ENGEO

Expect Excellence

Geotechnical Investigation

533 East Maddisons Road & 870 Goulds Road

Rolleston

Canterbury

Submitted to:

Hughes Developments Ltd

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ACENZ

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ENGEO Document Control:

Report Title	Geotechnical Investigation - 533 East Maddisons Road & 870 Goulds Road, Rolleston			
Project No.	12903.000.000	Doc ID	37	
Client	Hughes Developments Ltd	Client Contact	Kelvin Black	
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1 Introduction

ENGEO Ltd was requested by Hughes Developments Ltd to undertake a Geotechnical Investigation of the property at 533 East Maddisons Road & 870 Goulds Road, Rolleston, Canterbury. This work has been carried out in accordance with variation proposal (ref P2016.000.248).

The purpose of the assessment was to develop a geological model of the site; assess the likely future land performance; comment on the suitability of the site for residential subdivision; address the requirements of Section 106 of the Resource Management Act (RMA); and provide recommendations for subdivision works and foundations for typical timber framed residential dwellings.

Our scope of works included the following:

- Complete a desktop study of relevant available geotechnical and geological publications, including the NZ Geotechnical and Environment Canterbury Databases.
- Undertake a geotechnical site walkover.
- Undertake up to 12 hand augers and Scala penetrometer tests to a maximum depth of approximately 1 m below ground level to assess the near surface material types and strength characteristics.
- Organise and technically supervise the excavation of up to 11 test pits including geotechnical logging of the exposed soils.
- Prepare a report outlining our findings on the ground conditions and the suitability of the site for residential subdivision. This will include geotechnical advice on the likely foundation Technical Category, conceptual foundation recommendations for typical timber framed residential dwellings, and address likely geohazards as required by Section 106 of the RMA. Our scope of work does not include the additional lot specific investigations associated with the design level geotechnical report required for Building Consent.

2 Site Description

The site at 533 East Maddisons Road & 870 Goulds Road covers a total area of 8 ha, and has the following legal description (Selwyn District Council):

- 533 East Maddisons Road - Lot 3 DP 326339 (4 ha)
- 870 Goulds Road - Lot 4 DP 355996 (4 ha)

It is located approximately 4 km south of Rolleston town centre, and is bounded to the west by Goulds Road. Rural properties border the site on the remaining sides (Figure 1).

Figure 1: Site Location Plan

Aerial photograph sourced from Canterbury Maps. Not to scale.

3 Geological Model

3.1 Regional Geology

The site has been regionally mapped by GNS (Forsyth et al., 2008) as being underlain by grey river alluvium.

3.2 Geomorphology

The site comprises relatively flat ground, with gentle undulations and depressions in some areas. As evident on aerial imagery (Canterbury Maps, 2016) and observed during our site walkover conducted on 17 and 18 September 2018, undulating and depressed ground can be attributed to paleo-channels, which traverse the site in a general northwest to southeast trend. Based on our testing, silt and sand deposits with variable thickness (up to 0.5 m) are expected to have in-filled the paleo-channels where they have not remained as channel features. Inferred paleo-channels have been mapped to give an indication of areas with potential channel in-fill (Appendix 1).

3.3 Geohazards

3.3.1 Seismicity

There are no known or mapped faults in the immediate area of the site, however the site may be at risk of ground shaking induced by movement of proximal or distal faults.

The site is located between two recently discovered fault systems, the Greendale Fault and the Port Hills Fault, the ruptures of which initiated the ongoing Canterbury Earthquake Sequence (CES). The Greendale Fault has been mapped approximately 5.5 km north-north-west of the site and trends roughly east-west with a surface rupture of approximately 28 km (GNS, 2015), while the Port Hills Fault remains unmapped as the fault did not rupture at the surface. Movement on the Port Hills Fault is believed to have occurred at a depth of 1 km to 2 km below ground surface.

Large regional areas of faulting (GNS, 2015) namely the Ashley Fault, Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard 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).

3.3.2 Liquefaction and Lateral Spreading

The site is located within an area mapped as ‘Zone of very low liquefaction potential’ (Canterbury Maps, Selwyn liquefaction susceptibility; 2006).

3.4 Site Investigation

Site investigations to assess the shallow subsurface material types and strength characteristics were undertaken by ENGEO on 17 and 18 of September 2018. The investigations comprised 10 hand auger boreholes and 11 test pit investigations with associated Scala penetrometer tests.

The investigations revealed subsurface conditions across the site are consistent with the published geological mapping, as summarised in Table 1.

Table 1: Generalised Summary of Subsurface Conditions

Depth to Top of Layer (m)	Soil Type	Layer Thickness (m)	Density / Consistency	Additional Comments
0.0	TOPSOIL	0.2 to 0.4	Firm to Stiff	
0.3	ALLUVIUM	0.1 to 0.2	Firm to Stiff	Not present at all locations
0.4	Sandy GRAVEL	Unknown, but in excess of 10 m	Medium Dense to Dense	

It should be noted that test pits 4, 5 and 7 encountered a sand or silt layer within the sandy gravel layer. The layer was between 0.1 m and 0.2 m thick and occurred between 0.4 and 0.8 m depth.

3.5 ECan Boreholes

A review of three deep ECan borehole logs, one located near the southern side of the site (M36/7521), (M36/20535), and the other south of the 870 Goulds Road lot (M36/4221) was conducted (Canterbury Maps). The location of these boreholes is presented in Figure 2. The logs from the three holes of interest are presented in Appendix 3 and indicate the site is broadly underlain by a mixture of sandy and claybound gravels to depths of at least 30 m below ground level. Layers of silt in the upper 0.5 m are recorded in the bore well (M36/20535).

