Appendix 8: Geotech Investigation for Mid Block

GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

274 & 294 Lincoln Rolleston Road, Rolleston

Client: Goulds Development Limited

Project Reference:	LTC20428
Revision:	Revision A
Date:	17 February 2021

Documentation Control:

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Document Title:	**Geotechnical Report for Proposed Land Use Change**	
Address:	274 & 294 Lincoln Rolleston Road, Rolleston	
Revision:	Revision A	
Client:	Goulds Development Limited	
Project Reference:	LTC20428	
Author:		Luke Challies, Associate Geotechnical Engineer BEngTech (Civil), MEngNZ
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Table of Contents:

Appendices:

1.0 Introduction

1.1 Project Brief

LandTech Consulting Limited. (LandTech) were engaged by Goulds Development Limited (the Client) to carry out a geotechnical investigation at 274 & 294 Lincoln Rolleston Road, Rolleston and part of 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 accessed from Lincoln Rolleston Road in Rolleston. The site is indicated in Figure 1 below, and is located approximately 1.4km to the south east of the Rolleston Township. The site comprises part of 139 Levi Road, and all of 274 & 294 Lincoln Rolleston Road, Rolleston. The legal descriptions and areas are shown below in table 1 below.

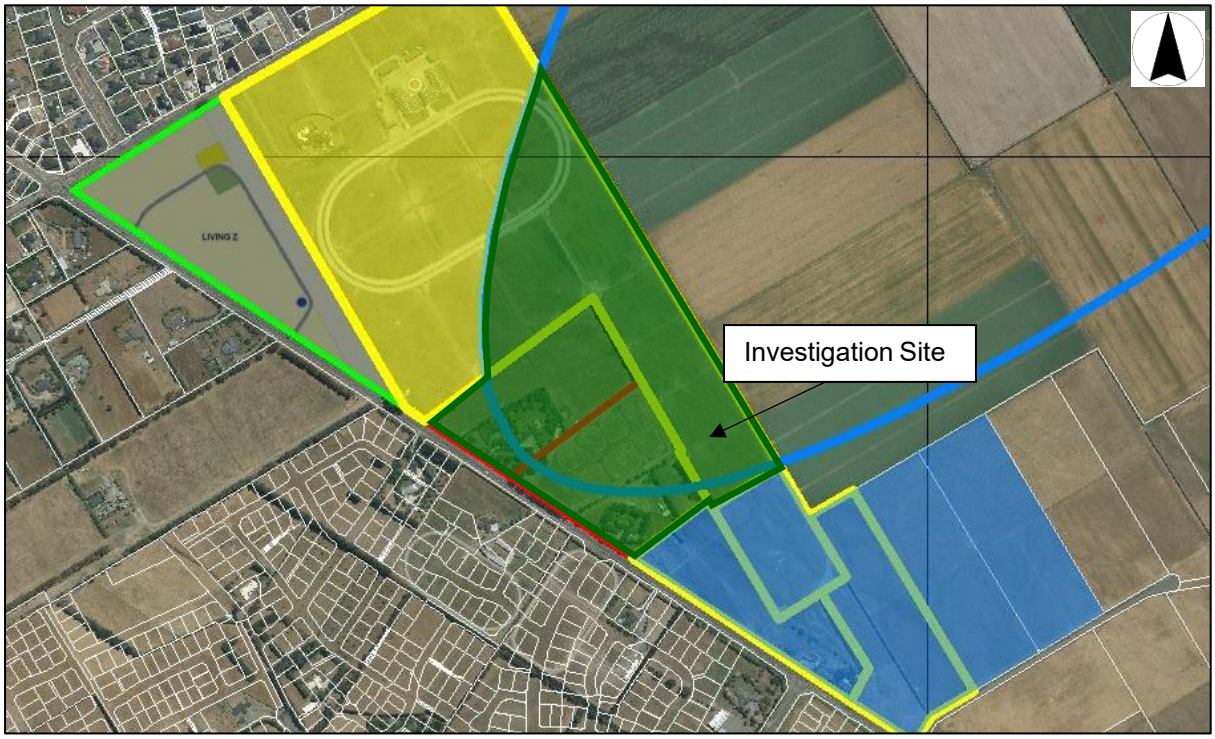

Figure 1: Aerial photograph of investigation site.

Previously the yellow and blue shaded area have been subject to a geotechnical investigation for Land Use Change. This Land Use Change report covers the land in between, shaded in green. The location of the investigated area and approximate location of the decibel restrictions is shown on the attached drawings LTC20428/1.

Table 1: Address and Legal Descriptions of the Land use change site.

