Pacific Geotech
Consulting Geotechnical Engineers

GEOTECHNICAL REPORT: Proposed Residential Development

29 Shirley Street and 2-4 Milton Street

Byron Bay

One Project MGMT Group

July 2022

PG-7463

VERYSION 2

E: info@pacgeo.com.au
www.pacgeo.com.au ABN: 62 615 248 952

Pacific Geotech
Consulting Geotechnical Engineers

Ref: PG-7463, 2022-03-15, GR VER 2
Author: Peter Elkington

27th July 2022

One Project MGMT Group
Email: james@onepmgroup.com

ATTN: JAMES DAVIDSON

Dear Sir,

GEOTECHNICAL INVESTIGATION – PROPOSED RESIDENTIAL DEVELOPMENT
29 SHIRLEY STREET AND 2-4 MILTON STREET, BYRON BAY

Enclosed is a copy of our report for the above project dated July 2022. An electronic copy of the report has been issued.

Should you have any queries regarding this report, please do not hesitate to contact Peter Elkington at this office.

Yours faithfully,

P. ELKINGTON (RPEQ 7226)

For and on behalf of
PACIFIC GEOTECH PTY LTD

TABLE OF CONTENTS

Appendices

1.0 INTRODUCTION

This report contains the results of the geotechnical investigation and provides advice and recommendations relating to the following:

- Subsurface conditions in accordance with AS 1726
- Foundation Recommendations
- Characteristic ground surface movements
- Earthworks considerations
- Earthquake considerations
- Batter slope recommendations
- Retention considerations
- Retaining wall design parameters
- Construction Considerations

Proposed Development

It is understood that the proposed development is to comprise the construction of a three-storey residential building over a single level basement at the above site. Earthworks are envisaged to consist of cuts of up to 3m for the basement.

Building loads are unknown at this stage, but a footprint load in the order of 40kPa is expected.

2.0 METHODOLOGY

The geotechnical investigation comprised the drilling and sampling of 6 boreholes to depths of 6.0m, using a Digga PDT 1 drilling rig and 100mm solid flight augers, across the proposed building and pavement areas. Dynamic Cone Penetrometer (DCP) testing was conducted adjacent to the boreholes.

The soil classification descriptions and field tests were carried out in general accordance with Australian Standards.

AS 1726	Geotechnical Site Investigations
AS 1289	Methods of Testing Soils for Engineering Purposes

Borehole records, Dynamic Cone Penetrometer test results and a site plan showing the test locations are appended to the report.

3.0 SITE DESCRIPTION

The site of the proposed development is located at 29 Shirley Street and 2-4 Milton Street, Byron Bay.

At the time of the investigation, the site was occupied by an existing backpackers accommodation building, with associated car parking, swimming pool, courtyard, gardens and volleyball courts.

Vegetation comprised short grass cover, and medium to large sized trees and shrubs.

The site was generally level and drainage was considered fair to poor but improved by the local stormwater network around the existing structures.

Refer following aerial and site photographs for typical site conditions.

AERIAL IMAGE

SITE PHOTOGRAPHS

4.0 GEOTECHNICAL MODEL

The subsurface profile encountered in the boreholes generally consisted of sand, initially loose but becoming medium dense and dense to the termination of testing

Table 1 presents a summary of the encountered subsurface profile. Detailed borehole record sheets are appended to this report.

TABLE 1 SUBSURFACE PROFILE SUMMARY

BH No.	FILL	NATURAL SAND			BH TD
		Loose	Medium dense	Dense	
BH 01	0.0-2.1	NE	2.1-TD	NE	6.0
BH 02	0.0-0.9	0.9-1.5	1.5-2.2 2.6-TD	2.2-2.6	6.0
BH 03	0.0-1.3	NE	1.3-3.4 3.7-TD	3.4-3.7	6.0
BH 04	0.0-0.05	0.05-1.1	1.1-3.2 3.7-TD	3.2-3.7	6.0
BH 05	0.0-0.5	0.5-2.3	2.3-5.5	5.5-TD	6.0
BH 06	0.0-1.1	NE	1.1-TD	NE	6.0

Notes:
1. All depths in metres below ground level at time of investigation.
2. NE - Not Encountered; TD - Termination Depth.

5.0 GROUNDWATER

Groundwater was noted in the boreholes at depths of between 2.1m and 3.2m at the time of drilling in the boreholes. Water levels can be expected to vary with seasonal and climatic conditions.

Typically the groundwater levels in the area are encountered at levels of approximately RL 0.5m to RL 1.0m. Fluctuations of +/- 0.5m are typically noted in the area.

Increases in the groundwater levels often occur following significant rainfall events (floods) with the groundwater levels to as much as RL 1.5m to RL 2.0m being noted in the area.

6.0 SITE CLASSIFICATION

The investigation and laboratory test results indicate that the development site would be classified Class 'S', slightly reactive, in accordance with AS 2870-2011 'Residential Slabs and Footings'. This is not recommended for structural purposes but is suitable for hydraulic design purposes.

7.0 EARTHWORKS AND SITE PREPARATION CONSIDERATIONS

Earthworks are expected to comprise of cuts of up to 3m. Some over-excavation may be required to allow for ground improvement works beyond the basement level.

It is recommended that the following site preparation and earthworks procedures be carried out as part of the earthworks procedures during development.