Figure 2: ECan Well Borehole Locations

Aerial photograph sourced from Canterbury Maps. Not to scale.

3.6 Groundwater

Groundwater is recorded in the surrounding boreholes between approximately 7 m and 8 m depth.

3.7 Site Seismic Class

In accordance with NZS 1170.5:2004, Class D applies to this particular site, defining it as a 'deep or soft soil sites'.

4 Liquefaction Assessment

Based on our site investigation and observations, and owing to the nature of the subsurface materials and depth to groundwater at the site, we consider the potential for liquefaction and lateral spreading on the site to be very low.

We therefore consider the site of the proposed subdivision to have Technical Category 1 (TC1) future land performance whereby future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.

5 RMA Section 106 Requirements and Suitability to Subdivide

Section 106 of the Resource Management Act 1991 states a consent authority may refuse to grant a subdivision consent, or may grant a consent subject to specific consent conditions if the land is likely to be subject to the following:

- Erosion, including surface and subsurface erosion, associated with water and wind.
- Falling debris, including rockfall that could impact the site from upslope sources.
- Subsidence, which involves the removal of underlying support by natural or artificial means.
- Slippage, which is defined as the downslope transfer of materials by sliding and / or flowage.
- Inundation, which may be sourced from streams, coastal processes or excess precipitation.

Based on our observations and the nature of the site, its performance during the CES, and the site's distance from the nearest significant watercourse, we consider it is unlikely for the site to be subject to any of the above hazards and, as such, the site is considered suitable for subdivision from a geotechnical perspective.

6 Geotechnical Recommendations

6.1 Earthworks

Earthworks carried out for the subdivision shall be in accordance with NZS 4404:2010, Land Development and Subdivision Infrastructure and NZS 4431:1989, Code of Practice for Earthfilling for Residential Development. In particular, any areas to receive fill should be stripped of any vegetation, topsoil, non-engineered fill, soft or organic soils prior to fill placement.

Fill may comprise clean natural sandy gravel or silty soils, or clean imported soils and / or granular fill, compacted to achieve no less than 95% of maximum dry density. Fill faces steeper than 2:1 and higher than 600 mm should be retained and referred back to ENGEO. Although unlikely, where any springs or groundwater seeps are encountered they should be intercepted with suitable drainage and discharged to a Council approved outlet.

All unretained batters of pond and stormwater drains constructed with the native sandy gravel material should be at an inclination of 1V:3H, with protection schemes in place to control erosion of the formed batters within the waterways.

A comprehensive earthworks specification should be provided to the earthworks contractor prior to starting excavations and an inspection / testing regime agreed, along with a robust erosion and sediment control plan.

6.2 Subdivision Roading

Vegetation, any organic or deleterious material, topsoil and non-engineered fill should be removed from the site under pavement areas prior to aggregate placement. Based on our observations during testing, we consider the natural ground below the topsoil at the site should provide an adequate subgrade for the proposed pavement areas.

6.3 Stormwater Control

Concentrated stormwater flows from all impermeable areas must be collected and carried in sealed pipes to the Council system or an alternative disposal point subject to approval from Council. Uncontrolled stormwater must not be allowed to saturate the ground as this will potentially affect future foundation performance both statically and during future seismic activity.

6.4 Foundations

Foundations for future proposed residential dwellings within the subdivision may comprise pad, strip or slab foundations designed in accordance with the provisions of NZS 3604 Timber Framed Buildings.

Site specific testing will be required for Building Consent, to confirm the bearing materials and capacity. For preliminary design, we anticipate that a geotechnical Ultimate Bearing Capacity of 300 kPa may be assumed for foundations bearing on natural silt, sandy gravel or engineered fill, below any topsoil. We anticipate this to be typically below 0.3 m depth based on our subsurface investigations.

7 References

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GNS Science (2015). New Zealand Active Faults Database. Retrieved May 2018, from http://data.gns.cri.nz /af.

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The Ministry of Business, Innovation, and Employment (2016). New Zealand Geotechnical Database. Retrieved December 2017, from https://www.nzgd.org.nz.

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, Hughes Developments Ltd, 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 assessments 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 should 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 Engineers NZ/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

Jacinta Morgan

Engineering Geologist

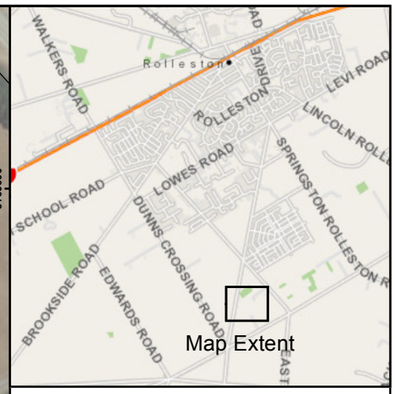
Report reviewed by

Neil Charters, CMEngNZ (CPEng)

Principal Geotechnical Engineer

APPENDIX 1:

Test Location and Paleo Channel Plan



Legend

- Hand auger
- Test pit
- site
- Property title boundary
- Inferred Paleo-Channel

Aerial: LINZ and Eagle Technology, CC-BY-3.0-NZ.
Map image: Eagle Technology, CC-BY-3.0-NZ.