Address	Legal Description	Area (ha)
274 Lincoln Rolleston Road	Lot 2 DP 67190 BLK III Leeston SD	4.00
294 Lincoln Rolleston Road	Lot 1 DP 67190 BLK III Leeston SD	4.00
139 Levi Road	Lot 2 DP 416195 & Lot 2 DP 322710	(part of) 30.43

The property is currently used for horse training throughout the Levi Road section, while the two Lincoln Rolleston Road sections are rural lifestyle blocks with houses, axillary buildings, swimming pool (#294), and associated small paddocks. The land is essentially flat with no obvious changes in elevations and undulations. Hedges occupy the majority of the property boundaries and also line some internal fences on the Lincoln Rolleston Road Properties.

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 15 February 2021. 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.

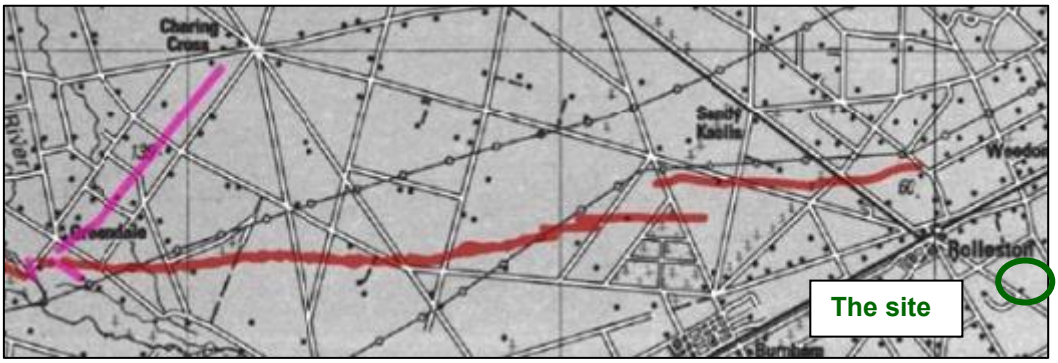

Figure 2: shows excerpt from figure A.1e of the referenced report (red line is a definite or likely fault).

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 leaves 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 eastern corner of 294 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 500m to the north, near Levi Road. 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 near the road side of 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. This soil types is 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 below in Figure 3), shows evidence of paleo river channels near the northern corner of the investigation 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 area investigated for the proposed Land Use Change.

Figure 3: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 15 February 2021)

5.0 Field Investigation

Our field investigation took place on 02 February 2021 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 & ST02) within TP01 & TP02.

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. LTC20428/ 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.

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 (below) and detailed descriptions are given in the subsequent sections.

Table 2: Subsurface summary

Test pit ID	Test Pit Depth	Topsoil Depth	Soil Depth	Scala Depth
TP01 / ST01	2.5	0.3	0.5	0.5
TP02 / ST02	3.2	0.3	1.2	1.6
TP03	2.5	0.3	1.2	1.3
TP04	2.5	0.4	1.5	1.5
TP05	3.2	0.4	2.0	2.3
TP06	2.6	0.3	2.1	2.4

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 0.3m and 0.4m 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 below the topsoil within all test positions. The depth of these soils ranged from between 0.5m (TP01) and 2.1m (TP06) below ground level, and typically comprised a moist fine sandy silt or sandy fine silt. Typically, the deeper deposits of soil were encountered near the northern corner of the property, with shallower deposits at the southern end nearer Lincoln Rolleston Road. The attached test location reference to the depth of soil shown.

Scala penetrometer testing within the soils generally ranged from 2 and 6 Blows / 100mm penetration. Higher blow counts at depth are due to contact with the underlying gravels, with refusal encountered where blow counts exceeded 25 blows per 100mm of penetration.

6.3 River Deposits

River Deposits were encountered below the surficial layer of soils from between 0.5m (TP01) and 2.1m (TP06) to the termination depth of all test locations at depths between 2.5m to 3.2m. The River Deposits generally comprised fine to coarse sandy, fine to coarse subrounded gravel. The gravel deposits were 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 TP01 & TP02; the location of the test pits are shown on the LandTech *Site Test Plan*, Drawing No. LTC20428/ 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 3: Average soakage rates

	TP01 / ST01	TP02 / ST02
Average Soak Rate (mm/hour)	2005	653
Percolation Rate (L/m^2/min)	30	6

Based on the test results the Lincoln Rolleston Road side of the property appears be more freely draining than the remainder of the investigation area. The test pit soil log also reflects this with a shallow capping of soil in this location.

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 preliminary evaluation of possible geotechnical hazards associated with this site.

8.1 Erosion

The surface of the property is near level 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. The Selwyn District Council (SDC), Selwyn's Flooding and Coastal Hazards Map (sourced from https://apps.canterburymaps.govt.nz/SelwynNaturalHazards/, accessed 15 February) shows flooding map show pockets of water to 0.2m depth throughout the site, and no obvious larger scale inundation. SDC should be contacted to determine whether a detailed flooding assessment is required.

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 0.5m and 2.1m 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. 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, 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.

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 for 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, Goulds Development 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 Test Location Plan

North

KEY:

TP01 — Proposed LandTech Consulting Test Pit locations carried out on 02 February 2021

SP01 — Proposed LandTech Consulting Soakage Test Locations carried out on 02 February 2021

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
26/01/2021	A	Test Plan

Lincoln Rolleston Road - Mid Section
ROLLESTON

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Drawing No.	Drawn by:	Date:
LTC20428/1	L C	15 February 2021
Scale: 1: 2000 (A3)	Checked by: D W	Revision: A

Filename: LTC20264 - Drawings.dwg

APPENDIX B

Environment Canterbury Well logs

canterbury maps

Canterbury Maps

N

0 0.07 0.14 0.21 0.28 Kilometres

Scale: 1:5,000 @A3

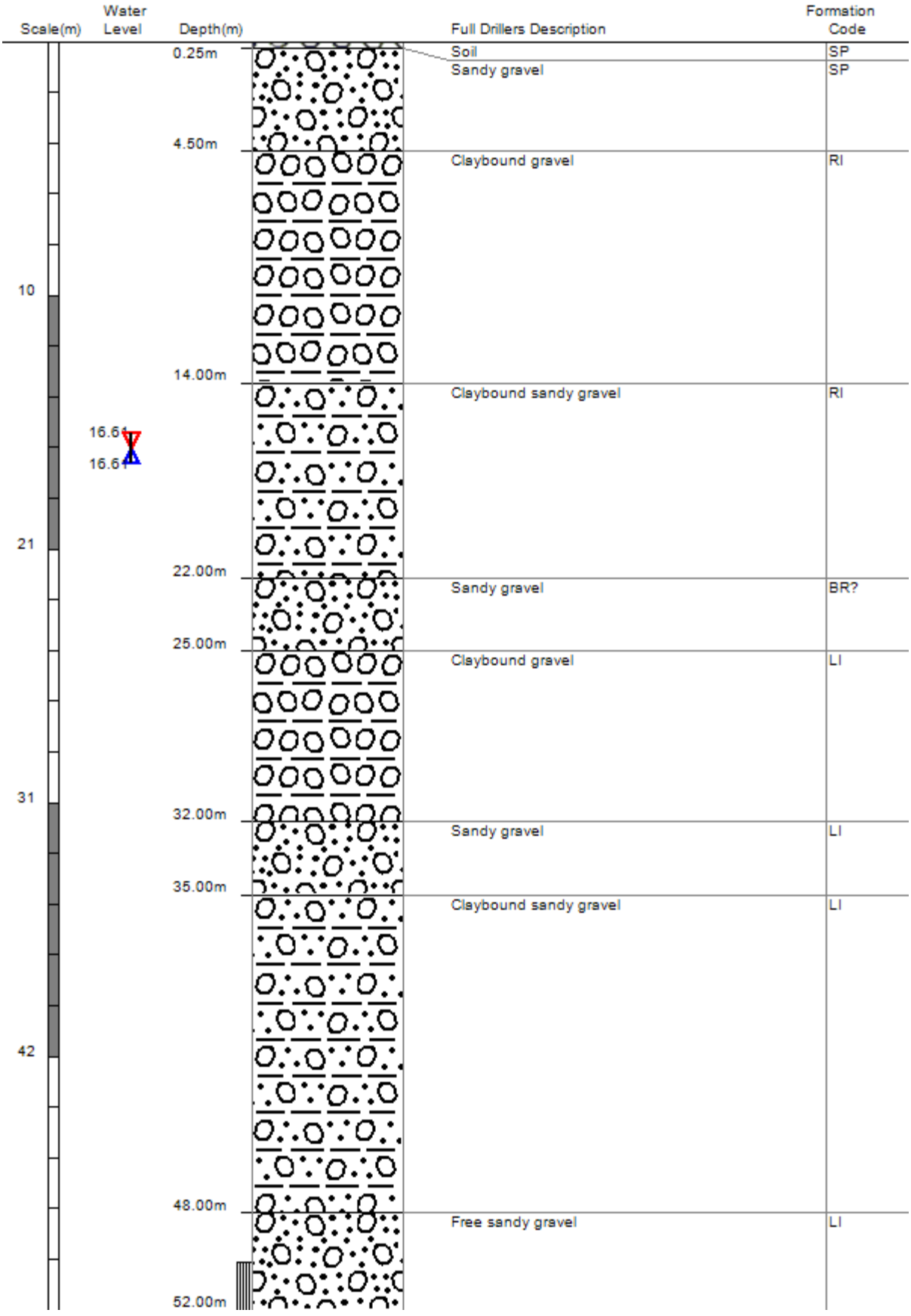
Map Created by Canterbury Maps on 12/10/2020 at 12:49 PM

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

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

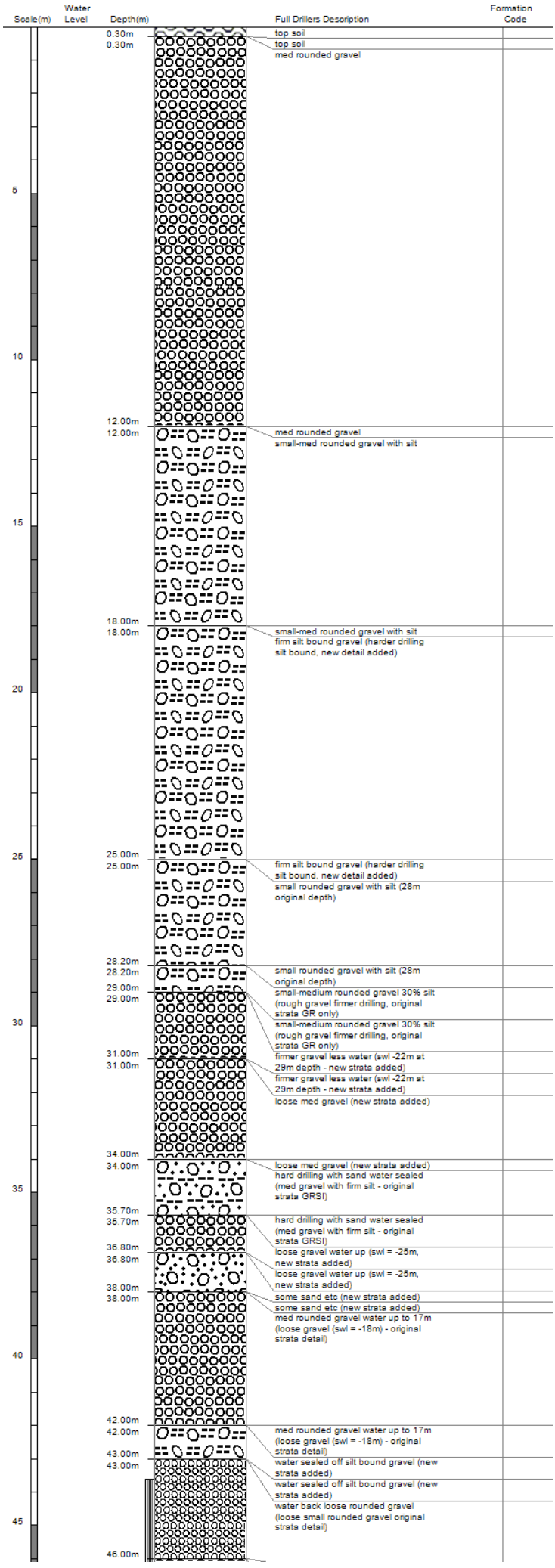
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



