ENGEO

Expect Excellence

Geotechnical Investigation for Proposed Subdivision

550 Birchs Road
Lincoln 7672

Submitted to:

Mike Early

Bellamy's Consulting Real Estate Agents

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ACENZ

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ENGEO Document Control:

Report Title	Geotechnical Subdivision Investigation – 550 Birchs Road, Lincoln				
Project No.	11896.000.000/01	Document ID	01		
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1 Introduction

ENGEO Ltd (ENGEO) was requested by Mike Early of Bellamy's Consulting Real Estate Agents to undertake a geotechnical investigation to support the proposed 15 lot subdivision at 550 Birchs Road (herein referred to as 'the site') as outlined in our proposals (ref. P2015.000.090) dated 29 January and 12 February 2015.

The scope of this study consists of:

- A desktop study of relevant publically available environmental, geotechnical and geological publications to assess likely ground conditions in the area of the site and historic aerial photographs;
- A geotechnical inspection of the site to identify any land damage following the 2010 / 2011 Canterbury earthquake sequence;
- Review of available EQC borehole data (BH_36073 and BH_33769);
- Completion of up to twelve hand augers with associated Scala Penetrometer and Shear Vane tests to a target depth of approximately 3 – 4 m below ground level in the proposed lots to assess the subsurface material types and strength characteristics;
- Supervision of one machine drilled borehole to approximately 15 m depth including Standard Penetration Tests (SPTs) at 1.5 m intervals and geotechnical logging of core samples; and
- Presentation of this report outlining our findings on the ground conditions and the suitability of the site for residential subdivision.

Our scope of works did not include assessment of the structural integrity of the existing house at the site.

2 Site and Project Description

The site is located in Lincoln, on a relatively flat section of 21,645 m^2 (Figure 1). The north-western and western parts of the site are predominantly vegetated land with a walnut orchid in the western corner and an area of Eucalyptus trees in the northwest, the eastern part of the site is predominantly grassed paddock land, and the south-eastern and central part of the site is a predominantly residential area containing a dwelling, swimming pool, grassed tennis court and garage. It is bound to the southeast by Birchs Road, to the southwest by a rural residential lot, to the northwest by a rural lot and to the northeast by the Lincoln Baptist Church site.

Figure 1: Site Location Plan and Investigation Locations

⊕ = Hand Testing Location.

⊙ = Borehole Test Location.

= Proposed Lot number (for the purpose of this report).

All images sourced from Google Maps.

The Canterbury Earthquake Recovery Authority (CERA) has mapped the site within the 'Green Zone' where buildings are typically considered suitable for repair or rebuilding. The site has not been assigned a Technical Category by the Ministry of Business, Innovation and Employment (MBIE) and is classified as Rural and Unmapped.

3 Area Wide Geotechnical Data

3.1 Regional Geology

The South Island of New Zealand is located on the northeast-southwest trending boundary between the Pacific and Australian Tectonic Plates. This convergent plate boundary causes the ongoing uplift of the Southern Alps. The rapid uplift leads to high erosion rates with braided river systems supplying large volumes of eroded sediment to the coast. The Canterbury Plains are a result of these rivers depositing sediment in broad, overlapping alluvial fans. Variable sedimentation rates and changes in sea level associated with glaciation and tectonic uplift have resulted in a dynamic deposition environment producing the sequence of interbedded terrestrial, estuarine and shallow marine sediment underlying the Canterbury region.

The site is regionally mapped at a 1:250,000 scale by GNS Science (Forsyth, 2008) as being predominantly underlain by grey river alluvium beneath plains or low-level terraces.

3.2 Seismicity

Historically, Christchurch City has been considered to be in a region of low concentrations of active faults and seismicity. However, in 2010/2011 the Canterbury region had four earthquakes with magnitude greater than M6. As a result, there is a heightened level of seismic risk stemming from the recently discovered Greendale, Lyttelton and Port Hills Faults. The seismic activity in the Canterbury region is currently considered to have increased the probability of another large (M6.0-7.9) earthquake to 7% between the time of writing and March 2016.

Preliminary mapping of the faulting in Canterbury illustrates the approximate locations of the Greendale Fault and subsurface Lyttelton Fault rupture, the distribution of associated aftershocks and known active faults in the Canterbury area. Large regional areas of faulting namely the Ashley Fault, Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard risk to the Christchurch area due to the anticipated size of earthquakes generated. The largest of these faults is the Alpine Fault, which has a return period of 250-300 years and is expected to produce a M8 earthquake. The last rupture on the Alpine Fault is believed to have occurred in 1717 (Pettinga et al., 2001).

