Appendix C

Preliminary Geotechnical Assessment

Memorandum

To:	Ying Liu	**Date:**	12 June 2018
From:	Jacqui Coleman	**Our Ref:**	4216997
Copy:			
Subject:	MOE Drury West Primary School, Due Diligence Assessment - Geotechnical Desktop study		

1 Introduction

The Ministry of Education (MOE) has commissioned Beca to provide consultancy services to evaluate, assess and designate a site for a potential primary school in the Drury West Special Housing Area (SHA) in Drury, South Auckland. A due diligence assessment has been undertaken and a preferred site has been identified.

The designated site is located at the northern end of 41 Burberry Road (refer Figure 1) and is in the order of 3ha in size. The site is made up of four packages of land which are identified as Areas A, B, C and D. This desk top appraisal is also to inform the valuers of any potential geotechnical risks and allow them to price each of the packages of land for purchase.

Figure 1: Site Plan of proposed Drury West primary school. The area of each of the packages of land is as follows:

A= 0.09ha

B= 0.34 ha

C= 0.29 ha

D= 2.28 ha

2 Site Description

The sites are at an elevation of RL 15m and are relatively flat, with both site A and D sloping gently to the northwest and west. A gas pipeline is located just west of the western boundary of property D. The topography of each of the packages of land is as follows:

- A - gently slopes to northwest, flatter than 1V:10H.
- B - gently undulating, flatter than 1V:10H.
- C - virtually flat, the western boundary is susceptible to flooding.
- D - >90% flatter than 1V:10H, there is a steep slope just west of western boundary.

3 Geology and Faulting

The published geological map (Edbrooke, 2001) indicates that this site is underlain by Puketoka Formation sediments, including mud, silts, pumiceous silty sands, interbedded with organic layers, and overlain by weathered volcanic soils. The Puketoka Formation is less than 2 million years old and based on well logs in the area is potentially up to 45m thick. These sediments overly 5 million year old Kaawa Formation shelly sandstones and mudstones, and the 20 million year old Waitemata Group rock at depth.

3.1 Faulting

The nearest active faults to the site, being faults that have shown activity within the last 125,000 years (GNS active fault database), are:

- Drury Fault - 4km east,
- Wairoa North Fault - 15km east, and
- Kerepehi Fault - 50km east

Of these faults, the Kerepehi Fault has shown the most recent activity between 2,000 to < 3500 years ago.

4 Previous Investigations

Twenty eight handaugers were drilled up to 3m depth, on neighbouring properties as part of a 2016 investigation (Lander, 2017) to assess ground conditions for development of a future subdivision in the area. The nearest hand augers are some 340m southwest of the site.

Two water bores were also drilled east of the site for domestic supply in the area.

5 Ground Profile and Land Use

The nearest ground investigations, located 340m to the southwest of the site (Lander, 2017) indicate the following ground profile:

- Topsoil 100 mm to 500 mm thick, averaging 200 mm
- 0.2 -16m - stiff to very stiff clayey silts with some localised layers of organic rich soils
- 16 - 42m sand/ soft sandstone
- 42 - 46m peat/lignite

- 46m+ Kaawa Formation

Within some of these nearby investigations groundwater was encountered at 3m below ground level.

5.1 Land Use Capability

The Auckland Council Unitary Plan Figure 9.3 Land Use Capability (LUC) indicates that the site lies within a category 2 versatile soils classification. This is land with slight to moderate physical limitations for arable use. Factors contributing to this classification are readily available water, favourable climate, favourable topography, good drainage, and soils easily adapted to a wide range of agricultural uses.

However, historically there have been many issues with drainage (when irrigation is required for horticultural purposes) in these clay rich soils, and we would not recommend soakage/groundwater disposal in the near surface soils

6 Geotechnical Risks

6.1 Foundations

Without site specific investigations, softer ground or lenses of organics may be present and if present, can pose constraints to shallow foundations.

Clay rich soils of the Puketoka Formation are considered to be susceptible to settlement by large loads, as well as sensitive and expansive, which foundation design will need to consider.

6.2 Slope Stability

The packages of land are flat to gently sloping, with no obvious signs of instability as viewed from Auckland Council Geomaps viewer.

However, the western boundary of package D slopes down to a farm dam. To reduce the potential risk of lateral spreading or seismic induced slope movements, we recommend that buildings be setback from this boundary. This potential setback would be confirmed during detailed design.

