the design subgrade level, the exposed surface will require inspecting and test rolling in the presence of a geotechnical engineer to identify and delineate any areas of loose, soft, or unsuitable subgrade material or where the design CBR value is considered to be not achievable. The test roll should be carried out using a smooth drum roller to pass over the entire subgrade area 4 to 6 times under low speed and in static mode. Following the inspection and test roll, areas of soft or unsuitable subgrade where the design CBR is not considered to be achievable shall be excavated to a suitable foundation level. The excavated areas should then be backfilled using controlled fills placed and compacted to 95% SMDD in layers not exceeding 200mm thick.

All earthworks and geotechnical level 2 sampling and testing is to be carried out under the guide of AS3798 – Guidelines on earthworks for commercial and residential developments.

If floor slabs are designed to be suspended, subgrade preparation beneath them is considered to be unnecessary. However, root-affected and organic soils should still be stripped and replaced with surface levelling fill below the footprint of the slab.

6.2.2 Fill Placement and Compaction

Any minor fill (up to 1.0m) which is to support pavements or lightly loaded ground slabs should be placed in a controlled manner as outlined below, and in general accordance with the relevant Australian Standard (AS 3798 – Earthworks for residential and commercial developments). If any major filling is required (greater than 1m), then it is subject to a site-specific earthwork specification.

The results of the fieldwork indicate that the natural residual and colluvial strata underlying the site may be used for filling provided any organic or deleterious materials are removed. Over-sized cobbles and boulders will also need removal or pre-treatment.

If it is intended to import fill material, granular material is preferred for general filling provided the fill material of low to medium plasticity. Any imported filling proposed for either building or pavement areas should consist of granular material such as completely decomposed granodiorite, crushed sandstone or similar. The fill must be well compacted and cannot contain any demolition waste or other contaminants. Fill material should not contain vegetation, organic matter, high plasticity clayey soils, or particle greater than 75mm. Plasticity index of the fill materials should be limited to 30%.

It is recommended to place a final layer of compacted granular fill with a thickness of 150mm to finish the construction platform to protect the subgrade from soil moisture variation. Filling material should be placed with density ratio and moisture content specified in Table 6.

Table 6 - Compaction specifications

Fill Material	Loose Layer Thickness	Minimum Compaction Ratio	Moisture content
General fill	250mm	95%	± 2% OMC
Engineering fill to support pavement and subgrades	250mm	100%	± 2% OMC

OMC Optimum Moisture Content

General fill (with a compaction ratio of 95%) cannot be relied on appropriate foundation strata for the shallow footings, to support pavement and subgrades. Placement of fill will require strict moisture control to ensure that adequate compaction is achieved.

All fill materials should be placed in accordance with AS3798 – 2007 Guidelines on earthworks for commercial and residential developments.

Over-compaction should be avoided due to the potential for ground surface heave, which may cause ground slabs to crack and distortion in paving. It is recommended that a programme of density testing be implemented to ensure that the required level of compaction is being achieved in accordance with AS1289 to minimum Level 2 standard, but Level 1 is recommended in preference.

Methods of maintaining moisture content may include the use of plastic membranes or gravel layers over the surface of the exposed subgrade or lime blending within the upper subgrade layers. Maintaining correct moisture content within the subgrade will be assisted if there are minimal delays in construction of ground slabs and pavements after completion of earthworks. Interception and relief of subsoil seepage in all areas of significant cut is essential if subsequent softening of the subgrade below ground slabs and pavements is to be avoided.

It is recommended that all compaction control testing in areas that will support structures and pavements to be completed under appropriate supervision by an approved Geotechnical Inspection and Testing Authority (GITA). Further advice should be sought where filling is required to support major structures.

Any off-site disposal of excavated materials will require an assessment for re-use or classification of the soils in accordance with EPA guidelines. This includes fill soils and natural soils removed from site. Environmental assessments may need to be undertaken on excavated soils to classify spoil prior to removal from site.

6.3 Site Sub-Soil Classification

Determination of the lots' sub-soil classification has been carried out in accordance with AS1170.4:2007 Structural Design Actions Part 4: Earthquake Actions in Australia and is presented in table below.

Table 7 - Sub-Soil Classification Summary

Lot	Sub-soil Class	Hazard Factor z
1 - 17	Ce – Shallow soil	0.10

6.4 Site Classification

The site is underlain by uncontrolled fill to a maximum depth of 0.5m at borehole BH03. Hence, the site is classified as Class P in accordance with to AS2870:2011 – Residential Slabs and Footings.

However, given that the fill thickness varies between 0.2m and 0.5m, the lots can be reclassified given that all footings are founded in the natural stratum through the filling.

The results of shrink-swell index and plasticity testing indicate that the natural colluvium silty clay, clay, or gravelly clay and residual clayey sand are typically low to medium plasticity and have low to moderate potential for shrinkage and swelling movements due to changes in soil moisture content. The lot classifications have been determined and are summarised in Table 8.

Table 8 – Lot Classification Summary

Lot	Lot Classification	Lot	Lot Classification	Lot	Lot Classification
1	M	7	S	13	S
2	M	8	S	14	S
3	M	9	M	15	M
4	M	10	S	16	M
5	M	11	S	17	M
6	M	12	S		

S = Class S: Slightly reactive clay sites with estimated surface movement y_s less than 20mm
M = Class M: Moderately reactive clay sites with estimated surface movement y_s between 20mm and 40mm

The classification given in Table 8 are appropriate for the undeveloped lots at the time of writing this report. Revision of the lot classifications may be required once development details and proposed site works for individual lots are known.

6.5 Footings

The existing fill is not a suitable foundation material, and the proposed structures should be founded on the natural stratum only. For lightly loaded, settlement-insensitive, structures, it may be feasible to design shallow footings founded uniformly in natural colluvium or residual soil. Parameters for shallow footing design are presented in Table 9.

It should be noted that the provided bearing pressures do not apply to raft footing designs. If a raft footing is proposed, an assessment of settlements needs to be made using the applied loads and geometry. Alliance can assist in the geotechnical aspects of this design if required.

Table 9 - Preliminary Geotechnical Parameters for Shallow Foundations with Vertical Centric Loads

Description	Allowable Bearing Pressure (kPa)	Youngs Modulus (MPa)
Colluvium/Residual CLAY, firm to stiff	100(1)(2)	7

(1) Based on a 1.0m square pad footing, 0.5m deep.
(2) Separate settlement assessment should be undertaken to ensure that the footing settlements are within the tolerable range.

If completely weathered granodiorite or granitic boulders are encountered, the allowable bearing capacity can be increased to 600kPa, but this is not consistence across the proposed subdivision. Allowable bearing pressure is not a soil property, but also a function of the size of the footing, embedment depth, and load eccentricity. Larger and deeper footings have larger bearing capacities, and eccentric loads reduce the bearing capacity. It is recommended that the footings are founded on the same strata to minimise the risk of differential settlement.

Additional geotechnical investigations may be required should highly loaded and settlement sensitive structures be proposed.

It is noted that the geotechnical investigation was not carried out at the newly proposed water tank location. However, based on Alliance experience, the ground condition at the proposed water tank, situated approximately 400m north from the geotechnical investigation locations, would not be much dissimilar to ground conditions presented in Sections 4.2 and 4.3 within this report. The footing recommendations within this section can be applicable for the footing design of the groundwater tank given that the actual ground condition is verified and confirmed at the construction stage by a suitable geotechnical engineer. In addition, should the encountered ground conditions be different to the findings of this geotechnical investigation, the project geotechnical engineer should be informed prior to advancing the construction works.

All footing excavations are required to be cleaned of any loose or disturbed material and any water immediately prior to placing the concrete. Geotechnical inspection should be undertaken during pile boring or shallow footing excavation. An experienced geotechnical engineer or engineering geologist should be on site to confirm the design embedment depth and the assumptions made in this report regarding the subsoil conditions. The base of footing should be free of soft, loose, wet, or disturbed soils.

6.6 Preliminary Slope Stability Assessment

A preliminary slope risk hazards assessment has been carried out by Alliance geotechnical engineer during the geotechnical investigation. Given that the proposed structures on each lot are located at valley floors, it is expected that the geotechnical hazards for the exiting surface conditions to be low to very low, the risk to property to be low, and the risk to of injury or loss of life to be acceptable.

7 Limitations

Alliance Geotechnical Pty Ltd (Alliance) has prepared this report for the site, in accordance with Alliance's fee proposal and Terms of Engagement. This geotechnical report has been prepared for the client for this project and for the purposes outlined in this report. This report cannot be relied on for other projects, other parties on this site or any other site.

The comments and recommendations provided in this report are provided based on limited investigation. The borehole investigation and testing results provided in this report are indicative of the subsurface conditions at the site only at the specific sampling and testing locations, and to the depths drilled at the time of the

investigation. Subsurface conditions can change significantly due to geological and human processes. Where variations in conditions are encountered further geotechnical advice should be sought from Alliance.

APPENDIX A – Selected Site Photographs

Photo 1 – Granodiorite Boulders Observed at the Northwest Section of the Site

Photo 2 – General Site Conditions Looking Northeast

Photo 3 - Drilling and DCP Test Set Up at Borehole BH05 Looking Southwest

Photo 4 - SPT Split Spoon Samples at BH04, 1m (N=10)

APPENDIX B – Geotechnical Investigation Plan

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Site Plan Scale 1:780 on A3

Client Name :	Kosciuszko Thredbo Pty Ltd	Drawing Number :	14871-GR-1-A
Project Name :	Thredbo Golf Course Subdivision Development	Drawing Date :	12/05/2022
Project Location	Thredbo Golf Course, 2/4 Crackenback Drive, Thredbo NSW	Report Number :	14871-GR-1-1

N 0 20 Meters

APPENDIX C – Explanatory Notes, Borehole Logs with Core Box Photos, & Dynamic Cone Penetrometer Test Report

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Explanatory Notes
Drill & Excavation Logs

General

Information obtained from site investigations is recorded on log sheets. Soils and very low strength rock are commonly drilled using a combination of solid-flight augers with a Tungsten-Carbide (TC) bit. Descriptions of these materials presented on the “Borehole Log” are based on a combination of regular sampling and in-situ testing. Rock coring techniques commences once material is encountered that cannot be penetrated using a combination of solid-flight augers and Tungsten-carbide bit. The "Cored Borehole Log" presents data from drilling where a core barrel has been used to recover material - commonly rock.

The "Excavation – Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits or trenches.

The heading of the log sheets contains information on Project Identification, Hole or Test Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The scale is presented in the depth column as metres below ground level.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is included in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures, and geological unit. Material description and classifications are based on Australian Standard Geotechnical Site Investigations: AS 1726 - 2017 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

Drilling

Drilling, Casing and Excavating

Drilling methods deployed are abbreviated as follows

Abbreviation	Method
AS	Auger Screwing
ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
BH	Backhoe
E	Excavator
HA	Hand Auger
HQ	HQ core barrel (~63.5 mm diameter core) *
HMLC	HMLC core barrel (~63.5 mm diameter core) *
NMLC	NMLC core barrel (~51.9 mm diameter core) *
NQ	NQ core barrel (~47.6 mm diameter core) *
RR	Rock Roller
WB	Wash-bore drilling

* Core diameters are approximate and vary due to the strength of material being drilled.

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage. It is introduced to assist with the drill process, in particular, when core drilling. The introduction of drill fluid/water does not allow for accurate identification of water seepages.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

Abbreviation	Description
VE	Very Easy
E	Easy
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

Groundwater inflow water level

Samples/Tests

Samples collected and testing undertaken are abbreviated as follows

Abbreviation	Test
ES	Environmental Sample
DS	Disturbed Sample
BS	Bulk Sample
U50	Undisturbed (50 mm diameter)
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (*sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Device
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test
HB	Hammer Bouncing

Excavation Logs

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added. Photos are recommended.