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

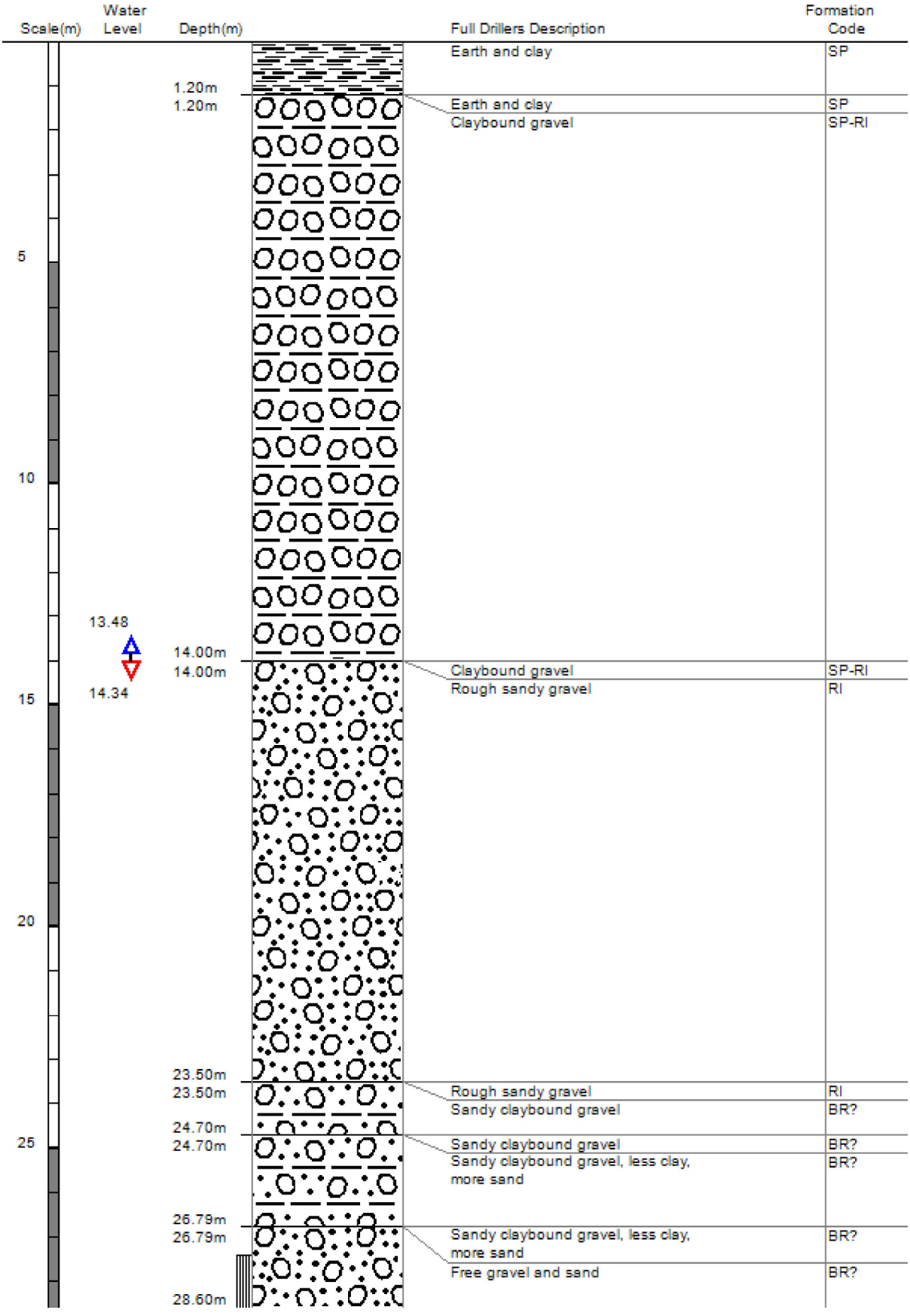
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/0328

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



APPENDIX C

Test Pit Logs

LandTech CONSULTING	Client: Goulds Development Limited Project: Proposed Land Use Change Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	Test Pit No.	TP01
		Sheet No.	1 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1551842 N5172200	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL			SILT, minor fine sand and organics, dark brown, dry to most, firm, non plastic [TOPSOIL/FILL]
ALL. D.	0.5		SILT, minor fine sand, light brown, stiff to very stiff, dry to moist, non plastic [ALLUVIAL DEPOSITS]
RIVER DEPOSITS	1.0		Fine to course subrounded to rounded sandy GRAVEL, brownish grey, very dense, dry to moist [RIVER DEPOSITS]
	1.5		moist to wet
	2.0		minor subrounded to rounded cobble
	2.5		End of Testpit (2.5m) Target depth achieved
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	5	
-0.2	6	
-0.3	7	
-0.4	11	
-0.5	25 +	
-0.6		
-0.7		
-0.8		
-0.9		
-1.0		
-1.1		
-1.2		
-1.3		
-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

LandTech Consulting Ltd. (Christchurch): Unit 6, 31 Carlyle Street, Sydenham
LandTech Consulting Ltd. (Auckland): 17 Nils Andersen Road, Whenuapai
Phone: (03) 390 1371
Phone: (09) 930 9334
Email: info@landtech.nz
Website: www.landtech.nz

LandTech CONSULTING	Client: Goulds Development Limited Project: Proposed Land Use Change Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	Test Pit No.	TP02
		Sheet No.	2 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1552060 N5172255	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL	0.0		SILT, minor fine sand, minor organics, dark brown, soft to firm, dry to most, non plastic [TOPSOIL/FILL]
ALLUVIAL DEPOSITS	0.5		SILT, minor fine sand, light brown, stiff, moist, non plastic [ALLUVIAL DEPOSITS]
	1.0		some fine to medium sand
RIVER DEPOSITS	1.5		Fine to course sandy fine to medium subrounded to rounded GRAVEL, brownish grey, dense to very dense, moist
	2.0		Fine to course sandy fine to course subrounded to rounded GRAVEL, minor subrounded to rounded cobble, brownish grey, very dense, moist to wet [RIVER DEPOSITS]
	3.0		
	3.5		End of Testpit (3.2m) Target depth achieved
	4.0		
	4.5		
	5.0		

Groundwater Level (m)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	3
-0.2	4
-0.3	7
-0.4	11
-0.5	15
-0.6	7
-0.7	7
-0.8	7
-0.9	7
-1.0	
-1.1	5
-1.2	5
-1.3	3
-1.4	3
-1.5	12
-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	

Scala Blow Count / 100mm

0 5 10 15 20 25

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
Phone: (03) 390 1371
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Website: www.landtech.nz

LandTech CONSULTING	Client: Goulds Development Limited Project: Proposed Land Use Change Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	Test Pit No.	TP03
		Sheet No.	3 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1551690 N5172276	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL	0.0		SILT, minor fine sand and organics, dark brown, soft to firm, dry to most, non plastic [TOPSOIL/FILL]
ALLUVIAL DEPOSITS	0.5		SILT, minor fine sand, light brown, stiff to very stiff, dry to moist, non plastic [ALLUVIAL DEPOSITS]
	1.0		
RIVER DEPOSITS	1.5		Fine to course subrounded to rounded sandy GRAVEL, greyish brown, very dense, moist [RIVER DEPOSITS]
	2.0		trace subrounded to rounded cobble
	2.5		moist to wet
	3.0		End of Testpit (2.5m) Target depth achieved
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	6
-0.2	10
-0.3	11
-0.4	9
-0.5	14
-0.6	10
-0.7	7
-0.8	9
-0.9	10
-1.0	
-1.1	4
-1.2	14
-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	

Scala Blow Count / 100mm

0 5 10 15 20 25

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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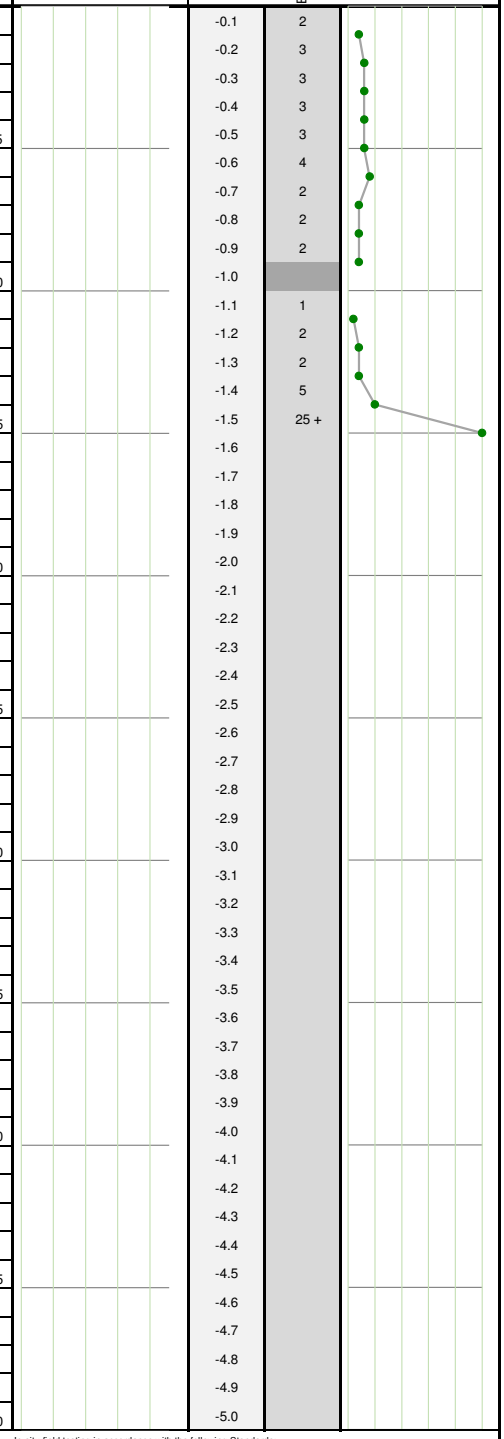
Website: www.landtech.nz

LandTech CONSULTING	Client: Goulds Development Limited Project: Proposed Land Use Change Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	Test Pit No.	TP04
		Sheet No.	4 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1551832 N5172420	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL	0.0		SILT, minor fine sand, minor organics, dark brown, soft to firm, moist, non plastic [TOPSOIL/FILL]
ALLUVIAL DEPOSITS	0.5		SILT, minor fine sand, light brown, firm, moist, non plastic [ALLUVIAL DEPOSITS]
	1.0		Fine to medium SAND, minor silt, light brown, loose to medium dense, moist
RIVER DEPOSITS	1.5		Fine to course sandy fine to course subrounded to rounded GRAVEL, greyish brown, very dense, moist to wet [RIVER DEPOSITS]
	2.0		trace subrounded to rounded cobble
	2.5		End of Testpit (2.5m) Target depth achieved
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		



Groundwater Level (m)

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: Goulds Development Limited Project: Proposed Land Use Change Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	Test Pit No.	TP05
		Sheet No.	5 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1551930 N5172535	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL	0.5		SILT, minor fine sand, minor organics, dark brown, soft to firm, dry to moist, non plastic [TOPSOIL/FILL]
ALLUVIAL DEPOSITS	1.0		SILT, minor fine sand, light brown, firm to stiff, dry to moist, non plastic [ALLUVIAL DEPOSITS]
	1.5		Fine to course SAND, minor silt, light brown, medium dense, moist
	2.0		
RIVER DEPOSITS	2.5		Fine to course sandy fine to course subrounded to rounded GRAVEL, minor silt, greyish brown, dense to very dense, moist to wet [RIVER DEPOSITS]
	3.0		
	3.5		End of Testpit (3.2m) Target depth achieved
	4.0		
	4.5		
	5.0		

Groundwater Level (m)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	6
-0.2	7
-0.3	10
-0.4	9
-0.5	8
-0.6	8
-0.7	13
-0.8	11
-0.9	8
-1.0	
-1.1	4
-1.2	5
-1.3	5
-1.4	6
-1.5	4
-1.6	4
-1.7	4
-1.8	4
-1.9	5
-2.0	4
-2.1	6
-2.2	10
-2.3	25 +
-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 25

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: Goulds Development Limited
Project: Proposed Land Use Change
Address: Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch

Test Pit No. TP06
Sheet No. 6 of 7

Drill Type:	6T Excavator	Project No:	LTC20428	Logged By:	MG
Drilled By:	BM Contracting Ltd	Coordinates:	NZTM2000 E1551839 N5172671	Shear Vane No:	NA
Date Started:	2-Feb-21	Ground Conditions:	Near level, Grass	Calibration Factor:	NA
Date Finished:	2-Feb-21	Groundwater Level (m):	Not encountered	Calibration Date:	NA

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/FILL	0.0		SILT, minor fine sand, minor organics, dark brown, soft to firm, dry to moist, non plastic [TOPSOIL/FILL]
ALLUVIAL DEPOSITS	0.5		SILT, with minor fine sand, light brown, firm, moist, non plastic [ALLUVIAL DEPOSITS]
	1.0		Fine to course SAND, minor silt, greyish light brown, medium dense, moist
	1.5		moist to wet
RIVER DEPOSITS	2.0		Fine to course sandy fine to course subrounded to rounded GRAVEL, minor silt, brownish grey, dense to very dense, moist to wet [RIVER DEPOSITS]
	2.5		End of Testpit (2.6m)
			Target depth achieved
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count	Scala Blow Count / 100mm
-0.1	4	
-0.2	4	
-0.3	5	
-0.4	7	
-0.5	9	
-0.6	7	
-0.7	6	
-0.8	4	
-0.9	6	
-1.0	4	
-1.1	5	
-1.2	5	
-1.3	6	
-1.4	6	
-1.5	8	
-1.6	7	
-1.7	6	
-1.8	5	
-1.9	6	
-2.0	5	
-2.1	6	
-2.2	12	
-2.3	15	
-2.4	25 +	
-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:	Paterson Pitts Group	
	Project:	Proposed Land Use Change	
	Address:	Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	
Test Type:	On-site soakage test	Project No:	LTC20428
Tested By:	Mazen Al-Haidar	Test Date:	2-Feb-21

Test ID:	TP01-ST1
Coordinates:	NZTM2000 E1551842 N5172200
Groundwater level:	Not Encountered
Method:	In accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual

Test Pit Dimensions

2	m	length
1	m	width
1.60	m	equivalent diameter

1) Test Details

Time (min.sec)	Time (sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0.00	0	0.00	1.8	-
0.21	21	0.35	1.7	0.286
0.45	45	0.75	1.6	0.250
1.29	89	1.48	1.5	0.136
2.17	137	2.28	1.4	0.125
2.28	148	2.47	1.3	0.545
6.45	405	6.75	1.2	0.023
8.52	532	8.87	1.1	0.047
10.54	654	10.90	1.0	0.049
13.20	800	13.33	0.9	0.041
15.53	953	15.88	0.8	0.039
18.33	1113	18.55	0.7	0.038
20.54	1254	20.90	0.6	0.043
23.11	1451	24.18	0.5	0.030
26.56	1616	26.93	0.4	0.036

2) Calculate Minimum Gradient

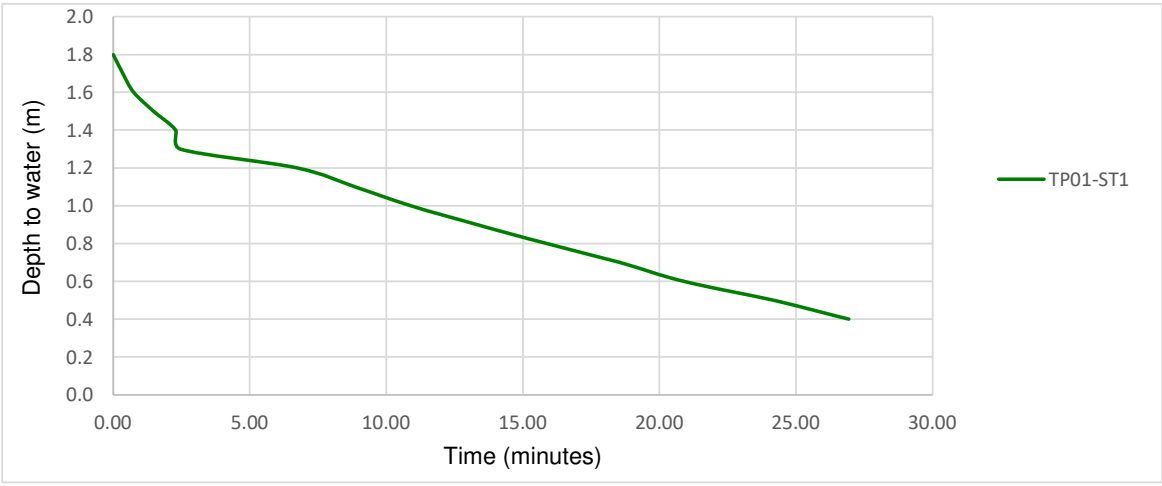
0.03 m/min

2005 mm/h

3) Calculate percolation rate

30 L/m2/min

1777 L/m2/hr



	Client:	Paterson Pitts Group	
	Project:	Proposed Land Use Change	
	Address:	Lincoln Rolleston Road - Mid-section, Rolleston, Christchurch	
Test Type:	On-site soakage test	Project No:	LTC20428
Tested By:	Mazen Al-Haidar	Test Date:	2-Feb-21
Test ID:	TP02-ST2	Test Pit Dimensions:	
Coordinates:	NZTM2000 E1552060 N5172255	2 m	length
Groundwater level:	Not Encountered	1 m	width
Method:	In accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual	1.60 m	equivalent diameter

1) Test Details

Time (min.sec)	Time (sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0.00	0	0.00	2.8	-
0.37	37	0.62	2.7	0.162
1.08	68	1.13	2.6	0.194
1.42	102	1.70	2.5	0.176
2.21	141	2.35	2.4	0.154
3.05	185	3.08	2.3	0.136
3.52	232	3.87	2.2	0.128
4.50	290	4.83	2.1	0.103
5.49	349	5.82	2.0	0.102
7.09	429	7.15	1.9	0.075
8.30	510	8.50	1.8	0.074
10.55	655	10.92	1.7	0.041
14.45	885	14.75	1.6	0.026
20.40	1240	20.67	1.5	0.017
26.31	1591	26.52	1.4	0.017
31.44	1904	31.73	1.3	0.019
36.51	2211	36.85	1.2	0.020
42.05	2525	42.08	1.1	0.019
47.38	2858	47.63	1.0	0.018
54.26	3266	54.43	0.9	0.015
1.02.36	3756	62.60	0.8	0.012
1.13.06	4386	73.10	0.7	0.010

2) Calculate Minimum Gradient

0.01 m/min

653 mm/h

3) Calculate percolation rate

6 L/m2/min

347 L/m2/hr