SOIL SURVEYS
Geotechnical Specialists

Report for Geotechnical Investigation
Multi Level Building
17 Hamilton Place & 26-28 Campbell Street, Bowen Hills

Attention: Watson Hua
Landitude Pty Ltd

Project No: 1-29185
Ref: 1-29185 BR 1.1
Date: 21 August 2025

Soil Surveys Engineering Pty Limited
ABN 70 054 043 631
soilsurveys.com.au
Brisbane, Level 1, 87 Schneider Road, Eagle Farm, QLD, 4009
Gold Coast, Unit 8, 140 Millaroo Drive, Helensvale, QLD, 4212
07 3369 6000

TABLE OF CONTENTS

Appendices

1.0 Introduction

1.1 General

This report presents the results of the preliminary geotechnical investigation carried out by Soil Surveys Engineering Pty. Limited for a proposed Multi Level Building located on the corner of 17 Hamilton Place & 26-28 Campbell Street, Bowen Hills.

The investigation was carried out in accordance with Soil Surveys Engineering Pty Limited proposal 1-29185 PR 1.1, following authorisation to proceed from Landitude Pty Ltd on the 26th June, 2025.

1.2 Proposed Development

It is understood that the proposed development is to cover Lot 2/RP83400, Lot 30/RP9982 and Lot 31/RP9982.

Development details are unknown, however it is expected that a multi level mixed used building with up to four levels of basement carparking will be proposed.

1.3 Scope of Geotechnical Services

The objective of this study was to identify materials and material properties and groundwater conditions to enable geotechnical assessment of the following:-

- Ground conditions
- Preliminary civil works recommendations
    - trafficability
    - excavatability
    - earthworks recommendations
    - batter recommendations
- Preliminary excavation support options
- Preliminary foundation options and design parameters
- Preliminary retaining wall design parameters
- Construction recommendations (where applicable)

2.0 Site Description

The site is located on the corner of 17 Hamilton Place & 26-28 Campbell Street, Bowen Hills and includes Lot 2 of RP83400, Lots 26 and 28 on RP9982. (Refer Figure 1).

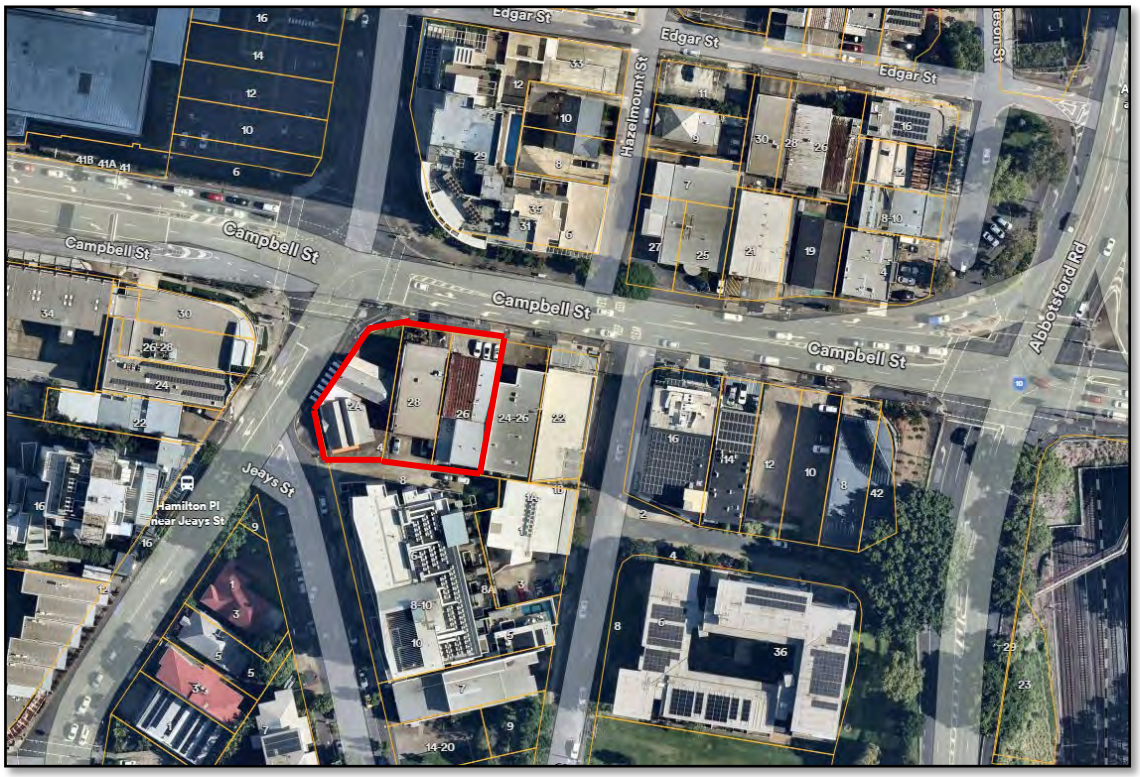


Figure 1 – Site Location

At the time of the investigation the three sites are occupied by commercial buildings of one to two levels. Carparking areas cover the front and rear of the site.

Brisbane City Council contour plans indicate the site falls slightly towards the north with ground levels between RL 20.0m and RL 19.0m.

3.0 Geotechnical Investigation

3.1 Field Investigation

Subsurface conditions at the site were investigated by drilling and sampling one borehole to a depth of 20.33m using our truck mounted Comacchio MCT-3 drilling rig. NMLC rock coring was carried out in the borehole from a depth of 0.40m to the termination depth.

The field work was carried out on the 21st July, 2025.

The soil classification descriptions, field and laboratory testing were carried out in general accordance with the following Australian Standards:-

- AS 1726-2017 - Geotechnical Site Investigations
- AS 1289 - Methods of Testing Soils for Engineering Purposes

A description of the investigation method, borehole records and a site plan showing the location of the boreholes are included in the Appendices.

Borehole coordinates were recorded using a hand held GPS device, with accuracy consistent with such devices.

4.0 Geotechnical Model

4.1 Local Geology

Reference to the Geological Survey of Queensland's 1:100 000 scale geological map (Brisbane Sheet 9543) indicates the site to be underlain by the Brisbane Tuff unit.

4.2 Subsurface Profile

The subsurface profile intersected at the borehole location comprised a minor fill layer overlying weathered Tuff.

Weathered Tuff was described as distinctly weathered, medium strength grading into slightly weathered and fresh rock with depth. The rock strengths are predominantly high to very high strength.

A detailed borehole record is included in Appendix B.

4.3 Groundwater

The Borehole was extended to the termination depth using wash boring and coring (water circulation) drilling methods and therefore groundwater (if any) could not be observed.