3.3 Nearby Subsurface Data

We have reviewed the Canterbury Geotechnical Database and available geotechnical reports from the area proximal to the site to identify subsurface conditions in the site area. The representative investigations are detailed in Table 1.

Table 1: Summary of Subsurface Data

CPT/Borehole Identifier	Position Relative to Site	Depth of Exploration (m)
BH_36073	~ 50 m northeast of the site	10.2
BH_33769	~ 80 m southeast of the site	15.5
CPT 1 – CPT 11 (Barton Fields – 564 Birchs Road)	~ 70 – 190 m south, south west and west of the site	1.0 – 2.2

3.4 Canterbury Geotechnical Database

We have reviewed the Canterbury Geotechnical Database in preparation of this report. Earthquake specific data including land damage is presented in Table 2 and discussed herein.

Table 2: Summary of Earthquake Specific Data

	Events			
	4 Sept 2010 (Mw 7.1)	22 Feb 2011 (Mw 6.2)	13 Jun 2011 (Mw 6.0)	23 Dec 2011 (Mw 5.9)
Regional Liquefaction and Lateral Spreading Observations (EQC)	No data available	No data available	No data available	No data available
Site Specific Aerial Photograph Liquefaction Interpretation[1]	No data available	No obvious signs of ejected material at the site or surrounding area	No data available	No data available
Mapped Ground Cracks (EQC)	No mapped ground cracks at the site or surrounding area			

[1]Interpreted by ENGEO.

3.5 Historic Aerial Photography

We reviewed limited aerial photographs of the site dating back to 1973. As it relates to potentially significant geotechnical engineering issues, we describe relevant observations from our aerial photograph review below:

- The site has been developed since at least 1973.
- The northern part of the site was pasture land and a greenhouse structure was present in the central northern part of the site in 1994; the south-eastern and western parts of the site appear to have been developed as orchards with linear planting lines during this time.
- The greenhouse structure was demolished or relocated and the north-western part of the site was a predominantly vegetated area by 2004; the north-eastern boundary of the site appears to have been moved southwest by approximately 20 m; several extensions had been added to the dwelling and the swimming pool had also been constructed by this time; the orchard area in the south-eastern corner appears to have been converted to lawn area.

4 Field Investigations and Site Conditions

4.1 Surface Conditions

ENGEO visited the site on 10 February 2015 and made the following observations:

Figure 2: Site Photographs

Photo 1: View towards the southeast of proposed Lots 2, 3 & 4.

Photo 2: View towards the northwest of the current walnut orchard and proposed Lots 7, 8, 9 & 10.

Photo 3: View towards the southwest of proposed Lots 5 & 6.

Photo 4: View towards the southwest of the current dwelling located in the central southern part of the site.

4.2 Hand Auger Borehole and Scala Penetrometer Testing

ENGEO completed twelve hand auger boreholes and associated Scala Penetrometer (Scala) tests to a maximum depth of 2.5 m depth. Standing water was not encountered in our hand auger boreholes, excluding hand auger borehole HA06 where standing water was encountered at 2.4 m depth.

Full logs are presented in Appendix 1 and are written in general accordance with the New Zealand Geotechnical Society field classification guidelines (NZGS, 2005).

4.3 Machine Borehole Testing

Pro-Drill Ltd drilled one machine borehole to 15.45 m depth with Standard Penetration Tests (SPTs) at 1.5 m intervals. Standing water was recorded at 4.2 m depth.

4.4 Summary of Subsurface Conditions

The material encountered in our subsurface investigations is broadly consistent with published mapping. Table 3 below provides a generalised summary of the subsurface conditions compiled from our site specific testing; consult the boring logs for specific subsurface conditions at each location.

Table 3: Summary of Subsurface Conditions

Depth (m)	Soil Type	Consistency/Density
0.0 to 0.7	Silt with trace gravel and rootlets [TOPSOIL]	Firm to Hard
0.3 to 2.5	Interbedded silt / sand mixture [ALLUVIUM]	Stiff to Hard / Medium Dense to Dense
1.7 to 4.5[1]	Sandy gravel with some silt and clay [ALLUVIUM]	Medium Dense to Dense
4.5 to 5.3[1]	Fibrous peat [PEAT]	N/A
5.3 to 5.7[1]	Silt with minor clay ad organics [ALLUVIUM]	Soft
5.7 to 5.9[1]	Fibrous peat [PEAT]	N/A
5.9 to 6.7[1]	Interbedded sand / silt mixture with some clay [ALLUVIUM]	Very Loose to Loose / Soft to Firm
6.7 to 15.45[1]	Sandy gravel [ALLUVIUM]	Medium Dense to Dense

[1] Data gained from onsite machine borehole BH01.

5 Geohazards and Geotechnical Assessment

The New Zealand Geotechnical Society's 2010 Guideline for the Identification, Assessment and Mitigation of Liquefaction Hazards recommends that liquefaction and lateral spread assessments should be carried out where there is a possibility of loss of life or loss of amenity of a building of Importance Level 2 or higher (as defined by NZS 1170.0:2002). This has been considered below.

5.1 Soil Classification

For the purpose of seismic design, we consider the soil classification in line with NZS 1170.5:2004 to be 'Class D – Deep or Soft Soil'.

5.2 Liquefaction Assessment

We have assessed the likelihood of liquefaction triggering and post-liquefaction induced vertical settlement occurring at the site using the machine borehole data following the methodology outlined by Idriss and Boulanger (2008).

We have assessed a minimum groundwater depth of 2.4 m in the analysis based on hand auger borehole testing on site.

Table 4 presents the results of our liquefaction analysis under ULS and SLS loading.

Table 4: Summary of Liquefaction and Lateral Spreading Analysis

Design Case	Calculated Vertical Settlement[1]	
	Total	Upper 10 m
ULS	30 mm	30 mm
SLS	15 mm	15 mm

[1] For an undeveloped site. Settlements beneath buildings are likely to be greater.

The liquefaction analysis is presented in Appendix 3.

The analysis indicates isolated thin layers of potentially liquefiable material are indicated within the profile, with up to 30 mm of vertical settlement and up to 15 mm of vertical settlement calculated within the upper 10 m under ULS and SLS conditions respectively. The analysis considers volumetric strain and does not account for ground loss due to ejecta. Owing to the extensive liquefiable layers and potentially liquefiable material below the groundwater table, sand boil formation and ejecta are likely to occur at the site under ULS shaking. Therefore, building settlements may exceed those calculated in the above analysis during ULS shaking.

The calculated settlements under SLS conditions meet the index criteria for Technical Category 1 (TC1) and the calculated settlements under ULS conditions meet the index criteria for TC2; however based on our site observations and area wide investigation, we consider that the calculated settlement results are over conservative and that the future site performance will be more in line with those expected for TC1.

5.3 Assessment Against RMA Section 106

We consider the original level ground not to be presently subject to erosion, significant subsidence (including liquefaction), falling debris, slippage or inundation by soil or rock in accordance with the provision of Section 106 of the Resource Management Act 1991. Furthermore we do not consider that future residential use of the land is likely to accelerate, worsen or result in material damage to the land provided that proper engineering practices are followed during any development, including those recommended in this report.

6 Conclusions and Geotechnical Recommendations

Although the site is classified by MBIE as Rural and unmapped, based on our subsurface investigations, site observations, surrounding subsurface testing and nearby ECan boreholes, results of subsurface tests we consider that the TC1 classification is appropriate for the site. We therefore recommend that the MBIE guidance for TC1 sites should be considered in the design phase.

The key geotechnical issues identified at the site as a result of our investigation and geotechnical analysis have been discussed in the preceding sections and are summarised below:

- The ground conditions encountered in the onsite hand auger borehole tests consisted of firm to hard topsoil up to 0.7 m depth; underlain by stiff to hard / medium dense to dense interbedded alluvium to the maximum testing depth of 2.5 m below ground level.

- The ground conditions encountered in the onsite machine borehole test consisted of topsoil in the upper 0.2 m, underlain by very stiff silty alluvium to 1.6 m depth, underlain by medium dense to dense sandy gravel to 4.5 m depth, underlain by two 0.8 m and 0.2 m thick peat layers intersected by a layer of soft cohesive alluvium, underlain by interbedded very loose to loose / soft to firm sand / silt mixture alluvium from 5.9 m to 6.7 m depth, underlain by medium dense to dense sandy gravel to the maximum testing depth of 15.45 m below ground level.
- The liquefaction analysis indicated up to 15 mm and 30 mm of settlement for the site under SLS and ULS conditions respectively.

The Scala tests were undertaken to assess the subsurface strength profile and to determine if ground beneath the site meets the requirements of "good ground", defined in NZS 3604:2011 as follows:

"Where the number of blows per 100 mm depth of penetration below the underside of the proposed footing at each test site exceeds:

- *5 down to a depth equal to twice the width of the widest footing; and*
- *3 at greater depths.*

Furthermore, the definition of "good ground" also excludes organic topsoil, peat, soft or very soft clay and / or uncertified fill below the depth of footing at any test site".

"Good ground" was encountered at varying depths in multiple lots at the site, this was considered in the below lot specific recommendations.