6.3 Earthworks and Infrastructure

The Papakura peat map (Papakura District Council, CBR01 Rev 0) indicates that the clay rich soils of the site have a CBR of between 3 and 7% which indicates moderate to potentially high strength soils and the potential for good engineering characteristics for foundations and earthworks handling. This is validated by the results of nearby hand auger investigations indicating that the near surface soils are typically stiff to very stiff clayey silts. However, without site specific investigations, localised areas of softer weaker or organic rich ground can be expected and the following potential hazards:

- Localised settlement of services and road pavement, if organic lenses are present
- Sandy pumiceous soils may be prone to piping soil erosion
- Weathered pumiceous soils of the Puketoka Formation are known to be sensitive on disturbance and contain halloysite and allophane clay minerals which require specific conditioning and handling during earthworks.

6.4 Flooding

30% of land package D is within the mapped floodplain area. This area will require specific drainage and investigation to asses for soft problematic soils.

6.5 Seismicity and Liquefaction

Although South Auckland is generally an area of low seismic risk (Edbrooke, 2001), and the clay rich soils of the Puketoka Formation are considered to have a low risk of liquefaction susceptibility, we recommend site investigations be undertaken to determine the site subsoil class to allow appropriate design of the foundations and building structures.

7 References

Edbrooke, S.W (compiler), 2001: Geology of the Auckland Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 3.

https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html

Lander Geotechnical, 2017: Preliminary Geotechnical Appraisal Report for Auranga Development B1, Drury.

Papakura District Council (unknown date): Papakura District CBR strength of soils, CBR01 Rev 0, 1:25,000 at A1 map.

8 Applicability

This memorandum has been verified by a geotechnical professional on the basis of the agreed commission. No amendments should be made to the content of this document without subsequent re-verification by the geotechnical author and verifier.

Jacqui Coleman
Associate - Engineering Geology
Direct Dial: +64-9-308 0868
Email: jacqui.coleman@beca.com

17 February 2017 Ref No: J00557

Karaka & Drury Limited

Attention: Mr M Tollemache

Dear Mark

RE: Preliminary Geotechnical Appraisal Report for Auranga Development B1, Drury

1 INTRODUCTION

Lander Geotechnical Consultants Limited have been engaged by Karaka & Drury Limited to undertake a desktop study and preliminary field investigation of geotechnical conditions within a study area delineated by the red boundary on attached Figure 01 and also depicted on the attached McKenzie & Co Consultants Limited drawings, known as the Auranga Development B1.

2 SCOPE AND OBJECTIVES

Our brief principally relates to the preparation of a Preliminary Geotechnical Appraisal Report (PGAR), in order to support a comprehensive structure planning process and subsequent plan change application.

More specifically, our scope of work for the PGAR comprises:

- Summary of the main topographical features present, soil types and underlying geology, areas of obvious historic land modification (e.g. fill), and potential constraints to future urban development
- The results of the Lander Geotechnical preliminary geotechnical field investigation to assess the nature, bearing qualities and relative uniformity of the subsoils to the depths likely to be affected by any future land development works and future building loads
- Preparation of a PGAR presenting the findings of this preliminary work

In preparing this report, Lander Geotechnical have reviewed the following previous plan variation report:

- Lander Geotechnical Consultants Limited, Preliminary Geotechnical Appraisal Report, Auranga Bay Development, Bremner Road, Drury, reference J00137, dated 19 January 2016

In addition, we have undertaken detailed studies on many properties within the Auranga A area to support various Resource Consent applications, and have drawn upon our experience here.

Lander Geotechnical Consultants Limited
P O Box 97 385, Manukau, Auckland 2241
Phone: 027 488 6882
Email: shane@landergeotechnical.co.nz

3 SITE SPECIFIC APPRAISAL FOR THE AURANGA BAY STUDY AREA

3.1 Site Description

3.1.1 General

The study area ("the site") comprises a number of separate properties, the legal descriptions and respective areas of each are able to be ascertained from Council's GIS database if required. The B1 area encompasses the central and north-western portions of the overall B1, B2 and B3 Auranga plan variation (B2 and B3 are covered by separate Geotechnical Reports). Generally speaking Bremner Road bisects through the central portion in an east to west direction and leads onto Jesmond Road that trends along the western boundary in a north to south direction. The northern portions of the site are flanked by short but steep slopes to a tidal river. Beyond the western, southern and eastern boundaries are existing farms and pastured land.

