Broadcrest Consulting Pty Ltd

45-47 Denman Avenue, Kootingal, NSW

Geotechnical Report

July 2023

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Document controls

Approval and Authorisation

Title	45-47 Denman Avenue, Kootingal, NSW Geotechnical Investigation
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Signed:	[redacted]
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Document Status

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Contents

1 EXECUTIVE SUMMARY

Broadcrest Consulting Pty. Ltd. were engaged by Tycoon Consultants & Investments Pty Ltd to conduct a Geotechnical Investigation at 45-47 Denman Avenue, Kootingal, NSW ('the site'). The purpose of this report is to provide information on the subsurface conditions to guide the design of the subdivision and future lots. A desktop study was conducted on the 18/07/2023 to identify site features and constraints for the site inspection.

The objective of this geotechnical report is to collate data on the surface and subsurface conditions of the site, specifically:

- Soil classification
- Depth to rock (if encountered)
- Ground water level (if encountered)
- General geotechnical constraints
- Design parameters for retaining walls and foundations
- General comments and recommendations.
- Site classifications for each lot

A site inspection was initially carried out on the 20/07/2023 which involved a visual assessment of the site, drilling of 12 boreholes using UD 50 tubes and DCP testing to refusal.

Given the recommendations in Section 6 are followed, the site is considered suitable for development.

2 INTRODUCTION

2.1 Background

Broadcrest Consulting Pty. Ltd. were engaged by Tycoon Consultants & Investments Pty Ltd to conduct a Geotechnical Investigation at 45-47 Denman Avenue, Kootingal, NSW ('the site'). The purpose of this report is to provide information on the subsurface conditions to guide the design of the subdivision and future lots. A desktop study was conducted on the 18/07/2023 to identify site features and constraints for the site inspection.

A site inspection was initially carried out on the 20/07/2023 which involved a visual assessment of the site, drilling of 12 boreholes using UD 50 tubes and DCP testing to refusal.

No rainfall had occurred within the four days prior to the site inspection. Photographs were taken of the site features for future reference.

2.2 Objectives

The objective of a geotechnical report is to collate data on the surface and subsurface conditions of the site, specifically:

- Soil classification
- Depth to rock (if encountered)
- Ground water level (if encountered)
- General geotechnical constraints
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3 SITE DESCRIPTION

3.1 Overview

The proposed development is located at 45-47 Denman Avenue, Kootingal, NSW. The site is bounded by

- Residential lots to the north and south.
- Denman road to the west, and
- Pasture to the east

At the time of inspection, the site was unoccupied and vegetated with pasture grass and scattered trees. Several small stockpiles of soil and demolition waste were identified. No signs of fill material were identified.

Figure 3.1: Site location with borehole locations

3.2 Historical Aerial Photography

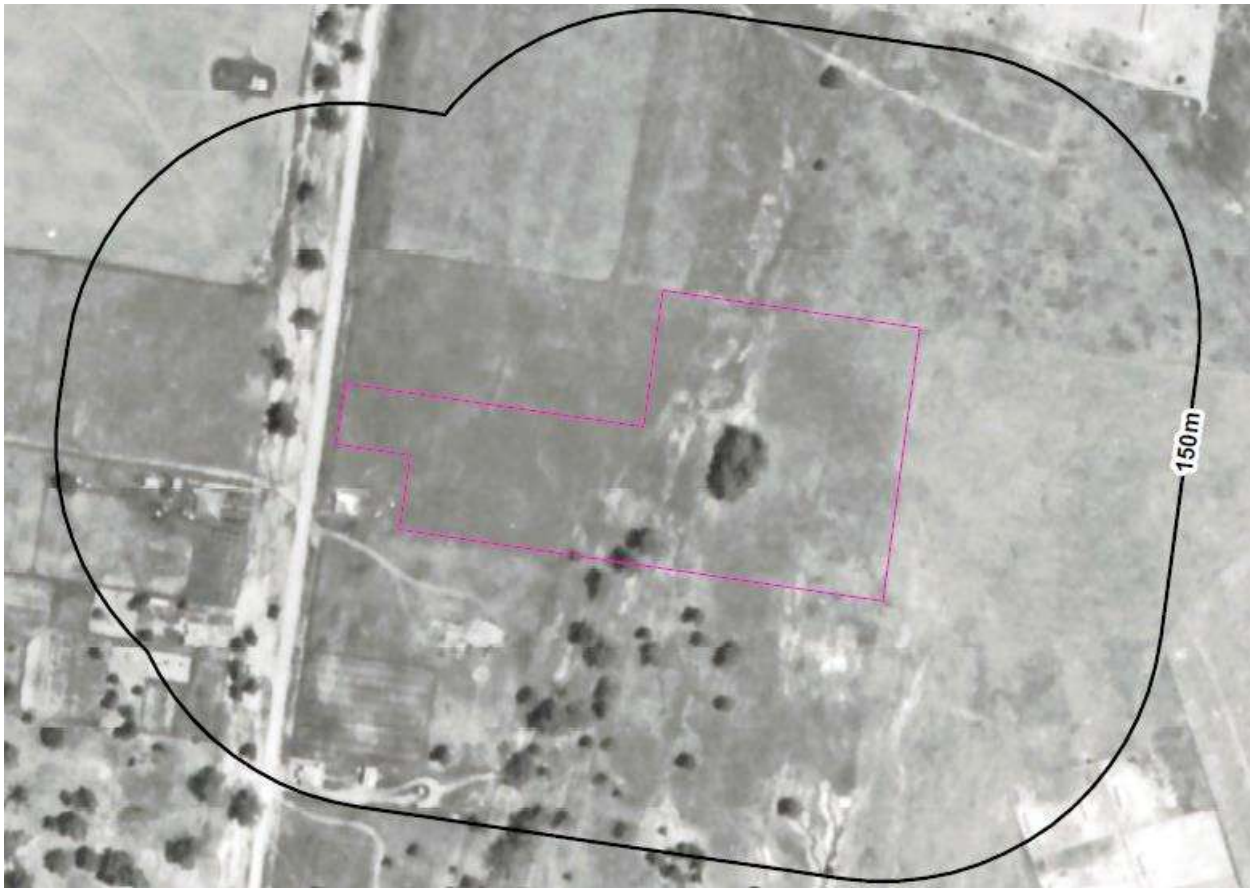

Figure 3.2.1: The 1943 imagery shows a vacant site vegetated with grass

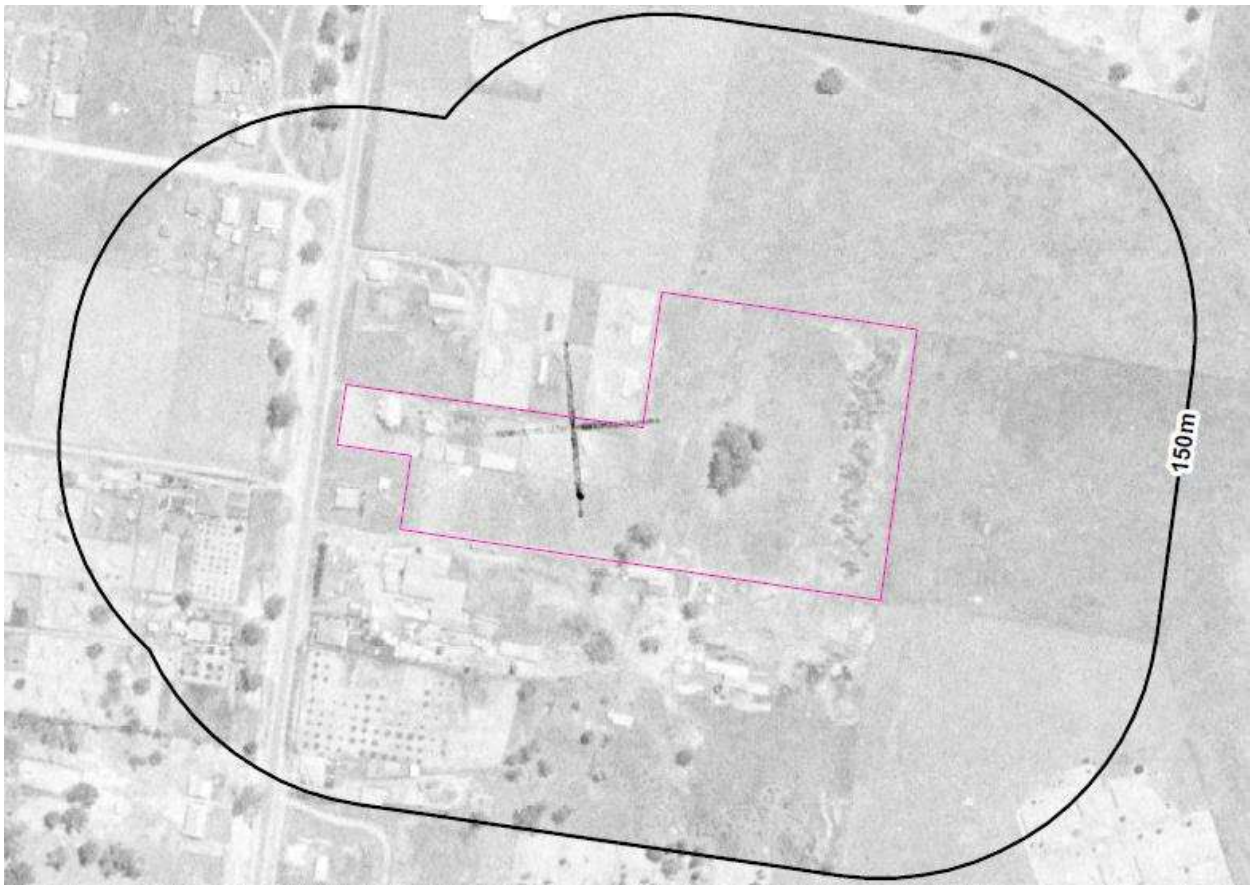

Figure 3.2.2: The 1954 imagery shows a new house and several nearby sheds on site

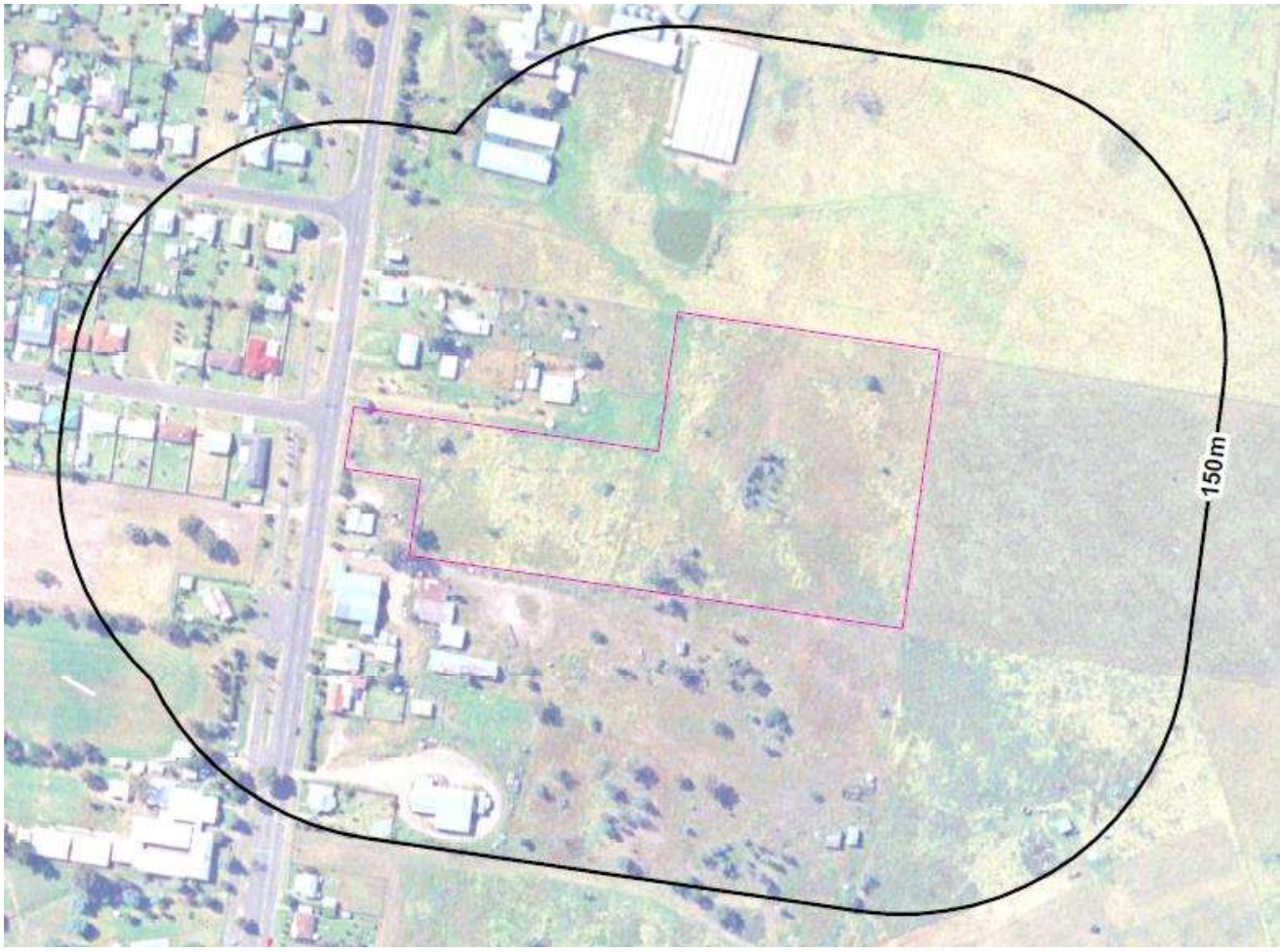

Figure 3.2.3: The 1997 imagery shows the houses and sheds have been demolished

3.3 Surface Observations

Field work was conducted by Broadcrest on the 20th of July 2023. During the inspections the following observations were made:

- The site is on a gently inclined hillside, sloping to the south
- The majority of the site was covered by pasture grass with isolated stands of trees.
- Access to the site can be made via Denman Ave to the east, Orchid drive to the south, or off Reginald Drive to the north.
- The site contained some dirt tracks, likely from vehicular movement.

Figure 3.1: Photo of the site looking from the south west to north east.

4 INVESTIGATION FINDINGS

4.1 Review of Surrounding Investigations

A desktop review was conducted surrounding the site to identify any publicly available investigations nearby. These investigations were read at a high level only to gain an understanding of the surrounding geology and subsurface conditions. No nearby geotechnical reports were identified for review, with the closest being Tininhull public school ~6.0km away

Table 4.1.1: Nearby geotechnical investigations by others

Name	Distance	Relevance
Tintinhull Public School: geotechnical investigation - Geotechnical Engineering - 2011	~6000m	Very Low
Groundwater Bore 10028928 - Drillers Log - Sand to 2.0m - Granite bedrock	~55m	Moderate

4.2 Geology

4.2.1: Desktop Review

A review of the NSW Simplified Geology mapping suggests the site is situated within PGi: Granite - I-type granite (see figure 4.2.3). These granites are interpreted to form by melting of igneous source rocks. Common minerals are quartz, feldspar, and biotite. The presence of amphibole is characteristic.

4.2.1: Site investigation findings

No coring was completed as part of the geotechnical investigation, and all observations were based on the recovered weathered rock from a TC-bit. The drilling indicates a transition between Sandstone (significant iron stone fragments present) over potential shale.

4.3 Soil Landscape

The Soil Landscape mapping lists the site within disturbed terrain, which indicates significant human influence through cut and fill actions.

Figure 4.2.3: NSW Seamless Geology

4.4 Subsurface Soil Conditions

Broadcrest Consulting completed the drilling, DCP and soil sampling for classification. The drilling process involved

- U50 undisturbed tube samples to refusal on rock
- DCP testing to refusal
- Field classification of strata encountered
- Logging of recovered soil samples (see Appendix A)

All boreholes were highly consistent, featuring:

0-200mm:	Topsoil, SAND with trace of gravel:
200-800mm:	CH: Sandy Silty CLAY with trace of gravel:
800 – 1000 Refusal:	EW Granite, presenting as Sandy CLAY with trace of gravel

The borelogs contained in Appendix A should be reviewed for detailed information on the encountered conditions, including depths.

Figure 3.1: Borehole 3 – Typical soil profile

4.5 Groundwater

No groundwater was encountered during the investigation.

4.6 Cut and Fill

No cut and fill was identified on the site.

5 SITE CLASSIFICATIONS

Site classifications for each lot have been determined based upon the desktop review, site investigation, soil classification and soil testing.

Lot 1, 4, 5, 6, 8, 14, 15, 22 and 23:
Based on the conditions encountered, it is recommended that the structural engineer select a footing system compatible with **Type P site classification** (AS 2870-2011) due to tree removal and/or existing structures. It may be possible to reassess the classification once the building envelop is known to a type S site classification.

The soil reactivity is anticipated to be slightly reactive (y_s = 20mm).

All other lots:
Based on the conditions encountered, it is recommended that the structural engineer select a footing system compatible with **Type S site classification** (AS 2870-2011).

The soil reactivity is anticipated to be slightly reactive (y_s = 20mm).

6 COMMENTS AND RECOMMENDATIONS

6.1 Site Preparation

Material removed from the site will need to be managed in accordance with current legislation and may require material type classification in accordance with NSW EPA (2014) Waste Classification prior to removal. Soil should be disposed at appropriately licenced facilities. Natural soil and bedrock may be classified as excavated natural material and re-used on other sites rather than disposed at a landfill, although it must be proven to be free of contamination.

Removal of soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in nearby waterways and on neighbouring land. All spoil on site should be properly controlled by soil erosion control methods in accordance with Landcom (2004) to prevent transportation of sediments off-site.

6.2 Groundwater

The infiltration of groundwater into an open excavation is likely to occur during and following rainfall events. Given the soil structure, the infiltration rates are expected to be low-moderate and should be manageable with a sump pump.

6.3 Excavation

Soils can be readily excavated using conventional earthmoving equipment. All excavation work should be completed with reference to the Code of Practice 'Excavation Work' (Oct 2013) by Safe Work Australia. Excavation method statements will need to be prepared by the excavation contractor prior to the issue of a CC.

6.4 Vibration

7.4.1 Structural

During excavation it will be necessary to use appropriate methods and equipment to keep ground vibration within acceptable limits. A typical provisional allowed vibration limit of 8.0 mm/sec Vector Sum Peak Particle Velocity (VSPPV) is considered standard industry practice for earthworks.

The German Standard DIN 4150-3 (Structural Vibration: Effects of Vibration on Structures) provides guideline values for short term vibration velocity at foundations. Short term vibration is classified as vibrations which do not occur often enough to cause structural fatigue.

Table 7.4.1 - Structural Damage – Short Term Vibration (mm/s) – German DIN 4150-3

Type of Structure	Velocity values in mm/s at the foundation at a frequency of			Plane of floor of uppermost storey
	Less than 10Hz	10-50Hz	50-100Hz	All frequencies
Building use for commercial purposes, industrial buildings and buildings of similar design	20	20-40	40-50	40
Dwelling and buildings of similar design and/or occupancy	5	5-15	15-20	15
Structures that because of their particular sensitivity to vibration and are of great intrinsic value (e.g. heritage listed structures)	3	3-8	8-10	8

It is recommended that building condition (dilapidation) surveys of adjacent buildings be undertaken prior to commencement of excavation. The building foundation types and conditions should be determined where possible, so as to assess the maximum acceptable vibration level to reduce the likelihood of damage and to provide evidence in the event of any damage claims.

7.4.2 Human comfort criteria

The human annoyance vibration assessment should be undertaken using the EPA's publication 'Assessing Vibration: A Technical Guideline', based on the BS 6472 Standard. This Guideline covers the appropriate methods and criteria for the assessment of the intrusive vibration on living and working space. The guideline describes the following:

- The characteristics of vibration and associated effects that can cause community disturbance and concern to people, in particular the occupants of buildings.
- Criteria defining values of vibration to protect amenity.
- Procedures for the measurement and evaluation of vibration values and other associated emissions.

A summary of the VDV criteria for human comfort limits are adopted from the EPA's publication 'Assessing Vibration: A Technical Guideline and are presented in Table 7.4.2 below.

Table 7.4.2 - Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night Time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical Areas[2]	0.10	0.20	0.10	0.20
Residents	0.20	0.40	0.13	0.26
Offices, Schools, Educational, institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

1) Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2) Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472–1992

6.5 Retaining Structures

Any excavation greater than 1.0m will require an appropriate shoring system or battering. For shoring of excavations greater than 2.0m are to be checked by a suitably qualified and experienced Geotechnical Engineer. Where a neighbouring structure is within the zone of influence of a retaining wall (section 6.5.4) advice should be sought from a geotechnical engineer.

6.5.1 Batter Slopes

Recommended maximum temporary batter slopes for the sub-surface materials present are given in Table 7.5 for completeness.

Table 7.5: Allowable batter slopes (H : V ratio)

Material	Short term[2]	Long term[2]
Clay - Firm	1.5 : 1	2 : 1
Clay – Stiff+	1 : 1	2 : 1

1) Subject to inspection by an experienced geotechnical engineer or engineering geologist
2) For cut heights no greater than 1.0m
3) Batters are note appropriate below ground water level

Suitable erosion and sediment prevention plans should be designed and implemented for all unsupported slopes. For long term batters, the slope is stabilised through the use of engineered design and/or appropriate vegetation. An environmental and risk analysis must be performed to ensure the risks from erosion, run-off and slope failure are managed and within acceptable limits.

6.5.2 Temporary shoring

Any temporary excavations into soil exceeding 2.0m depth should be supported by suitably designed and installed shoring system (in accordance with AS4678 Earth Retaining Structures). The soil pressure can be calculated using the Terzaghi formula for clay. The Engineer must include the ground water pressure in their capacity calculations unless a suitable external dewatering system is used and maintained.

For temporary shoring, it is typically adequate to select a shoring system which won't retain water and monitor the ground water in and beside the excavation to ensure compliance. Dewatering near existing structures can cause settlement. If dewatering near a structure an assessment by an experienced engineer should be sought prior to commencing works.

6.5.3 Permanent shoring

All permanent retaining structures must be designed by a qualified and suitably experienced Engineer in accordance with AS4678 and/or all applicable standards, legislation and guidelines. Full hydrostatic pressure from surface level should be assumed to account for events such as heavy rain and flooding.

6.5.4 General

The retaining wall designer should consider the additional surcharge loading from existing structures, construction equipment, backfill compaction and ground water.

Backfill should comprise of engineered fill, free of organic material, contaminants and deleterious substances and having a maximum particle size of 30 mm. Backfill should be placed in maximum 300 mm thick layers compacted using a hand-held compactor. Care should be taken to ensure excessive compaction stresses are not transferred to retaining walls. Appropriate drainage should be provided between backfill/soil exposure and retaining walls (e.g. strip drains and ag-line in free draining gravel).

Use of heavy machinery should be avoided, where possible, within 2 m of the crest of any open soil excavation greater than 1.0m to prevent excessive local surcharge loads, vibrations and undue settlement within exposed soils. Careful consideration of nearby structures (e.g. footings, services, utilities, etc.) must be given when they are within the excavation zone of influence. The excavation zone of influence extends as a triangle from the base of the excavation to ground level at 2H:1V. If any structure, utilities, etc, fall within this zone a qualified and suitably experienced engineer shall design a shoring system and develop an installation methodology which limits the settlement and horizontal movement so the structure will not be affected.

6.6 Footings

All top soil should be removed prior to construction of any structures or surface infrastructure. Table 6.1 below contains allowable bearing pressures which may be used for preliminary purposes. Design specific calculations should be completed using the DCP results, soil classification and applicable formulas at the design phase of the structures.

Table 6.1: Allowable bearing pressures*

DCP Result blows/100mm	Allowable bearing pressure (KPa)
4	80
6	140
10	220

* Based upon a 1m^2 footing at 0.3m below surface.

If socketing into the underlying XW granite, an allowable bearing capacity of 700kPA for piers between 300 and 500mm in diameter may be assumed.

All footings should be inspected by a geotechnical engineer prior to pouring.

6.7 Fill material

If filling more than 0.5m the reactivity is likely to increase and advice should be sought from Broadcrest Consulting.

Where fill material is introduced, bearing capacities are based upon the quality of compaction (see section 6.8). It is generally recommended that slabs should be piered through any fill material to prevent differential settlement.

If any foundations are proposed to bear on fill material, any retaining walls within 5.0m must be designed by a suitably qualified engineer based on an at rest condition (i.e, Kp with no movement).

Any alterations to existing surface levels on the site shall be undertaken in such a manner as to ensure that no additional surface water is drained onto or impounded on adjoining properties.

6.8 Compaction

All fill must be placed in accordance with Australian Standard AS 3798 'Guidelines on Earthworks for Commercial and Residential Developments'.

Materials preferred for use as engineered fill are well-graded granular materials, such as ripped or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in layers not greater than 200mm loose thickness, to a minimum density of 98% of Standard Maximum Dry Density (SMDD). After compaction, testing shall be conducted to verify that the level of compaction has been achieved though appropriate testing.

We recommend that at least Level 2 control of fill compaction, as defined in AS3798-2007, be adhered to on this site. However, if a floor slab is to rely on engineered fill for support, then we recommend a higher compaction control of Level 1. Preferably, the geotechnical testing authority (GTA) should be engaged directly on behalf of the client and not by the earthwork's subcontractor.

6.9 Engineering Plans

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained.

Once preliminary / proposed plans are completed, they should be assessed by a geotechnical engineer to ensure the recommendations within this report are sufficient. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented. All documentation should include construction notes with the relevant recommendations from this report included. A reference for the full geotechnical report and how to obtain it should be made within the construction notes.

7 LIMITATIONS OF THIS REPORT

This report has been prepared subject to a number of limitations. These include:

The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose;

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all point.;

In preparing this report, Broadcrest Consulting Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Broadcrest Consulting Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Broadcrest Consulting Pty Ltd assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Broadcrest Consulting Pty Ltd; and

This report is not to be relied upon for any purpose other than that defined in this report.