0 50 100
Metres

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

ENGEO
Expect Excellence

Christchurch Office
124 Montreal Street, Sydenham, Christchurch 8023
Tel: 03 328 9012, www.engeo.co.nz

Title:
Site and sampling location plan

Client: Hughes Developments Ltd		Figure No: 1
Project: 533 East Maddisons Road & 870 Goulds Road, Rolleston	Designed: JM Drawn: RW Checked: XX Date: Sep 18	Size: A3
Proj No: 12903.000.000_33	Scale: 1:2,000	Revision: A

ORIGINAL FIGURE PRINTED IN COLOUR

PATH: Z:\Projects\12901 to 13000\12903 - Farrington South Subdivision\033 - 533 East and 870 Goulds - Geotech\06_CAD-GIS & Figures\F01_SiteLoc.mxd

APPENDIX 2:

Hand Auger and Test Pit Logs

LOG OF AUGER HA01

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.3 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
0	TOPSOIL	ML	SILT with some sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].			M			2 4 6 8 10 12
			End of Hole Depth: 0.3 m Termination Condition: Practical refusal						>>
0.5									
1.0									

Hand auger met practical refusal at 0.3 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.4 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA02

533 East Madisons Road
Rolleston
12903.000.000

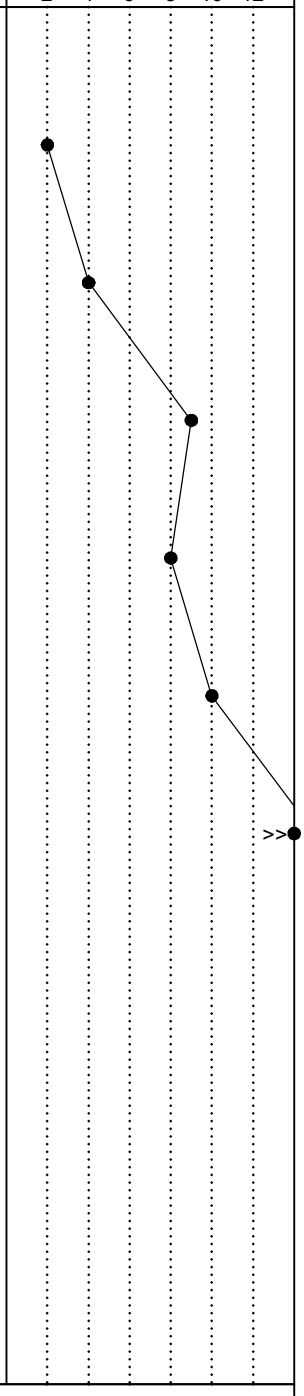
Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.2 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

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 minor sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].			M		
			End of Hole Depth: 0.2 m Termination Condition: Practical refusal					

Scala Penetrometer

Blows per 100mm



Hand auger met practical refusal at 0.2 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.6 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA03

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.4 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
	TOPSOIL	ML	SILT with trace sand and rootlets; brown. Low plasticity [TOPSOIL].			M			
	A	ML	SILT with some sand; greyish brown. Low plasticity. Sand, fine to medium.						
			End of Hole Depth: 0.4 m Termination Condition: Practical refusal						
0.5									>>
1.0									

Hand auger met practical refusal at 0.4 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.5 m depth.
Standing groundwater was not encountered
A= ALLUVIUM

LOG OF AUGER HA04

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.3 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
0	TOPSOIL	ML	SILT with minor sand and gravel, trace rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, subrounded to subangular [TOPSOIL].			W			2 4 6 8 10 12
			End of Hole Depth: 0.3 m Termination Condition: Practical refusal						>>
0.5									
1.0									

Hand auger met practical refusal at 0.3 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.5 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA05

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.3 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
0	TOPSOIL	ML	SILT with some sand and trace rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].			M			2 4 6 8 10 12
			Trace gravel encountered from 0.2 m depth.						
			End of Hole Depth: 0.3 m Termination Condition: Practical refusal						>>
0.5									
1.0									

Hand auger met practical refusal at 0.3 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.4 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA06

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.4 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
0	TOPSOIL	ML	SILT with some sand, trace gravel and rootlets; brown. Low plasticity [TOPSOIL].			M			
			End of Hole Depth: 0.4 m Termination Condition: Practical refusal					UTP	>>
0.5									
1.0									

Hand auger met practical refusal at 0.4 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.6 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA07

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.5 m
Hole Diameter : 50 mm

Shear Vane No : 2022
Logged By : EG
Reviewed By :
Latitude :
Longitude :

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 some sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].			M		
	A	ML	SILT with some sand; brownish grey. Low plasticity. Sand, fine to medium.			W		67/17
0.5			End of Hole Depth: 0.5 m Termination Condition: Practical refusal					
1.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

>>

Hand auger met practical refusal at 0.5 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.6 m depth.
Standing groundwater was not encountered
A = ALLUVIUM

GEOSCIENCE HAND AUGER 533 EAST MADISONS ROAD.GPJ NZ DATA TEMPLATE 2.GDT 20/9/18

LOG OF AUGER HA08

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.4 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
	TOPSOIL	ML	SILT with some sand and trace rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].			M			
	A	ML	SILT with some sand and trace gravel; greyish brown. Low plasticity. Sand, fine to medium.						
			End of Hole Depth: 0.4 m Termination Condition: Practical refusal						>>
0.5									
1.0									

Hand auger met practical refusal at 0.4 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.4 m depth.
Standing groundwater was not encountered
A = ALLUVIUM

LOG OF AUGER HA09

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.5 m
Hole Diameter : 50 mm

Shear Vane No : 2022
Logged By : EG
Reviewed By :
Latitude :
Longitude :