The majority of the site is in pasture or used for horticulture (glass house) activities. There are numerous dwellings and ancillary structures across the site associated with the current land uses.

The topography of the site is characterised by broad undulations and rolling terrain. Two shallow incised water courses are situated in the north-western section of the site and discharge into the tidal river to the north. There were no obvious signs of large scale instability or land modifications as a result of our preliminary work.

3.1.2 Tidal Margin

The foreshore tidal area associated with the study area is characterised by typically very steep to sub-vertical slope gradients (cliffs) of no more than an estimated 5m in height. For the most part these slopes are a covered by scrubby growth and gorse. One or two relatively minor erosional features (shallow seated slippage of overburden materials) are observed, mainly where the outside elbow of the tidal river forms. Otherwise there are no obvious no large scale slope instability feature along this foreshore area. Regression rates of the foreshore due to tidal influences and sea level change is beyond the scope of our service and we understand this will be addressed by others, if required.

3.2 Geology

The geology of the area is covered in a 1:250,000 scale map by Schofield (1967) and in numerous Auckland Regional Water Board groundwater resource publications, although not in great detail.

Better descriptions of the soils encountered on similar terrain to the north of the site are presented in Kermode (1991, 1992) and these have been used below:

- The site is underlain by the Puketoka Formation of the Tauranga Group sedimentary lithology (Late Pliocene – Early Pleistocene epoch). In summary, these deposits comprise terrace alluvium (clays, silts, sands, pumiceous silts and organic deposits) overlain in places by weathered volcanic ash.
- More specifically, the Puketoka Formation consists of undifferentiated, mainly pumiceous deposits of light-grey to orange-brown, well sorted (some graded, bedded 2-200mm), mud, sand and gravel comprising angular to well-rounded rhyolite pumice clasts and weathered rock derived from, the hinterland. Minor beds comprise white, pumiceous silt and clay, and black peat with rich organic clay. The deposits are very soft to soft, and weather to very soft, variously coloured clays, to depths as much as 10m. The formation is possibly up to 60m

thick (however Lander Geotechnical's observations of other study areas nearby to the north would suggest such a thickness may not exist here)

3.3 Earthquake Risk and Liquefaction Potential

Based on our knowledge of the Hingaia Peninsula (directly to the north, across the tidal river) and the Auranga A area (to the east), the general area is reportedly a low risk from earthquake occurrence. According to previous studies at Hingaia (which are considered to be applicable here), the Drury, Glenbrook, Karaka and Wairoa faults are reportedly the closest active faults and are located within approximately 5km of the study area.

- Development of the site should take into account earthquake risk and the design of future building foundations would likely need to include seismic loadings, as would be the case elsewhere in Auckland. Based on our experience at the Hingaia Peninsula just to the north, which is in the same geology and of similar topography, liquefaction potential is considered to be low risk in this local geology

3.4 Preliminary Borehole Findings

Our fieldwork covered the Auranga B1, B2 and B3 areas, and was undertaken on 25 January 2017 and 7 February 2017. It involved the drilling of 28 hand auger boreholes to depths of up to 3 metres. Of these hand augers, 12 were relevant to the B1 area (HA 2017-01 to 2017-12) and the positions are shown on attached Figure 01. A summary of findings is as follows:

- Topsoil was encountered at all borehole locations and ranged between 100mm and 500mm in thickness, averaging approximately 200mm.
- The natural subsoils investigated by our boreholes predominantly consisted of inorganic orange, brown, grey and yellow clayey silts, silty clays, silts and clays, with occasional sand and limonite inclusions. Organic inclusions was encountered in HA2017-05.
- Organic soils were encountered in HA's 2017-05 and comprised stiff, brown, organic clayey silts and silty clays from 0.5m to 1.4m depth.
- No filling was detected at our borehole locations although in farm environments the presence of old offal pits or rubbish pits can never be discounted.
- Vane shear strengths measured typically returned readings between 63kPa and UTP (unable to penetrate), indicating stiff to hard natural soils across the site. Isolated readings in HA2017-05 identified firm soils (i.e. less than 50kPa) at 1.5m and 3.0m depth, showing that there is some variation and pockets of weaker ground. Sensitivities to disturbance were typically in the range 2 – 5 (moderately sensitive to sensitive).
- Groundwater was encountered in HA's 2017-05 and 2017-07 at 2.8m and 2.7m depth respectively. Standing water levels measured at the completion of drilling were at depths of 3.0m and 2.8m respectively. Groundwater was not encountered in our other borehole locations during the time of our investigation.