4.4 Laboratory Testing

Selected rock core samples retrieved from the borehole were submitted for point load index testing (AS 4133.4.1-1993).

The results for the above laboratory testing are summarised in Table 1.

Table 1 Point Load Index Testing

Sample Depth (m)	Is50 (MPa)	AS 1726 Classification
1.75	3.13	Very High
3.74	3.52	Very High
6.18	3.56	Very High
8.29	4.90	Very High
9.63	3.34	Very High
12.38	3.85	Very High
14.22	4.69	Very High
16.45	2.95	High
18.27	3.66	Very High
20.30	4.71	Very High

5.0 Engineering Assessment

5.1 Trafficability

At the time of the field investigation, trafficability was considered to be good due to the existing pavement.

The contractor should fully inform himself of the ground conditions on site prior to commencement of earthworks. This requirement should be explicit in any earthworks specifications or contract.

Problems may arise from disturbance of the upper level soil fabric with removal of the existing structure. Depressions could be formed resulting in water traps and potential softening of adjacent and underlying soils.

Working Platforms For Tracked Plant and Heavy Construction Vehicles

The scope of Soil Surveys Engineering's study **DOES NOT** include the design of a working platform for heavy construction vehicles or heavy tracked plant.

Detailed design of a working platform should be carried out considering the operation of actual machinery proposed to be used and the areas of work. This is particularly important when considering the use of **heavy** piling rigs and **heavy** cranes – the piling/crane contractor should be consulted regarding their requirements.

Given the subsurface conditions encountered consists of shallow Tuff rock, it is expected that any working platform will be nominal only (less than 300mm).

5.2 Excavation Characteristics

General

It is anticipated that excavations will consist of the following:-

- Bulk Cuts – for site stripping and excavations.
- Trenching – for high level footings and underground services.
- Drilling – for bored pier foundations (if required).

Excavatability Comments

Based on geotechnical knowledge of excavations/earthworks on projects in the local area and the findings of the investigation, the following comments can be made on excavation characteristics;-

- Bulk Works & Trenching
  - Excavation into the upper section of the DW weathered rock may be possible using a single tyne ripper on an excavator.
  - In areas of SW, high strength to very high strength, specialised tools, e.g. rock breakers or rock saw will be required.

- Bored Piers
  - It should be noted that the ability to drill piers in the weathered rock material is not only dependent on material characteristics but also the type (power and size) of the bored pier drilling rig, drilling teeth, size of pier, etc. It is recommended that the drilling contractors be consulted on this matter. However, it is considered that the use of a large track mounted pier piling rig will be required for piers.

Vibrations

The effect of vibrations on adjacent structures from excavation works, particularly use of rock breakers, must be carefully be considered. Regardless, adequate vibration monitoring and control is recommended.

Inspection of Core

Soil Surveys Engineering hold core recovered from the Borehole drilled on this site.

It is recommended that tender documents include a requirement to inspect the core so that intending contractors can make their own assessment and judgement on the excavatability of the rock stratum.

5.3 Dewatering - Construction

The potential to encounter groundwater exists, however any flow is expected to be low.

For construction works, a drainage system comprising a gravel blanket, side drains etc., grading to a sump pump, could be considered.

5.4 Excavation/Boundary Retention

5.4.1 General

Basement construction details are unknown but up to a four level basement could be considered.

Considering expected earthworks, excavation support will be required.

Either a pier wall retention system or anchored panel system could be considered.

The retention system must be installed prior to excavation works.

Unsupported excavations, i.e. temporary cut batters are not recommended.

5.4.2 Detailed Design

DETAILED RETENTION SYSTEM DESIGN IS REQUIRED; a detailed soil-structure analysis must be carried out to determine an effective retention support system. This design would follow the detailed geotechnical investigation.

The requirement to limit deflections to acceptable levels should be explicit in the brief to retention system designers.

The effect of potential vertical and horizontal movements (resulting from deflection of the retention system) on existing adjacent structures, services, road etc. must be carefully considered. Services locations and adjacent building foundation systems must be considered in the retention system design.

The design of a support system should take into account overexcavation possibly associated with foundation construction, earthworks, services installation, etc.

UNSUPPORTED EXCAVATIONS ARE NOT RECOMMENDED.

Further, it is recommended that several monitoring stations be set up to check for movement during excavation. A regular monitoring program of these stations should be implemented e.g. twice daily during excavation and daily at any other time.

5.4.3 Pier and Panel System

In this option, piers are drilled (up to four diameters), with infill panels; piers are joined at the surface using a capping beam.

The following general construction procedure would be applicable:-

- Install bored piers **with a suitable embedment** below excavation level. This pier and panel option is dependent on suitable pier embedment below final platform level being achieved.
- Construct panels - excavate, install reinforcement between piers and spray with shotcrete.
- Install temporary ground anchors through each pier or install internal propping system
- Continue panel construction (i.e. excavation, installation, reinforcement and shotcrete).

Please note that permission to install anchors into adjacent properties would be required.

A maximum panel height of 2.0m is recommended; inspection by Soil Surveys Engineering is recommended at the commencement of construction to confirm panel height.

It is recommended that a capping beam be incorporated into the design. A capping beam has the advantage of:-

- Provides a convenient location for the first row of anchors and internal props.
- Provides a larger bearing surface for the top row of anchors and allows the adoption of larger anchors in the top row.

Joins the tops of the posts together thereby reducing the possibility of excessive movement of the top of a single post which could increase the potential for toe "kick out" before the placement of the lower anchor. This movement would also reduce the tension within the anchor thereby down grading its effectiveness at minimising movement within the wall of the excavation.

Figure 2 refers.