Material Description – Soil

Material Description - In accordance with AS 1726-2017

Classification Symbol - In accordance with the Unified Classification System (AS 1726-2017).

Abbreviation	Typical Name
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
SM	Silty sand, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity. *
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts.
CH	Inorganic clays of high plasticity, fat clays.
OH	Organic clays of medium to high plasticity, organic silts. *
Pt	Peat and other highly organic soils. *

* Additional details may be provided in accordance with the Von Post classification system (1922).

Organic Soils – Identification using laboratory testing:

Material	Organic Content - % of dry mass
Inorganic	<2
Organic Soil	<2 ≤ 25
Peat	> 25

Organic Soils – Descriptive terms for the degree of decomposition of peat:

Term	Decomposition	Remains	Squeeze
Fibrous	Little or none	Clearly recognizable	Only water No solid
Pseudo-fibrous	Moderate	Mixture of fibrous and amorphous	Turbid water < 50% solids
Amorphous	Full	Not recognizable	Paste > 50% solids

Particle Characteristics – Definitions are as follows:

Fraction	Component (& subdivision)		Size (mm)
Oversize	Boulders		> 200
	Cobbles		> 63 ≤ 200
Coarse grained soils	Gravel	Coarse	> 19 ≤ 63
		Medium	> 6.7 ≤ 19
		Fine	> 2.36 ≤ 6.7
	Sand	Coarse	> 0.6 ≤ 2.36
		Medium	> 0.2 ≤ 0.6
		Fine	> 0.075 ≤ 0.21
Fine grained soils	Silt		0.002 ≤ 0.075
	Clay		< 0.002

Secondary and minor soil components

In coarse grained soils – The proportions of secondary and minor components are generally estimated from a visual and tactile assessment of the soils. Descriptions for secondary and minor soil components in coarse grained soils are as follows.

Designation of components	Percentage fines	Terminology (as applicable)	Percentage accessory coarse fraction	Terminology (as applicable)
Minor	≤ 5	Trace clay / silt	≤ 5	Trace sand / gravel
	> 5 ≤12	With clay / silt	> 5 ≤12	With sand / gravel
Secondary	> 12	Silty or clayey	> 30	Sandy or gravelly

Descriptions for secondary and minor soil components in fine grained soils are as follows.

Designation of components	Percentage coarse grained soils	Terminology (as applicable)
Minor	≤ 5	Trace sand / gravel / silt / clay
	> 5 ≤12	With sand / gravel / silt / clay
Secondary	> 30	Sandy / gravelly / silty / clayey

Plasticity Terms - Definitions for fine grained soils are as follows:

Descriptive Term	Range of Liquid Limit for silt	Range of Liquid Limit for clay
Low Plasticity	≤ 50	≤ 35
Medium Plasticity	N/A	> 35 ≤50
High Plasticity	> 50	> 50

Particle Characteristics

Particle shape and angularity are estimated from a visual assessment of coarse-grained soil particle characteristics. Terminology used includes the following:

Particle shape – spherical, platy, elongated,

Particle angularity – angular, sub-angular, sub-rounded, rounded.

Moisture Condition – Abbreviations are as follows:

D	Dry, looks and feels dry.
M	Moist, No free water on remoulding.
W	Wet, free water on remoulding.

Moisture content of fine-grained soils is based on judgement of the soils moisture content relative to the plastic and liquid limit as follows:

MC < PL	Moist, dry of plastic limit.
MC ≈ PL	Moist, near plastic limit.
MC > PL	Moist, wet of plastic limit.
MC ≈ LL	Wet, near liquid limit.
MC > LL	Wet of liquid limit.

Consistency - of cohesive soils in accordance with AS 1726-2017, Table 11 are abbreviated as follows:

Consistency Term	Abbreviation	Indicative Undrained Shear Strength Range (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
Friable	**Fr**	-

Density Index (%) of granular soils is estimated or is based on SPT results. Abbreviations are as follows:

Description	Abbreviation	Relative Density	SPT N
Very Loose	**VL**	< 15%	0 - 4
Loose	**L**	15 - 35%	4 - 10
Medium Dense	**MD**	35 - 65%	10 - 30
Dense	**D**	65 - 85%	30 - 50
Very Dense	**VD**	> 85%	> 50

Structures – Fissuring and other defects are described in accordance with AS 1726-2017 using the terminology for rock defects

Origin – Where practicable an assessment is provided of the probable origin of the soil, e.g. fill, topsoil, alluvium, colluvium, residual soil.

MATERIAL DESCRIPTION - ROCK

Material Description – In accordance with AS 1726-2017

Rock Naming – Where possible conventional geological names are used within the logs. Engineering properties cannot be inferred directly from the rock names in the table, but the use of a particular name provides an indicative range of characteristics to the reader. Lithological identification of rock is provided to appreciate the geology of an area, to correlate geological profiles seen in boreholes or to distinguish boulders from bedrock.

Grain Size – Grain size is done in accordance with AS1726-2017 as follows:

For sedimentary rock:

Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mmto 0.6mm
Fine grained	Mainly 0.06mm to 0.2mm

For igneous and metamorphic rock:

Coarse grained	Mainly greater than 2 mm
Medium grained	Mainly 0.6mm to 2mm
Fine grained	Mainly less than 2mm

Colour - Rock colour is described in the moist condition.

Texture and Fabric

Frequently used terms:

Sedimentary Rock	Metamorphic Rock	Igneous
Bedded	Banded	Amorphous
Cross-bedded	Cleaved	Crystalline
Folded	Folded	Flow banded
Graded	Foliated	Folded
Interbedded	Gneissose	Lineated
Laminated	Lineated	Massive
Massive	Schistose	Porphyritic

Bedding and fabric:

Description	Spacing
Very Thickly Bedded	> 2m
Thickly Bedded	0.6m to 2m
Medium Bedded	0.2m to 0.6m
Thinly Bedded	60mm to 200mm
Very Thinly Bedded	20mm to 60mm
Thickly Laminated	6mm to 20mm
Thinly Laminated	< 6mm

Degree of development:

Massive	No layering or fabric. Rock is homogeneous.
Indistinct	Layering or fabric just visible, There is little effect on strength properties.
Distinct	Layering or fabric obvious. The rock may break more easily parallel to the fabric.