3.5 Geotechnical Considerations

3.5.1 Foundations for Buildings

Where inorganic natural ground is present, bearing capacity is expected to be in accordance with the limitations imposed by NZS3604 (i.e. 300 kPa geotechnical ultimate). However, as is evident from the

borehole findings to date the natural soils can contain pockets of weaker ground and/ or lenses of organics.

- Softer ground or lenses of organics can pose constraints to NZS3604 building foundations and residential end use, necessitating remediation during earthworks construction or specifically designed foundation solutions (e.g. “raft” foundations). Lander Geotechnical’s experience in the delivery of hundreds of building platforms to the north (in the Hingaia area) indicates only a small proportion of lots may be affected by soft ground or organic soils, but in due course more intensive physical site investigations associated with the Qualifying Developments will substantiate this risk.
- The soils are likely to fall within AS2870 Class M to H expansive site class, and this is subject to laboratory testing of soil samples collected during later more intensive investigations for the Resource Consent phase(s). Foundation design for end users will need to mitigate adverse effects from expansive soils.

3.5.2 Ground Stability

For the most part the land is gentle and rolling with no obvious signs of ground instability. However, the northern boundary of the site is characterised by relatively short, but sub-vertical to steep foreshores to a tidal river that display signs of active erosion and regression in localised areas.

- Consideration to development setbacks from the short, but steep, coastal slopes will need to be assessed during detailed geotechnical site investigations of the land for Resource Consent.
- Precedence at the Hingaia Peninsula to the north would suggest an Esplanade Strip of 20m (from MHWS) would be sufficient to accommodate long term regression of the tidal foreshore slopes and it is foreseeable that there would be little (if any) requirement for engineering intervention to minimise the rates of regression. In this case, there should be no undue concerns for future land use, provided any (Council owned) infrastructure within the Esplanade Strip is appropriately sited for longevity. However, specific comments relating to actual regression rates due to tidal influences and sea level rise are outside the scope of this report and may be commented on by others, if required.

3.5.3 Earthworks and Infrastructure

The natural deposits encountered across the site are typically of high strength and have good engineering characteristics for foundations and earthwork handling. Largely inorganic soils of relatively stiff to very stiff strength will be identified, although organic lenses and weaker sensitive layers are apparent in these materials.

- The natural soils may be prone to piping (internal) soil erosion particularly if they are found to contain high pumice content, however very little (if any) pumice was identified in the preliminary investigations for this report. Further geotechnical investigation should therefore assess this risk, especially if on-site stormwater management systems (e.g. rain gardens, attenuation ponds, etc.) are proposed.
- The identified materials can be sensitive to disturbance during earthworks and repetitive trafficking from heavy machinery, and some boreholes displayed isolated lenses that would have these characteristics. Careful site management and/ or subsoil drainage have been effective in minimising subgrade degradation issues on recent large residential developments in similar geology at the Hingaia area to the north. The deeper deposits in particular is likely to require conditioning prior to placement as filling as insitu moisture contents will likely be higher than those required for optimum compaction.

- Deep trenches are prone to collapse especially where ground water conditions change rapidly and the materials are less cohesive, but this risk can be minimised by appropriate shoring or battering as required by legislation and safe construction practices.
- Road subgrades are prone to degradation once exposed to the elements, but is normally dealt with by engineering design (e.g. subgrade improvement via undercutting and replacement, or lime stabilising, construction sequencing to reduce subgrade exposure time, etc.).
- High allophane content is associated with the surficial ash derived soils and appropriate earthworks methodologies specific to subsequent Qualifying Development subdivisional plans should be recommended to mitigate any problems associated with the placement and compaction of these soils, if this mineralogy is present.
- Underfill drainage is usually adopted to control natural groundwater springs in the various drainage features that may be modified during development. They generally pose no constraints to end use if they are buried deep within engineered fills, or if this is not possible they can be aligned to site boundaries to avoid future building platforms

4 CONCLUSIONS

The Auranga B1 area comprises topography and ground conditions that are reasonably well understood geotechnically. Precedence in this type of geology has been set via the large residential developments in the Hingaia area just north of the study area, and more recently Auranga A to the east. Provided there is due consideration to prevailing or perceived geotechnical issues during detailed site investigations for Resource Consent, then the study area as defined herein is considered suitable for re-zoning to future urban use.

5 RECOMMENDATIONS

The assessments presented in this report are based on a desktop review and visual inspections, plus a limited number of shallow borehole tests on the prevailing landform.

It is recommended that:

- To support future development (i.e. Resource Consent / Subdivision design), further physical geotechnical site investigations that are commensurate with subdivision and earthworks scheme(s) should be undertaken to substantiate ground conditions and address any geotechnical constraints. Such investigations are expected to comprise (but are not limited to) hand auger boreholes, trial pits using a hydraulic excavator in pre-existing fill areas, and soil sampling.
- Appropriate laboratory soil testing is undertaken to characterise engineering and earthworks handling properties, compressibility, permeability and susceptibility to erosion or dispersion. Experience with such testing at Auranga A suggests no major issues are likely to arise in this regard.

6 LIMITATIONS

This report has been prepared solely for the use of our client, Karaka & Drury Limited, its professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

For and on behalf of Lander Geotechnical Consultants Limited

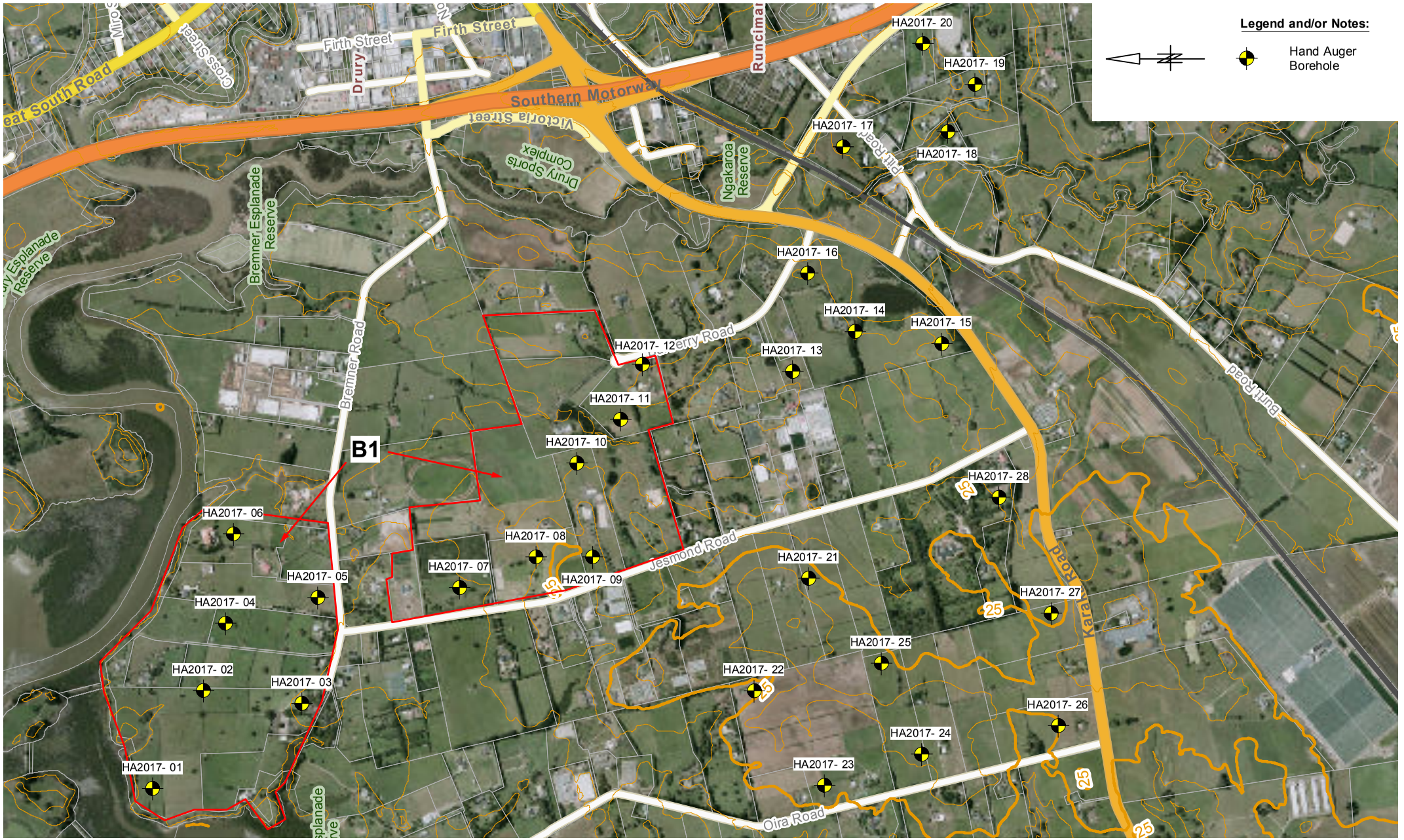
Prepared by:

T. Tiavare
Graduate Engineer

Reviewed and Authorised by:

S.G. Lander
Principal Geotechnical Engineer
MIPENZ, CPEng.

Attachments: Site Plan
Hand Auger Borehole Records
McKenzie & Co Consultants Limited indicative staging plan



BASE PLAN SOURCE: AUCKLAND COUNCIL GIS DATABASE, DATED:16/02/17

revision	description	drawn	approved	date

0 200 400 600
Horizontal Scale (metres)
0 200 400 600
Vertical Scale (metres)

drawn	TT
approved	SL
date	16/02/17
scale	1:10000
original size	A3

LANDER geotechnical

client: KARAKA AND DRURY LIMITED

project: AURANGA B1, DRURY

title: SITE PLAN

project no: J 00557

figure no: 01

Template revision: 1:1000 (10/12/14)

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 01
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 1 of 28
Job Number:	J00557	Vane Head: 1900 / Logged By: JL / Processor : GB / Date: 25.01.17	

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
SILT, light brown/ grey. Loose, dry, no plasticity [NATURAL]					
slightly clayey SILT, light orange/ brown. Very stiff, dry to moist, low to no plasticity, sensitive	0.5		171/ 33	5.2	
becoming clayey SILT with major fine sand, light grey streaked light orange/ brown, low plasticity					
becoming moderately sensitive	1.0		153/ 75	2.0	
CLAY with some fine sand, light grey mottled orange/ brown. Very stiff, moist, high plasticity, insensitive, with major limonite staining					
with major fine sand	1.5		105/ 59	1.8	
becoming moderately sensitive with a moderately thin bed of limonite	2.0		126/ 47	2.7	
clayey fine SAND, light yellow/ grey. Very stiff, wet, low plasticity, moderately sensitive					
becoming stiff	2.5		92/ 43	2.1	
at 3.0m, becoming very stiff					
EOB at 3.0m. Target Depth.	3.0		101/ 42	2.4	
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic				
Fill	Gravel	Siltstone	No Core				
Clay	Organic	Limestone					
Silt	Pumice	Volcanic					

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 02
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 2 of 28
Job Number:	J00557	Vane Head: 1900 / Logged By: JL / Processor : GB / Date: 25.01.17	

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
SILT, light orange. Loose, dry, no plasticity [NATURAL]					
becoming light brown/ grey					
silty CLAY, light orange streaked light grey. Very stiff, moist, high plasticity, sensitive, with minor limonite staining	0.5		120/ 16	7.5	
	1.0		102/ 31	4.9	
becoming stiff, insensitive	1.5		90/ 62	1.5	
becoming wet, with minor fine sand	2.0		93/ 59	1.6	
with major fine sand, with major limonite staining	2.5		74/ 43	1.7	
at 3.0m, becoming very stiff, moderately sensitive	3.0		117/ 55	2.1	
EOB at 3.0m. Target Depth.	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic				
Fill	Gravel	Siltstone	No Core				
Clay	Organic	Limestone					
Silt	Pumice	Volcanic					

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 03
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 3 of 28
Job Number:	J00557	Vane Head: 1900 / Logged By: JL / Processor : GB / Date: 25.01.17	

Borehole Location:	mN	mE	Ground R.L.
	Description:	Refer to site plan	

SOIL DESCRIPTION	Depth (m)	Vane Shear(kPa) peak / residual	Soil Sensitivity
TOPSOIL			
clayey SILT, dark orange. Very stiff, dry to moist, medium plasticity, insensitive [NATURAL]	0.5	154/107	1.4
becoming light orange, wet, with some fine sand	1.0	133/ 83	1.6
with some limonite staining	1.5	147/107	1.4
silty CLAY, light orange. Very stiff, moist, medium to high plasticity, insensitive, with minor limonite staining	2.0	132/114	1.2
with major fine sand	2.5	151/107	1.4
becoming orange mottled light grey	3.0	126/ 87	1.4
EOB at 3.0m. Target Depth.	3.5		
	4.0		
	4.5		
	5.0		
	5.5		
	6.0		

Standing Water Level: Sample and Laboratory / Other Test Details

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 04
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 4 of 28
Job Number:	J00557	Vane Head: 1750 / Logged By: AB / Processor : GB / Date: 25.01.17	

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
SILT, orange. Loose, moist to dry, no plasticity, sensitive [NATURAL]					
silty CLAY, light orange streaked grey. Very stiff, moist, medium plasticity, insensitive	0.5		144/ 31	4.6	
at 0.7m, becoming high plasticity	1.0		107/ 84	1.3	
becoming light grey, with minor to trace pink staining	1.5		113/ 60	1.9	
becoming moderately sensitive with some orange limonite silt inclusions and staining	2.0		119/ 60	2.0	
	2.5		103/ 35	2.9	
at 3.0m, becoming stiff	3.0		96/ 28	3.4	
EOB at 3.0m. Target Depth.	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 05

Sheet 5 of 28

Vane Head:	Logged By:	Processor :	Date:
1900	JL	GB	25.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
SILT, light brown/ grey. Loose, dry, no plasticity, sensitive [NATURAL]						
organic clayey SILT, dark brown. Stiff, moist, low plasticity, sensitive		0.5		105/ 22	4.8	
		1.0		74/ 21	3.5	
organic silty CLAY, dark brown. Stiff, wet, high plasticity, with some fibrous organic inclusions, push probed to 2.0m						
silty CLAY, light grey/ brown. Firm, wet, high plasticity, insensitive, with occasional fibrous organic inclusions		1.5		44/ 30	1.5	
becoming light blue/ grey, stiff, moderately sensitive		2.0		68/ 27	2.5	
becoming light green/ grey						
becoming very stiff		2.5		107/ 43	2.5	
at 3.0m, becoming firm, insensitive		3.0	▽	49/ 40	1.2	
EOB at 3.0m. Target Depth.		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater encountered 2.8m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 06

Sheet 6 of 28

Vane Head:	Logged By:	Processor :	Date:
1750	AB	GB	25.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, orange streaked grey. Very stiff, moist, medium plasticity, moderately sensitive [NATURAL]	0.5		181+		
becoming light grey, high plasticity	1.0		167/ 47	3.6	
becoming insensitive	1.5		113/ 63	1.8	
becoming moist to wet, with some orange limonite silt inclusions and staining	2.0		112/ 59	1.9	
becoming stiff, moderately sensitive	2.5		65/ 31	2.1	
EOB at 3.0m. Target Depth.	3.0		63/ 27	2.3	
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic				
Fill	Gravel	Siltstone	No Core				
Clay	Organic	Limestone					
Silt	Pumice	Volcanic					

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 07
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 7 of 28
Job Number:	J00557	Vane Head: 1750 / Logged By: AB / Processor : GB / Date: 25.01.17	

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION

Depth (m)	Legend	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
	TOPSOIL				
	silty CLAY, orange mottled grey. Very stiff, moist, medium plasticity, moderately sensitive [NATURAL]				
0.5			107/ 34	3.1	
1.0	becoming blue/ grey, stiff, high plasticity, with trace orange streaking		71/ 22	3.2	
1.5	becoming very stiff becoming light blue/ grey, medium plasticity, with some fine sand		119/ 57	2.1	
2.0	becoming insensitive		138/ 73	1.9	
2.5	becoming stiff becoming wet	▽	63/ 44	1.4	
3.0	at 3.0m, becoming very stiff, moderately sensitive EOB at 3.0m. Target Depth.		100/ 28	3.6	
3.5					
4.0					
4.5					
5.0					
5.5					
6.0					

LANDER geotechnical

Comments:
Groundwater encountered 2.7m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic				
Fill	Gravel	Siltstone	No Core				
Clay	Organic	Limestone					
Silt	Pumice	Volcanic					

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 08

Sheet 8 of 28

Vane Head:	Logged By:	Processor :	Date:
1750	AB	GB	25.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, dark orange/ brown. Very stiff, moist to dry, medium plasticity, moderately sensitive [NATURAL]	0.5		164/ 47	3.5	
SILT, light orange. Loose, moist to dry, no plasticity					
with occasional pink streaking	1.0		181+		
becoming moderately sensitive	1.5		155/ 71	2.2	
silty CLAY, brown/ grey. Very stiff, moist, medium to high plasticity, with minor limonite silt inclusions and staining					
becoming orange/ brown, medium plasticity	2.0		181+		
becoming insensitive	2.5		153/ 80	1.9	
becoming streaked orange/ pink and yellow/ grey					
at 3.0m, becoming moderately sensitive	3.0		138/ 60	2.6	
EOB at 3.0m. Target Depth.	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 09

Sheet 9 of 28

Vane Head:	Logged By:	Processor :	Date:
307	JL	GB	26.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
clayey SILT, dark orange. Hard, dry to moist, low plasticity [NATURAL]					
	0.5		UTP		
becoming moist	1.0		UTP		
becoming very stiff, moderately sensitive	1.5		114/ 57	2.0	
becoming yellow/orange	2.0		112/ 56	2.0	
becoming insensitive	2.5		130/106	1.2	
	3.0		174/106	1.6	
EOB at 3.0m. Target Depth.	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 10

Sheet 10 of 28

Vane Head:	Logged By:	Processor :	Date:
1750	AB	GB	26.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
silty CLAY, orange/ brown. Very stiff, moist, medium plasticity [NATURAL]					
	0.5		181+		
becoming brown					
becoming light yellow/ brown	1.0		181+		
becoming brown streaked grey, high plasticity					
becoming insensitive	1.5		159/ 93	1.7	
	2.0		144/ 84	1.7	
becoming brown, medium plasticity					
becoming moderately sensitive	2.5		138/ 63	2.2	
	3.0		173/ 65	2.7	
EOB at 3.0m. Target Depth.	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : KARAKA & DRURY LIMITED

Project Location : AURANGA B1, B2 & B3, DRURY

Job Number: J00557

Auger Borehole No. HA2017- 11

Sheet 11 of 28

Vane Head:	Logged By:	Processor :	Date:
1750	AB	GB	25.01.17

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL						
SILT, orange/ brown. Loose, dry, no plasticity, sensitive [NATURAL]						
becoming light orange		0.5		179/ 34	5.3	
silty CLAY, orange/ brown mottled light orange. Very stiff, moist, medium plasticity		1.0		181+		
becoming red/ pink mottled orange						
becoming red/ pink		1.5		181+		
		2.0		181+		
becoming pink/ red mottled orange/ brown		2.5		181+		
becoming orange/ brown						
EOB at 3.0m. Target Depth.		3.0		181+		
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client :	KARAKA & DRURY LIMITED	**Auger Borehole No.**	HA2017- 12
Project Location :	AURANGA B1, B2 & B3, DRURY		Sheet 12 of 28
Job Number:	J00557	Vane Head: 1750 / Logged By: AB / Processor : GB / Date: 25.01.17	

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear(kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL				
clayey SILT, dark brown streaked orange/ brown. Very stiff, dry, low plasticity, with minor limonite silt inclusions, with topsoil leeching to 0.5m [NATURAL]	0.5	181+		
silty CLAY, mottled orange and grey. Very stiff, moist, medium plasticity, insensitive, with minor limonite silt inclusions and staining				
at 0.8m, becoming orange streaked grey				
becoming cream/ grey, high plasticity	1.0	152/ 87	1.7	
becoming moderately sensitive	1.5	105/ 53	2.0	
becoming blue/ grey				
becoming insensitive	2.0	152/103	1.5	
becoming orange streaked blue/ grey, with trace fine sand				
without fine sand	2.5	159/107	1.5	
	3.0	135/ 73	1.8	
EOB at 3.0m. Target Depth.	3.5			
	4.0			
	4.5			
	5.0			
	5.5			
	6.0			

LANDER geotechnical

Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: TT

Topsoil	Sand	Sandstone	Plutonic
Fill	Gravel	Siltstone	No Core
Clay	Organic	Limestone	
Silt	Pumice	Volcanic	