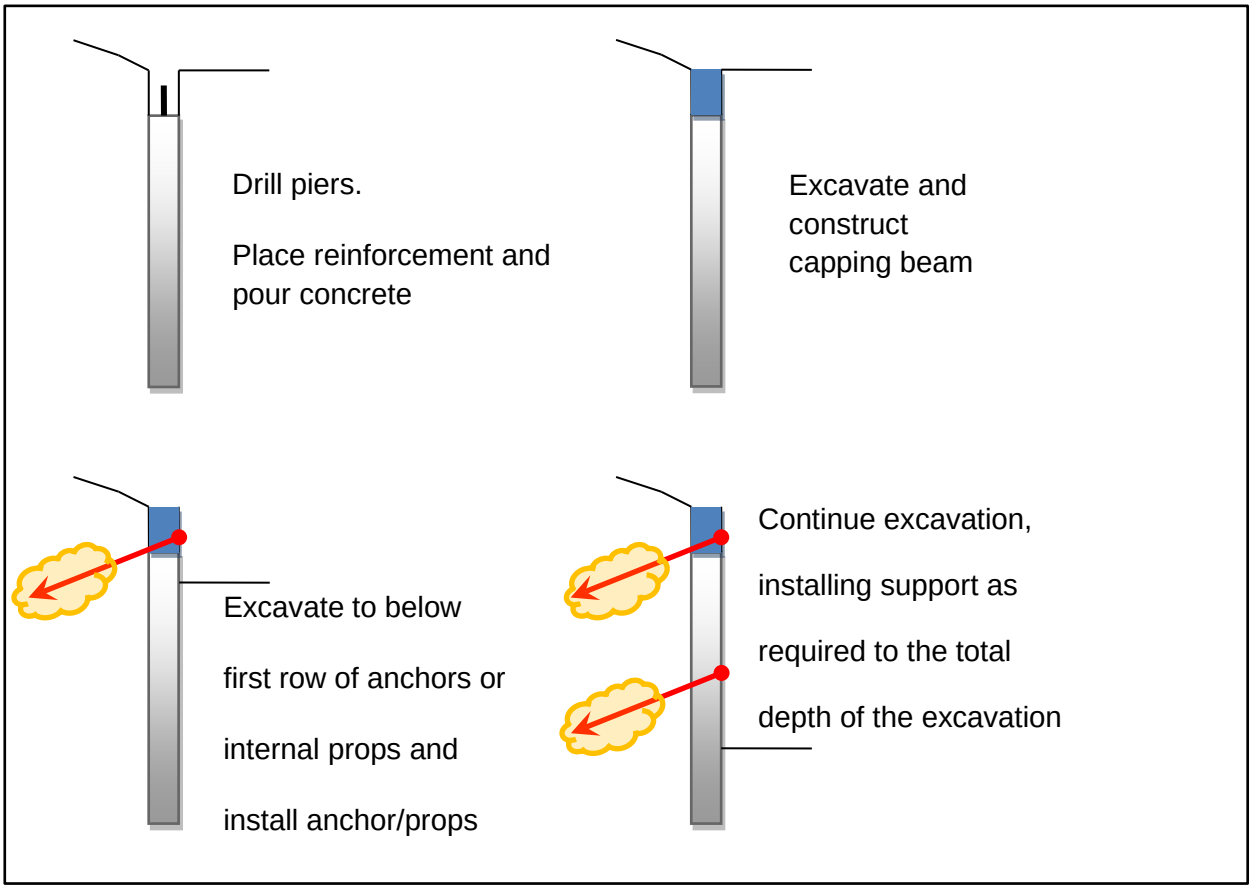


Figure 2

A minimum pier diameter of 0.60m should be adopted for anchored piers, however, pier diameter is dependent on the moment capacity of the pier section, lateral deflection requirement, boundary conditions, etc.

5.4.4 Anchor Design

Anchor design should consider the following:-

- Anchor free length should extend from the anchor head to 0.15H (H is total excavation height) behind the design failure plane drawn up at 60° from the base of the cut with a minimum length of 3.0m (temporary only).
- Anchor bond length will depend upon desired anchor capacity, drill hole size and material parameters of intersected material. An allowable bond stress of 250kPa for SW rock or better could be adopted. It is recommended that pull out tests be carried out during excavation to better assess these values. It is possible that greater values could be used, subject to test results.
- Anchors are designed as temporary.

5.4.5 Anchor with Mesh/Shotcrete

An anchored with mesh/shotcrete wall is considered appropriate for temporary support of the rock stratum and below the pier and panel system. If some lateral movement at the top of the cut is possible, a dowelled system could be considered.

A maximum panel size of 2.0m wide by 2.0m high is recommended, subject to inspection during excavation works.

The method of construction for this wall type comprises excavation in stages/levels; at each level excavate on a hit one/miss two basis leaving the buttress supporting the area to be retained (Refer Figure 3 and Figure 4). The anchor/dowel hole is drilled, anchor/dowel placed and grouted, panel steel placed and sprayed.

Drainholes (in conjunction with strip drains) should be drilled during the process and a short piece of PVC placed in the neck of the hole during spraying to allow the hole to continue through the wall.

Once a panel has been completed the adjoining panels should then be excavated and the process repeated until all panels have been constructed.

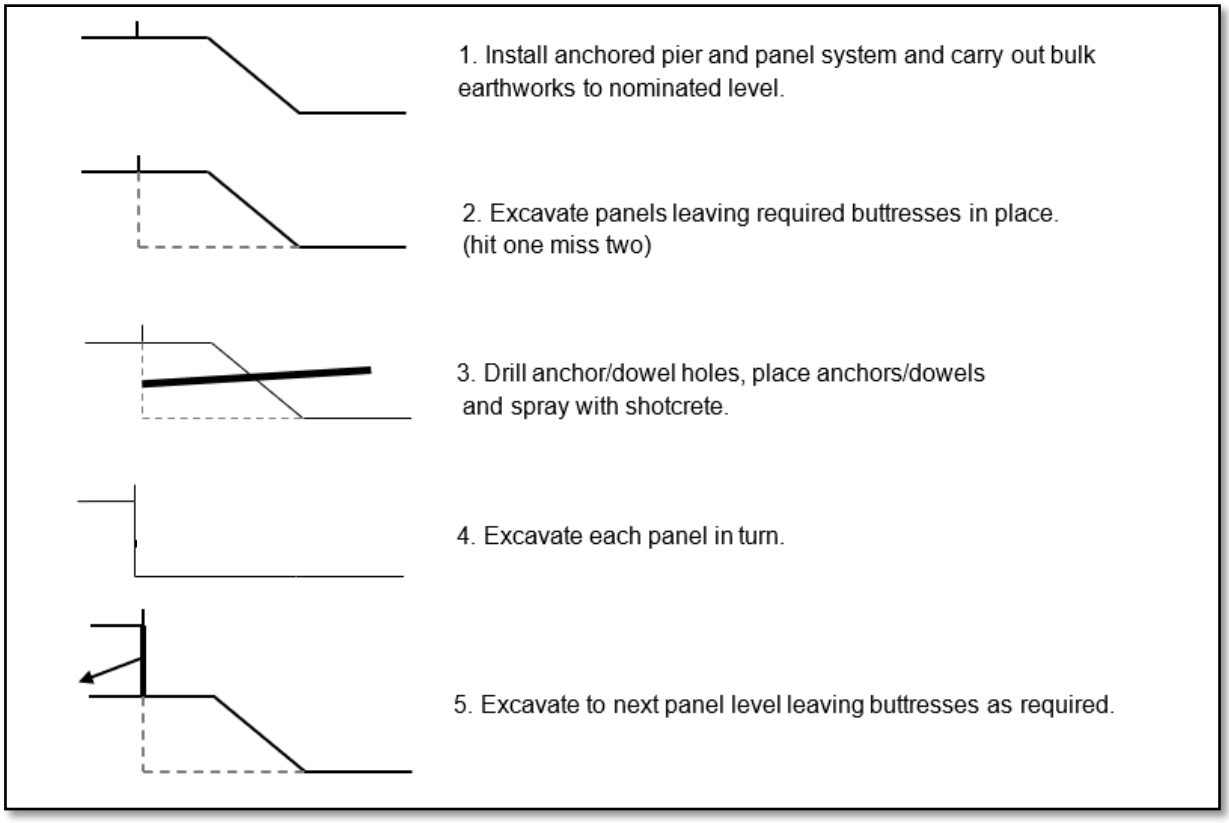


Figure 3 Construction Sequence for Anchor/Dowel, Mesh Shotcrete Wall

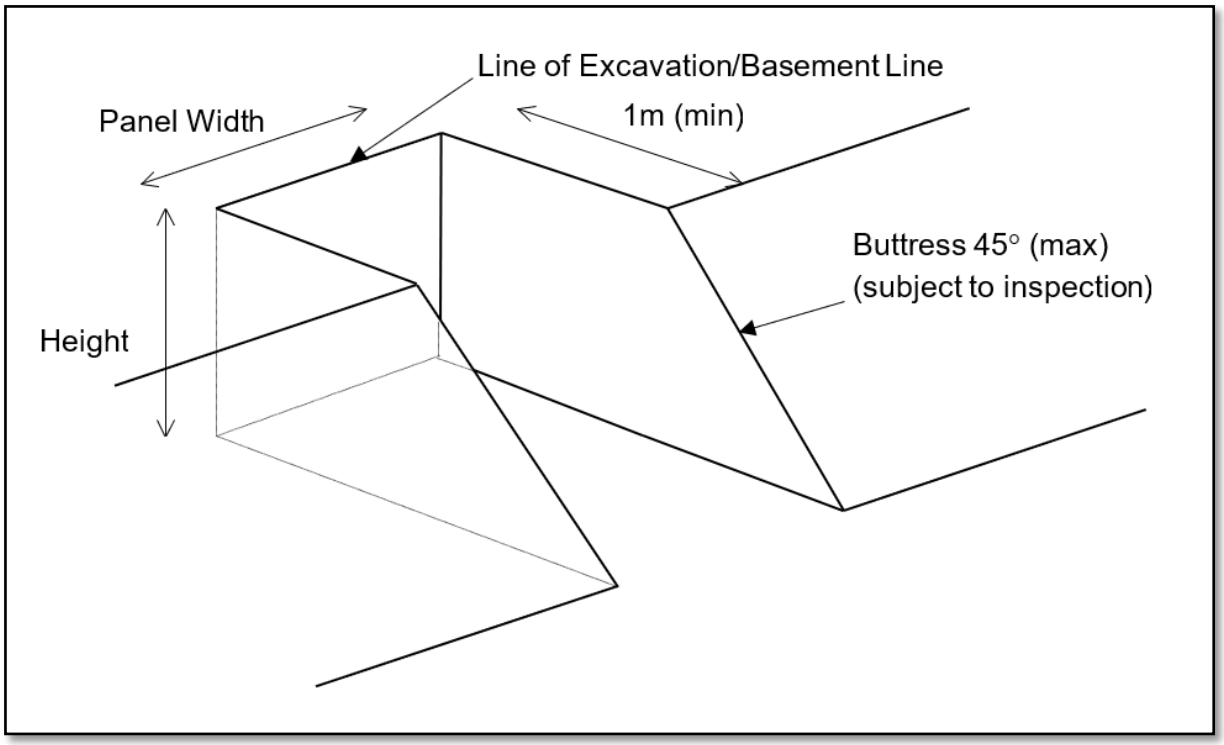


Figure 4 Buttress Detail

5.4.6 Design Comments

As noted previously, **detailed retention system design is required**; Soil Surveys Engineering would be pleased to assist with the geotechnical engineering aspects of the design process following the detailed geotechnical investigation.

However, please note that Soil Surveys Engineering do not produce engineering drawings; our geotechnical engineering retention design will be provided in a report which sets out sufficient detail to allow the drafting (by others) of engineering drawings for construction. These drawings should (at least) consist of an elevation showing anchor installation locations (if required) as well as typical sections and other design/construction parameters. Soil Surveys Engineering can provide geotechnical design review of the drawings.

It should be noted that as well as geotechnical design review of drawings, construction inspections (i.e. inspection of piers associated with pier and panel system, inspections during bulk earthworks, etc. - please contact Soil Surveys Engineering for advice) will also be required. **Soil Surveys Engineering is however not able to provide construction inspection services unless we have reviewed and approved any drawings prepared from our report PRIOR TO CONSTRUCTION COMMENCING**.

Further, vertical and lateral movement of soils will occur for any non-anchored system; movements occur as a result of stress release caused by the excavation.

The effect of potential vertical and horizontal movement on the adjacent road, services etc. must be carefully considered. Service location must be considered in the retention system design. The construction methods described may need to be modified following detailed design.

5.4.7 Dilapidation Survey

Adjacent buildings, roads and underground services are located adjacent to proposed works.

It is recommended that a dilapidation survey of adjoining structures, roads, etc. be carried out in order to establish their present condition prior to commencement of construction.

This survey should include the following:-

- The general condition of the property, i.e. condition of all exposed walls, pavement condition, etc.
- The extent of existing damage (if any)
- Photographs/video

Actual locations of underground services and adjacent building foundation systems should be established prior to construction.

5.5 Basement Retaining Walls

Retaining walls should be designed in accordance with AS 4678-2002 'Earth Retaining Structures'.

It is recommended that any retaining structure be designed in accordance with AS 4678-2002 'Earth Retaining Structures'. Section 3 of this code outlines the design requirements for these retaining structures which specifically includes both Ultimate and Serviceability Limit Modes. It is recommended that the retaining structures be assessed for each of these modes.

Please note that the following section provides general recommendations with respect to some of these limit modes, however, it doesn't provide a detailed assessment in full accordance with the above mentioned modes for AS 4678. A detailed assessment can be undertaken of the geotechnical aspects of the Limit Modes for the proposed retaining structures once details of the wall have been provided.

The following parameters (unfactored) may be adopted for basement wall design (Table 2).

Table 2 Parameters for use in Retaining Wall Design

Material		Density (kN/m^3)	Earth Pressure Coefficient			Long Term Drained Ø
			Vertical Wall			
			Ko	Ka	Kp	
Fill/Natural Soils		19	0.53	0.36	2.70	28°
Weathered Rock	**DW**	24	0.43	0.27	3.70	35°
	SW/FR	25	0.38	0.24	4.20	38°

Lateral pressure assessment must also consider hydrostatic pressure and surcharge loadings.

Adequate surface and subsoil drainage should be provided for all retaining walls on the site. Cut off/interceptor drains should also be provided around the high side of the wall t ensure stormwater runoff from the area above the wall is suitably diverted.

The placement of a filter fabric between the retained soil and the drainage material (e.g. granular backfill) for protection against silting of the drainage material is recommended. The outlets to subsoil pipe drains must be located beyond the ends of the walls and connected to a proper drainage system. It is suggested the pipes be wrapped in filter fabric to minimise silting.

5.6 Building Foundation

5.6.1 General

Following bulk excavations to create the basement, it is expected that the basement subgrade will comprise slightly weathered to fresh Tuff, ranging from high to very high strength.

Given the subsurface conditions encountered and expected buildings loads, pad footings could be considered with all footings founded into the high to very high strength Tuff.

5.6.2 Site Classification as per AS 2870-2011

According to AS2870-2011 the site has been designated Class ‘P’ due to the potential for the site to be subject to abnormal soil moisture conditions due to the removal of the building from the site.

Following bulk excavation exposing the weathered rock, Class ‘A’ conditions are expected.

5.6.3 Site Classification as per AS 1170.4-2007

It is recommended that the following coefficients be adopted for the design of the structure on this site according to AS 1170.4-2007 Structural design actions Part 4: Earthquake actions in Australia:-

- Hazard Factor (Z) = 0.08 – Figure 3.2 (F)
- Site sub-soil class (Refer Section 4 of Code) – Class Be – Rock Site

5.6.4 High Level Footings

High level strip/pad footings should be founded a minimum depth of 300mm into high to very high strength Tuff rock.

Footings founded into the high to very high strength Tuff may be designed to suit a minimum allowable bearing capacity of 3000kPa.

The above allowable bearing capacities are based on a Factor of Safety of 3.

It is recommended that all allowable bearing capacities are confirmed by an experienced geotechnical engineer/engineering geologist from Soil Surveys Engineering.

Settlement under load is expected to be essentially elastic on loading. When design loads are finalised, assessment can be made of expected settlements. It is anticipated that maximum settlements at these values of bearing pressure would be in the order of 10mm to 20mm under individual pad footings.

5.6.5 Adjacent Feature/Excavation Considerations

Where proposed or existing footings/piers (adjacent buildings) are located adjacent to proposed or existing feature/excavations (e.g. retaining walls, underground service trenches, etc), the effect of the feature/excavation on proposed or existing footings/piers must be carefully considered. Deepening of proposed footings/piers is expected to be required in such circumstances.

5.6.6 Inspections

It is recommended that inspections be undertaken by an experienced and qualified geotechnical engineer from Soil Surveys Engineering following footing and during pier excavations to confirm the adequacy of the founding soils. Inspections should be carried out prior to the placement of reinforcing steel and ordering of concrete.

5.6.7 Basement Slab

For design purposes, it is recommended that the basement slab be designed adopting principles as contained in the Cement & Concrete Association of Australia, Industrial Floors & Pavements, Guidelines for Design, Construction & Specifications.

It is envisaged that weathered Tuff will be exposed at basement level over the site, For design (but subject to inspection), a design CBR value of 20% and a modulus of subgrade reaction (k) of 70kPa/mm may be adopted where weathered rock forms the subgrade.

Inspections should be carried out during bulk excavation work to fully assess subgrade conditions and CBR values.

The basement slab will need to be designed for groundwater/seepage. A drained basement comprising an under slab drainage system (gravel drainage layer with a grid of 'ag' pipes) with permanent pumps could be considered subject to water quality issues, long term maintenance of pumps, etc. Please note that groundwater may need to be treated (prior to discharge) to bring water quality criteria to acceptable levels in accordance with Authority requirements.

6.0 Limitations

We have prepared this report for the use of **Landitude Pty Ltd**, for design purposes in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by parties other than **Landitude Pty Ltd**; it may not contain sufficient information for purposes of other parties or for other uses. Please note that any third party relying on the information contained in this report for any purpose whatsoever does so entirely at its own risk, and any duty of care to that third party is excluded.

Any interpretation or recommendation given by Soil Surveys Engineering shall be understood to be based on judgement and experience and not on greater knowledge of the facts than the reported investigations would imply. The interpretation and recommendations are therefore opinions provided for our client's sole use in accordance with the specific brief. As such they do not necessarily address all aspects of ground behaviour on the subject site. Information provided by others has been taken in good faith, but no liability can be accepted for information provided by others.

The preliminary nature of this study is emphasised.

Further geotechnical drilling and engineering assessment is required when access for large drilling rigs becomes available (i.e., post demolition works).

Your attention is drawn to 'Appendix A', 'Notes Relating to this Report'. Interpretation of factual data given in this report is based on judgement, not a greater knowledge of facts other than those reported.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore consider the spacing and depth of test locations, the method of investigation, the frequency of sampling and testing and the possibility of other than "straight line" variations between

the test locations. Subsurface conditions between and below test locations may vary significantly from conditions encountered at the test locations.

Please note that should, following detailed design, footings or piers/piles be required to extend within 3B (B = footing width/pier diameter) above the termination level of the boreholes or any excavations extend below borehole termination levels, Soil Surveys Engineering should be contacted immediately. In this case, geotechnical data in this report should be considered preliminary only; additional investigation is likely to be required.

If conditions encountered on site during construction appear to vary from those expected from the information contained in the report, the Company strongly recommends that it immediately be notified. Most problems are more readily resolved when conditions are exposed than at some later stage, after the event. Should Soil Surveys Engineering not be notified or if this notification is delayed, then Soil Surveys cannot be held responsible for the affect that any variation has on any aspect of the development.

Soil Surveys Engineering consider that a documentation review service (during the design phase and prior to construction) to verify that the intent of geotechnical recommendations is properly reflected in the design, along with construction inspections, forms a very important component of the geotechnical engineering design service/process.

The geotechnical review ensures geotechnical risks to our client and their project are minimised at the design and tender stage of the project. Further, with Soil Surveys Engineering being commissioned to carry out geotechnical construction inspections, an opportunity at the time of construction to confirm any assumptions made in the preparation of the report and allow the effect of any normally occurring variation in ground conditions to be assessed with respect to construction becomes available.

The above statements are not intended to reduce the level of responsibility accepted by Soil Surveys Engineering in accordance with our commission, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in doing so and the risks they accept should they decline to have Soil Surveys Engineering carry out a geotechnical documentation review and geotechnical construction inspections.

It is highly recommended that the Client avail themselves of these review and inspection services; our standard rates will apply.

Cameron Johnson (RPEQ 7052)
Principal Geotechnical Engineer

For and on behalf of
Soil Surveys Engineering Pty Limited

Appendices

Appendix A
Notes Relating to this Report

NOTES RELATING TO THIS REPORT

September, 2019

INTRODUCTION

These notes are provided by Soil Surveys Engineering Pty Limited (the Company) to complement the geotechnical report in regard to classification methods and field procedures. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited information about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such information obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and at the time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

Soils - The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726-2017 (Geotechnical Site Investigations), where appropriate. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the dominant particle size and behaviour as set out in AS 1726-2017.

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, shear vane, laboratory testing or engineering examination. The strength terms are defined in AS 1726-2017 Table 11.

Non-cohesive soils are classified on the basis of relative density usually based on insitu testing or engineering examination (see AS 1726-2017 Table 12).

Rocks - Rock types are classified by their geological names (AS 1726-2017 Tables 15 to 18), together with descriptive terms regarding weathering (AS 1726-2017 Table 20), strength (AS 1726-2017 Table 19), defects (AS 1726-2017 Table 22), etc.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon sample disturbance, (information on strength and structure).

Undisturbed samples are taken by pushing a thin walled sample tube, usually 50mm diameter (U50), into the soil and withdrawing it with 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, volume change potential 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.

SAMPLE STORAGE – SOIL, ROCK AND WATER SAMPLES

Soil samples (not subject to testing) are not stored beyond a period of 90 days of taking or receiving said soil sample. Rock core (not subject to testing) is not stored beyond a period of six months of taking or receiving said rock core.

Should any party require that soil samples (not subject to testing) be stored beyond 90 days, or rock core (not subject to testing) be stored beyond six months, please contact Soil Surveys Engineering.

Water samples (not subject to testing) are not stored beyond a period of seven days of taking or receiving water samples.

TEST LOCATIONS

Test locations (e.g. boreholes, CPT's, test pits etc.) were based on available access at the time of testing. Test locations may have been shifted if access was not suitable.

Unless noted otherwise, accuracy of test locations are to the accuracy of hand held GPS equipment.

INVESTIGATION METHODS

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

Test Pits - These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3.0m for a backhoe and up to 6.0m for an excavator. Limitations of test pits are the problems associated with 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 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the augers can occur on a variety of materials such as hard clay, gravel or rock fragments and does not necessarily indicate rock level.

Continuous Spiral Flight Augers - The borehole is advanced using 75mm to 300 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the augers. Information from the drilling (as distinct from specific sampling) is of relatively lower reliability due to remoulding, inclusion of cuttings from above or softening of samples by groundwater, or

uncertainties as to the original depth of the samples. Augering below the groundwater table has a lower reliability than augering above the water table. Various drill bits are attached to the base of the augers during the drilling. The depth of refusal of the different bit types can provide information as to the strength of the material encountered. Generally the 'TC' bit (a tungsten carbide tipped screw type bit) is used.

Wash Boring - The borehole is usually advanced by a rotary bit with water or fluid pumped down the hollow drill rods and returned up in the space between the rods and the soil or casing, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration. More accurate information on soil strata is gained by regular testing and sampling using the Standard Penetration Test (SPT) and undisturbed thin walled tube samples (U50).

Mud Stabilized Drilling - Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilize the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from regular intact sampling (e.g. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling - A continuous core sample is obtained using a diamond or tungsten carbide tipped core barrel. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable method of investigation. In rocks, NMLC coring (nominal 52 mm diameter) is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses is determined on site by the supervisor. If the location of the loss is uncertain, it is placed at the top end of the run, when the core is placed in a storage tray and recorded on the log.

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. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" - Test 6.3.1.

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

In the case where full penetration is obtained with successive blow counts for each 150 mm of, say 4, 6 and 7 blows, the record shows,

4, 6, 7 N = 13

In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm, the record shows:

15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, it is noted on the borehole logs.

A modification to the SPT test is where the same driving system is used with a solid 600 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid SPT are shown as "N_c" on the borehole logs, together with the number of blows per 150 mm penetration.

Cone Penetration Tests - Test Method - Cone Penetration Tests (CPT) are carried out in accordance with AS 1289 Test 6.5.1-1999, using an electrical friction-cone penetrometer.

The test essentially comprises the measurement of resistance to penetration of a cone of 35.7 mm diameter pushed into the soil at a rate of 10-20 mm per second by hydraulic force. The resistance to penetration is recorded in terms of pressure on the end area of the cone (cone resistance, q_c, in MPa) and friction on the side of the 135 mm long sleeve immediately above the top of the cone (friction resistance, f_s, in kPa). These forces are measured by electrical transducers (strain gauges) within the cone device. The ratio between friction resistance and cone resistance is also calculated as a percentage, i.e.-

$$\text{Friction Ratio (FR)} = \frac{\textit{Friction Resistance, } f_s\ (kPa)\ x\ 100}{\textit{cone resistance, } q_c\ (kPa)}$$

The friction ratio, FR, is generally low in sands (less than 1% or 2%) and generally higher in clays (say 3% or more). The interpretation of sandy clays, clayey sands and material with a high silt content is more difficult, but intermediate values (between 1% and 3%) would be expected. Highly organic clays and peats generally have a friction ratio in excess of 5%.

Static cone data is recorded in the field on disc for later presentation using computer aided drafting.

The equipment can be operated from any conventional drill rig. A total applied load in the range of 4 to 10 tonnes is required for practical purposes, although lighter loads may be used. The cone penetrometers are available with various capacities of cone resistance ranging up to 100 MPa for general purpose investigations, while a range of 0 to 10 MPa can be used where more sensitive investigations of soft clay are required.

The cone resistance value provides a continuous measure of soil strength or density, and together with the friction ratio, provide very useful indications of the presence of narrow bands of geotechnically significant layers such as thin, soft clay layers or lenses of sand which might otherwise be missed using conventional drilling methods.

The lithology of the encountered soils is interpreted from static cone data and is generally presented on the static cone log sheets.

It is important to note that the lithology is interpreted information and is based on research by Schmertmann (1970), Sanglerat (1972), Robinson and Campinalli (1986), modified to suit local conditions as indicated by borehole information and laboratory testing.

As soils generally change gradually it is sometimes difficult to accurately describe depths of strata changes, although greater accuracy is obtained with the static cone compared with conventional drilling. In addition, friction ratios decrease in accuracy with low cone resistance values, and in desiccated soils. As a result, some overlap and minor discrepancies may exist between static cone and nearby borehole information.

Portable Dynamic Cone Penetrometers - Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 100mm increments of penetration.

The DCP comprises a Cone of 20 mm diameter with 30 degree taper attached to steel rods of smaller section.

The cone end is driven with a 9 kg hammer falling 510 mm (AS 1289 Test 6.3.2). The test was developed initially for pavement subgrade investigations, and empirical correlations of the test results with California Bearing Ratio have been published by various Road Authorities. The Company has developed their own correlations with Standard Penetration tests and Density Index tests in sands.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological 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. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of 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 lower permeability soils, it may enter the hole slowly or perhaps not at all during the time the hole is open.
- A localized 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 bailed out of the bore and mud must be washed out of the hole or "reverted" if water observations are to be made.

More reliable measurements can be made by use of standpipes which are read after stabilizing at periods ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence 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 with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is important to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms and the attached explanatory notes summarize important aspects of the Laboratory Test Procedures adopted.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. The information provided in Soil Surveys Engineering reports is opinion and interpretation and not factual. The client/contractor increases their risk by not retaining the person who authored the geotechnical report, to carry out site inspection and review (overseeing role) during construction, to confirm opinion and interpretation expressed in the report is accurate. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. If this happens, the Company will be pleased to

review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. Since the test sites in any exploration represent a very small proportion of the total site and since the exploration only identifies actual ground conditions at the test sites, even under the best circumstances actual conditions may vary from those inferred to exist. No responsibility is taken for:-

- Unexpected variations in ground and/or groundwater conditions.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of other persons.
- Any work where the company is not given the opportunity to supervise the construction using the Companies designs/recommendations.

If differences occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

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

Extreme events including but not limited to the results of climate change, e.g. flood levels above previously identified levels, beach scour or erosion beyond normal expectations (as identified by local authorities) extreme rainfall events, war, espionage, sabotage may result in different conditions between time of investigation and time of construction.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information in Construction Contracts (1987)”, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances, where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are propose or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer. We would be happy to assist in this regard as an extension of our investigation commission. Construction drawings should be reviewed by Soil Surveys Engineering, with sufficient time to allow changes if required, prior to inspections. Otherwise Soil Surveys Engineering reserves the right to refuse to carry out inspections.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

i. Site visits during construction to confirm reported ground conditions
ii. Site visits to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, the stability of a filled or excavated slope; or
iii. Full-time engineering presence on site.

In the vast majority of cases it is advantageous to the principal for the geotechnical engineer who wrote the investigation report to be involved in the construction stage of the project.

The geotechnical engineer cannot take responsibility for variations in encountered conditions, where he is not given the opportunity to review plans for the proposed development with sufficient time to allow review and make changes to the proposed development if required, and where he is not given the opportunity to inspect the site and oversee construction methods with regard to site conditions with sufficient time to observe all relevant site conditions and operations.

RESPONSIBLE USE OF GEOTECHNICAL INFORMATION

Recommendations in our report are for design purposes only and provided on the basis that inspections are carried out to allow finalisation of opinions and recommendations contained in our report.

The geotechnical investigation consisting of field and laboratory testing has been carried out to indicate typical conditions by indicating conditions and parameters at the specific locations of boreholes/test pits. Subsurface conditions are indicated at these locations only and the inference of conditions between or away from these locations (interpolation and extrapolation) involves a certain degree of risk. Persons inferring such conditions or carrying out such inferences should do so with a degree of caution and conservatism which is commensurate with the consequences of the risk of error.

Estimates of volumes based on our findings require interpolation and extrapolation between test locations and as such may be significantly different from actual volumes.

Appendix B
Borehole Record Sheets

Soil Surveys Engineering Pty. Limited
Specialist in Applied Geotechnics
PO Box 317, Paddington, 4064
+61 7 3369 6000
info@soilsurveys.com.au
www.soilsurveys.com.au
SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH01

Project Number: 1-29185
Project Name: Multi Level Building
Location: Cnr Hamilton Pl & Campbell St, Bowen Hills
Client: Landitute Pty Ltd
Date: 21/07/2025

Easting: 503557 Northing: 6963980 RL:
Logger: CM/CO Operator: CM Machine: MCT-3

Drilling Method (TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	Samples and Remarks
	0.10		FILL Sandy SILT (ML): non-plastic, grey dark grey brown, soft, fine grained sand, with ash, moist.	
	0.40		NATURAL Distinctly weathered TUFF (DW): medium strength, light grey, orange brown.	
	1.0		TUFF, pink mottled orange, pyroclastic texture, with xenoliths, limonite staining.	0.66 m; J, **45°,** C, R, O, Z 0.81 m; J, **15°,** P, S, O, Z 1.03 m; J, **10°,** P, S, O, Z 1.27 m; J, **10°,** P, S, O, Z 1.75m, Is50 = 3.13 MPa
	2.00		TUFF, purple mottled orange, pyroclastic texture, with xenoliths and vesicles, minor limonite staining in joints.	2.00 m; J, **10°,** P, R, O, S 2.03 m; J, **15°,** P, R, O, Z 2.30 m; J, **10°,** P, S, O, Z 3.26 m; J, **20°,** P, R, O, S 3.74m, Is50 = 3.52 MPa 3.69 m; J, **10°,** P, S, O, Z 4.60 m; J, **0°,** P, S, O, S 4.87 m; J, **10°,** P, R, O, S 4.97-5.16 m; J, **80°,** U, R, O, S 5.10 m; J, **10°,** P, S, O, S 5.32 m; J, **5°,** P, R, O, Z 5.65 m; J, **10°,** P, R, O, S 5.97 m; J, **5°,** P, R, O, S 6.18m, Is50 = 3.56 MPa 6.23 m; J, **30°,** C, S, O, Z 6.28 m; J, **10°,** P, R, O, Z 7.23 m; J, **30°,** C, S, O, Z 7.79 m; J, **5°,** P, S, O, Z 8.12 m; J, **25°,** C, S, O, Z 8.29m, Is50 = 4.9 MPa 8.70 m; J, **5°,** P, S, O, Z 9.14 m; J, **40°,** C, R, O, S
	9.50		TUFF, purple mottled pink, pyroclastic texture, with xenoliths interbedded, with near vertical joints.	9.63m, Is50 = 3.34 MPa 9.52 m; J, **5°,** P, R, F, S 9.91-10.00 m; J, **70°,** C, R, O, S 10.52-10.64 m; J, **70°,** C, S, O, S
	11.0			

Comments:
1. Drilling fluid loss at 1.80m

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved: CJ
Date: 21/08/2025

Soil Surveys Engineering Pty. Limited
Specialist in Applied Geotechnics
PO Box 317, Paddington, 4064
+61 7 3369 6000
info@soilsurveys.com.au
www.soilsurveys.com.au
SOIL SURVEYS

BOREHOLE RECORD SHEET

Location Number: BH01

Project Number: 1-29185
Project Name: Multi Level Building
Location: Cnr Hamilton Pl & Campbell St, Bowen Hills
Client: Landitute Pty Ltd
Date: 21/07/2025

