Appendix 5: Geotech Investigation north block

GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

139 Levi Road, Rolleston

Client: Four Stars Development Limited

Project Reference:	LTC20264
Revision:	Revision A
Date:	13 October 2020

Documentation Control:

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Document Title:	**Geotechnical Report for Proposed Land Use Change**	
Address:	139 Levi Road, Rolleston	
Revision:	Revision A	
Client:	Four Stars Development Limited	
Project Reference:	LTC20264	
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1.0 Introduction

1.1 Project Brief

LandTech Consulting Limited. (LandTech) were engaged by Four Stars Development Limited (the Client) to carry out a geotechnical investigation at 139 Levi Road, Rolleston (the Site). The geotechnical investigation is in relation to the proposal to change the land use within the investigated area.

The geotechnical investigation has been carried out to determine a geological model of the site, qualitatively assess the future land performance (i.e. during seismic events) and provide preliminary recommendations for site development.

This geotechnical report summarises the findings of our investigation and assessment. It includes a preliminary geotechnical assessment of the site, and may be used to support the land use change application to the Selwyn District Council (SDC). This report is not intended to support the subdivision application, individual house design or corresponding Building Consents, and further testing will be needed to address these applications.

1.2 Scope of Works

The geotechnical investigation for the proposed development included the following:

- Review of the New Zealand Geotechnical Database (NZGD) and other relevant geological/ geotechnical data;
- Detailed walkover inspection;
- Intrusive field investigation (i.e. test pits and insitu strength testing);
- Collation of field data and drafting;
- Geotechnical assessment;
- Provision of preliminary recommendations for development; and
- Preparation of this geotechnical report, detailing all of the above.

2.0 Site & Project Description

The investigation site is located near the corner of Levi Road and Lincoln Rolleston Road in Rolleston. The site is indicated in Figure 1 below, and is located approximately 1.1km to the south east of the Rolleston Township. The site comprises part of 139 Levi Road, legally described as Lot 2 DP416195 and Lot 2 DP 322710, and covers a total area of 30.43ha (sourced from https://mapviewer.canterburymaps.govt.nz/ on 11 October 2020).

Due the zoning of a decibel restriction associated with the Christchurch Airport extending into the eastern portion of the property, only the northern and western portion of the property has been investigated for the Land Use Change Application. The location of the investigated area and approximate location of the decibel restrictions is shown on the attached drawings LTC20264/1.

Figure 1: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 11 September 2020)

The property is generally flat and is currently used for horse training, and a stables and associate building are located in the northern portion of the site near Levi Road, along with a dwelling in the western corner. A training oval occupies the centre of the property, along with several tracks providing accesses to the paddocks. The land is essentially flat with no obvious changes in elevations and undulations.

3.0 Area Geology

Reference has been made to the *New Zealand Geology Web Map*, GNS Science, http://data.gns.cri.nz/geology/, website accessed 11 September 2020. The reviewed sources indicate that the site is underlain by Holocene Aged River Deposits. These materials generally comprise rounded to subrounded gravel and cobble sized particles within a matrix of silt and sand, deposited via the lateral and vertical migration of the past and present river systems, from the Southern Alps, out toward the east coast. Due to the depositional environment, the geotechnical characteristics of this material can be variable.

The characteristics of the River Deposits can vary widely over small distances. These variances include vertical and horizontal differences in both soil particle size distribution and consolidation. It is discussed above that these materials generally comprise gravel and cobbles; however, interbedded horizons of fine to coarse grained sand, silt and clay can also exist. They can also be capped by loessal soils or finer grained silts and sands.

3.1 Faults in Canterbury

For the purpose of our investigation we have referred to a Selwyn District earthquake fault report compiled by GNS Science and Environment Canterbury (ECan). The referenced report is titled:

- *General distribution and characteristics of active faults and folds in the Selwyn District, North Canterbury*, GNS Science and Environment Canterbury, dated July 2013.

The reference report gives a general outline of the nature of geologically active areas within the Selwyn District. Figure 6 in the referenced report indicates that the investigation site is located within 10km of the mapped Greendale Fault, to the northwest.

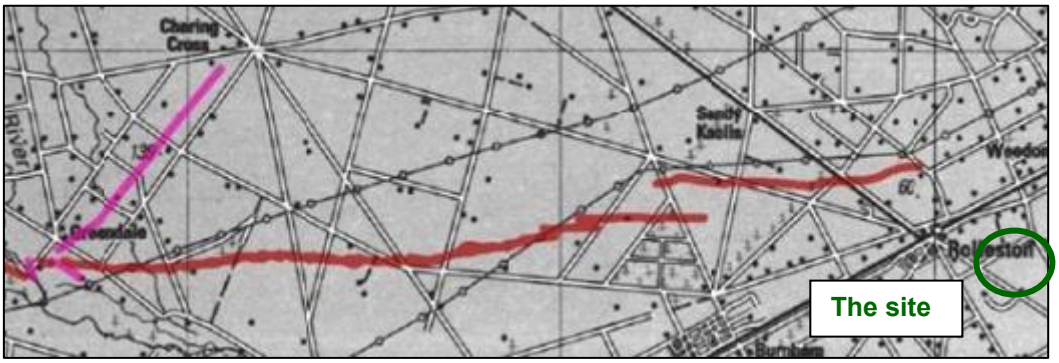

Figure 2: shows excerpt from figure A.1e of the referenced report (red line is a definite or likely fault).