Features, inclusions, and minor components - Features, inclusions and minor components within the rock material shall be described where those features could be significant such as gas bubbles, mineral veins, carbonaceous material, salts, swelling minerals, mineral inclusions, ironstone or carbonate bands, cross-stratification, or minerals the readily oxidise upon atmospheric exposure.

Moisture content - Where possible descriptions are made by the feel and appearance of the rock using one according to following terms:

Dry	Looks and feels dry.
Moist	Feels cool, darkened in colour, but no water is visible on the surface.
Wet	Feels cool, darkened in colour, water film or droplets visible on the surface.

The moisture content of rock cored with water may not be representative of its in-situ condition.

Durability – Descriptions of the materials durability such as tendency to develop cracks, break into smaller pieces or disintegrate upon exposure to air or in contact with water are provided where observed.

Rock Material Strength – The strength of the rock material is based on uniaxial compressive strength (UCS). The following terms are used:

Term / Abbreviation		Description	UCS (MPa)	Point Load Strength Index (MPa)
Very Low	**VL**	Crumbles under firm blow with sharp end of pick, can be peeled with a knife; too hard to cut a triaxial by hand; 30mm pieces can be broken by hand.	0.6 – 2	0.03 – 0.1
Low	**L**	Easily scored with a knifed; indentations 1-3mm show with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	2 – 6	0.1 – 0.3
Medium	**M**	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.	6 – 20	0.3 – 1
High	**H**	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.	20 – 60	1 – 3
Very High	**VH**	Hand specimen breaks with pick after more than one blow; rock rings under hammer.	60 – 200	3 – 10
Extremely High	**EH**	Specimen requires many blows with geological pick to break into intact materials; rock rings under hammer.	> 200	> 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical logs as follows:

D	Diametral Point Load Test
A	Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown. Point Load Strength Index test results are presented as $I_{s\,(50)}$ values in MPa.

Weathering – Weathering classification assists in identification but does not imply engineering properties. Descriptions are as follows:

Term / Abbreviation		Description
Residual Soil	**RS**	Material has soil properties. Mass structure and material texture and fabric of original rock not visible, but the soil has not been significantly transported.
Extremely Weathered	**EW**	Material has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Highly Weathered	**HW**	Material is completely discoloured, significant decrease in strength from fresh rock.
Moderately Weathered	**MW**	Material is `completely discoloured, little or no change of strength from fresh rock.
Slightly Weathered	**SW**	Partly stained or discoloured, little or no change to strength from fresh rock.
Fresh	**FR**	No signs of mineral decomposition or colour change.

Alteration – Physical and chemical changes of the rock material due to geological processes by fluids at depth at pressures and temperatures above atmospheric conditions. Unlike weathering, alteration shows no relationship to topography and may occur at any depth. When altered materials are recognized, the following terms are used:

Term / Abbreviation				Description
Extremely Altered		**XA**		Material has soil properties. Structure, texture, and fabric of original rock are still visible. The rock name is replaced with the name of the parent material, e.g., Extremely Altered basalt. Soil descriptive terms are used.
Highly Altered	**Distinctly altered**	**HA**	**DA**	The whole of the rock material is discoloured. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be higher or lower due to loss of minerals or precipitation of secondary minerals in pores.
Moderately Altered	**Distinctly altered**	**MA**	**DA**	The whole of the rock material is discoloured. Little or no change of strength from fresh rock. The term 'Distinctly Altered' is used where it is not practicable to distinguish between 'Highly Altered' and 'Moderately Altered'. Distinctly Altered is defined as follows: - The rock may be highly discoloured; - Porosity may be higher due to mineral loss; or may be lower due to precipitation of secondary minerals in pores; and - Some change of rock strength.
Slightly Altered		**S**		Rock is slightly discoloured. Little or no change of strength from fresh rock.

Alteration is only described in the context of the project where it has relevance to the civil and structural design.

Defect Descriptions

General and Detailed Descriptions – Defect descriptions are provided to suit project requirements. Generalized descriptions are used for some projects where it is unnecessary to describe each individual defect in a rock mass, or where multiple similar defects are present which are too numerous to log individually. The part of the rock mass to which this applies is delineated.

Detailed descriptions are given of defects judged to be particularly significant in the context of the project. For example, crushed seams in an apparently unstable slope. As a minimum, general descriptions outlining the number of defect sets within the rock mass and their broad characteristics are provided where it is possible to do so.

Defect Type – Defect abbreviations are as follows:

BP	Bedding parting	**SSM**	Sheared seam	**DB**	Drilling break
JT	Joint	**CS**	Crushed seam	**HB**	Handling break
SS	Shear surface	**SM**	Infilled seam		
SZ	Sheared zone	**EWS**	Extremely weathered seam		

Sheared surfaces, sheared zones, sheared seams, and crushed seams are generally faults in geological terms.

Defect Orientation

For oriented core: The dip and dip direction are recorded as a two-digit and three-digit number separated by a slash, are collected e.g., 50°/240° and there is not core loss that could obscure core orientation. If alternative measurements are made, such as dip and strike or dip direction relative to magnetic north this shall be documented.

For non-oriented core: The dip is recorded as a two-digit number, e.g., 10°. In vertical boreholes the dip is generally measured relative to the horizontal plan. If the borehole is inclined the dip is generally measured from the core axis.

Surface Roughness – Defect surface roughness is described as follows:

VR	**Very rough**	Many large surface irregularities with amplitude generally more than 1 mm.
RO	**Rough**	Many small surface irregularities with amplitude generally less than 1 mm.
SO	**Smooth**	Smooth to touch. Few or no surface irregularities.
PO	**Polished**	Shiny smooth surface
SK	**Slickensided**	Grooved or striated surface, usually polished.

Surface Shape – Defect surface roughness is described as follows:

PL	**Planar**	The defect does not vary in orientation.
CU	**Curved**	The defect has a gradual change in orientation
UN	**Undulating**	The defect has a wavy surface.
ST	**Stepped**	The defect has one or more well defined steps
IR	**Irregular**	The defect has many sharp changes of orientation

Defect Infilling – Common abbreviation as follows:

Ca	Calcite	**Fe**	Iron Oxide	**Qz**	Quartz
Cy	Clay	**MS**	Secondary mineral	**X**	Carbonaceous

Defect Coatings and Seam Composition - Coatings are described using the following terms:

CN	**Clean**	No visible coating.
SN	**Stained**	No visible coating but surfaces are discoloured.
VN	**Veneered**	A visible coating of soil or mineral, too thin to measure; may ne patchy.
CO	**Coating**	A visible coating up to 1 mm thick. Soil in-fill greater than 1 mm shall be described using defect terms (e.g., infilled seam). Defects greater than 1 mm aperture containing rock material great described as a vein.

Defect Spacing, Length, Openness and Thickness – Described directly in millimetres and metres. In general descriptions, half order of magnitude categories is used, e.g. joint spacing typically 100 mm to 300 mm, sheared zones 1m to 3m thick.

Depending on project requirements and the scale of observation, spacing may be described as the mean spacing within a set of defects, or as the spacing between all defects within the rock mass. Where spacing is measured within a specific set of defects, measurements shall be made perpendicular to the defect set.

Where significant, the nature of the defect end condition is recorded in the context of the scale of the exposure.

Block Shape – Where it is considered significant, block shape should be described using terms given in Table 23, AS 1725:2017.

Stratigraphic Unit – Geological maps related to the project are used for the designation of lithological formation name and, where possible geological unit name, e.g., Bringelly Shale, Potts Hill Sandstone Member.

Core Loss – Core loss occurs when material is lost during the drilling process It is shown at the bottom of the run unless otherwise indicated where core loss is known.

Total Core Recovery – The percentage of rock recovered excluding core loss per core run.

Defect Spacing – The spacing of successive defects or the mean spacing for relatively broken core.

Fracture Index – Which is the number defects per metre of core.

Rock Quality Designation (RQD) – The percentage of sound core pieces of 100mm or greater per core run and is calculated using Deere et al. (1989) method.

Rock Classification System – For design purpose, Sydney Rock Mass Classification System (Pells et al. 1998, 2019) is adopted.

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BH No: BH01
Sheet: 1 of 1
Job No: 14871

Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Started: 27/04/2022
Project: Thredbo Golf Course Subdivision
Finished: 27/04/2022
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A **Borehole Size:** 110 mm
Rig Type: GEMCO 210B **Hole Coordinates** 616227E, 5958982N **Driller:** JB **Logged:** KN
RL Surface: 1382.6m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater not encountered.	1382.5			--	FILL: Clayey SILT, low plasticity, dark grey, trace fine to medium grained sand. Appears moderately to well compacted.		MC ~ PL	--	FILL
		1382.0	0.5		SP	Extremely weathered granodiorite recovered as Gravelly SAND, fine to medium grained, poorly graded, orange brown, fine to medium subangular and angular gravel, with clay.		M	MD - D	EXTREMELY WEATHERED ("FULLY DECOMPOSED") GRANODIORITE.
		1381.5	1.0				DS: 1.0m - 1.5m			
		1381.0	1.5			TC-bit refusal on inferred granodiorite boulder. Borehole BH01 terminated at 1.6m				
		1380.5	2.0							
		1380.0	2.5							
		1379.5	3.0							
		1379.0	3.5							
		1378.5	4.0							
		1378.0	4.5							
			5.0							

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BH No: BH02
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Job No: 14871

Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Started: 27/04/2022
Project: Thredbo Golf Course Subdivision
Finished: 27/04/2022
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A **Borehole Size:** 110 mm
Rig Type: GEMCO 210B **Hole Coordinates** 616194E, 5958952N **Driller:** JB **Logged:** KN
RL Surface: 1386.1m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater not encountered.	1386.0	0.5		--	FILL: Clayey SILT, low plasticity, dark grey, trace fine to medium grained sand. Appears moderately to well compacted.		MC ~ PL	--	FILL
		1385.5			SP	Extremely weathered granodiorite recovered as Gravelly SAND, fine to medium grained, poorly graded, orange brown, fine to medium subangular and angular gravel, with clay.		M	(MD - D)	EXTREMELY WEATHERED ("FULLY DECOMPOSED") GRANODIORITE.
		1385.0	1.0				DS: 1.0m - 1.4m			
		1384.5	1.5			TC-bit refusal on inferred granodiorite boulder. Borehole BH02 terminated at 1.4m				
		1384.0	2.0							
		1383.5	2.5							
		1383.0	3.0							
		1382.5	3.5							
		1382.0	4.0							
		1381.5	4.5							
			5.0							

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Job No: 14871

Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Project: Thredbo Golf Course Subdivision
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A

Started: 27/04/2022
Finished: 27/04/2022
Borehole Size: 110 mm

Rig Type: GEMCO 210B **Hole Coordinates** 616133E, 5958932N **Driller:** JB **Logged:** KN
RL Surface: 1388.2m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater not encountered.	1388.0	0.5		- -	FILL: Clayey SILT, low plasticity, dark grey, trace fine to medium grained sand.		MC > PL	- -	FILL
		1387.5	1.0		CL-CI	Silty CLAY, low to medium plasticity, orange brown, with fine subangular gravel, trace fine to medium grained sand.			F - St	COLLUVIUM
		1387.0					SPT 2, 3, 2 N=5 *			
		1386.5	1.5				U50: 1.5m - 1.7m			
		1386.0	2.0		SC	Clayey SAND, fine to medium grained, poorly graded, orange brown, with fine to medium angular gravel.	SPT 11, 16, 16 N=32 *	M	MD - D	Possibly RESIDUAL
		1385.5	2.5			Borehole BH03 continued as cored hole				
		1385.0	3.0							
		1384.5	3.5							
		1384.0	4.0							
		1383.5	4.5							
			5.0							

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Cored Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Started: 27/04/2022
Project: Thredbo Golf Course Subdivision
Finished: 27/04/2022
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A **Borehole Size:** 110 mm
Rig Type: GEMCO 210B **Hole Coordinates** 616133E, 5958932N **Driller:** JB **Logged:** KN
RL Surface: 1388.2m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (●- Axial O- Diametral) EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	$Is_{(50)}$ MPa D- diametral A- axial	RQD %	Defect Spacing mm 30 100 300 1000 3000	Additional Data
		1388.0	0.5								
		1387.5	1.0								
		1387.0	1.5								
		1386.5	2.0								
		1386.0			Continued from non-cored borehole						
NMLC	40% - 50% water lost.	1385.5	2.5	+ + + + + +	GRANODIORITE, coarse grained, dark grey, brown yellow, and pale grey, crystalline, flow banded at 50°.	FR EW/HW	●	D 0.97 A 2.58	< 13		2.6m - JT, 0°, PL, VR, CN 2.62m - JT, 0°, PL, VR, CN 2.64m - JT, 90°, PL, VR, CN 2.65m - JT, 0°, PL, VR, CN 2.65m-2.80m - EWS, VR, Gravelly SAND
		1385.0	3.0		No core, 1.15m.						
		1384.5	3.5								
		1384.0	4.0		Target Depth. BH03 terminated at 4m						End of BH03.
		1383.5	4.5								
			5.0								

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BH No: BH04
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Job No: 14871

Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Project: Thredbo Golf Course Subdivision
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A
Started: 27/04/2022
Finished: 27/04/2022
Borehole Size: 110 mm

Rig Type: GEMCO 210B **Hole Coordinates** 616133E, 5958903N **Driller:** JB **Logged:** KN
RL Surface: 1388.1m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater not encountered.	1388.0			--	FILL: Clayey SILT, low plasticity, dark grey, trace fine to medium grained sand.		MC > PL	--	FILL
					CL-CI	CLAY, low to medium plasticity, brown orange, trace fine to medium subangular gravel.			St	COLLUVIUM
		1387.5	0.5			At 0.5m: Becoming with fine to medium subangular gravel.	U50: 0.5m - 0.7m			
		1387.0	1.0				SPT 2, 4, 6 N=10 *			
		1386.5	1.5		CL-CI	Gravelly CLAY, low to medium plasticity, orange brown, fine to medium angular gravel, trace fine to medium grained sand.	DS: 1.5m - 1.9m			
		1386.0	2.0			TC-bit refusal on inferred granodiorite boulder. Borehole BH04 terminated at 1.9m				
		1385.5	2.5							
		1385.0	3.0							
		1384.5	3.5							
		1384.0	4.0							
		1383.5	4.5							
			5.0							

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Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Project: Thredbo Golf Course Subdivision
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A
Started: 27/04/2022
Finished: 27/04/2022
Borehole Size: 110 mm

Rig Type: GEMCO 210B **Hole Coordinates** 616010E, 5958864N **Driller:** JB **Logged:** KN
RL Surface: 1391.2m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Groundwater not encountered.	1391.0	0.0		- -	FILL: Clayey SILT, low plasticity, dark grey, trace fine to medium grained sand,		MC >= PL	- -	FILL
					CL-CI	Silty CLAY, low to medium plasticity, dark brown, trace fine to medium grained sand.		MC ~ PL	St	COLLUVIUM
		1390.5	0.5		CI	Gravelly CLAY, low plasticity, brown mottled pale brown, fine to medium subangular gravel, trace fine to medium grained sand.	DS: 0.5m - 1.0m	MC >= PL		
		1390.0	1.0				SPT 1, 7, 8/130mm *			
		1389.5	1.5			Borehole BH05 continued as cored hole				
		1389.0	2.0							
		1388.5	2.5							
		1388.0	3.0							
		1387.5	3.5							
		1387.0	4.0							
		1386.5	4.5							
			5.0							

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Cored Borehole Log

Alliance Geotechnical Pty Ltd
T: 02 9675 1777
F: 02 9675 1888
E: office@allgeo.com.au
W: www.allgeo.com.au

Client: Kosciuzko Thredbo Pty Ltd
Project: Thredbo Golf Course Subdivision
Location: 2/4 Crackenback Drive, Thredbo NSW 2625
Hole Location: Refer to Drawing 14871-GR-1-A
Started: 27/04/2022
Finished: 27/04/2022
Borehole Size: 110 mm

Rig Type: GEMCO 210B
Hole Coordinates 616010E, 5958864N
Driller: JB
Logged: KN
RL Surface: 1391.2m
Contractor: GE Drilling
Bearing: ---
Checked: AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (● - Axial, O - Diametral; EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	Is(50) MPa (D- diametral, A- axial)	RQD %	Defect Spacing mm (30, 100, 300, 1000, 3000)	Additional Data
		1391.0									
			0.5								
		1390.5									
			1.0								
		1390.0									
			1.5								
					Continued from non-cored borehole						
NMLC	40% - 50% water lost.	1389.5		+ +	GRANODIORITE, coarse grained, dark grey, brown yellow, and pale grey, crystalline, flow banded at 30°.	MW/SW		D 0.61, A 1.5			1.75m - Flow band parting, 30°, PL, RO, CN
											1.84m - JT, 0°, PL, RO, CN
											1.86m - Flow band parting, 30°, PL, RO, CN
											1.87m - Flow band parting, 30°, PL, RO, CN
											1.90m - Flow band parting, 30°, PL, RO, CN
											1.95m - JT, 0°, PL, RO, CN
			2.0		At 2.0m: Quartz clast, 20mm.				10		2.00m-2.33m - JT, 90°, CU, VR, CO, Cy
		1389.0									
					No core, 0.27m.						
			2.5								
		1388.5			Target Depth. BH05 terminated at 2.6m						End of BH05.
			3.0								
		1388.0									
			3.5								
		1387.5									
			4.0								
		1387.0									
			4.5								
		1386.5									
			5.0								

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Alliance Geotechnical Pty Ltd
T: 1800 288 188
E: office@allgeo.com.au
W: www.allgeo.com.au

BH No: BH06
PAGE 1 OF 2
Job No: 14871

Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Started: 27/04/2022
Project: Thredbo Golf Course Subdivision
Finished: 27/04/2022
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A **Borehole Size:** 110 mm
Rig Type: GEMCO 210B **Hole Coordinates** 616142E, 5958868N **Driller:** JB **Logged:** KN
RL Surface: 1386.3m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	Not encountered	1386.0	0.0		--	FILL: Silty CLAY, low to medium plasticity, dark brown, trace fine to medium grained sand and fine subangular gravel.		MC ~ PL	--	FILL
					CI-CH	CLAY, medium plasticity, dark orange, with silt, trace medium subangular gravek and fine to medium grained sand.			St	COLLUVIUM
		1385.5	0.5							
			1.0		CL-CI	CLAY, low to medium plasticity, dark orange, with silt and fine subagular gravel, trace sand	SPT 6, 10, 4 N=14 *			
		1385.0				Between 1.3m and 1.4m: Trace medium to coarse subangular granodiorite fragments.				
			1.5		CL-CI	Gravelly CLAY, low to medium plasticity, orange brown, fine to medium angular gravel, trace fine to medium grained sand.	U50: 1.5m - 1.7m			
		1384.5			--	GRANODIORITE, coarse grained, dark grey, grey, and pale grey, crystalline, low strength, highly weathered.		--	--	GRANODIORITE BOULDER
			2.0			Borehole BH06 continued as cored hole				
		1384.0								
			2.5							
		1383.5								
			3.0							
		1383.0								
			3.5							
		1382.5								
			4.0							
		1382.0								
			4.5							
		1381.5								
			5.0							

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Alliance Geotechnical Pty Ltd
T: 02 9675 1777
F: 02 9675 1888
E: office@allgeo.com.au
W: www.allgeo.com.au

Cored Borehole Log

Client: Kosciuzko Thredbo Pty Ltd
Started: 27/04/2022
Project: Thredbo Golf Course Subdivision
Finished: 27/04/2022
Location: 2/4 Crackenback Drive, Thredbo NSW 2625 **Hole Location:** Refer to Drawing 14871-GR-1-A **Borehole Size:** 110 mm
Rig Type: GEMCO 210B **Hole Coordinates** 616142E, 5958868N **Driller:** JB **Logged:** KN
RL Surface: 1386.3m **Contractor:** GE Drilling **Bearing:** --- **Checked:** AS/MAG

Method	Water	RL (m)	Depth (m)	Graphic Log	Material Description	Weathering	Estimated Strength (●- Axial O- Diametral) EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	$Is_{(50)}$ MPa D- diam-etral A- axial	RQD %	Defect Spacing mm 30 100 300 1000 3000	Additional Data
		1386.0	0.5								
		1385.5	1.0								
		1385.0	1.5								
		1384.5			Continued from non-cored borehole						
NMLC	40% - 50% water lost.		2.0		GRANODIORITE, coarse grained, dark grey, grey, and pale grey, crystalline, flow banded at 0°.	SW					2.00m - JT, 0°, PL, RO, CN
		1384.0			At 2.20m: Becoming dark grey, brown yellow, and pale grey, flow banded at 45°.			D 1.65 A 3.55			2.30m - Flow band parting, 45°, PL, RO, CN 2.35m - Flow band parting, 45°, PL, RO, CN
			2.5			MW/SW					
		1383.5			No core, 2.08m.						2.55m - JT, 0°, PL, RO, CN 2.58m - Flow band parting, 45°, PL, RO, CN 2.60m - EWS, 45°, PL, VR, Sandy GRAVEL 2.60m-2.85m - JT, 60°, UN, VR, VN, Cy
			3.0								
		1383.0									
			3.5								
		1382.5							18		
			4.0								
		1382.0									
			4.5								
		1381.5									
			5.0		Target Depth. BH06 terminated at 4.9m						End of BH06.

Core Box Photo – Borehole BH03 – Box 1/

Client Name	Thredbo Kosciuszko Pty Ltd	Photo Number	–
Project Name	Thredbo Golf Course Subdivison	Photo Date	27 April 2021
Project Location	2/4 Crackenback Drive, Thredbo NSW	Report Number	14871-GR-1-1

Core Box Photo – Borehole BH05 – Box 1/1

Client Name	Thredbo Kosciuszko Pty Ltd	Photo Number	–
Project Name	Thredbo Golf Course Subdivison	Photo Date	27 April 2021
Project Location	2/4 Crackenback Drive, Thredbo NSW	Report Number	14871-GR-1-1

Core Box Photo – Borehole BH06 – Box 1/1

Client Name	Thredbo Kosciuszko Pty Ltd	Photo Number	–
Project Name	Thredbo Golf Course Subdivison	Photo Date	27 April 2021
Project Location	2/4 Crackenback Drive, Thredbo NSW	Report Number	14871-GR-1-1

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Phone: 1800 288 188
Email: office@allgeo.com.au
Website: www.allgeo.com.au

Dynamic Cone Penetrometer (DCP) Test Report

Client	Kosciuszko Thredbo Pty Ltd	**Report Number**	14871-GR-1-1
Project Name	Thredbo Golf Course Subdivision	**Project Number**	14871
Project Location	2-4 Crackenback Drive, Thredbo NSW	**Date Tested**	27 April 2022
Test Method	AS 1289.6.3.2		