Easting: 503557 Northing: 6963980 RL:
Logger: CM/CO Operator: CM Machine: MCT-3

Drilling Method TC	WB	RR	NMLC	Casing	Depth	Graphic	Description	Samples and Remarks
							TUFF, purple mottled pink, pyroclastic texture, with xenoliths interbedded, with near vertical joints. *(continued)*	11.23 m; J, **10°,** C, S, O, S 11.31 m; J, **25°,** C, S, O, S 11.42 m; J, **10°,** P, S, O, Z
					12.0			11.80 m; J, **5°,** P, S, O, Z 12.02 m; J, **25°,** C, S, O, Z
								12.38m, Is50 = 3.88 MPa 12.33 m; J, **45°,** C, S, O, S 12.45-12.67 m; J, **75°,** U, S, O, S
					13.0			12.82-12.97 m; J, **75°,** U, R, O, S
								13.52-13.64 m; J, **75°,** C, S, O, S 13.73 m; J, **15°,** P, S, O, Z 13.92 m; J, **15°,** C, S, O, S
					14.0			14.22m, Is50 = 4.69 MPa 14.32-14.42 m; J, **65°,** C, R, O, S
					15.0			14.66-14.78 m; J, **70°,** U, S, O, S
								15.64 m; J, **45°,** C, S, O, S
					16.0			16.15 m; J, **45°,** C, R, O, S 16.21-16.32 m; J, **65°,** C, R, O, S 16.45m, Is50 = 2.95 MPa 16.50 m; J, **10°,** C, S, O, Z
					17.0			16.86 m; J, **55°,** C, S, O, S 17.16 m; J, **45°,** C, R, O, S 17.26 m; J, **30°,** I, R, O, S 17.30-17.47 m; J, **70°,** U, R, O, S
					18.0			17.83 m; J, **45°,** C, R, O, S 18.04 m; J, **1°,** P, R, O, S 18.27m, Is50 = 3.66 MPa 16.65-19.86 m; J, **75°,** U, R, O, S 18.32 m; J, **15°,** P, R, O, Z
					19.0			18.77 m; J, **50°,** C, R, O, S 18.93 m; J, **45°,** C, R, O, S
								19.54 m; J, **15°,** C, S, O, Z
					20.0			
					20.33			20.3m, Is50 = 4.71 MPa
							BOREHOLE BH01 TERMINATED AT 20.33 m	
					21.0			
					22.0			

Comments:
1. Drilling fluid loss at 1.80m

Water First Noted Water Steady Level

Weathering Grades
RS - Residual Soil
XW - Extremely weathered
HW - Highly weathered
DW - Distinctly weathered
MW - Moderately weathered
SW - Slightly weathered
FR - Fresh

Rock Strength
RS - Residual Soil
VL - Very low
L - Low
M - Medium
H - High
VH - Very high
EH - Extremely high

Samples
U50
SPT
Disturbed Sample
Bulk Sample

Approved: CJ
Date: 21/08/2025

BH01 - 0.40m to 5.00m (Box 1 of 5)

BH01 - 5.00m to 9.00m (Box 2 of 5)

BH01 - 9.00m to 13.00m (Box 3 of 5)

PROJECT NUMBER 1-29185			TITLE **CORE PHOTOGRAPHS** Multi Level Building
BOREHOLE NUMBER BH01	DATE 23/07/2025	CHECKED BY GB	
CLIENT Landitute Pty Ltd			
LOCATION Cnr Hamilton Pl and Campbell St, Bowen Hills			

SOIL SURVEYS ENGINEERING

BH01 -13.00m to 17.00m (Box 4 of 5)

BH01 - 17.00m to 20.33m (Box 5 of 5)

PROJECT NUMBER 1-29185			TITLE **CORE PHOTOGRAPHS** Multi Level Building
BOREHOLE NUMBER BH01	DATE 23/07/2025	CHECKED BY GB	
CLIENT Landitute Pty Ltd			SOIL SURVEYS ENGINEERING
LOCATION Cnr Hamilton Pl and Campbell St, Bowen Hills			

Appendix C
Laboratory Test Certificates

Soil Surveys Engineering Pty. Limited
Specialist in Applied Geotechnics
PO Box 317, Paddington, 4064
+61 7 3369 6000
info@soilsurveys.com.au
www.soilsurveys.com.au
SOIL SURVEYS

POINT LOAD INDEX TEST REPORT

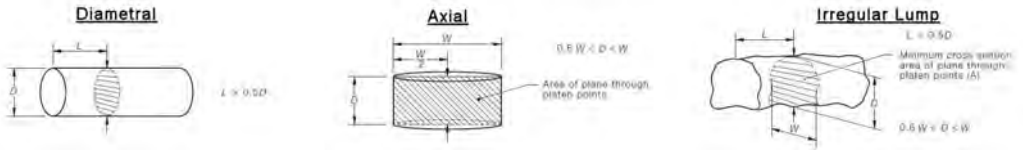
as per AS4133.4.1-2007

Project Number : 1-29185 **Project Name : Civil Construction Works**

Project Location : Cnr Hamilton Pl & Campbell St, Bowen Hills

Project Client : Landitute Pty Ltd

Borehole	Depth	Rock Type	Weathering Grade	Moisture Condition	Test Method	Core Size (mm)	Date Drilled	Date Tested	Failure Type	Failure Load (kN)	Is (MPa)	Is50 (MPa)	AS1726 Classification	Operator
BH01	1.75	TUFF	SW	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	8.3	3.07	3.13	VERY HIGH	CO
BH01	3.74	TUFF	SW-FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	9.4	3.46	3.52	VERY HIGH	CO
BH01	6.18	TUFF	SW-FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	9.5	3.49	3.56	VERY HIGH	CO
BH01	8.29	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	13.0	4.81	4.9	VERY HIGH	CO
BH01	9.63	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	8.9	3.28	3.34	VERY HIGH	CO
BH01	12.38	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	10.3	3.81	3.88	VERY HIGH	CO
BH01	14.22	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	12.5	4.61	4.69	VERY HIGH	CO
BH01	16.45	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	7.8	2.9	2.95	HIGH	CO
BH01	18.27	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	9.7	3.59	3.66	VERY HIGH	CO
BH01	20.30	TUFF	FR	Field	Diametral	52	21/07/2025	23/07/2025	Through rock mass	12.5	4.63	4.71	VERY HIGH	CO



Appendix D
Site Plan

SCALE: 1:350 at A4	DRAWING TITLE: **BOREHOLE LOCATION PLAN** Multi Level Building	CLIENT: Landitute Pty Ltd	SOIL SURVEYS
DRAWING NUMBER: 1-29185-01 / DATE: 21/08/2025 / CHECKED: ___		LOCATION: Cnr Hamilton Pl & Campbell St, Bowen Hills	