- All earthworks operations should be carried out in general accordance with AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".
- Trafficability across the site at the time of the investigation was assessed to be fair to good with no difficulties encountered beyond the existing structures at the time of the investigation. Following stripping and excavation for the basement, the exposed sands will be difficult to traffic for conventional vehicles. Consideration could be given to adopting a 150mm layer of pavement gravel as a working platform across the site.
- All topsoil (i.e. soil containing organic matter) and soils containing deleterious matter should be stripped from the construction area at the commencement of the earthworks operation. Dirty sands (i.e. >5% fine content) could be difficult to manage and consideration could be given to the disposal of this material.
- The stripped surface should be proof rolled using a vibrating roller or a large vibrating plate compactor (say 300kg), to identify areas of weak surficial soils and to compact the upper level material.
- The "clean" sands on site will be suitable for re-use as structural fill, provided material is free of organic matter and deleterious material. The silty sand may prove difficult to re-use and consideration should be given to preferential disposal of this material.
- Imported fill should be of fair to good quality with a minimum Soaked CBR value of 10%, a maximum lss=1.0% and a maximum particle size of 75mm, or a clean sand.
- All filling should be undertaken in layer thicknesses of approximately 250mm (or as appropriate for the compaction equipment being used). Fill should be compacted to a minimum dry density ratio of 98% Standard in accordance with AS1289 5.1.1 for cohesive fill and 75% Density Index for non-cohesive fill (i.e. sand).
- Field density testing should be carried out to check the standard of compaction achieved and the placement moisture content. The frequency and extent of testing should be as per guidelines in AS.3798-2007.

8.0 EARTHQUAKE CONSIDERATIONS

The design should consider the effects of an earthquake on the founding soils, as outlined in AS.1170.4-2007, Part 4.

Liquefaction occurs as a result of pore pressures increasing and reducing the effective stress to zero with consequent loss of strength.

The likelihood of liquefaction for an earthquake can be related to sand density. For an acceleration of 0.08g, the following assessments as shown in Table 2 have been made.

TABLE 2

Liquefaction Potential	Density Index (%)
Very Likely	<35 (very loose to loose)
Likely	35 – 54 (medium dense)
Unlikely	>64 (medium dense to very dense)

Testing results indicated that sands that are likely to undergo liquefaction extended to depths in the order of 3m. These materials will require removal, or recompaction, as part of the foundation improvement works and therefore all sands likely to undergo liquefaction will be removed from site during construction.

Reference to Section 4.2 in AS1170.4-2007, it is recommended that a site classification of "Class Ce – shallow soil site" be adopted, in accordance with the definitions presented in "Section 4.2 – Class Definitions".

9.0 BATTERS – SHORT TERM EXCAVATION PROFILE

It is understood that cut batters to 3m in height will be required as part of the basement construction.

Considering the proposed maximum height of cut, the following recommendations are made for the bulk excavation of the site.

Batters < 2.0m in height

- 1V:1.5H batter with crest of batter >2m from buildings or structures.

Batters > 2.0m in height

- 1V:1.5H batter with the crest of the batter at least 2.0m inside the site boundary.
- 2.0m minimum distance from any building or structure.

If batters are to be left exposed for an extended period of time, a battler angle of 1V:2H is recommended and berm widths are to be strictly maintained. The above batter slopes assume no seepage is present in the batters and the batters are above the water table.

10.0 TEMPORARY BATTER SUPPORT

Where the excavations cannot be battered to a stable angle, they will need to be supported to prevent instability. Support systems could include:

- Sheet Piles – anchoring or cross-bracing of the excavation are likely to be required for sheet piles or possibly cantilevered, and due consideration should be given to the potential for anchor installation and vibration to adversely affect adjacent areas.
- Contiguous Piles – whilst no vibration is associated with their installation, it is likely a more expensive solution.

Where sheet piles are to installed through medium dense or 'denser' sands, pre-drilling may be required to ensure installation.

Where sands are retained, shoring pressures should be based on the lateral earth pressure coefficients given in Table 3, in conjunction with a triangular pressure distribution where the pressure can be calculated from $P=0.5ka\ \gamma\ H^2$, provided the excavation is not surcharged by adjacent buildings/services and some tolerance or movement exists.

TABLE 3 LATERAL EARTH PRESSURE COEFFICIENTS

Material	Strength	Unit Weight (t/m^3)	Lateral Earth Pressure Coefficients (K)	
			Flexible	Propped
Sands	Very loose to loose	1.8	0.40	0.60
	Medium dense	2.0	0.30	0.50
	Dense to very dense	2.1	0.25	0.45

Pressures for unsurcharged propped walls could be designed based on a uniform pressure distribution with depth, where the pressure $P = 0.65ka\ \gamma\ H$ (kPa) where H is the depth of the excavation. The shoring wall should also be checked for a triangular distribution calculated using the lateral earth pressure coefficients present in Table 3 for a propped wall.

The temporary support system should also take into consideration the possible needs to over-excavate the basement for ground improvement works.

It should be noted that lateral deflection of the retention system will occur, irrespective of the retention system adopted. In additional to lateral movements, vertical movement of the soils behind the retention system will result. The effects of the vertical and horizontal movements may be seen at a distance equal to 2 or 3 times the height of the excavation.

Subject to detailed design, movements as much as 1% to 2% of the depth of the excavation could occur behind a cantilevered pile wall.

11.0 PERMANENT RETAINING WALLS

Basement walls should be designed using a pressure coefficient for the at rest case of $K_0 = 0.5$.

Unit wall force P is given by:-

$$P = 0.5\ K_0\ \gamma\ H_1^2 \text{ (kN/m run of wall)}$$

Passive resistance at the base of the wall can be calculated from:-

$$P = 0.5\ K_p\ \gamma\ H_w^2$$

where K_p = 3.25 (ignores wall friction effects) for medium dense sands

H_w = front face of wall contributing to passive resistance (m)

For the sliding resistance calculation, the angle of friction for sand (ϕ) compacted to not less than 75% density index can be taken as 32° for walls with a key. For walls without a key, the angle of friction for sliding resistance should be taken as $\frac{2}{3}\ \phi$ or 21°.

12.0 BUILDING FOUNDATIONS

Given the encountered subsurface profile, a high level raft type footing system would generally be suitable for the support of the proposed structure, with appropriate ground improvement works and due consideration of the potential hydrostatic uplift forces.

Assuming an excavation depth of 3m for the basement, provided the founding soils are compacted to a minimum Density Index of 75% for a minimum depth of 750mm below the footings, an allowable bearing capacity of 175kPa could be adopted for the foundation design.

This classification could be achieved through the insitu compaction of the founding soils but may require some over-excavation of the founding soils, compaction of the exposed material and the replacement of the excavation using "clean" sand.

It should be noted that silty sands were encountered across the site. Some difficulties in treating these sands should be expected.

It is strongly recommended that if a high level footing system is to be adopted, sufficient "clean" sand from higher in the excavation profile be stockpiled on-site, to allow for the replacement of the silty sands at the founding level.

To enable the required ground improvement works to be undertaken, the following earthworks operation is recommended:

i. Install the temporary retention system and dewatering system.

ii. Dewater the site to at least 0.6m below the excavation level.

iii. Excavate the site to the design basement level and test the base of the excavation to determine the extent of over-excavation required.

iv. Following determination of the required extent of over-excavation, excavate the site to the required level and compact the exposed sands using a large (300kg plus) vibrating plate compactor or a small smooth drum roller. It should be noted that the silty sands encountered at some test locations could be difficult to compact and manage, if not appropriately dewatered. It may be necessary to remove the silty sands and replace them with clean sands from higher in the excavation profile.

v. Replace the over-excavation with "clean" sand and compact in layers to the design founding level. The founding soils should be compacted to a minimum Density Index of 75% (in accordance with AS 1289 5.6.1).

Foundation Design Parameters

For footings founded 3m below the ground level, an allowable bearing capacity of 175kPa could be adopted, following confirmation that a minimum Density Index of 75% is present for a minimum depth of 750mm below the footings.

If the exposed sands are disturbed or loosened during the excavation operation, they should be recompacted. Consideration should be given to placing a 50mm thick (minimum) concrete binding layer across the footings, immediately following excavation.

Settlement Potential

Settlements from underlying improved sands and natural soils beneath a pad footing of 2.5m width (i.e. maximum column load of 1100kN) at a nominal founding depth of 3.0m below existing ground level at a design bearing pressure of 175kPa have been calculated to be in the order of 15mm to 20mm with anticipated differential settlements of between 25% and 50% of the calculated total settlement for pad footings founded at a similar depth.

The settlement will occur as "immediate" settlement as the building loads are applied.

Hydrostatic Uplift Forces

For a fully tanked basement, hydrostatic uplift forces should be considered in the design. It is recommended hydrostatic uplift forces in groundwater levels to at least RL1.5 to 2.0 be taken into consideration on this site and checked for the Q_{100} flood condition.

13.0 DEWATERING CONSIDERATIONS

Construction of the basement and foundation system will likely require dewatering. The groundwater will need to be lowered to a minimum of 0.7m below the final excavation depths, to allow the compaction of the founding soils to be achieved. Groundwater was noted at approximately 5m below ground level and excavation of up to 6m could be expected. Drawdown of approximately 2m is therefore expected to be required.

Dewatering is typically achieved through the use of perimeter spears and internal wells.

Settlements inducted by ~2m of drawdown (i.e. 20kPa effective stress increase) are estimated to result in settlements of less than 5mm. Therefore, it is considered that the effects of dewatering on the adjoining structures will be minimal.

14.0 CONSTRUCTON MONITORING

Construction vibrations could potentially cause settlement in the loose upper level sands, thereby damaging nearby structures founded in these strata. A suitable vibration monitoring plan should be developed for the development. Prior to commencement of construction on site, it is recommended that a detailed dilapidation survey be undertaken to establish the condition of all existing adjacent structures.

14.1 Monitoring

It is recommended that monitoring points should be established on the retention system to check for deflections during excavation. A suggested spacing of the monitoring points would be 10m along the walls. A regular monitoring program of these stations should be implemented.

Monitoring must commence before any excavation to establish baseline readings.

14.2 Preconstruction Survey

Prior to commencement of construction on site, it is recommended that a dilapidation survey be undertaken on the adjacent structures.

This survey should include the following:

- The extent of exiting damage (if any)
- The general condition of the property, ie. Condition of all exposed columns and beams, partition walls and cladding etc.
- Road, kerb and channel and footpath condition adjacent development site.

15.0 SITE MANAGEMENT

To maintain the long term performance of the structure, good management of the soil conditions and the development is vital throughout the life of the development.

The following are some specific comments with respect to site management.

- The ground surface around the perimeter of the buildings should slope away from the structure and fall to the stormwater system. Water should not be allowed to pond adjacent to the buildings.
- Founding soils should not be allowed to become saturated.
- Service trenches under the buildings should be kept to a minimum. Saturation of the on-site material will result in an increase in settlement potential.
- Footings should be poured immediately after excavation. If footings cannot be poured on the same day as excavation, a blinding layer of 50mm thickness is recommended.

16.0 LIMITATIONS

We have prepared this report for the Proposed Residential Development at 29 Shirley Street and 2-4 Milton Street, Byron Bay. The report is provided for the exclusive use of One Project MGMT Group, for this project only and for the purposes outlined in the report. It should not be used by, or relied upon, for other projects on the same or different sites or by a third party. In preparing this report, we have relied upon information provided by the client or their agents.

The results are indicative of the subsurface conditions on site only at the specific testing locations. Subsurface conditions can change between test locations and the design and construction should take the spacing of the testing and testing methods adopted and the potential for variation between the test locations.

It is recommended that Pacific Geotech be engaged to provide advice and ensure the development is undertaken in accordance with the assumptions made in writing this report.

This is not to reduce the level of responsibility accepted by Pacific Geotech, but rather to ensure that the parties who may rely on the information contained in this report are aware of the responsibilities they assume in doing so.

P. ELKINGTON (RPEQ 7226)

For and on behalf of
PACIFIC GEOTECH PTY LTD

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

Notes Relating to this Report

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.

Every care has been taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical conditions and contains recommendations or suggestions for design and construction. However, unexpected variations in ground conditions will occur. The potential for this will depend partly on testing, spacing and sampling frequency.

If variations are identified, Pacific Geotech would be pleased to assist with additional investigations or advice to resolve the matter.

Copyright

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.

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.

Description and Classification Methods

The description and classification of soils and rocks used in this report are based on AS 1726.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the percent of other particles present (e.g. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silty	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density which can be correlated from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very Loose	less than 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) and can be quantified by the Pocket Penetrometer test, Vane Shear test, laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 - 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 - 400
Hard	greater than 400
Friable	strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc.

Planarity	
CU	Curved
DIS	Discontinuous
IR	Irregular
PR	Planar
ST	Stepped
UN	Undulose

Roughness	
POL	Polished
RJ	Rough
S	Smooth
SL	Slickened
VR	Very Rough

Defects	Type
BP	Bedding Parting
CL	Cleavage
CO	Contact
CS	Crushed Seam
CZ	Crushed Zone
DB	Drilling Break
DK	Dyke
DL	Drill Lift
DZ	Decomposed Zone
FC	Fracture
FL	Foliation
FZ	Fracture Zone
HB	Handling Break
IS	Infilled Seam
JT	Joint
H	Schistosity
SI	Sill
SM	Seam
SS	Shear Seam
SZ	Shear Zone
VN	Vein
VO	Void

Sampling

Sampling is undertaken during the fieldwork to allow examination of the soil or rock and to allow laboratory testing to be undertaken.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content and minor constituents. Bulk samples are similar but of greater volume required for some test procedures such as CBR testing.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and collecting a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

Investigation Methods

Test Pits: These are typically undertaken with a backhoe or a tracked excavator, allowing examination of the insitu soils. Limitations of test pits are the problems associated with collapse of the pits, disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of typical diameter of between 50mm to 75mm advance manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, gravel, hard clays and collapse of the borehole (typically in non-cohesive soil).

Continuous Spiral flight Augers: The borehole is advanced using 65mm to 100mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. Augers of up to 300mm in diameter are used to recover larger volumes of sample. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights. Samples can be disturbed and layers may become mixed. Augering below the groundwater table can be less reliable than augering above the water table.

A Tungsten Carbide (TC) bit for auger drilling into rock can be used to indicate rock strength and continuity by variation in drilling resistance and from examination of recovered rock fragments but provides only an indication of the likely rock strength. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is advanced by a bit attached to the end of a hollow rod string, with water being pumped down the drill rods and returned up the annulus of the borehole, carrying the drill cuttings. Changes in stratification can be determined from the return, together with information from "feel" and rate of penetration.

The borehole can be stabilised through the use of drilling mud as a circulating fluid. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. This technique provides a reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel is used, which gives a core of about 50mm diameter. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a disturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposed", Test 6.3.1.

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

The test results are reported in the following form:

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

Cone Penetrometer Testing (CPT): Cone Penetrometer Testing with or without pore pressure measurement (CPTu) is carried out using a Cone Penetrometer in general accordance with AS 1289 6.5.1, 1999.

In the tests, a 36mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the fractional resistance on a separate 135mm long sleeve, immediately behind the cone. Pore Pressure is recovered through a pore ring located either within, or more usually immediately behind the cone/tip.

As penetration occurs (at a rate of approximately 20mm per second) and data is recorded every 20mm of penetration, the results are presented graphically.

The information provided on the plot comprises:

- Cone resistance – expressed in mPa
- Sleeve friction – expressed in kPa
- Friction ratio – the ratio of sleeve friction to cone resistance expressed as a percentage.
- Pore pressure in kPa
- Tilt of probe (in degrees).

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and rising to 2% to as high as 8%, and higher in organic soils. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes, etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive.

Dynamic Cone Penetrometers:

Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod into the ground with a 9kg sliding hammer dropping 510mm and counting the blows for successive 100mm increments of penetration.

Logs

The borehole or test pit logs are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of the boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

Groundwater

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be flushed from the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes from which ongoing monitoring can be undertaken.

Fill

The present of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, steel ,etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult to reliably determine the extent of the fill.

Laboratory Testing

Laboratory testing is carried out in general accordance with Australian Standard 1289 'Methods of Testing Soil for Engineering Purposes'.

Site Anomalies

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

Review of Design

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a design review.

Site Inspection

Pacific Geotech would be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related:

Requirements could range from:

i. a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii. a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii. full time engineering present on site.