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 some sand and trace rootlets; brown. Sand, fine to medium [TOPSOIL].			W		
	ALLUVIUM	ML	SILT with some sand and trace gravel; greyish brown. Low plasticity. Sand, fine to medium.			M		
0.5			End of Hole Depth: 0.5 m Termination Condition: Practical refusal					133/33
1.0								

Scala Penetrometer

Blows per 100mm

2 4 6 8 10 12

>>

Hand auger met practical refusal at 0.5 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.7 m depth.
Standing groundwater was not encountered

GEOSCIENCE HAND AUGER 533 EAST MADISONS ROAD.GPJ NZ DATA TEMPLATE 2.GDT 20/9/18

LOG OF AUGER HA10

533 East Madisons Road
Rolleston
12903.000.000

Client : Hughes Development Ltd
Client Ref. : 12903
Date : 18/09/18
Hole Depth : 0.3 m
Hole Diameter : 50 mm

Shear Vane No :
Logged By : EG
Reviewed By :
Latitude :
Longitude :

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
0	TOPSOIL	ML	SILT with some sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine [TOPSOIL].			M			
0.3			End of Hole Depth: 0.3 m Termination Condition: Practical refusal						
0.5									
1.0									

Scala Penetrometer: Blows per 100mm — 2, 4, 6, 8, 10, 12; >>

Hand auger met practical refusal at 0.3 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 0.4 m depth.
Standing groundwater was not encountered

GEOSCIENCE HAND AUGER 533 EAST MADISONS ROAD.GPJ NZ DATA TEMPLATE 2.GDT 20/9/18

LOG OF TEST PIT TP01

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.625912
Bucket Type/Size : 600 mm **Longitude** : 172.383173

Depth (m)	Material	Excavatability (Relative Scale) Easier–Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	TS		ML	Sandy SILT with trace rootlets; brown. Low plasticity. Sand, fine to medium [TOPSOIL].				F - St		
	ALLUVIUM		ML	Sandy SILT; light brown. Low plasticity. Sand, fine to medium.				F - St		
			GW	Sandy fine to coarse GRAVEL; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	MD - D		
2.0				Depth of Excavation: 2.1 m Termination Condition: Target depth						

Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP02

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 1.9 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.625755
Bucket Type/Size : 600 mm **Longitude** : 172.381923

Depth (m)	Material	Excavatability (Relative Scale) Easier – Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	TS		ML	SILT with some sand, minor gravel and trace rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				St		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles and tree roots; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	MD - D		
1.0				Tree roots cease from 1.2 m depth.						
1.5										
2.0				Depth of Excavation: 1.9 m Termination Condition: Target depth						

Test pit met target depth at 1.9 m.
Standing groundwater was not encountered
TS = TOPSOIL

GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP03

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.625972
Bucket Type/Size : 600 mm **Longitude** : 172.3817

Depth (m)	Material	Excavatability (Relative Scale) Easier – Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	TS		ML	SILT with some sand, minor gravel and trace rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				F		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	MD - D		>>
1.0										
1.5										
2.0				Depth of Excavation: 2.1 m Termination Condition: Target depth						

Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

LOG OF TEST PIT TP04

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.62642
Bucket Type/Size : 600 mm **Longitude** : 172.382414

Depth (m)	Material	Excavatability (Relative Scale) Easier–Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0	TS		ML	SILT with some sand, minor gravel and trace rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				F - St		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles and tree roots; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.				MD		
			SM	Fine to medium SAND; light brown. Poorly graded.				MD		
1.0			GW	Sandy fine to coarse GRAVEL with minor cobbles and tree roots; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	D		
1.5										
2.0				Depth of Excavation: 2.1 m Termination Condition: Target depth						

Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

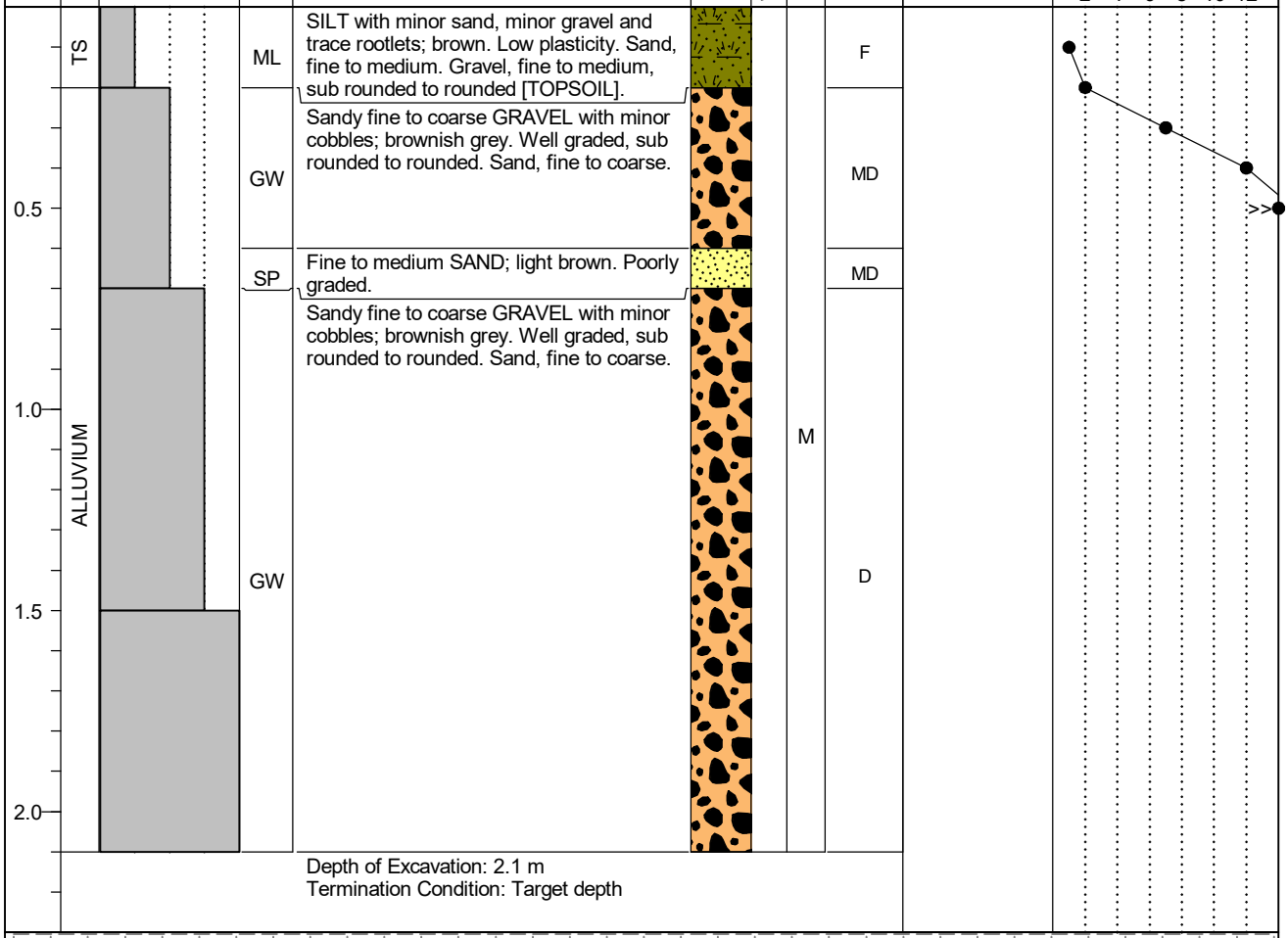
GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP05

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.627215
Bucket Type/Size : 600 mm **Longitude** : 172.382536



Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

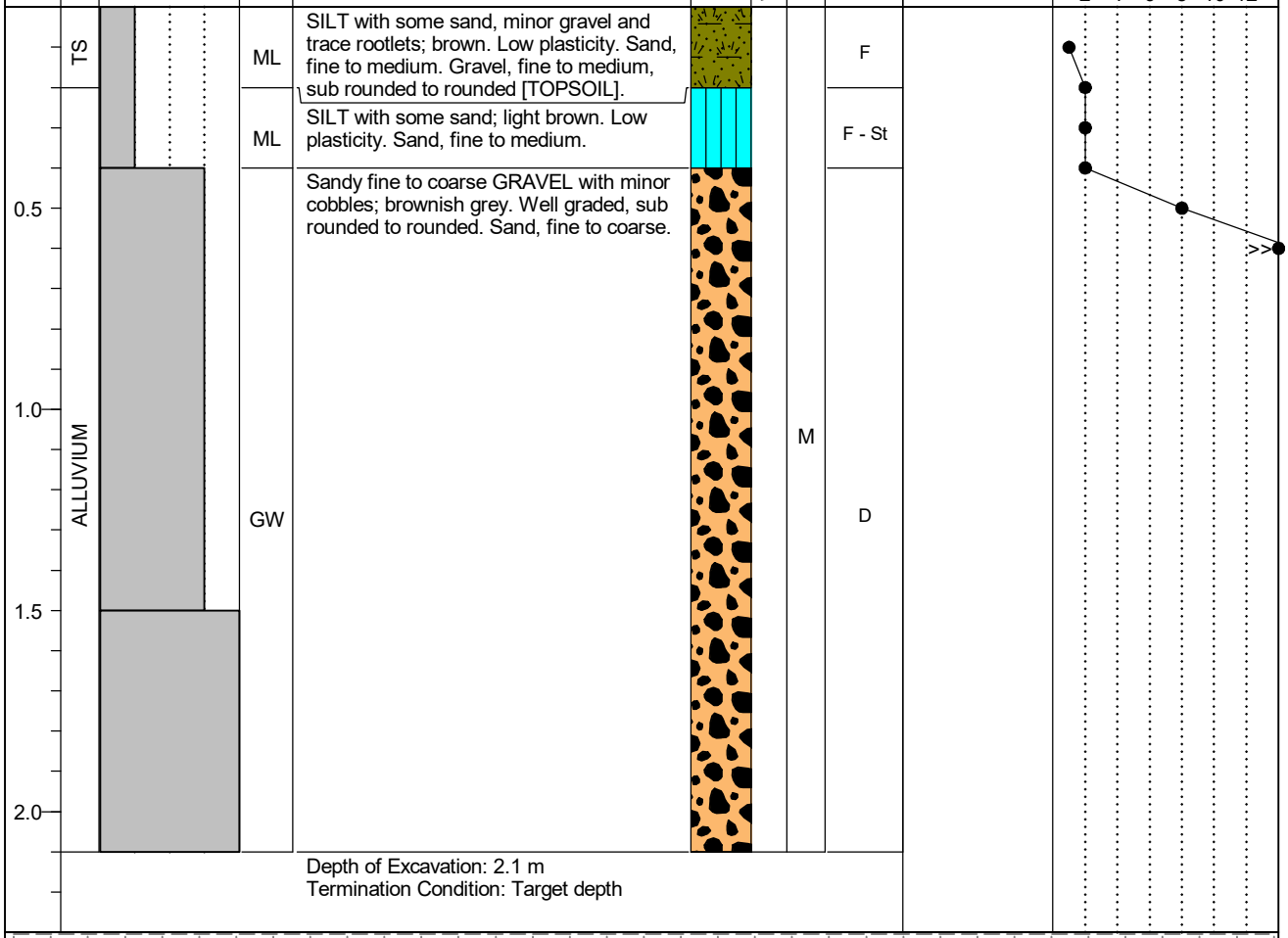
GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP06