Test Number	**DCP01**	**DCP02**	**DCP03**	**DCP04**	**DCP05**	**DCP06**
Test Location	Refer to Drawing 14871-GR-1-A					
Surface Material	FILL: Clayey SILT	FILL: Clayey SILT	FILL: Clayey SILT	FILL: Sandy Clayey SILT	FILL: Clayey SILT	FILL: Silty CLAY
Surface Condition	MC ≥ PL	MC ≥ PL	MC > PL	MC >PL	MC ≥ PL	MC ~ PL
Approximated RL (m AHD)	1382.6	1386.1	1388.2	1388.1	1391.2	1396.3
0.00 – 0.15 m	3	6	5	8	5	4
0.15 – 0.30 m	8	9	5	12	7	9
0.30 – 0.45 m	9	9	7	10	10	9
0.45 – 0.60 m	5	25/100mm	14	10	8	8
0.60 – 0.75 m	19	Refusal	15	3	16	25/100mm
0.75 – 0.90 m	26		10/50mm	7	25/140mm	Hammer Bouncing
0.90 – 1.05 m	27		Refusal	10/20mm	Refusal	
1.05 – 1.20 m	Refusal			Refusal		
1.20 – 1.35 m						

Notes: This test report is intended to be read in conjunction with the geotechnical report by Alliance Geotechnical (ref: 14871-GR-1-1).

APPENDIX D – Undisturbed Samples Photographs and Laboratory Test Certificates

Photo 5 - U50 Sample at BH03, 1.5m-1.7m

Photo 6 - U50 at Borehole BH04, 0.5m-0.7m

Photo 7 - U50 Sample at Borehole BH06, 1.5m-1.7m

Material Test Report

alliance
geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14871-2**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 19108
Sample Number: 22-19108A
Date Sampled: 27/04/2022
Dates Tested: 10/05/2022 - 13/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH03, Depth: 2.0-2.45m**
Material: Gravelly SAND, trace clay, orange brown, fine to medium sub-angular and angular gravel

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

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Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14871-2**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 19108
Sample Number: 22-19108B
Date Sampled: 27/04/2022
Dates Tested: 10/05/2022 - 13/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH04, Depth: 1.5-1.9m**
Material: Gravelly CLAY, medium plasticity, orange brown, with fine to medium angular and subangular gravel

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	46		
Plastic Limit (%)	31		
Plasticity Index (%)	**15**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	7.5		
Cracking Crumbling Curling	Cracking		

Material Test Report

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Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

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WORLD RECOGNISED ACCREDITATION

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14871-2**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 19108
Sample Number: 22-19108C
Date Sampled: 27/04/2022
Dates Tested: 10/05/2022 - 16/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH05 , Depth: 0.5-1.0m**
Material: Gravelly CLAY, low plasticitiy, brown pale brown, fine to medium subanglur granite gravel, trace fine to medium grained sand

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	35		
Plastic Limit (%)	29		
Plasticity Index (%)	**6**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	4.5		
Cracking Crumbling Curling	None		

Material Test Report

Report Number: **14871-2**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 19108
Date Sampled: 27/04/2022
Dates Tested: 10/05/2022 - 10/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Location: 2/4 Crackenback Drive, Thredbo

alliance
geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

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Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Moisture Content AS 1289 2.1.1			
Sample Number	Sample Location	Moisture Content (%)	Material
22-19108C	BH05 , Depth: 0.5-1.0m	12.6 %	Gravelly CLAY, low plasticitiy, brown pale brown, fine to medium subanglur granite gravel, trace fine to medium grained sand
22-19108D	BH02 , Depth: 1.0-1.4m	13.5 %	Gravelly CLAY, low to medium plasticitiy, orange brown, fine to medium subanglur gravel, trace fine to medium grained sand
22-19108E	BH01 , Depth: 1.0-1.5m	12.8 %	Gravelly SAND, trace fine to medium grained sand, with clay

Material Test Report

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Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

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Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14871-1**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 18961
Sample Number: 22-18961C
Date Sampled: 27/04/2022
Dates Tested: 02/05/2022 - 06/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH06 , Depth: 1.5 - 1.7m**
Material: CLAY, medium plasticity, dark orange, with silt, trace medium sub-angular gravel and fine to medium grained sand

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	36		
Plastic Limit (%)	24		
Plasticity Index (%)	**12**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	4.0		
Cracking Crumbling Curling	Cracking		

Material Test Report

Report Number: **14871-1**
Issue Number: 1
Date Issued: 30/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Khue Nguyen
Project Number: 14871
Project Name: Thredbo Golf Course Subdivision
Project Location: 2/4 Crackenback Drive, Thredbo
Work Request: 18961
Date Sampled: 27/04/2022
Dates Tested: 02/05/2022 - 10/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Location: 2/4 Crackenback Drive, Thredbo

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geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

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Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	22-18961A	22-18961B			
Date Sampled	27/04/2022	27/04/2022			
Date Tested	10/05/2022	10/05/2022			
Material Source	Bore Hole	Bore Hole			
Sample Location	BH03 (1.5 - 1.7m)	BH04 (0.5 - 0.7m)			
Inert Material Estimate (%)	4	3			
Pocket Penetrometer before (kPa)	280	200			
Pocket Penetrometer after (kPa)	220	140			
Shrinkage Moisture Content (%)	25.4	20.8			
Shrinkage (%)	**2.4**	**1.8**			
Swell Moisture Content Before (%)	25.3	21.0			
Swell Moisture Content After (%)	26.3	30.5			
Swell (%)	**-0.1**	**-0.1**			
Shrink Swell Index Iss (%)	**1.3**	**1.0**			
Visual Description	CLAY	CLAY			
Cracking	SC	SC			
Crumbling	No	No			
Remarks	Nil	Nil			

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
Cracking Terminology: UC Uncracked, SC Slightly Cracked, MC Moderately Cracked, HC Highly Cracked, FR Fragmented.
NATA Accreditation does not cover the performance of pocket penetrometer readings.