APPENDIX B

BOREHOLE RECORD SHEETS

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 01
Page 1 of 1

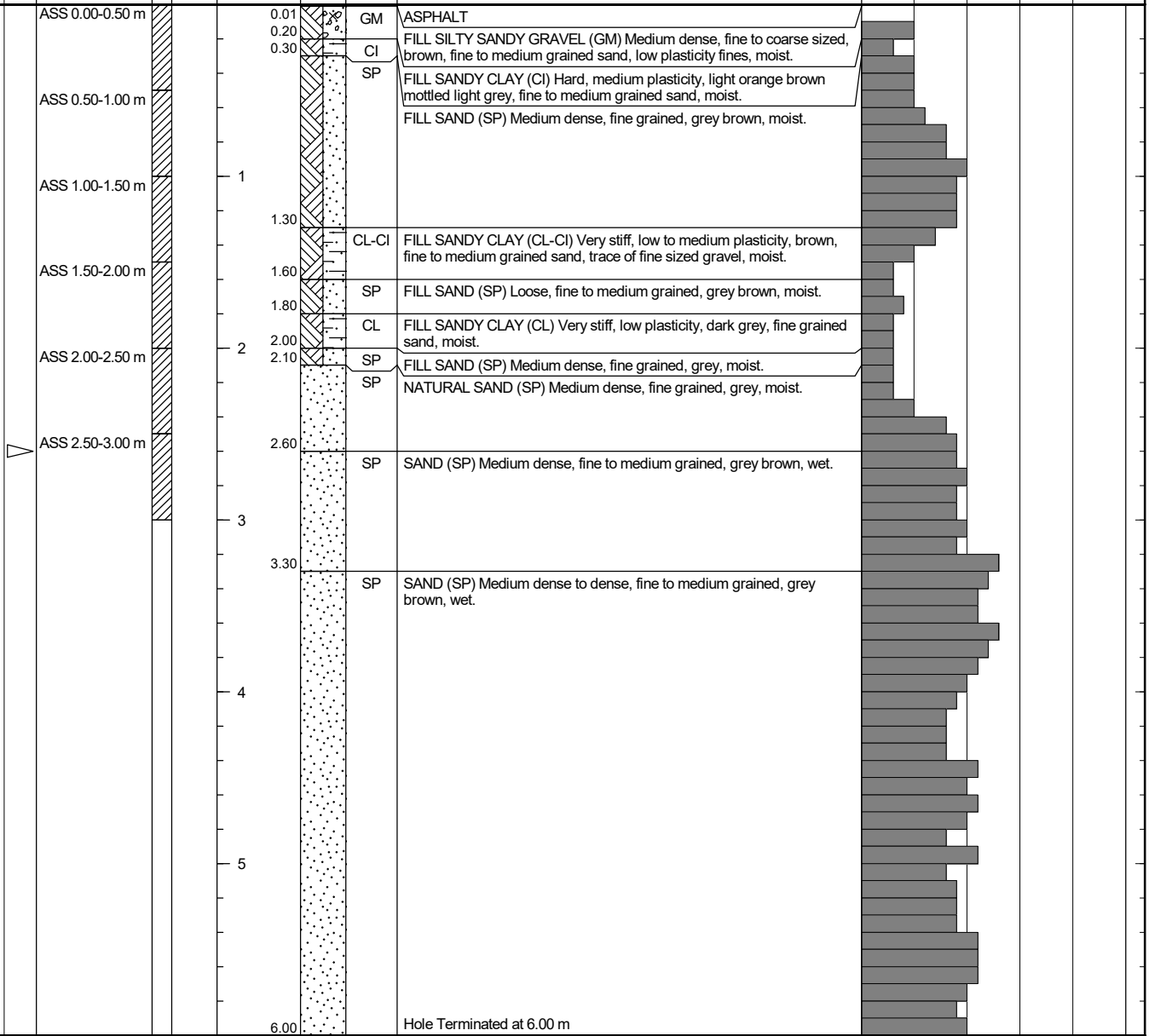
Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD
		Operator:	EA

Drilling Information | ***Soil Description*** | ***DCP***

Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			ASS 0.00-0.50 m			0.01		GM	ASPHALT
						0.20			
						0.30		CI	FILL SILTY SANDY GRAVEL (GM) Medium dense, fine to coarse sized, brown, fine to medium grained sand, low plasticity fines, moist.
								SP	FILL SANDY CLAY (CI) Hard, medium plasticity, light orange brown mottled light grey, fine to medium grained sand, moist.
			ASS 0.50-1.00 m						FILL SAND (SP) Medium dense, fine grained, grey brown, moist.
			ASS 1.00-1.50 m			1			
						1.30		CL-CI	FILL SANDY CLAY (CL-CI) Very stiff, low to medium plasticity, brown, fine to medium grained sand, trace of fine sized gravel, moist.
			ASS 1.50-2.00 m			1.60		SP	FILL SAND (SP) Loose, fine to medium grained, grey brown, moist.
						1.80		CL	FILL SANDY CLAY (CL) Very stiff, low plasticity, dark grey, fine grained sand, moist.
			ASS 2.00-2.50 m			2.00			
						2			
						2.10		SP	FILL SAND (SP) Medium dense, fine grained, grey, moist.
								SP	NATURAL SAND (SP) Medium dense, fine grained, grey, moist.
		▽	ASS 2.50-3.00 m			2.60		SP	SAND (SP) Medium dense, fine to medium grained, grey brown, wet.
						3			
						3.30		SP	SAND (SP) Medium dense to dense, fine to medium grained, grey brown, wet.
						4			
						5			
						6.00			Hole Terminated at 6.00 m

DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
0 5 10 15 20 25



Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 2.6m.
2. Standpipe installed to 6.0m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 02
Page 1 of 1

Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD
		Operator:	EA

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	ASS 0.00-0.50 m			0.10		GP	FILL SANDY GRAVEL (GP) Loose, fine to medium sized, dark grey, fine to medium grained sand, moist.	
						0.30		SP		
			ASS 0.50-1.00 m			0.50		SP	FILL SAND (SP) Loose, fine to medium grained, light orange brown, low plasticity fines, trace of fine sized gravel, moist.	
						0.70		SP	FILL SAND (SP) Medium dense, fine grained, grey, moist.	
			ASS 1.00-1.50 m D 1.10-1.50 m			0.90		SP	FILL SAND (SP) Loose, fine grained, grey brown, moist.	
					1			SP	FILL SAND (SP) Very loose, fine grained, dark grey, moist.	
			ASS 1.50-2.00 m			1.50		SP	NATURAL SAND (SP) Very loose to loose, fine grained, grey, moist.	
			ASS 2.00-2.50 m		2	2.20		SP	SAND (SP) Medium dense, fine grained, dark grey brown, moist.	
			D 2.20-2.50 m					SP	SAND (SP) Medium dense to dense, fine grained, dark brown, moist.	
			ASS 2.50-3.00 m			2.60		SP	SAND (SP) Medium dense, fine grained, brown, moist.	
					3	3.20		SP	SAND (SP) Dense, fine grained, dark brown, wet.	
					4	4.10		SP	SAND (SP) Medium dense, fine grained, grey brown, wet.	
					5	6.00			Hole Terminated at 6.00 m	

DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm: 0 5 10 15 20 25

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Remarks
1. Groundwater encountered at 3.2m.

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 03
Page 1 of 1

Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD
		Operator:	EA

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T			ASS 0.00-0.50 m B 0.00-0.60 m			0.20		SP	FILL SAND (SP) Loose, fine grained, grey, with organics, moist.	
			ASS 0.50-1.00 m					SP	FILL SAND (SP) Very loose to loose, fine grained, grey, moist.	
			ASS 1.00-1.50 m			1.10		SP	FILL SAND (SP) Medium dense, fine grained, dark grey, moist.	
						1.30		SP	NATURAL SAND (SP) Medium dense, fine grained, grey, moist.	
			ASS 1.50-2.00 m							
			ASS 2.00-2.50 m							
		▽	ASS 2.50-3.00 m			2.60		SP	SAND (SP) Medium dense, fine to medium grained, grey, wet.	
						3.40		SP	SAND (SP) Dense, fine to medium grained, grey brown, wet.	
						3.70		SP	SAND (SP) Medium dense, fine to medium grained, brown, wet.	
						6.00			Hole Terminated at 6.00 m	

DCP axis: 0, 5, 10, 15, 20, 25

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Remarks
1. Groundwater encountered at 2.6m.

Pacific Geotech
Consulting Geotechnical Engineers

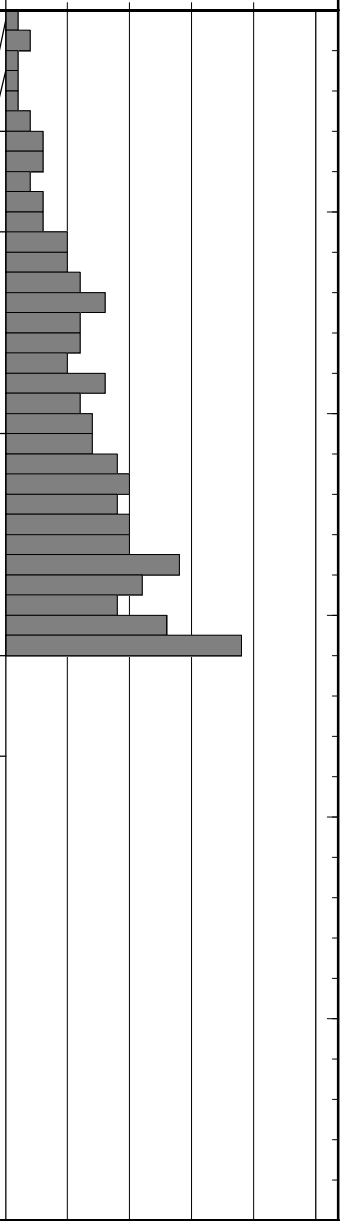
Borehole No.
BH 04
Page 1 of 1

Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD
		Operator:	EA

Drilling Information | ***Soil Description*** | ***DCP***

Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T		▽	ASS 0.00-0.50 m			0.05		SP	FILL SAND (SP) Very loose, fine grained, lgiht grey, trace of fine to medium sized gravel, moist.
						0.30		SP	NATURAL SAND (SP) Very loose to loose, fine grained, dark grey, moist.
			ASS 0.50-1.00 m D 0.60-1.00 m			0.60		SP	SAND (SP) Very loose, fine grained, dark grey, moist. SAND (SP) Loose to medium dense, fine grained, light grey, moist.
			ASS 1.00-1.50 m			1.10		SP	SAND (SP) Medium dense, fine grained, light grey, moist.
			ASS 1.50-2.00 m						
			ASS 2.00-2.50 m			2.10		SP	SAND (SP) Medium dense, fine to medium grained, light grey brown, wet.
			ASS 2.50-3.00 m D 2.60-3.00 m			3.20		SP	SAND (SP) Dense, fine to medium grained, brown, wet.
						3.70		SP	SAND (SP) Medium dense to dense, fine to medium grained, grey brown, wet.
						6.00			Hole Terminated at 6.00 m



Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 2.1m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 05
Page 1 of 1

Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: EA

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	D 0.60-1.00 m			0.05		GP	FILL GRAVEL (GP) Very loose, fine to coarse sized, grey, moist.	0 5 10 15 20 25
						0.20		SP	FILL SAND (SP) Very loose, fine grained, grey, with organics, moist.	
						0.50		SP	FILL SAND (SP) Loose, fine grained, grey brown, moist.	
								SP	NATURAL SAND (SP) Loose to medium dense, fine grained, light grey, moist.	
			D 2.30-2.50 m			1.60		SP	SAND (SP) Very loose to loose, fine grained, light grey, moist.	
						2.30		SP	SAND (SP) Medium dense, fine to medium grained, light grey, moist.	
						3.20		SP	SAND (SP) Medium dense, fine to medium grained, light grey brown, wet.	
						5.50		SP	SAND (SP) Dense, fine grained, grey brown, wet.	
						6.00			Hole Terminated at 6.00 m	

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Remarks
1. Groundwater encountered at 3.2m.

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 06
Page 1 of 1

Project No.: PG-7463

Client:	One Project MGMT Group	Commenced:	04/03/2022
Project Name:	Proposed Residential Development	Logged By:	EA
Hole Location:	29 Shirley Street, Byron Bay	Checked By:	
Hole Position:			
Drill Model and Mounting:	Digga PDT 1	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: EA

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	D 0.30-0.50 m			0.30		SP	NATURAL SAND (SP) Very loose, fine grained, grey, moist (with traces of charcoal).	
						0.60		SP	SAND (SP) Very loose to loose, fine grained, dark grey, moist.	
						1.10		SP	SAND (SP) Loose, fine grained, grey brown, moist.	
						2.60		SP	SAND (SP) Medium dense, fine grained, light grey, moist.	
						3.90		SP	SAND (SP) Medium dense, fine to medium grained, grey brown, wet.	
						6.00		SP	SAND (SP) Dense, fine to medium grained, grey brown, wet.	
									Hole Terminated at 6.00 m	

0 5 10 15 20 25

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Remarks
1. Groundwater encountered at 2.6m.

APPENDIX C

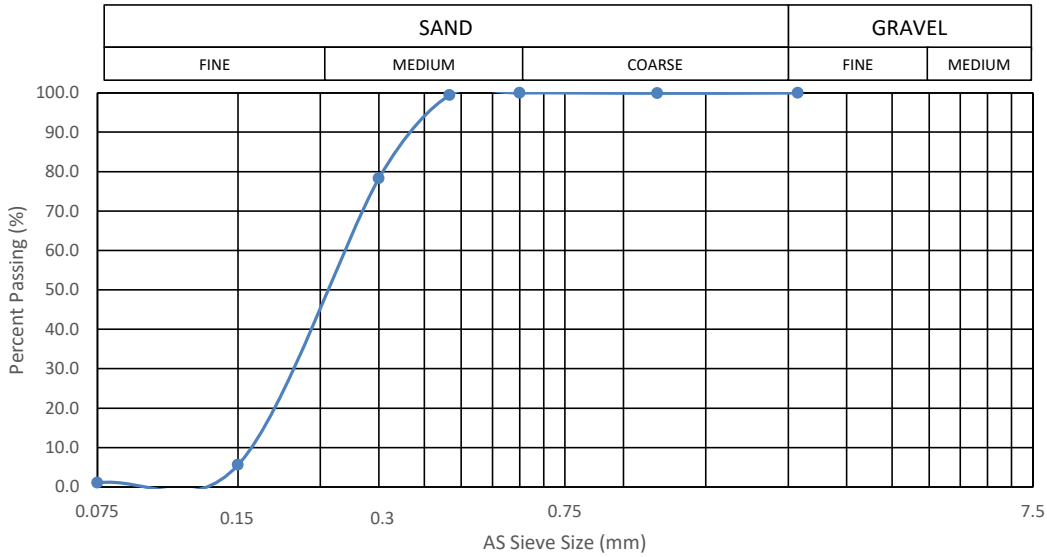
LABORATORY TEST CERTIFICATES

Pacific Geotech
Consulting Geotechnical Engineers

Particle Size Distribution Report			
Client:	One Project MGMT Group	Project Number:	PG-7463
Address:	29 Shirley Street, Byron Bay	Report Number:	PG-7463-PSD-01
Project Name:	Proposed Residential Development	Report Date:	5/04/2022
		Test Method:	AS 1289.3.6.1

Sample Location:	**BH02 @ 2.2m**
Sampling Method:	DISTURBED
Sampled By:	PACIFIC GEOTECH
Date Sampled:	4/03/2022
Date Tested:	5/04/2022
Material Type:	**(SP) SAND**

AS Sieve Size (mm):	Percent Passing (%):
2.36	100
1.18	100
0.600	100
0.425	99
0.300	78
0.150	6
0.075	1



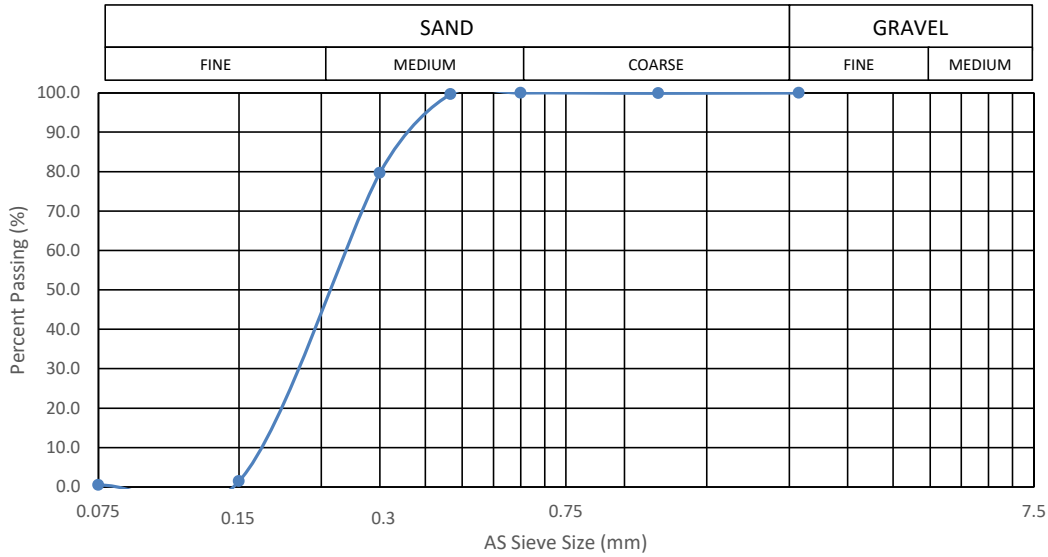
P: (07) 5636 4680 F: (07) 5636 0286 E: info@pacgeo.com.au
3 Jowett Street, Coomera, Qld, 4209 | PO Box 499, Paradise Point, Qld, 4216
www.pacgeo.com.au