6.1 New Foundations

As outlined in the MBIE guidance, expected settlements for TC1 sites under Ultimate Limit State (ULS) and Serviceability Limit State (SLS) design loads are up to 25 mm and up to 15 mm, respectively. In accordance with the MBIE guidance, we recommend designing foundations to handle these anticipated settlements.

We consider the following lot specific recommendations to be suitable for the proposed subdivision, excluding Lot 1, the "Future Road" Lot and the "Future Reserve" Lot due to current and proposed land use.

Your Structural Engineer may have alternative options capable of tolerating the settlements anticipated for this site. Specific lot and test locations are shown in Figure 1, lot locations in figure 1 are purely for the purpose of this report.

For the construction of new foundations at the site we provide the following lot specific recommendations:

Lot 2

We recommend a NZS 3604:2011 concrete slab foundation designed to bear on "good ground" below topsoil (0.3 m depth in hand auger borehole HA07).

Lot 3

We recommend a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.4 m depth in hand auger borehole HA08).

Lot 4

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.3 m depth in hand auger borehole HA09).

Lot 5

We recommend a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.4 m depth in hand auger borehole HA10).

Lot 6

We recommend a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.5 m depth in hand auger borehole HA03).

Lot 7

We recommend a NZS 3604:2011 concrete slab foundation specifically designed to bear on natural ground below topsoil (0.3 m depth in hand auger borehole HA02) assuming a geotechnical Ultimate Bearing Capacity of 300 kPa.

Lot 8

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.4 m depth in hand auger borehole HA11).

Lot 9

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.4 m depth in hand auger borehole HA01).

Lot 10

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.3 m depth in hand auger borehole HA12).

Lot 11

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.7 m depth in hand auger borehole HA04).

Lot 12

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.4 m depth in hand auger borehole HA05).

Lot 13

We recommend that a NZS 3604:2011 concrete slab foundation designed to bear on “good ground” below topsoil (0.7 m depth in hand auger borehole HA06).

Additional Considerations

- During site preparation, all grass and topsoil should be undercut from within the building footprint plus a minimum of 1.0 m beyond the perimeter foundation line.
- Foundations should be designed by a Chartered Professional Engineer practicing in foundation design;
- We advise that future building work takes into consideration the recommendations of the MBIE guidance. We recommend referring to Table 7.2 of the MBIE guidance for the maximum recommended weights for wall and roof cladding; and
- ENGEO should be given the opportunity to review the foundation design drawings prior to submitting for Building Consent in order to verify that the recommendations presented in this report have been interpreted as intended.

7 References

Bradley, B. A. & Hughes, M. (2012). Conditional Peak Ground Accelerations in the Canterbury Earthquakes for Conventional Liquefaction Assessment. *Technical Report Prepared for the Department of Building and Housing*.

Canterbury Earthquake Recovery Authority (2013). Canterbury Geotechnical Database. Retrieved March 2015, from https://canterburyrecovery.projectorbit.com/cgd

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Forsyth, P., Barrell, D. J., & Jongens, R. (2008). Sheet 16 - Geology of the Christchurch Area 1:250,000. Institute of Geological and Nuclear Sciences.

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Selwyn District Council. Property Information. Retrieved March 2015, from http: http: //www.selwyn.govt.nz/my-property/rates/search-properties

Standards Association of New Zealand (2002). Structural Design Actions – General Principles: Amendment 4, NZS 1170.0:2002. Standards New Zealand, Wellington.

Standards Association of New Zealand (2004). Structural Design Actions, Part 5: Earthquake Actions – New Zealand, NZS 1170.5:2004. Standards New Zealand, Wellington.

The Ministry of Business, Innovation, and Employment (2012). Guidance - Repairing and Rebuilding Houses affected by the Canterbury Earthquakes.

We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

8 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Mike Early (Bellamy's Consulting Real Estate Agents), their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site inspections and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the IPENZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (03) 328 9012 if you require any further information.

Report prepared by

Jacob Cornall

Engineering Geologist

Reviewed by

Matt Wiley, CPEng

Principal Geotechnical Engineer

APPENDIX 1

Hand Auger Logs, Scala Penetrometer and Shear Vane Test Results

LOG OF HAND AUGER HA01

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.5 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RB/RP
Reviewed By : JCL
Latitude : -43.628537
Longitude : 172.491957

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				VSt-H	UTP
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.			M	H	UTP
1.0								UTP
1.5			End of Hole Depth: 1.5 m Termination Condition: Practical refusal					
2.0								
2.5								
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

>>

Hand auger met practical refusal at 1.5 m depth on hard material.
Scala Penetrometer met practical refusal at 1.5 m depth.
Dip test showed no standing water.
No Scala Penetrometer data collected between 1.0 m and 1.4 m depth due to hard material.

GEOSCIENCE HAND AUGER HA TEMPLATE - BLANK.GPJ NZ DATA TEMPLATE 2.GDT 6/3/15

LOG OF HAND AUGER HA02

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.6 m
Hole Diameter : 50 mm

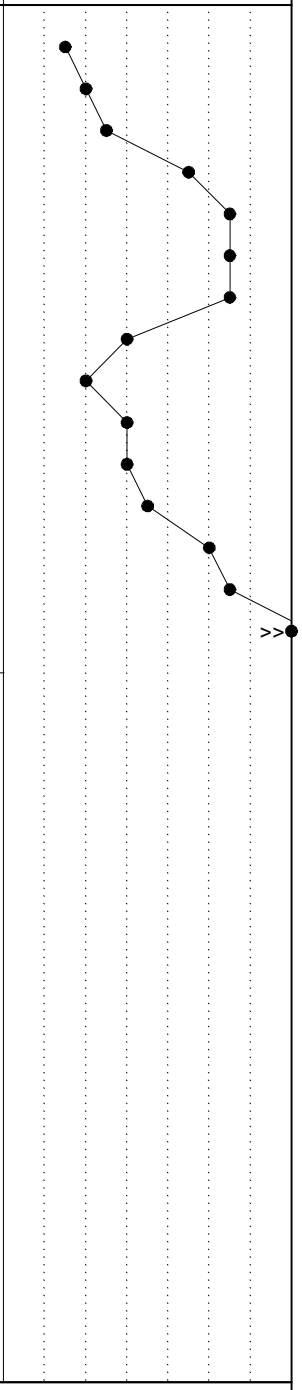
Shear Vane No : 1150
Logged By : RP/RB
Reviewed By : JCL
Latitude : -43.628663
Longitude : 172.492227

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				F-VSt	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.			M	H	UTP
1.0								UTP
1.5								UTP
			End of Hole Depth: 1.6 m Termination Condition: Practical refusal					
2.0								
2.5								
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12



Hand auger met practical refusal at 1.6 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.5 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA03

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.7 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RB/RP
Reviewed By : JCL
Latitude : -43.628805
Longitude : 172.492591

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace gravel and rootlets; brown. Low plasticity [TOPSOIL].				VST-H	UTP
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.			M	H	UTP
1.0		SP	Fine SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.				MD	
1.5			Some silt encountered from 1.4 m depth.				D	
			End of Hole Depth: 1.7 m Termination Condition: Practical refusal					

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

>>

Hand auger met practical refusal at 1.7 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.8 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA04

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 2.2 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RP/RB
Reviewed By : JCL
Latitude : -43.629183
Longitude : 172.493592

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace gravel and rootlets; brown. Low plasticity [TOPSOIL].				St-H	UTP
0.5	ALLUVIUM	ML	SILT with trace sand; brownish grey with orange mottles. Low plasticity.			M	VSt-H	UTP
1.0		SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.				MD	
1.5		ML	SILT; grey with orange mottles. Low plasticity.				St-H	
2.0			End of Hole Depth: 2.2 m Termination Condition: Practical refusal					
2.5								
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

>>

Hand auger met practical refusal at 2.2 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 2.2 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA05

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.4 m
Hole Diameter : 50 mm

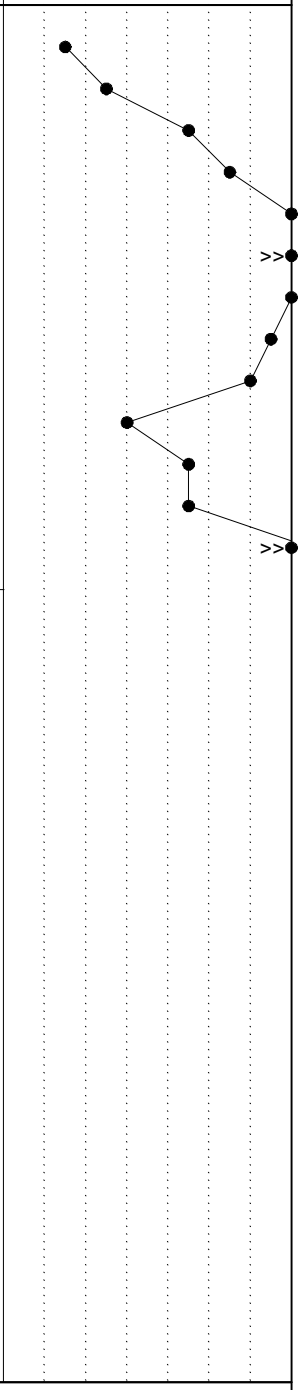
Shear Vane No : 1150
Logged By : RP/RB
Reviewed By : JCL
Latitude : -43.629202
Longitude : 172.493902

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace gravel and rootlets; brown. Low plasticity [TOPSOIL].				F-VSt H	
0.5	ALLUVIUM	ML	SILT with trace sand; brownish grey with orange mottles. Low plasticity. Some sand encountered from 0.7 m depth. Sand, fine, poorly graded, subrounded to subangular.			M	H	UTP
1.0		SP	Fine SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.				MD-D	UTP
		SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.				D N/A	
1.5			End of Hole Depth: 1.4 m Termination Condition: Practical refusal					
2.0								
2.5								
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12



Hand auger met practical refusal at 1.4 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.3 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA06

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 2.5 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RB/RP
Reviewed By : JCL
Latitude : -43.629367
Longitude : 172.493696

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].			M	VSt-H	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.				VSt-H	
1.0		SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.			W	MD	
1.5		ML	SILT with trace organics; grey with orange mottles. Low plasticity.		▼		St-H	
2.0		SP	Fine to medium SAND with trace gravel; grey. Poorly graded, subrounded to subangular.			S	D	
2.5			End of Hole Depth: 2.5 m Termination Condition: Practical refusal					
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

Hand auger met practical refusal at 2.5 m depth on inferred gravel.
Scala Penetrometer met target depth at 2.9 m.
Dip test showed standing water at 2.4 m depth.

LOG OF HAND AUGER HA07

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

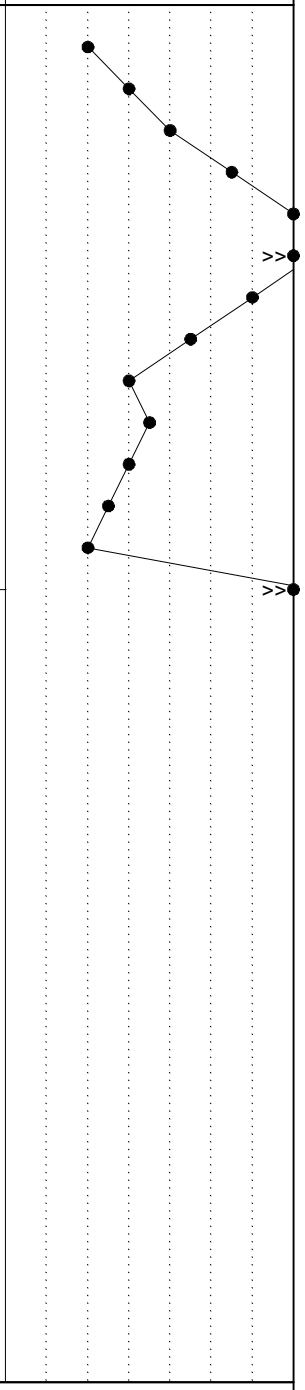
Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.4 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RB/RP
Reviewed By : JCL
Latitude : -43.629007
Longitude : 172.493973

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				St-H	
0.5	ALLUVIUM	SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.			M	D	
1.0							MD-D	
1.3		ML	SILT; brownish grey with orange mottles. Low plasticity.			W	St-H	
1.4			End of Hole Depth: 1.4 m Termination Condition: Practical refusal					

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 1.4 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.4 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA08

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

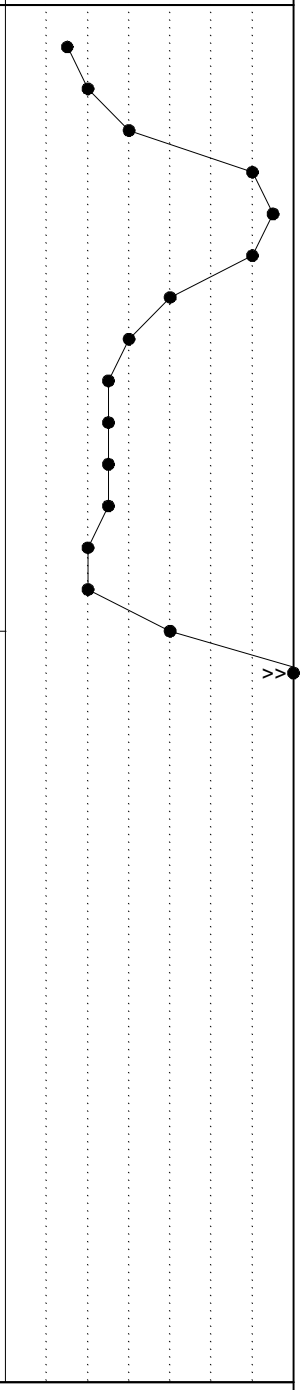
Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.5 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RP/RB
Reviewed By : JCL
Latitude : -43.628854
Longitude : 172.493537

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				F-St	UTP
							VSt-H	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.				H	
		SP	Fine SAND with minor silt; brownish grey. Poorly graded, subrounded to subangular.			M	MD	
1.0		SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.				MD	
		ML	SILT with trace sand; grey with orange mottles. Low plasticity.				H	
1.5			End of Hole Depth: 1.5 m Termination Condition: Practical refusal					
2.0								
2.5								
3.0								

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 1.5 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.6 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA09

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

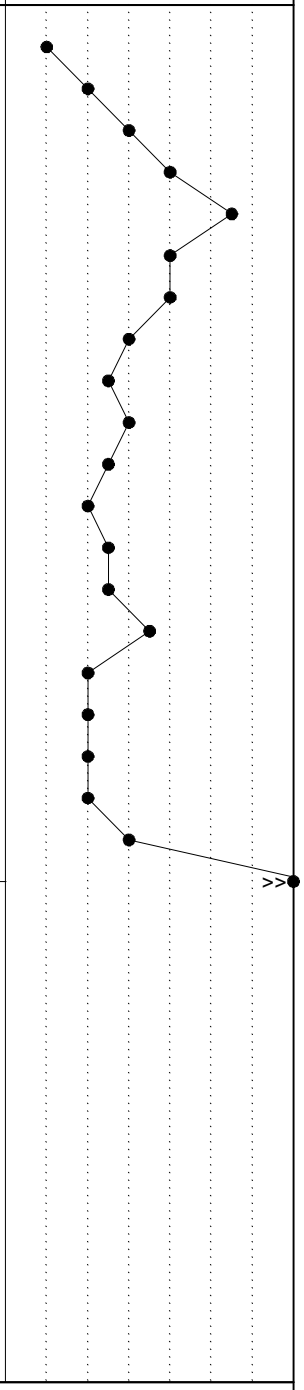
Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 2.1 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RB/RP
Reviewed By : JCL
Latitude : -43.628671
Longitude : 172.493109

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				F-VSt	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.				H	UTP
1.0		SM	Silty fine SAND; brownish grey with orange mottles. Poorly graded, subrounded to subangular.			M	MD	
1.5		ML	SILT; brownish grey with orange mottles. Low plasticity.			W	H	UTP
2.0		SP	Fine to medium SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.				D	
			End of Hole Depth: 2.1 m Termination Condition: Practical refusal					

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 2.1 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 2.1 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA10

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.7 m
Hole Diameter : 50 mm

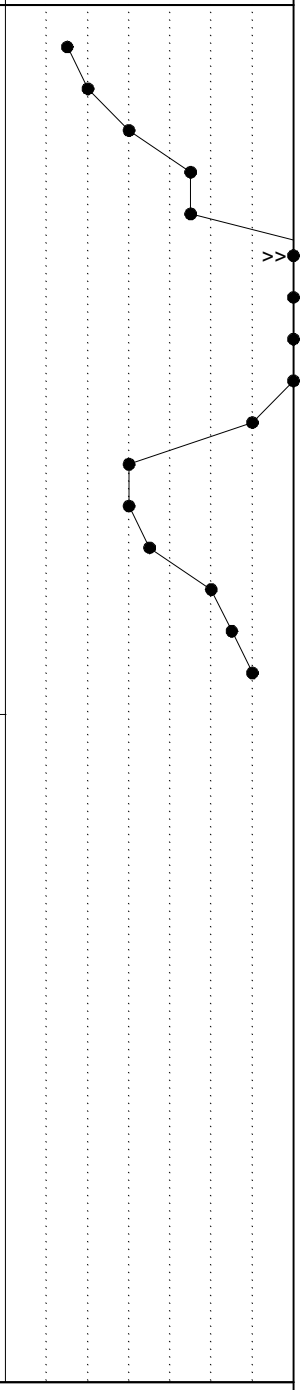
Shear Vane No : 1150
Logged By : RP
Reviewed By : JCL
Latitude : -43.628648
Longitude : 172.492718

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				F-St	
							VSt-H	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.			M	H	UTP
1.0		SP	Fine SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.				MD-D	UTP
1.5		ML	SILT with some sand; brownish grey with orane mottles. Low plasticity. Sand, fine, poorly graded, subrounded to subangular.				H	
			End of Hole Depth: 1.7 m Termination Condition: Practical refusal					
2.0								
2.5								
3.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12



Hand auger met practical refusal at 1.7 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.6 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA11

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

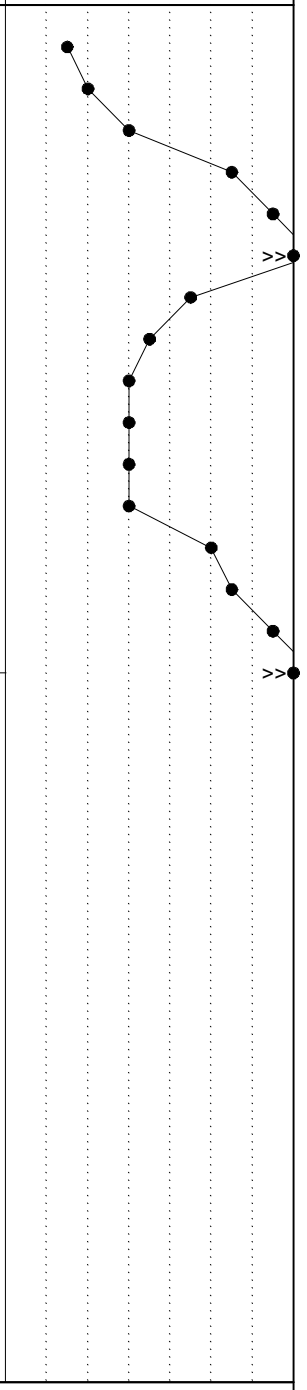
Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.6 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RP
Reviewed By : JCL
Latitude : -43.628503
Longitude : 172.492343

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				F-St / VSt-H	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.				H	UTP
		SP	Fine SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.			M	MD	
1.5		ML	SILT with trace sand; brownish grey with orane mottles. Low plasticity.				H	UTP
			End of Hole Depth: 1.6 m Termination Condition: Practical refusal					

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 1.6 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.6 m depth.
Dip test showed no standing water.

LOG OF HAND AUGER HA12

Subdivision Investigation
550 Birches Road
Lincoln
11896.000.000/01

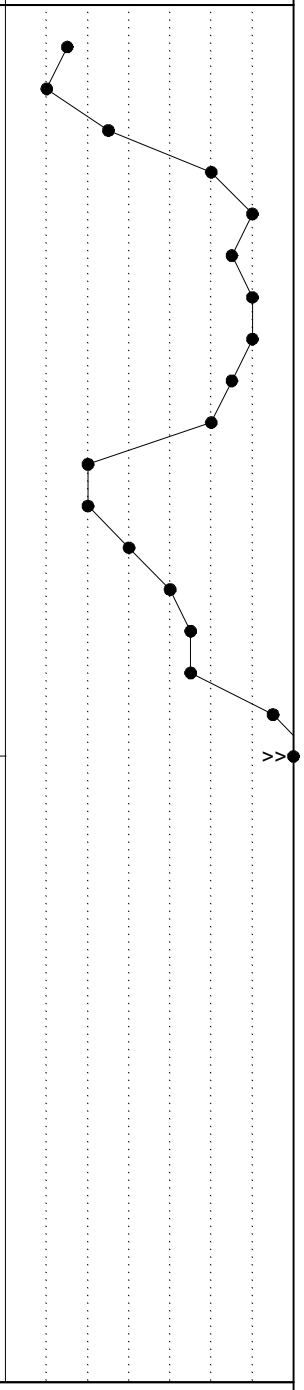
Client : Mike Early (Bellamy's)
Client Ref. : 11896.000.000/01
Date : 24/02/15
Hole Depth : 1.8 m
Hole Diameter : 50 mm

Shear Vane No : 1150
Logged By : RP
Reviewed By : JCL
Latitude : -43.628369
Longitude : 172.492073

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
0.0	TOPSOIL	ML	SILT with trace rootlets; brown. Low plasticity [TOPSOIL].				S-St	
0.5	ALLUVIUM	ML	SILT; brownish grey with orange mottles. Low plasticity.			M	H	UTP
1.0		SP	Fine SAND with trace silt; brownish grey. Poorly graded, subrounded to subangular.				MD	UTP
1.5		ML	SILT with minor sand; brownish grey with orane mottles. Low plasticity. Sand, fine, poorly graded, subrounded to subangular.				H	
2.0			End of Hole Depth: 1.8 m Termination Condition: Practical refusal					
2.5								
3.0								

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 1.8 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 1.8 m depth.
Dip test showed no standing water.