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.625724
Bucket Type/Size : 600 mm **Longitude** : 172.380425



Depth of Excavation: 2.1 m
Termination Condition: Target depth

Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP07

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.626217
Bucket Type/Size : 600 mm **Longitude** : 172.380858

Depth (m)	Material	Excavatability (Relative Scale) Easier–Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0	TS		ML	SILT with some sand, minor gravel and trace rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				St		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.				MD - D		
			ML	SILT with some fine sand; light brown. Low plasticity.				VSt		
1.0			GW	Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	D		
1.5										
2.0				Depth of Excavation: 2.1 m Termination Condition: Target depth						

Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
TS = TOPSOIL

GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP08

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2.1 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.627099
Bucket Type/Size : 600 mm **Longitude** : 172.379952

Depth (m)	Material	Excavatability (Relative Scale) Easier – Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	T		ML	SILT with minor sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				F		
0.5	ALLUVIUM			Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.						
1.0			GW				M	MD - D		
1.5										
2.0				Depth of Excavation: 2.1 m Termination Condition: Target depth						

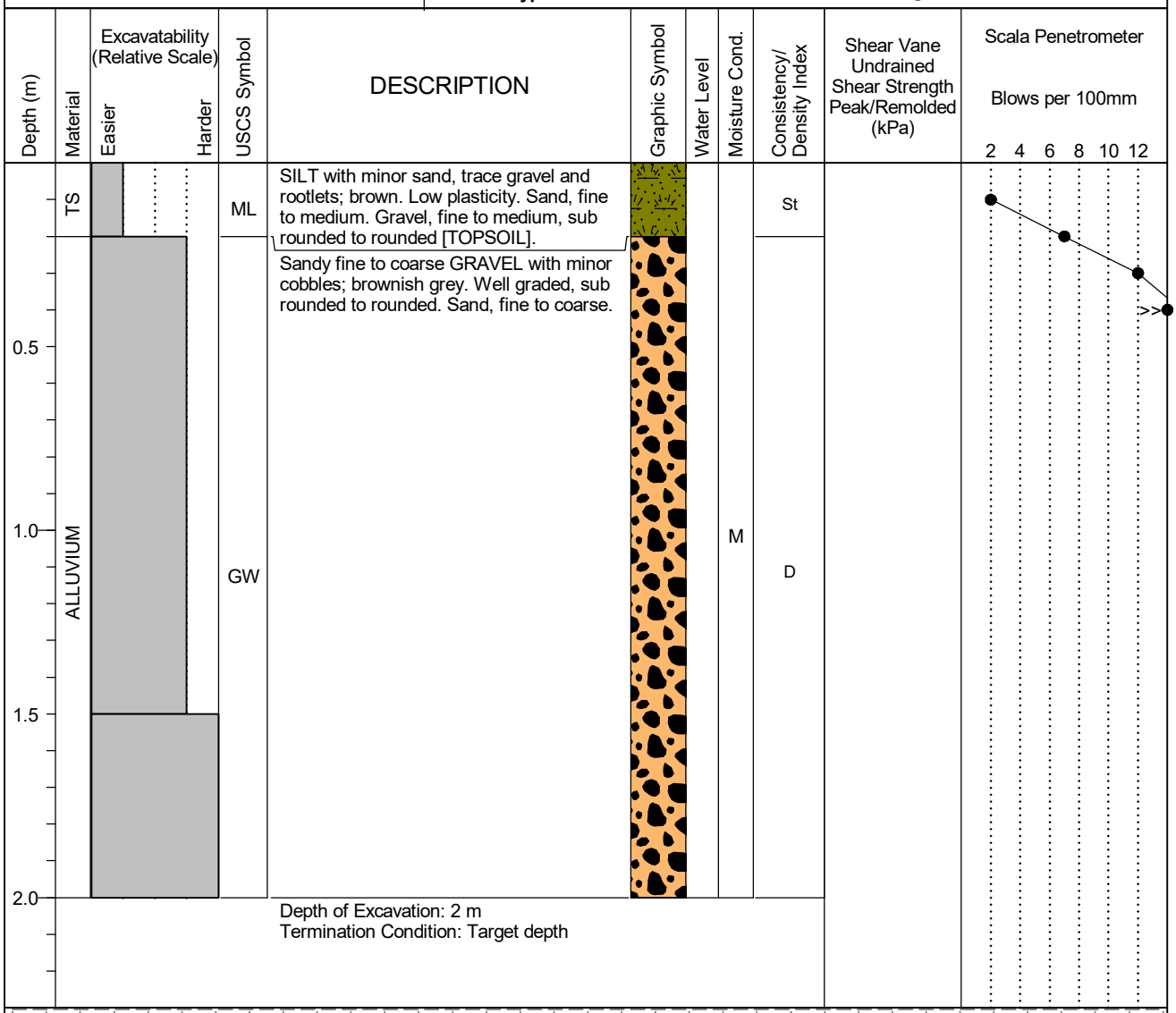
Test pit met target depth at 2.1 m.
Standing groundwater was not encountered
T = TOPSOIL