Pacific Geotech
Consulting Geotechnical Engineers

Particle Size Distribution Report			
Client:	One Project MGMT Group	Project Number:	PG-7463
Address:	29 Shirley Street, Byron Bay	Report Number:	PG-7463-PSD-02
Project Name:	Proposed Residential Development	Report Date:	5/04/2022
		Test Method:	AS 1289.3.6.1

Sample Location:	BH04 @ 2.6m
Sampling Method:	DISTURBED
Sampled By:	PACIFIC GEOTECH
Date Sampled:	4/03/2022
Date Tested:	5/04/2022
Material Type:	**(SP) SAND**

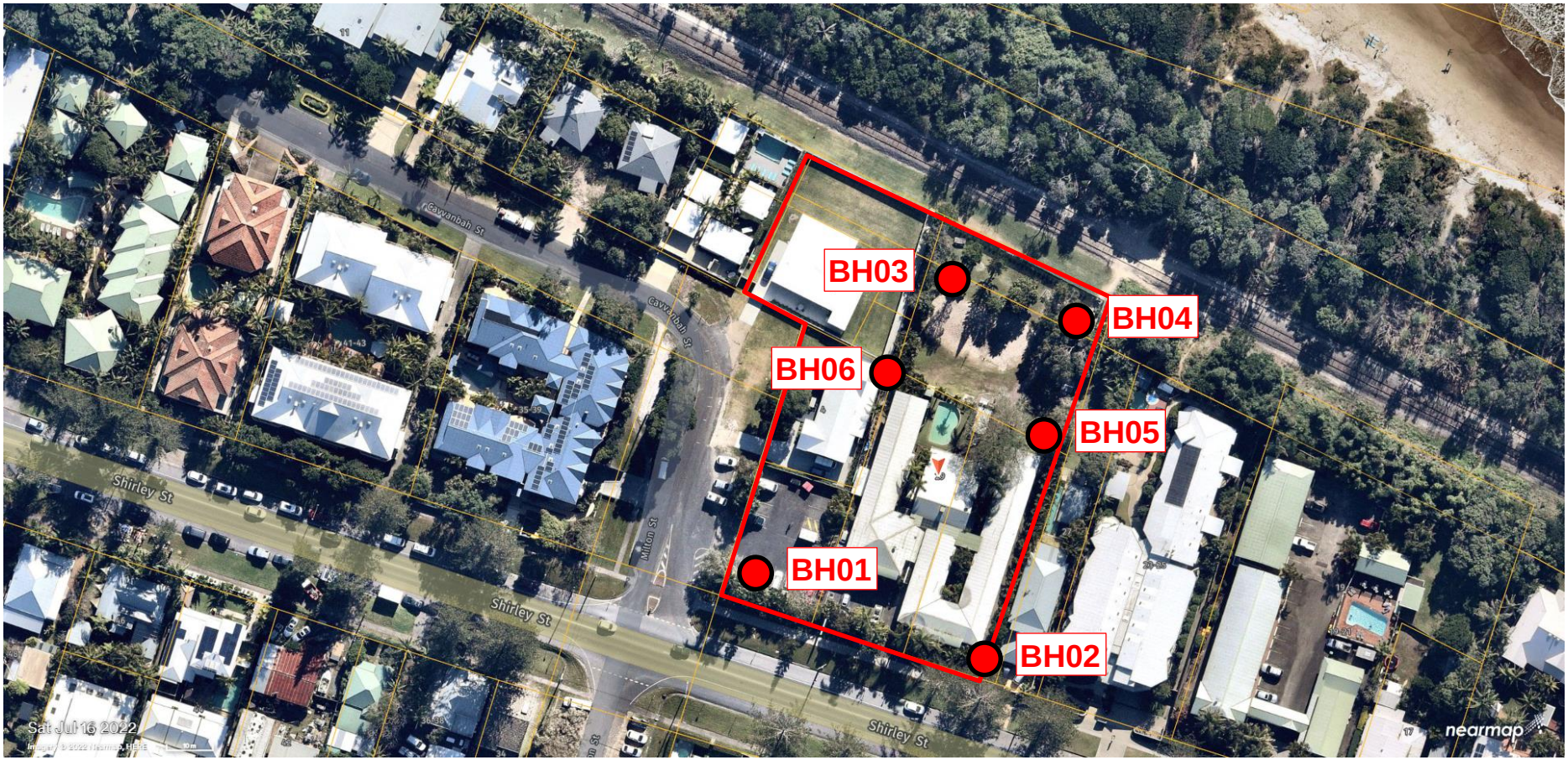
AS Sieve Size (mm):	Percent Passing (%):
2.36	100
1.18	100
0.600	100
0.425	100
0.300	80
0.150	2
0.075	0



P: (07) 5636 4680 F: (07) 5636 0286 E: info@pacgeo.com.au
3 Jowett Street, Coomera, Qld, 4209 | PO Box 499, Paradise Point, Qld, 4216
www.pacgeo.com.au

APPENDIX D

SITE PLAN



Pacific Geotech
Consulting Geotechnical Engineers

Drawn AB	Project:	Proposed Residential Development	Drawing No. PG-7463-02	A4
Date Jul 2022	Location:	29 Shirley Street and 2-4 Milton Street, Byron Bay		
Checked	Client:	One Project MGMT Group		