The Greendale Fault and associated blind faults of the Darfield earthquake sequence have been defined by GNS Science via field inspection, aerial photograph interpretation and regional geologic mapping. The reference source indicates that these faults were unknown prior to 2010 and the ages of previous ruptures are also not known. This leave the potential for further unmapped faults to exist within the locality of the investigation site.

4.0 Geotechnical Data Review

Reference has been made to sources including the New Zealand Geotechnical Database (NZGD): http://www.nzgd.org.nz/ and Environment Canterbury (ECan): http://canterburymaps.govt.nz/ (accessed 11 September 2020). The following text summaries the findings of our data review:

- The MBIE *Residential Foundation Technical Category* Map indicates the site is located within an area designated as N/A - Rural and Unmapped. This indicates that normal consenting procedures apply.

- According to Canterbury Maps there are a series of Ecan wells within close proximity to the site. The associated bore logs for the following ECan wells have been reviewed, and are attached within Appendix B:

    - M36/0328, drilled to 28.6m and located with the neighbouring property to the south of the site at 232 Lincoln Rolleston Rd site. The borelog for the well shows earth and clay to 1.2m depth underlain by claybound to rough sandy gravel to the drill depth. Water levels from 1989, indicate a groundwater level of between 13.5m and 14.3m below ground level.

    - M36/8287, drilled to 46.1m and located at the northeastern corner of the site. The borelog for the well shows topsoil to 0.3m depth underlain by gravels to the drill depth. Ground water levels are indicated at 15.3m below ground level at the time of drilling.

    - M36/5292, drilled to 52.0m and located 80m to the south of the site near 294 Lincoln Rolleston Road. The borelog for the well shows topsoil and clay to 0.3m depth underlain by sandy gravel or claybound gravel to the drill depth. Initial groundwater levels are indicated at 12.2m below ground level at the time of drilling.

- According to the Environment Canterbury Soil Type map, the site is mapped as primarily *Typic Immature Plallic Soils* with a deep silty loam, while the northern corner of the site is mapped as a *Typic Immature Plallic Soils* having a moderately deep silty loam. Both soil types are described as having *moderate over slow* permeability.

- Eastern Canterbury Liquefaction susceptibility (2012), shows the site is located within an area were *Liquefaction damage is unlikely.*

- A review of historical photograph of the site from between 1940 and 2004 has been carried out on information available from Canterbury Maps. Imagery from 1940 to 1944 (shown overleaf in Figure 3), shows evidence of paleo river channels near the northern corner of the site. It is therefore possible additional channels are present within the investigation site. Some historic infilling of these paleo channels could have taken place as part of farming activities. However, our investigation found limited evidence of filling having taken place across the general subdivision site.

Figure 3: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 11 September 2020)

5.0 Field Investigation

Our field investigation took place on 21 September 2020 and comprised the following components:

- Detailed walkover inspection; and
- Excavation of Six test pits (TP01 – TP06) and associated Scala penetrometer testing; and
- Soakage testing (ST01) within TP06.

Each test was positioned evenly across the site away from infrastructure and animals, and test locations are shown on the LandTech *Site Test Plan*, Drawing No. LTC20264/ 1 (attached in Appendix A). The positions have been located via a hand-held GPS without survey control and are therefore approximate only.

The soil conditions encountered within the hand augerholes and test pits were logged by LandTech field staff in accordance with New Zealand Geotechnical Society *Guideline for the Description of Soil and Rock for Engineering Purposes* (2005). The test pit logs and corresponding photographs are attached in Appendix B, while the hand augerhole logs are within Appendix C.

The undrained shear strength of the fine-grained soils was recorded where applicable using a Geovane hand held shear vane in accordance with the NZGS *Guideline for Hand Held Shear Vane Test*, published August 2001. The peak and remoulded vane shear strength values have been factored in terms of BS1377.

Dynamic Cone (Scala) Penetrometer testing was carried out near the test pit locations to determine a soil density profile. Testing procedures were in accordance with NZS 4402:1988, Test 6.5.2, *Dynamic Cone Penetrometer*. The test results are shown on test pit logs.

Soakage testing was carried out in general accordance with the Auckland City Soakage Design Manual, worksheet W1: Falling-head Percolation Test. That being the change in water depth against time was recorded. A slight modification for the diameter of the holes has been made with a simple area conversion from a rectangle to a circle to give an equivalent diameter.

6.0 Subsurface Conditions

The sites subsurface conditions generally comprised a surficial layer of topsoil underlain by a sequence of Alluvial / Loess deposits followed by River Deposits. This is consistent with the geology described in Section 3.0 (Area Geology). A subsurface summary is given in Table 2 and detailed descriptions are given in the subsequent sections.

Table 1: Subsurface summary

Test pit ID	Test Pit Depth	Topsoil Depth	Soil Depth	Scala Depth
TP01	3.2	0.3	2.8	2.4
TP02	3.2	0.3	2.9	2.5
TP03	2.8	0.3	1.2	1.3
TP04	2.6	0.3	1.5	1.6
TP05	3.0	0.3	1.4	1.4
TP06	2.8	0.2	1.4	1.4

Table notes: Measurements are in metres (m) below present ground level
Scala penetrometer refusal considered when an excess of 20 blows /100mm penetration occurs

6.1 Topsoil

Topsoil was encountered from the surface at all test locations and ranged between the depths of 0.2m and 0.3m below present ground level (bpgl). This mostly comprised dark brown silt with minor fractions of fine to coarse grained sand. The topsoil is not considered suitable for the support of building foundations.

6.2 Alluvial / Loess Deposits

Soil deposits comprising either alluvial soils or loessal soils where present above the river deposits at depth. The depth of these soils ranged from between 1.2m (TP03) and 2.9m (TP02) below ground level, and typically comprised a moist fine sandy silt. Typically, the deeper deposits of soil where encountered along the northern boundary towards the northwestern corner.

Scala penetrometer testing within the soils generally ranged from 2 and 5 Blows / 100mm penetration. Higher blow counts at depth are due to contact with the underlying gravels.

Where possible shear vane testing was carried out in the silt materials, peak shear vane testing ranged from between 107kPa and 187+kPa indicating a very stiff soil.

6.3 River Deposits

River Deposits were encountered below the surficial layer of sandy silts from between 1.2m (TP03) and 2.9m (TP02) to the termination depth of all test locations (TP01 – TP06). The River Deposits generally comprised fine to coarse sandy, fine to coarse subrounded gravel. The gravel deposits where described as moist, while larger cobbles were also encountered.

Scala penetrometer testing was unable to penetrate the gravels with refusal typically being achieved in contact with the underlying gravels, indicative of dense packing.

6.4 Soakage

The soakage capacity of the gravel was tested within TP05; the location of the test pits are shown on the LandTech *Site Test Plan*, Drawing No. LTC20264/ 1 (attached in Appendix A). The results of the soakage testing are attached in Appendix C.

The results of the calculated average soakage rates are shown in Table 3 below:

Table 2: Average soakage rates

	SP01 / TP06
Average Soak Rate (mm/hour)	368
Percolation Rate (L/m^2/min)	10

Following the testing silt was loaded in the base to a thickness of around 0.2m thick which likely impeded the flow. While the Test pit was being filled the maximum height the above the base the water level rose to was 0.5m, at a flow rate of 833L/min or 520L/m^2/min. This shows that infiltration from the side walls contributes a considerable amount to the drainage.

Based on the variable subsurface conditions throughout this site (i.e. depth of soil), we recommend additional soakage testing be carried out in the location of proposed soakage basins to determine more representative percolation rates to design from.

6.5 Site Seismicity

For the purpose of applying requirements of NZS 1170.5:2004 the site subsoil is Class D – Deep or Soft Soil Site. This classification is based on depths of soil exceeding the limits of Table 3.2 of the reference standard. seismic hazard factor (Z) for the site is 0.3 as per the standard.

7.0 Qualitative Liquefaction Analysis

The MBIE & New Zealand Geotechnical Society Inc. report titled *Earthquake geotechnical engineering practice, Module 3: Identification, assessment and mitigation of liquefaction hazards* (2016) explains that the evaluation of the geologic susceptibility of liquefaction is a key aspect in the evaluation of liquefaction potential at a given site.

Based on our desktop study and field investigation, we have established that the site is generally underlain by Holocene Age horizons of tightly packed gravel (i.e. River Deposits) with average ground water levels of around 13.0m. In addition to this ECan (2012) liquefaction susceptibility maps has indicated that the site is unlikely to be damaged via earthquake induced liquefaction.

The region comprises a rural/unmapped Residential Foundation Technical Category (based on MBIE); however, is considered an area that is not likely to be susceptible to liquefaction induced damage. This is based on the geology underlying the site (i.e. Holocene Aged River Deposits), the previously referenced reports and maps, and our qualitative liquefaction assessment.

Based on our assessment of the investigation site, we are categorising existing property as Technical Category 1 (TC1) with damaging liquefaction unlikely and consider the site suitable for residential development from a geotechnical perspective.

8.0 Geotechnical Hazard Evaluation

Section 106 of the Resource Management Act 1991 outlines hazards that must be assessed when a territorial authority considers subdivision of land. This section outlines our evaluation of possible geotechnical hazards associated with this site. Based on the results of our investigation and assessment, we consider this site suitable for land use change to residential zoning from a geotechnical perspective.

8.1 Erosion

The surface of the property is near level to undulating with no general contour/runoff direction. During our field investigation, we did not observe any obvious signs of erosion from concentrated surface runoff. Furthermore, we do not consider the proposed site development will increase the erosion potential provided stormwater is disposed of in a controlled manner subject to usual Council Consenting procedures.

8.2 Inundation

Assessment for inundation from flooding is not a part of the scope of this report and therefore has not been fully assessed. A basic review of online mapping available from CanterburyMaps has been carried out and no information for the site was evident. If required an assessment should be carried out by suitably experienced consultant.

8.3 Subsidence

It is discussed in previous sections of this report, liquefaction is not likely to occur within the investigation site. This is due to the shallow depth to gravel and gravelly sand layers (between 1.2m and 2.9m below the site) and the ECan well logs indicating that groundwater in the area is at an average of around 13.0m below ground level.

This means that corresponding liquefaction induced subsidence is unlikely, as per the site performance through the CES. Foundation settlements are also considered unlikely due to the dense nature of the subsoils. This is provided in our recommendations given further herein are followed regarding further investigation, foundation design and construction.

8.4 Falling Debris

No tall standing slopes exist in the vicinity of the investigation site, therefore falling debris hazard is non-existent.

8.5 Slippage

Due to the site being near level to gently undulating, it's removed location from any major waterways, and inferred non-liquefiable nature of the underlying subsoils, slippage via liquefaction-induced lateral spreading is not considered to affect the subdivision site. No other geotechnical mechanism of slippage was noted during out field investigation or from our assessment.

8.6 Contamination

Whilst not a requirement of Section 106 of the RMA 1991, soil contamination is a potential geotechnical hazard that should be considered when making Consent applications to territorial authorities where ground disturbance works are proposed (i.e. foundation excavations etc.). This indicates no HAIL activities are recorded to have taken place at the site, according to the register. This does not confirm the site has no soil contamination, but only indicates the Regional Council does not have records of potentially hazardous activities taking place the site that could lead to soil contamination.

9.0 Geotechnical Recommendations

It is stated in the previous sections that the site has been classified as TC1; based on our desktop study, the underlying geology and qualitative liquefaction assessment. Following our assessment, we consider the site suitable land use change to residential zoning from a geotechnical perspective. Our recommendations with regard to site development and preliminary foundation design follow subsequently.

9.1 Preliminary Foundation Recommendations

Due to the low risk of liquefaction at the subdivision we have classified the investigation site as TC1, and conclude the River Deposits beneath any surficial soils meet the criteria for “good ground” as defined by NZS3604:2011. Some areas of weak upper surficial soils may require foundations to be subject to specific engineering design due to low bearing capacities. Alternatively, earthworks during subdivision may compact any weak upper layers so standard foundations can be utilised without engineering design input. The extent of any weak upper soils can be determined with further shallow soil testing as part of the subdivision design/consenting stage.

9.2 Preliminary Earthwork Recommendations

All proposed earthworks will need to be carried out to the requirements of NZS 4431:1989, ‘Code of Practice for Earthfilling for Residential Development’. All unsuitable materials (vegetation, organic or detritus material, and organic rich topsoil etc.) should be stripped from any areas of earthworks and stockpiled well clear of operations or carted from the site.

10.0 Future Geotechnical Involvement

Should the land use change be approved and a subdivision plan be made, a more detailed geotechnical investigation will be required to more accurately identify areas of deep alluvial soils and provided further geotechnical recommendations for the subdivision development.

Dependent on the extent of earthworks during the subdivision stage and involvement from a geo-professional to observe areas of stripped ground and fill compaction, additional lot specific shallow soil testing may be required. The results of which may supersede our preliminary foundation recommendations if the test results differ to our area wide investigation. However, the risk of differing ground conditions is considered to be low, due to the relatively uniform presence of dense river gravels throughout the general Rolleston area. Potential variations could be from deeper areas of surficial alluvial soils or localised uncontrolled filling in the past.

11.0 Limitations

This geotechnical report has been prepared for our Client, Four Stars Investment Limited, for the purposes of supporting a Land Use Change application to the Selwyn District Council. This report shall not be extrapolated for other nearby sites or used for any other purposes without the express approval of LandTech and their Client.

This report has been based on the results of tests at point locations; therefore, subsurface conditions could vary away from the assumed geotechnical model. Should exposed soil conditions vary from those described herein we request to be informed to determine the continued applicability of our recommendations. We have attempted to conduct a thorough investigation of soil types across the site, within the agreed scope of works. However, variations still may exist as soils can vary naturally and due to previous human activities, which LandTech have no control over and should not be held accountable for.

The geotechnical investigation was confined to geotechnical aspects of the site only and did not involve the assessment for environmental contaminants. In addition, our investigation and analyses have also not taken into account possible fault rupture that may cause deformations and displacements of the ground directly below the site. This type of assessment is outside of the scope of our geotechnical engagement.

END OF REPORT

APPENDIX A

LandTech Site Test Plan

KEY:

- TP01 — LandTech Consulting Test Pit locations Carried out on 21 September 2020
- SP01 — LandTech Consulting Soakage Test Locations Carried out on 21 Septembner 2020
- Investigated Area
- Existing Boundaries
- 50 dBA contour

NOTES:

Locations of features approximate only.

Original sheet size A3

Boundary information on this *Site Test Plan* adapted from LINZ website: www.data.linz.govt.nz (accessed 04 September 2020)

AMENDMENTS

DATE	REV	DESCRIPTION
12/10/2020	A	Test Plan

Check all dimensions and levels on site before commencing construction.

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139 Levi Road

ROLLESTON

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Drawing No.	Drawn by:	Date:
LTC20264/1	L C	12 October 2020

Scale:	Checked by:	Revision:
1: 2000 (A3)	D W	A

Filename: LTC20264 - Drawings.dwg

APPENDIX B

Environment Canterbury Well logs

canterbury maps

Canterbury Maps

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0 0.07 0.14 0.21 0.28 Kilometres

Scale: 1:5,000 @A3

Map Created by Canterbury Maps on 12/10/2020 at 12:49 PM

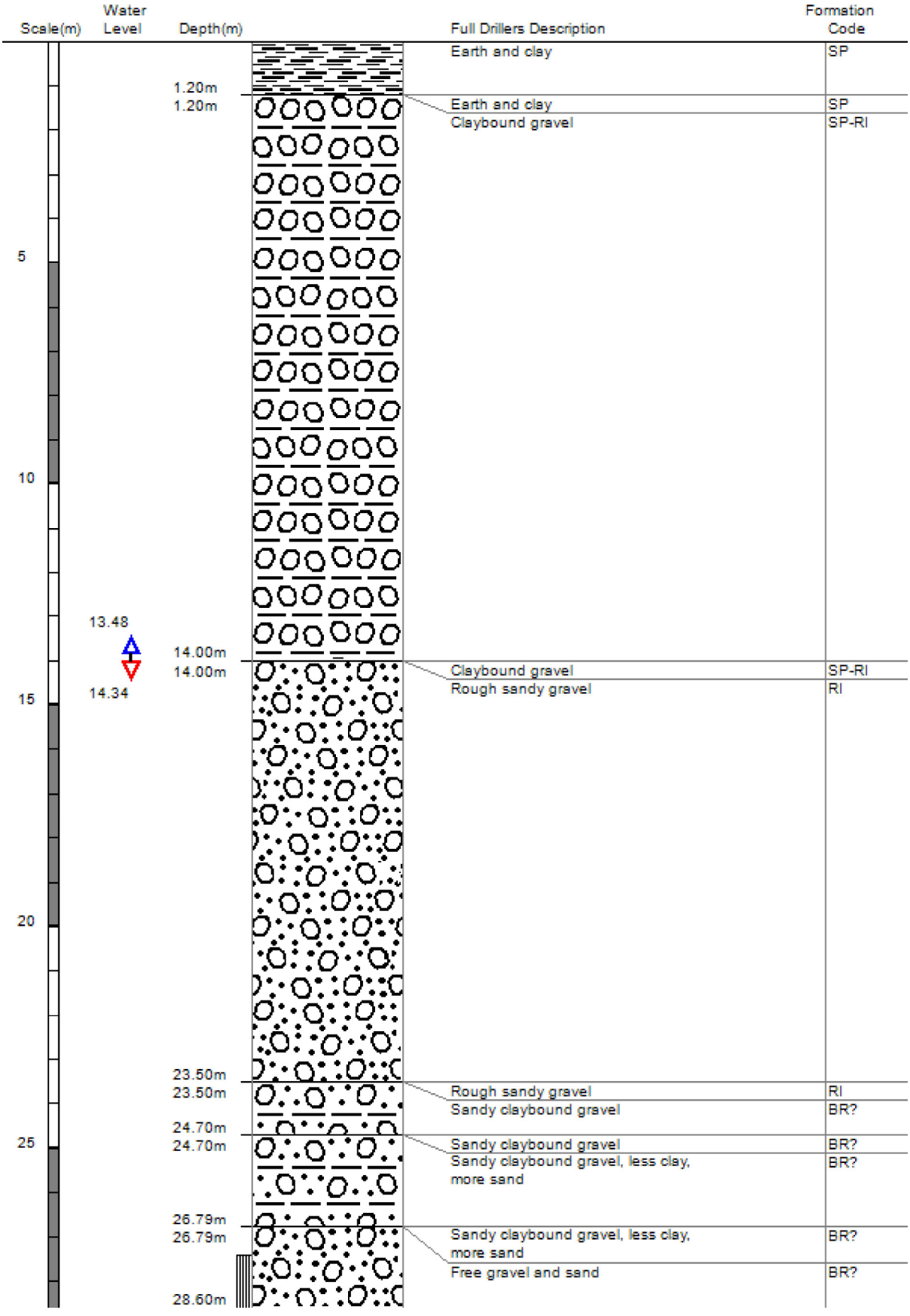
M36/4839
M36/4743
M36/8287
M36/4430
M36/0127
M36/4427
M36/3036
644
M36/7766
618
M36/8240
61
M36/0254
M36/8518
BX23/0827
BX23/0508
M36/5292
M36/4870
M36/4865
M36/0328
BX23/0528
BX23/0420
BX23/0571
BX23/0620
M36/5359
BX23/0648
BX23/0618
M36/4894
Levi Rd
Lincoln Rolleston Rd
Reuben Ave
Turin Ave
Rory St
Branthwaite Dr
Falcon Rd
Gregra Ave
Nobeline Dr

Environment Canterbury, Land Information New Zealand, GNS Science, Te Rūnanga o Ngāi Tahu, Department of Conservation, New Zealand Archaeological Association, Environment Canterbury, Canterbury Maps Partners, Open Street Maps, Environment Canterbury

Borelog for well M36/0328

Grid Reference (NZTM): 1552007 mE, 5172190 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 42.6 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Cable Tool
Borelog Depth: 28.6 m Drill Date: 20-Aug-1980

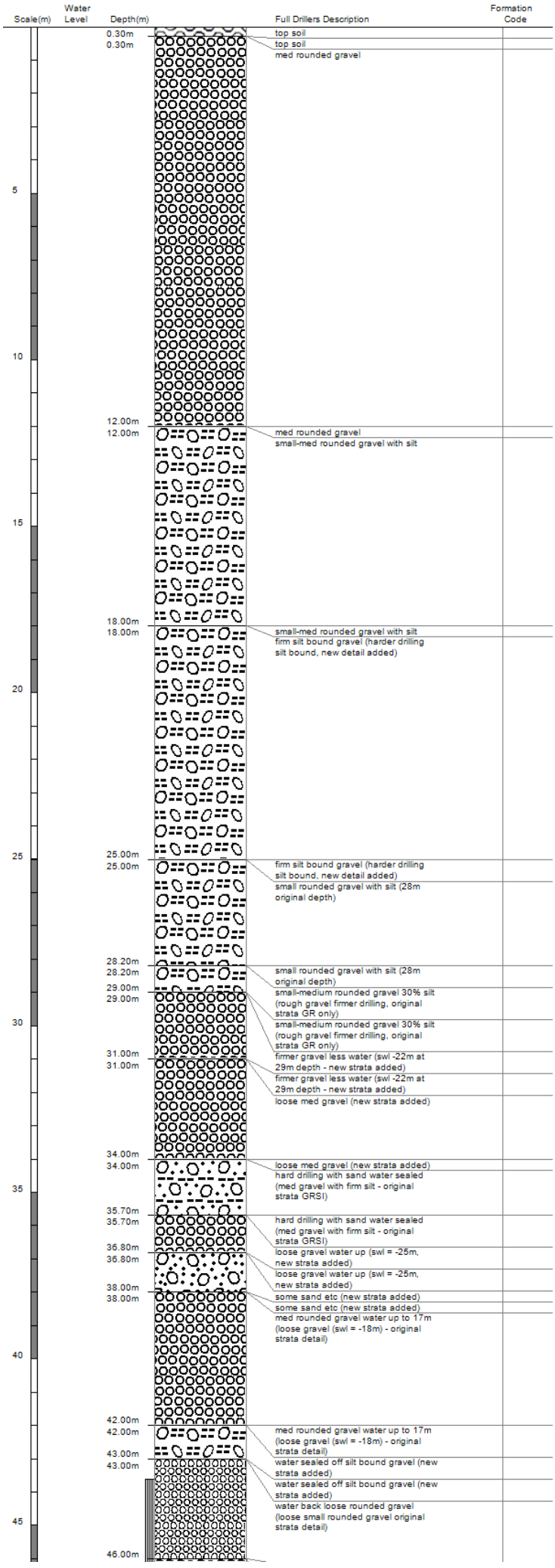
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/8287

Grid Reference (NZTM): 1551585 mE, 5172834 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 45.9 m +MSD Accuracy: < 0.5 m
Driller: Dynes Road Drilling
Drill Method: Rotary/Percussion
Borelog Depth: 46.1 m Drill Date: 15-Jan-2007

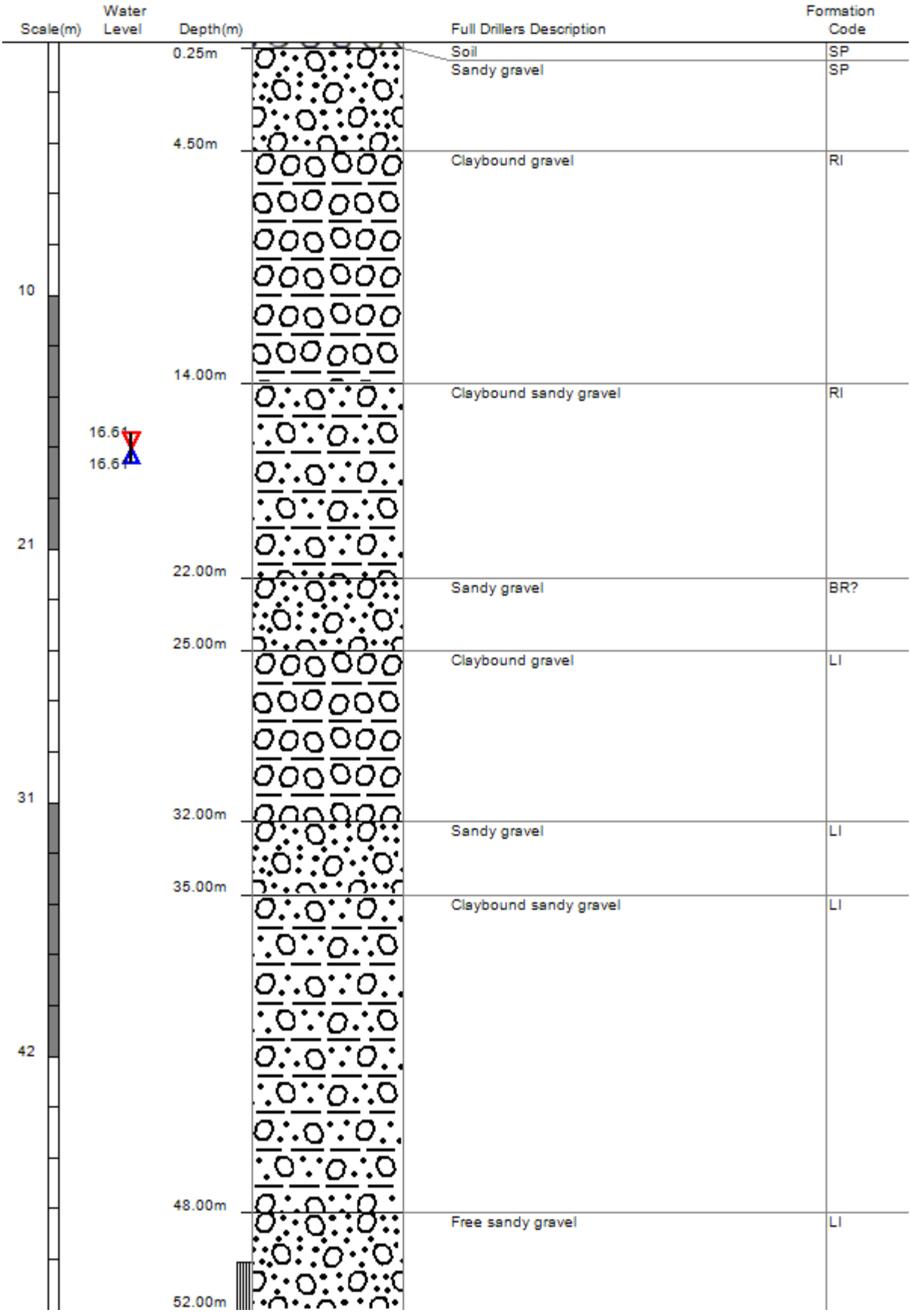
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/5292

Grid Reference (NZTM): 1551672 mE, 5172222 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 44.4 m +MSD Accuracy: < 2.5 m
Driller: Smiths Welldrilling
Drill Method: Rotary Rig
Borelog Depth: 52.0 m Drill Date: 15-Sep-1997

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



APPENDIX C

Test Pit Logs

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP01
Sheet No. 1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551391 N5172741	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T.SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS / LOESS	0.5		SILT, some fine sand, brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.5		Fine sandy, SILT, light brown, stiff, moist, non-plastic
RIVER DEPS.	3.0		Fine sandy fine to coarse sub-rounded GRAVEL, brown, dense, moist [RIVER DEPOSITS]
	4		End of Test Pit 2.8m [TARGET DEPTH]
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)
Peak:
Remoulded:
0 50 100 150 200
160

Dynamic Cone Penetrometer
Scala Blow
0 5 10 15 20

Depth (m)	Blow Count
-0.1	2
-0.2	3
-0.3	4
-0.4	4
-0.5	5
-0.6	3
-0.7	3
-0.8	3
-0.9	4
-1.0	3
-1.1	2
-1.2	2
-1.3	3
-1.4	2
-1.5	1
-1.6	2
-1.7	2
-1.8	2
-1.9	2
-2.0	2
-2.1	2
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-2.4	4
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-3.3	
-3.4	
-3.5	
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-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

In-situ field testing in Scala Penetrometer Shear Vane Testing:

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP02
Sheet No. 1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551545 N5172856	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T.SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS	0.5		Fine sandy SILT, light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	2.5		SILT, minor fine sand, light brown, mottled orange, stiff, moist, non-plastic
RIVER D.	3.0		Fine sandy, fine to coarse, subrounded to round GRAVEL, brown, very dense, moist [RIVER DEPOSITS]
	3.2		End of Test Pit 3.2m [TARGET DEPTH]

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)
Peak:
Remoulded:
0

Dynamic Cone Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	3	
-0.2	3	
-0.3	5	
-0.4	4	
-0.5	4	
-0.6	3	
-0.7	3	
-0.8	3	
-0.9	2	
-1.0	2	
-1.1	2	
-1.2	3	
-1.3	2	
-1.4	3	
-1.5	2	
-1.6	3	
-1.7	4	
-1.8	5	
-1.9	3	
-2.0	3	
-2.1	3	
-2.2	2	
-2.3	3	
-2.4	3	
-2.5	3	
-2.6		
-2.7		
-2.8		
-2.9		
-3.0		
-3.1		
-3.2		
-3.3		
-3.4		
-3.5		
-3.6		
-3.7		
-3.8		
-3.9		
-4.0		
-4.1		
-4.2		
-4.3		
-4.4		
-4.5		
-4.6		
-4.7		
-4.8		
-4.9		
-5.0		

Scala Blow Count / 100mm: 0 5 10 15 20

In-situ field testing in accordance with the following Standards:
Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer
Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
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Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING

Client: Four Stars Development Ltd
Project: Geotechnical Investigation for Proposed Land Use Change
Address: 139 Levi Road, Rolleston

Test Pit No. TP03
Sheet No. 1 of 1

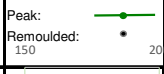
Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551724 N5172860	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS / LOESS	0.5		Fine sandy SILT, yellowish light brown, very stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS] trace subrounded to round boulders
	2.0		
	2.5		
	3.0		End of Test Pit 2.8m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

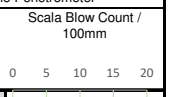
In-situ Field Testing

Shear Strength (kPa)



Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	3
-0.2	3
-0.3	3
-0.4	4
-0.5	3
-0.6	3
-0.7	3
-0.8	3
-0.9	4
-1.0	3
-1.1	9
-1.2	12
-1.3	25+
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	



In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Website: www.landtech.nz

LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP04
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1552364 N5171882	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS / LOESS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
	1.5		
RIVER DEPOSITS	2.0		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	2.5		trace subrounded to round bouders, wet
	3.0		End of Test Pit 2.6m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

150 200

187+

Dynamic Cone Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	7	
-0.2	5	
-0.3	4	
-0.4	3	
-0.5	3	
-0.6	3	
-0.7	3	
-0.8	2	
-0.9	3	
-1.0	3	
-1.1	3	
-1.2	4	
-1.3	3	
-1.4	5	
-1.5	14	
-1.6	25+	
-1.7		
-1.8		
-1.9		
-2.0		
-2.1		
-2.2		
-2.3		
-2.4		
-2.5		
-2.6		
-2.7		
-2.8		
-2.9		
-3.0		
-3.1		
-3.2		
-3.3		
-3.4		
-3.5		
-3.6		
-3.7		
-3.8		
-3.9		
-4.0		
-4.1		
-4.2		
-4.3		
-4.4		
-4.5		
-4.6		
-4.7		
-4.8		
-4.9		
-5.0		

0 5 10 15 20

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP05
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551650 N5172615	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS / LOESS	0.5		Fine sandy SILT, yellowish light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS] trace to minor subrounded boulders
	2.0		
	2.5		
	3.0		End of Test Pit 3.0m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

150 200

187+ UTP

Dynamic Cone Penetrometer

Depth (m)	Blow Count
-0.1	5
-0.2	7
-0.3	5
-0.4	5
-0.5	3
-0.6	3
-0.7	3
-0.8	3
-0.9	2
-1.0	3
-1.1	3
-1.2	6
-1.3	7
-1.4	25+
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Scala Blow Count / 100mm

0 5 10 15 20

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Website: www.landtech.nz

LandTech CONSULTING	Client: Four Stars Development Ltd Project: Geotechnical Investigation for Proposed Land Use Change Address: 139 Levi Road, Rolleston	Test Pit No.	TP06
		Sheet No.	1 of 1

Drill Type:	6T Hydraulic Excavator	Project No:	LTC20264	Logged By:	M Gunn
Drilled By:	BM Contracting	Coordinates:	NZTM2000 E1551614 N5172361	Shear Vane No:	2255
Date Started:	21-Sep-20	Ground Conditions:	Near level, grass	Calibration Factor:	1.333
Date Finished:	21-Sep-20	Groundwater Level (m):	Not Encountered (21-Sep-30)	Calibration Date:	16-Mar-20

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
T. SOIL	0.0		SILT, some fine sand, dark brown, stiff, moist, non-plastic, trace organics and rootlets [TOPSOIL]
ALLUVIAL DEPOSITS / LOESS	0.5		Fine sandy SILT, light brown, stiff, moist, non-plastic [ALLUVIAL DEPOSITS / LOESS]
	1.0		
RIVER DEPOSITS	1.5		Fine to coarse sandy, sub rounded GRAVEL, minor silt, brown, dense, moist [RIVER DEPOSITS]
	2.0		
	2.5		
	3.0		End of Test Pit 2.8m [TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (21-Sep-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

107

Dynamic Cone Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm (0 5 10 15 20)
-0.1	2	
-0.2	2	
-0.3	3	
-0.4	3	
-0.5	3	
-0.6	2	
-0.7	3	
-0.8	2	
-0.9	3	
-1.0	4	
-1.1	3	
-1.2	4	
-1.3	9	
-1.4	25+	
-1.5		
-1.6		
-1.7		
-1.8		
-1.9		
-2.0		
-2.1		
-2.2		
-2.3		
-2.4		
-2.5		
-2.6		
-2.7		
-2.8		
-2.9		
-3.0		
-3.1		
-3.2		
-3.3		
-3.4		
-3.5		
-3.6		
-3.7		
-3.8		
-3.9		
-4.0		
-4.1		
-4.2		
-4.3		
-4.4		
-4.5		
-4.6		
-4.7		
-4.8		
-4.9		
-5.0		

In-situ field testing in accordance with the following Standards:

Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

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Website: www.landtech.nz

APPENDIX D

Soakage Test Results

	Client:	Four Stars Development Limited	
	Project:	Proposed Land Use Change	
	Address:	Lincoln Rolleston Road, Rolleston	
Test Type:	On-site soakage test	Project No:	LTC20264
Tested By:	L Challies	Test Date:	21-Sep-20

Test ID:	TP05/SP01	Test ID:	
Coordinates:	NZTM2000 E1551650 N5172615	Coordinates:	
Groundwater level:	Not Encountered	Groundwater level:	
Method:	In accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual	Method:	

Test Pit Dimensions

2	m	length
1	m	wide
1.60	m	equivalent diameter

1) Test Details

Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	0.5	-
250	4.17	0.4	0.024
1590	26.50	0.3	0.004
2360	39.33	0.2	0.008

2) Calculate Minimum Gradient

0.01	m/min	368	mm/h

3) Calculate percolation rate

10	L/m2/min
587	L/m2/hr