LOG OF TEST PIT TP09

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.627602
Bucket Type/Size : 600 mm **Longitude** : 172.379965



Test pit met target depth at 2 m.
Standing groundwater was not encountered
TS = TOPSOIL

LOG OF TEST PIT TP10

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.627912
Bucket Type/Size : 600 mm **Longitude** : 172.380877

Depth (m)	Material	Excavatability (Relative Scale) Easier – Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	TS		ML	Sandy SILT with trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				St		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	MD - D		>>
1.0										
1.5										
2.0				Depth of Excavation: 2 m Termination Condition: Target depth						

Test pit met target depth at 2 m.
Standing groundwater was not encountered
TS = TOPSOIL

GEOSCIENCE TEST PIT LOG - PHOTOS 533 EAST MADDISONS - 870 GOULDS ROAD TEST PIT LOGS.GPJ NZ MASTER DATA TEMPLATE.GDT 20/9/18

LOG OF TEST PIT TP11

Geotechnical Investigation

533 East Maddisons / 870 Goulds
Rolleston, Christchurch
12903.000.000

Client : Hughes Developments Ltd. **Shear Vane No** :
Date : 18/09/2018 **Logged By** : HB
Max Test Pit Depth : 2 m **Reviewed By** : JM
Digger Type/Size : Bucket Excavator/ 7 tonnes **Latitude** : -43.626891
Bucket Type/Size : 600 mm **Longitude** : 172.381343

Depth (m)	Material	Excavatability (Relative Scale) Easier – Harder	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength Peak/Remolded (kPa)	Scala Penetrometer Blows per 100mm (2 4 6 8 10 12)
0.0	TS		ML	SILT with some sand, trace gravel and rootlets; brown. Low plasticity. Sand, fine to medium. Gravel, fine to medium, sub rounded to rounded [TOPSOIL].				F - St		
0.5	ALLUVIUM		GW	Sandy fine to coarse GRAVEL with minor cobbles; brownish grey. Well graded, sub rounded to rounded. Sand, fine to coarse.			M	MD - D		>>
1.0										
1.5										
2.0				Depth of Excavation: 2 m Termination Condition: Target depth						

Test pit met target depth at 2 m.
Standing groundwater was not encountered
TS = TOPSOIL

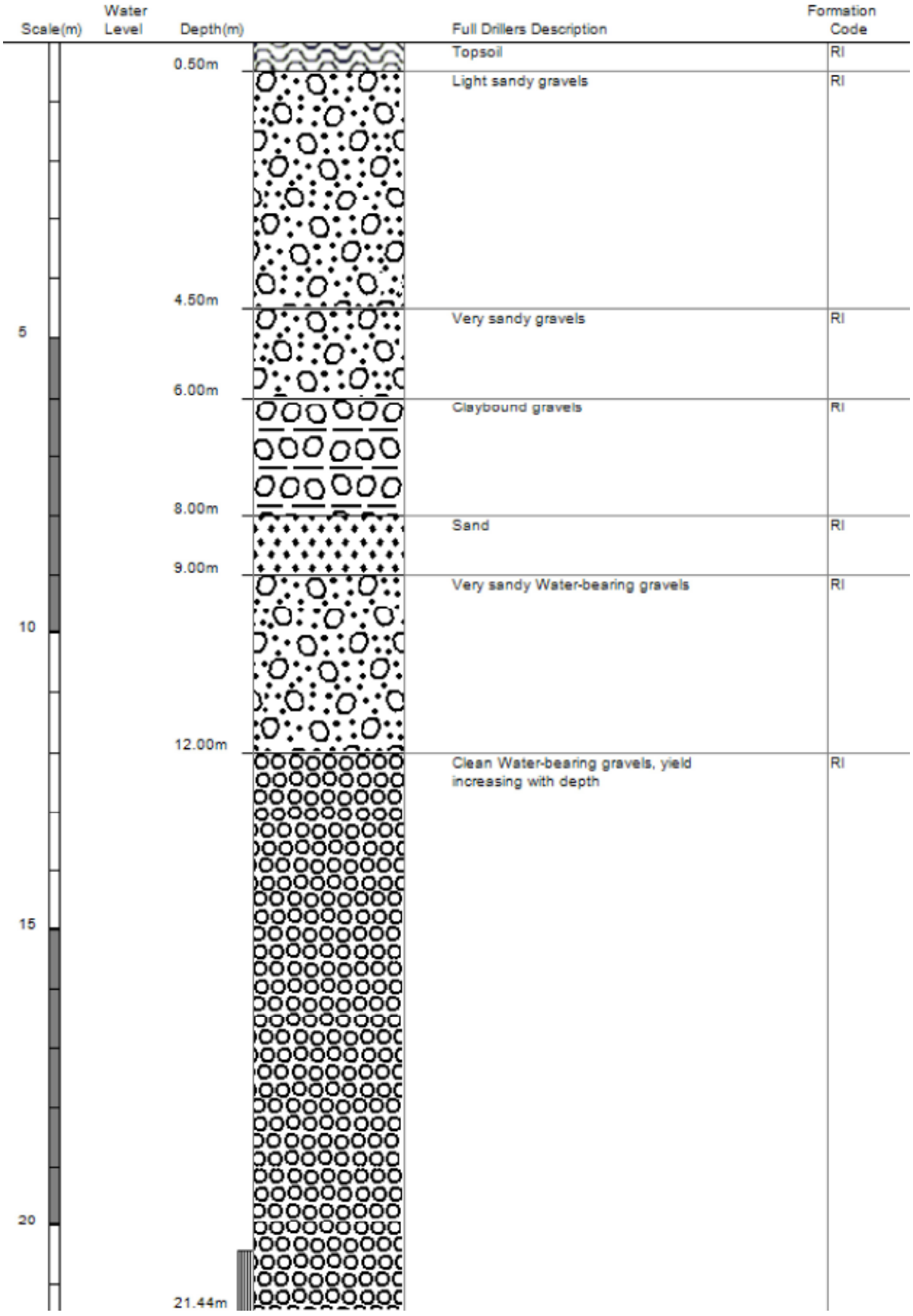
APPENDIX 3:

ECan Well Borehole Logs

Borelog for well M36/4221

Grid Reference (NZTM): 1550161 mE, 5169165 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 35.5 m +MSD Accuracy: < 2.5 m
Driller: Weedons WellDrilling
Drill Method: Rotary/Percussion
Borelog Depth: 21.4 m Drill Date: 04-Feb-1991

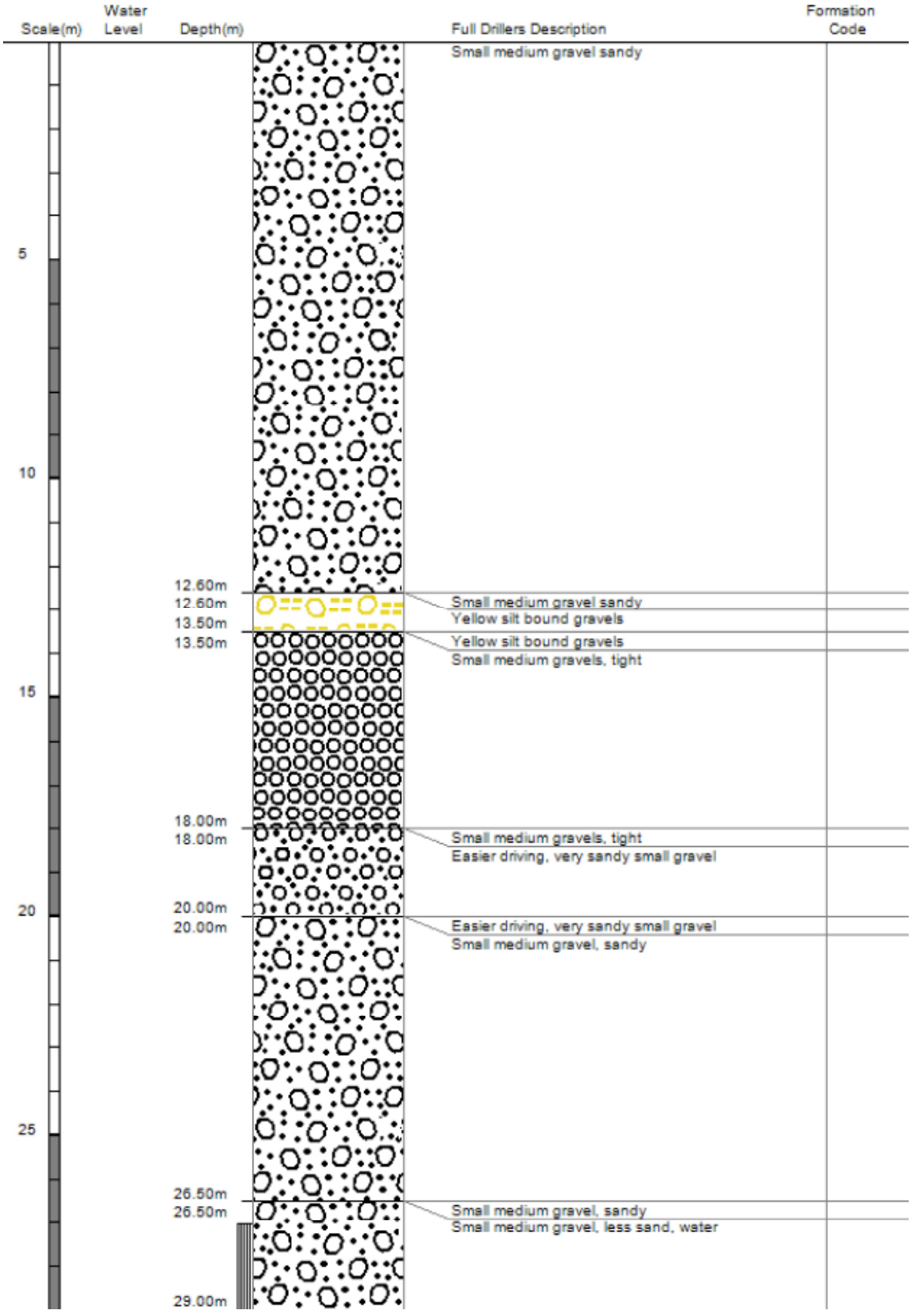
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/7512

Grid Reference (NZTM): 1550238 mE, 5169431 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 34.9 m +MSD Accuracy: < 0.5 m
Driller: Dynes Road Drilling
Drill Method: Cable Tool
Borelog Depth: 29.0 m Drill Date: 01-Dec-2003

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/20535

Grid Reference (NZTM): 1550018 mE, 5169231 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: 35.0 m +MSD Accuracy: < 0.5 m
Driller: Daly Water Wells Ltd
Drill Method: Rotary Rig
Borelog Depth: 30.0 m Drill Date: 04-Feb-2011

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha