

Appendix 5: Geotechnical Report



GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

Corner of Creyke & West Coast Roads (Section 1 SO 1227), Darfield Client: Rupert Jack & Catherine Elizabeth Wright

Project Reference: LTCL17312

Revision: A

Date: 22 December 2017

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1.0 Introduction

1.1 Project Brief

LandTech Consulting Ltd. (LandTech) were engaged by Rupert Jack & Catherine Elizabeth Wright (the Client) to carry out a geotechnical investigation on the corner of Creyke & West Coast Roads, Darfield. The geotechnical investigation is in relation to the proposed land use change of the property from rural to residential and commercial.

The geotechnical investigation has been carried out to determine a geological model of the site, assess the future land performance (i.e. during seismic events) and assess the suitability of the proposed land use change from a geotechnical perspective. Where applicable assessment and reporting has been conducted in accordance with the Ministry of Business, Innovation and Employment document; Repairing and rebuilding houses affected by the Canterbury Earthquakes, dated December 2012 (MBIE Guidelines, 2012), and any relevant updates.

This geotechnical report summarises the findings of our investigation and assessment. It includes our evaluation of natural hazards, suitability of the proposed development, and may be used to support a Land Use Change Application to the Selwyn District Council.

1.2 Scope of Works

The geotechnical investigation for the proposed subdivision included the following:

- Desktop review of existing geological, geotechnical and natural hazard information;
- Detailed walkover inspection;
- Intrusive field investigation (i.e. testpit excavations);
- Geotechnical assessment and natural hazard evaluation; and
- Preparation of this geotechnical report, detailing all of the above and recommendations.

2.0 Site Description

The investigation site is located on the corner of Creyke & West Coast Roads (State Highway 73), Darfield and is legally described as Section 1 SO 1227. The property is approximately trapezoid shaped in plan view and 30.8ha in total area (the site area has been sourced from https://mapviewer.canterburymaps.govt.nz/, accessed 14 December 2017); as shown in Figure 1 and on the LandTech *Site Plan*, Drawing No. LTCL17312/ 1 (attached in Appendix A). The site is bound to the north by West Coast Road and Creyke Road runs adjacent the eastern site boundary. At present the property comprises a rural/pastoral setting and the ground surface is generally near level to undulating with a gradual fall toward the south. An open drainage channel flows along the southern boundary and is indicated on the LandTech *Site Plan* (referenced above).



Figure 1: Aerial photograph of investigation site



(Source: https://mapviewer.canterburymaps.govt.nz/, accessed 14 December 2017)

3.0 Proposed Development

Baseline Group have provided a drawing titled: *Outline Development Plan – Section 1 SO 1227, Plan Change – Darfield*, Sheet 1/1, Revision 1, dated 3 June 2016. The drawing indicates it is proposed to change the current land use from rural to commercial and residential. The proposed development following an approved land change by the Selwyn District Council will include the construction of commercial buildings (with associated car parking and landscaping), a community centre, low and medium density residential properties.

4.0 Area Geology

Reference has been made to the various maps and resources made available by GNS and NZGD (for example, the *New Zealand Geology Web Map*, http://data.gns.cri.nz/geology/, accessed 14 December 2017). The reviewed sources indicate that the site is underlain by Late Pleistocene River Deposits. These materials generally comprise rounded to subrounded gravel and cobble sized particles deposited via the lateral and vertical migration of the past and present river systems, from the Southern Alps, out toward the east coast.

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.



4.1 Faults in Canterbury

New Zealand rests on the boundary between the Pacific and the Australian Tectonic Plates. This boundary is marked by a series of surface expressions through the Marlborough, North Canterbury, Wairau, Awatere, Clarence and Hope Faults. These faults converge near Otira and form the Alpine Fault. In places away from these major faults are smaller/minor faults that act in taking up some of the tectonic plate movements (for example the active Porters Pass Fault). These faults, and unknown unmapped faults below the Canterbury Plains contribute to the seismic hazard of the region.

The tectonic plates are constantly moving with respect to one another, and the Earth's crust can only accommodate a certain level of stress/strain before rupture occurs. This has been demonstrated during the recent Canterbury Earthquake Sequence (CES) and Kaikoura Earthquakes. The ruptures will generally emerge along a fault line and result in an earthquake. Depending on the nature and depth of the fault, an earthquake needs to be larger than approximately Mw 6.0 to 6.5 for the rupture to break through to the surface.

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 sourced report gives a general outline of the nature of geologically active areas within the Selwyn District; indicating that the site is located approximately 10.0Km north of the mapped Greendale 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 (if any) are also not known. The slip rate of the Greendale Fault has not been established and the Recurrence Interval is estimated to be 5,000 years or greater.

Potential hazards related to the Greendale Fault and other unknown faultlines is 1) strong ground motion and 2) the effects of abrupt ground surface offset or buckling which may result. With this being said, the reference report states that "of the later villages and towns, Springfield and Hororata are the only ones that lie close to known or suspected active faults" (GNS Science & ECan, 2013: 29).



5.0 Geotechnical Data Review

For the purpose of our desktop study/geotechnical data review we have referred to a number of sources including:

- New Zealand Geotechnical Database (NZGD); https://www.nzgd.org.nz/;
- Environment Canterbury (ECan): http://canterburymaps.govt.nz/; and
- Selwyn District Plan: http://eplan.selwyn.govt.nz/#!Property/3303741 (accessed 5 September 2017).

The following text summarises the findings of our data review:

- NZGD indicates that the site is located within Green Zone (CERA Residential Zoning Maps) and is classified as N/A – Rural & Unmapped according to Ministry of Business, Innovation and Employment (MBIE).
- The ECan Liquefaction Hazard Map (2012) shows that the site is located in an area where damaging liquefaction is unlikely.
- The Selwyn District Plan shows that the site rests within the *Outer Plains Planning Zone*. In these areas the Council specify that only one house is to exist per 20ha of land.
- The GNS Science Post 4 September 2010 & Post 22 February 2011 Observation Maps do not indicate the occurrence of liquefaction at the surface within the site (or surrounding area) as a consequence of the two referenced earthquakes.
- Local ECan well log data indicate that the area is underlain by river gravels from the surface and to a depth of at least 200m (based on Well L35/0624 & BX22/0051). This is in concurrence with the geology described by GNS Science and described in Section 4.0 (Area Geology).

6.0 Field Investigation

The field investigation for the site was carried out 19 December 2017; it comprised the following components:

- Detailed walkover inspection; and
- Excavation of 16 testpits;

The density of testing was determined in accordance with Part D of the MBIE Guidelines (2012) for Land Use Changes in Canterbury. Where in areas of known dense gravel and deep groundwater, shallow investigations in leu of boreholes and CPT's are suitable.



All field tests have been measured in via Garmin hand held GPS and are therefore approximate only. The test locations are shown on the LandTech *Site Plan*, Drawing No. LTCL17312/ 1 (attached in Appendix A).

The testpits were excavated by Francis Ward Ltd. via 8T digger and the soil conditions encountered were logged by a LandTech Engineering Geologist. The soil was logged in accordance with New Zealand Geotechnical Society *Guideline for the Description of Soil and Rock for Engineering Purposes* (2005). The field logs are attached in Appendix B.

7.0 Subsurface Conditions

The sites subsurface conditions mostly comprised a surficial layer of topsoil (and occasional Loess Deposits) underlain by gravel River Deposits. This is generally consistent with the geology described in Section 3.0 (Area Geology) and Section 5.0 (Geotechnical Data Review). Geologic summaries are given in Table 1 and detailed geologic descriptions follow in the subsequent sections.

Table 1: Subsurface summary

Testpit ID	Easting	Northing	Testpit Depth	Depth of Topsoil	Depth of Loess	Groundwater Level
TP01	1529278	5184289	3.0	0.3	NE	NE
TP02	1529436	5184283	3.0	0.3	NE	NE
TP03	1529688	5184253	3.0	0.4	NE	NE
TP04	1529971	5184198	3.0	0.3	NE	NE
TP05	1530131	5184185	3.0	0.3	NE	NE
TP06	1530353	5184142	3.0	NE	0.7	NE
TP07	1529232	5184178	3.0	0.2	NE	NE
TP08	1529430	5184145	3.0	NE	0.4	NE
TP09	1529669	5184102	3.0	0.4	0.7	NE
TP10	1529948	5184090	3.0	0.2	NE	NE
TP11	1530221	5184042	3.0	0.4	0.7	NE
TP12	1529232	5184036	3.0	0.4	NE	NE
TP13	1529431	5184006	3.0	NE	0.4	NE
TP14	1529656	5183976	3.0	0.4	NE	NE
TP15	1529948	5183939	3.0	0.2	0.5	NE
TP16	1530108	5183969	3.0	0.3	0.7	NE

Table notes:

Coordinates are New Zealand Trans Mercator 2000 (NZM2000)

Measurements are in metres (m) below present ground level (bpgl)

NE = Not Encountered



7.1 Topsoil

Topsoil was encountered as a surficial deposit within most test locations. These materials were generally only up to 0.4m below present ground level (bpgl) and comprised brown silt with minor fractions of sand and gravel.

The topsoil is not considered suitable for the support of pavement, buildings or other permanent structures. This is due to its variable composition and strength characteristics that bear the potential for differential settlement.

7.2 Loess Deposits

Loess was encountered at a number of locations (indicated in Table 1) between the upper topsoil mantle and the underlying River Deposits and up to 0.7m bpgl. It is a windblown deposit, common around the Canterbury Plains and generally comprised major fractions of silt with subordinate and minor fractions of fine to coarse grained sand, and fine to coarse grained rounded to subrounded river gravel.

The Loess Deposits are described as yellowish brown/grey, very stiff to hard, non-plastic and moist. Scala penetrometer test results within these materials were mostly higher than 4 blows/100mm penetration.

7.3 River Deposits

River Deposits were encountered underlying the surficial topsoil and Loess Deposits to the termination depth of all testpits (i.e. 3.0m bpgl). These materials generally comprised horizons of fine to coarse grained rounded to subrounded gravel, with subordinate and minor fractions of fine to coarse grained sand, silt, rounded to subrounded cobbles and occasional boulders.

The density of these materials has been described as "tightly packed"; this term is a tactile field description defined as material that requires a pick for removal, either as lumps or as disaggregated material (NZGD, 2005).

7.4 Groundwater

The groundwater table was not encountered during our field investigation, however layers within the River Deposits have been described as moist to wet. A review of local ECan wells via https://mapviewer.canterburymaps.govt.nz/ (accessed 20 December 2017) indicates that the water table is approximately 80m below the ground; however, this does not preclude the existence of perched groundwater tables within the underlying strata.



It is inferred that groundwater levels within the site will be prone to fluctuation. For example, levels are expected to rise following periods of prolonged and/or heavy rain fall and fall during drier times. Groundwater levels will also be connected to seasonal river levels, and groundwater recharge from the alps and foothills.

7.5 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. The seismic hazard factor (Z) for the site is 0.3 as per the standard.

8.0 Qualitative Liquefaction Assessment

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 assessment 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 Late Pleistocene horizons of tightly packed gravel (i.e. River Deposits) with groundwater levels generally below 80.0m depth. In addition to this the GNS Science Post 4 September 2010 & Post 22 February 2011 Observation Maps do not indicate the occurrence of liquefaction at the surface within the site (or surrounding area) as a consequence of the two referenced earthquakes.

8.1 Land Classification

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. Late Pleistocene Aged River Deposits), the previously referenced reports and maps, and the qualitative assessment. Based on our assessment, we consider that the site can be classified as Technical Category 1 (TC1), and consider the property suitable for land use change from a geotechnical perspective.

9.0 Natural Hazard Evaluation

The following assessment addresses geo-hazards outlined in Section 106 of the RMA. These geo-hazards should be contemplated when making an application for subdivision of land (following the pending land use change). When considering the required geo-hazards, we have made our evaluations with respect to the proposed land use change with the potential for subdivision.



9.1 Erosion

The surface of the property is near level to undulating and the topography generally falls toward the southern 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 developments will increase the erosion potential provided stormwater is disposed of in a controlled manner subject to usual Council Consenting procedures.

9.2 Flooding

For the purpose of our investigation the Selwyn District Council District Plan has been accessed (weblink: http://eplan.selwyn.govt.nz/, accessed 20 December 2017). The District Plan indicates that the site is located within *Outer Plains Planning Zone*, and is not located within an area of flood risk.

9.3 Liquefaction Induced Subsidence and Inundation

It is discussed in previous sections of this report, liquefaction is not likely to occur within the investigation site. This means that liquefaction induced ground damage (i.e. subsidence and inundation) is not likely to occur. Other forms of land subsidence are also not considered to be associated with the site, with the underlying ground conditions exhibiting a competent and stable nature.

9.4 Falling Debris and Slippage

No tall standing slopes exist in the vicinity of the investigation site, therefore falling debris hazard is non-existent, similarly, with risk of slippage (i.e. near level site).

10.0 Geotechnical Suitability

The site is not considered to be at risk of natural hazards, due to the topographic and geologic setting. Our qualitative assessment has found the property is equivalent to the residential classification TC1. This is with respect to liquefaction potential.

Based on the results of our field investigation, the natural ground below any surficial topsoil is considered to meet the criteria of "good ground" in accordance with Verification Method B1/VM1 of the New Zealand Building Code. In saying this, additional geotechnical investigations of appropriate spatial density will be needed during future Subdivision/Building Consent application stages of the development.

The competent and stable nature of the subsurface conditions mean that standard land development engineering, and follow-on building and foundation construction, is considered applicable for this site; this is from a geotechnical perspective.



Therefore, it is our professional geotechnical opinion that the proposed land use change for the site, from rural to commercial and residential, is suitable. The future proposed developments are not considered to be at risk of natural hazards and the local territorial authorities can rely on this when considering the Land Use Change application.

11.0 Limitations

This geotechnical report has been prepared for our Client, Rupert jack & Catherine Elizabeth Wright, for the purposes of supporting Consent applications 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.

Industry investigation, research and analysis of Christchurch's seismic events has resulted in modifications to the building codes (including MBIE Guidelines, 2012). Because of this, further changes are to be expected with time. The findings and recommendations of this geotechnical report may require modification to accommodate any changes before building works are implemented. In these circumstances, it is recommended that LandTech is engaged to review the findings of this report are reviewed.

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.

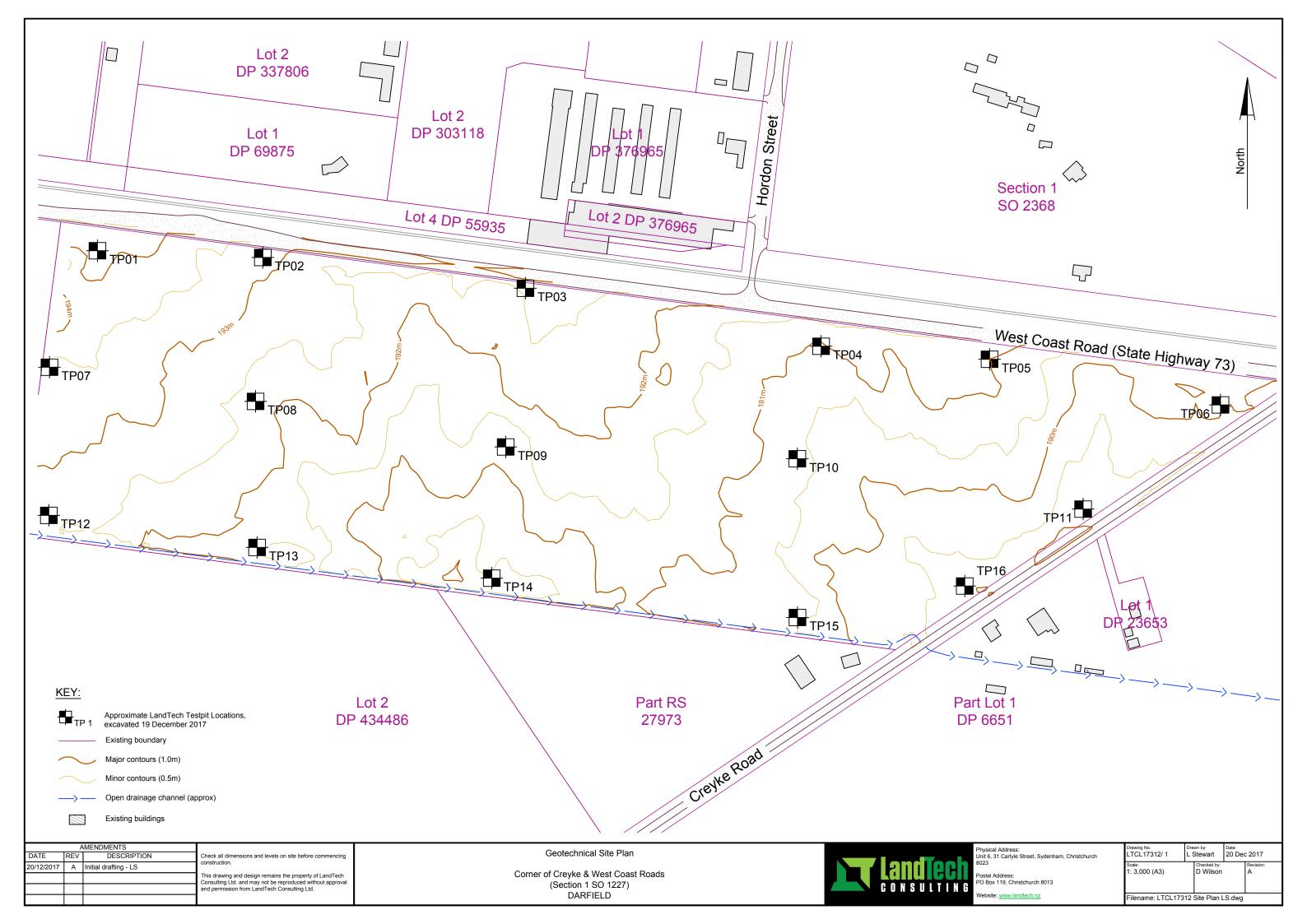
END OF REPORT



Appendix A Site Plan







Appendix B Field Investigation Logs







Testpit No.

Sheet No.

1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewart NZTM2000 E1529278 N5184289 NA NA Excavated By: Coordinates: Shear Vane No: Date Started: 19-Dec-17 Ground Conditions: Calibration Factor: Near level/undulating, pasture

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Testpit No. TP02
Sheet No. 1 of 1

Excavator Type: 9T Digger Project No: LTCL17312 Logged By: L Stewart Excavated By: Francis Ward Ltd. Coordinates: NZTM2000 E1529436 N5184283 Shear Vane No: NA Date Started: 19-Dec-17 Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Date Finished: 19-Dec-17 Groundwater Level (m): Not Encountered Calibration Date: NA

Date	Finish	ned:	19-Dec-17	Groundwater Level (m):	Not Encount	ered Calibration Date:						NA	
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							_			-4.9			
\vdash	5.0					_	5.0	In-situ field testing in acc	ordance with	-5.0 the following Stan	dards:		
								Scala Penetrometer Test	ing: NZS 440	2:1988, Test 6.5.2	2, Dynamic Cone P		
								Shear Vane Testing: Gui	deline for Ha	nd Held Shear Var	ne Test, NZGS, Au	gust 2001	



Testpit No. TP03

Sheet No. 1 of 1 Address: Excavator Type Project No: LTCI 17312 Logged By: L Stewar NZTM2000 E1529688 N5184253 Excavated By: Coordinates: Shear Vane No: N/ Date Started: Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Groundwater Level (m): Not Encountered Calibration Date: NA In-situ Field Testing Stratigraphy $\widehat{\Xi}$ Soil description in accordance with Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc. 2005 $\widehat{\Xi}$ Dynamic Cone Penetrometer Shear Strength (kPa) Groundwater Depth Scala Blow Count / Ξ 100mm Depth Remoulded: 10 15 20 SILT, some fine to medium sand, brown, very stiff, dry, non-plastic, trace fine to coarse rounded to subrounded gravel inclusions [TOPSOIL] -0.1 3 -0.2 4 6 -0.3 20 -0.4 Fine to coarse rounded to subrounded GRAVEL, minor to some fine to -0.5 0.5 medium sand, minor silt, grey, tightly packed, moist [RIVER DEPOSITS] -0.7 -0.8 -0.9 -1.0 1.0 1.0 Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor silt, grey, tightly packed, moist, trace rounded to subrounded cobble inclusion -1.1 -1.2 -1.3 -1.4 1.5 -1.5 RIVER DEPOSITS -1.6 -1.7 NOT Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, brown and grey mottles, tightly packed, moist to wet, trace rounded to subrounded -1.8 -1.9 cobble inclusions -2.0 2.0 2.0 -2.1 -2.2 -2.3 -2.4 -2.5 2.5 -2.6 -2.7 -2.8 -2.9 3.0 3.0 -3.0 -3.1 End of Testpit 3.0m [TARGET DEPTH] -3.3 3.5 -3.4 3.5 -3.5 -3.6 4.0 -3.7 -3.8 -3.9 -4.0 4.0 -4.1 -4.2 -4.3-4.4 -4.5 -4.7 -4.8 -4.9

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



Testpit No. TP04
Sheet No. 1 of 1

Excavator Type: 9T Digger Francis Ward Ltd. Project No: LTCL17312 Logged By: L Stewart Excavated By: NZTM2000 E1529971 N5184198 NA NA Coordinates: Shear Vane No: Date Started: 19-Dec-17 Ground Conditions: Calibration Factor: Near level/undulating, pasture

	Finish		19-Dec-17 Groundwater Level (m): Not Encou			Calibration Date:						
Į				Groundwater Level (m)				In-situ Fie	eld Testing			
Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with Guideline for the Field Classification and		Ê	Choor Ctro	Shear Strength (kPa) Dynamic			c Cone Penetrometer		
ratign	epth	raphi	Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc 2005	wate	Depth (m)	Siledi Silei	igiii (KFa)			Scala Blow Count /		
Š		Ō		puno	"	Peak:	-	Depth (m)	Cour	100mm		
				ğ		Remoulded: 0	•	Dep	Blow Count	0 5 10 15 20		
_		$\wedge \wedge$	SILT, minor fine to medium sand, trace fine to coarse rounded to subrounde	i				-0.1	4			
TOPSOIL		$\times \times$	gravel, brown, very stiff, dry, non-plastic [TOPSOIL]		_			-0.2	7	1		
10		\times			l -			-0.3	20	•		
	-	24	Silty fine to coarse rounded to subrounded GRAVEL, some fine to coarse	1	_			-0.4				
	0.5		sand, yellowish grey, tightly packed, moist [RIVER DEPOSITS]		0.5			-0.5				
								-0.6				
	-	500			_			-0.7				
					_			-0.8				
	-	77774	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL,		_			-0.9				
	1.0	2000	brownish grey, tightly packed, moist, trace rounded to subrounded cobble inclusions		1.0			-1.0				
		()(A)				1		-1.1				
		20/4			-	1		-1.2				
		200		0	-	1		-1.3				
		J. J. Sa.		NOT ENCOUNTERED		1		-1.4				
ίδ	1.5	2071		LNN	1.5	1		-1.5				
RIVER DEPOSITS		240Y		NCO				-1.6				
DEP		100		JT E	_			-1.7				
/ER		2017		ž	_			-1.8				
2		44X			_			-1.9				
	2.0				2.0			-2.0				
								-2.1				
								-2.2				
								-2.3				
		200						-2.4				
	2.5	í Y L			2.5			-2.5				
		207	Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand to sandy, brownish grey, tightly packed, moist to wet	'	_			-2.6				
		74 9 Y	salay, somisting by, agray pasked, most to wet		_			-2.7				
					_			-2.8				
		XI `			_			-2.9				
	3.0	1414			3.0			-3.0				
	_		End of Testpit 3.0m		_			-3.1				
	_		[TARGET DEPTH]		_			-3.2				
	_				l –			-3.3				
	_				1 -	1		-3.4				
	3.5				3.5			-3.5				
	_				-	-		-3.6				
	4				-	1		-3.7				
	-				-	1		-3.8				
	-				-	1		-3.9 -4.0				
	4.0				4.0			-4.0 -4.1				
	-				1 -	1		-4.1				
	-				1 -	1		-4.2				
	\exists				-	1		-4.4				
	7				4-	1		-4.5				
	4.5				4.5			-4.6				
	-				l –	1		-4.7				
	-				l –	1		-4.8				
	-				l –	1		-4.9				
	F 0					1		-5.0				
H	5.0			+	5.0	In-situ field testing i	n accordance with		dards:			
						Scala Penetrometer						
					<u> </u>	Shear Vane Testing	: Guideline for Ha	ınd Held Shear Var	ne Test, NZGS, Au	igust 2001		



Testpit No. TP05
Sheet No. 1 of 1

Project No: LTCL17312 Logged By: L Stewart NZTM2000 E1530131 N5184185 Excavated By: Coordinates: Shear Vane No: NA NA NA 19-Dec-17 Calibration Factor: Date Started: Ground Conditions: Near level/undulating, pasture 19-Dec-17 Calibration Date: Date Finished: Groundwater Level (m): Not Encountered

Date	FIIIISI	icu.	19-Dec-17 Groundwater Lever (III). Not Encoun	icica			Cambration	Juio.				INA
				(m)		In-situ Field Testing						
hy	(u	go.		Groundwater Level (m)	æ			3				
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.,	Iter L	Depth (m)	Shear Strength (kPa)		Dynamic Cor				
Stra	Dep	Grap	2005	ndwa	Dep	Peak:	Œ)	onut	So	ala Blow		′
				Groun		Remoulded:	Depth (m)	Blow Count				
		^ ^	Ou T	Ŭ		0			0	5 10	15	20
TOPSOIL	_	$\langle \times \rangle$	SILT, some fine to coarse sand, trace fine to coarse rounded to subrounded gravel, brown, very stiff, moist, non-plastic [TOPSOIL]		_		-0.1	6		•		
OPS	_	$\langle \rangle \langle \rangle$			_		-0.2	6				
_	_	$\times \times$	076 (7)		_		-0.3	20			_	•
		200	Silty fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand to sandy, yellowish grey, tightly packed, moist [RIVER DEPOSITS]		_		-0.4					
	0.5				0.5		-0.5		I			- 1
					_		-0.6					
	_	74 9 Y	Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand, minor silt, brownish grey, tightly packed, moist		_		-0.7					
	_				_		-0.8					
					_		-0.9					
	1.0	/997			1.0		-1.0		I			-
	_	10		1	l _]	-1.1					
	_	144 Ì		1	l _]	-1.2					
				Ð	l _]	-1.3					
	_	100		NOT ENCOUNTERED	l _]	-1.4					
Z	1.5	<i>\$4</i>		N N	1.5		-1.5		l			
POS				ENC.	_		-1.6					
3 DE				ΡÓΤ	_		-1.7					
RIVER DEPOSITS		200		_	_		-1.8					
1 4	_				_		-1.9					
	2.0	207			2.0		-2.0		I—			-
	_	740Y			_		-2.1					
	_				_		-2.2					
	_	201			_		-2.3					
	_	49Y			_		-2.4					
	2.5	1 16	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL,		2.5		-2.5		l			-
	_	3	brownish grey, tightly packed, moist to wet, trace rounded to subrounded		_		-2.6					
	_	TYX.	cobble inclusions		_		-2.7					
	_	X 44			_		-2.8					
	_	200			_		-2.9					
	3.0	? \7 F			3.0		-3.0		l —			-
	_		End of Testpit 3.0m		_		-3.1 -3.2					
	_		[TARGET DEPTH]		_		-3.3					
	_				_		-3.4					
	2.5			I	_	1	-3.5					
	3.5			1	3.5		-3.6					1
				I	-	1	-3.7					
	-			I	-	1	-3.8					
				1	-	1	-3.9					
	4.0			1	4.0	1	-4.0					
	0			I	7.0		-4.1					
					-]	-4.2					
				1	l –	1	-4.3					
				I]	-4.4					
	4.5				4.5]	-4.5					
				1			-4.6					
				I			-4.7					
				1]	-4.8					
				I]	-4.9					
	5.0			L	5.0		-5.0		L			
						In-situ field testing in accordance with						
				I		Scala Penetrometer Testing: NZS 440 Shear Vane Testing: Guideline for Ha						
Ь				1		5		,,/*				



Testpit No. TP06
Sheet No. 1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewart Excavated By: NZTM2000 E1530353 N5184142 Coordinates: Shear Vane No: NA NA NA 19-Dec-17 Calibration Factor: Date Started: Ground Conditions: Near level/undulating, pasture 19-Dec-17 Date Finished: Groundwater Level (m): Not Encountered Calibration Date:

λí		D)		Groundwater Level (m)			In-situ Fie	eld Testing		
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.,	er Le	Depth (m)	Shear Strength (kPa) Dynamic Cone Penetrometer				
trati	Dept	raph	2005	dwate	Dept	-	Ê	Ĕ	Scala Blow Count / 100mm	
0)		0		roun		Peak: ** Remoulded: **	Depth (m)	Blow Count	TOOHIII	
				9		0	De	Blov	0 5 10 15 20	
		× × × >	SILT, minor fine to medium sand, yellowish brown, very stiff, hard, moist, non-plastic [LOESS DEPOSITS]				-0.1	4		
SI		× × × >	plastic [ESESS SET SCITO]				-0.2	5	I I	
POSI	_	× × × >					-0.3	6		
S DE		× × × >					-0.4	12		
LOESS DEPOSITS	0.5	× × × >			0.5		-0.5	14		
12	_	× × × >	minor fine to coarse rounded to subrounded gravel		_		-0.6	20+		
	l _	× × × >	City fire A		_		-0.7			
	_	200	Silty fine to coarse rounded to subrounded GRAVEL, some fine to medium sand, grey, tightly packed, moist [RIVER DEPOSITS]		_		-0.8			
	_				_		-0.9			
	1.0				1.0		-1.0			
	_	20 Y			_		-1.1			
	-	16			_		-1.2 -1.3			
	-	KA `		RED	-		-1.4			
	1.5			NOT ENCOUNTERED	1.5		-1.5			
	1.5	¥99	trace rounded to subrounded cobbles	ICON	1.5		-1.6			
"	_			T EN	_		-1.7			
SITS	_	TXX		N	_		-1.8			
DEPC	_				_		-1.9			
RIVER DEPOSITS	2.0				2.0		-2.0			
N S	2.0	L X	some fine to coarse sand		2.0		-2.1			
		A-1	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, grey,				-2.2			
		1997	tightly packed, moist, trace rounded to subrounded cobble inclusions				-2.3			
							-2.4			
	2.5				2.5		-2.5			
	_	TXX					-2.6			
	_	X			_		-2.7			
	_	200			_		-2.8			
	_				_		-2.9			
	3.0				3.0		-3.0			
	_	ł	End of Testpit 3.0m		_		-3.1 -3.2			
	_	ł	[TARGET DEPTH]		_		-3.2			
	_	ł			_		-3.4			
		1					-3.5			
	3.5				3.5		-3.6			
	_	1			_		-3.7			
	_	1			_		-3.8			
							-3.9			
	4.0	1			4.0		-4.0			
							-4.1			
							-4.2			
	l _						-4.3			
	l _						-4.4			
	4.5	1			4.5		-4.5			
	l –	4			_		-4.6			
	l –	-					-4.7			
	-	-			_		-4.8			
	l –	-			-		-4.9 -5.0			
\vdash	5.0			\vdash	5.0	In-situ field testing in accordance with		idards:		
						Scala Penetrometer Testing: NZS 440	2:1988, Test 6.5.	2, Dynamic Cone F		
						Shear Vane Testing: Guideline for Har	nd Held Shear Va	ne Test, NZGS, Au	gust 2001	



Client: Rupert Jack & Catherine Elizabeth Wright Project: Geotechnical Investigation for Proposed Land Use Change Testpit No. Sheet No.

Cnr Creyke & West Coast Roads (Section 1 SO 1227), Darfield 1 of 1 Address: Excavator Type: Project No: LTCI 17312 Logged By: L Stewar NZTM2000 E1529232 N5184178 Excavated By: Coordinates: Shear Vane No: N/ 19-Dec-17 Date Started: Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Date Finished: 19-Dec-17 Groundwater Level (m): Not Encountered Calibration Date: NA In-situ Field Testing Stratigraphy $\widehat{\Xi}$ Soil description in accordance with Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc. 2005 $\widehat{\Xi}$ Dynamic Cone Penetrometer Shear Strength (kPa) Groundwater Depth Scala Blow Count / Ξ 100mm Depth Remoulded: 10 15 20 SILT, minor fine to medium sand, brownish grey, very stiff, moist, non-plastic, trace fine to coarse rounded to subrounded gravel [TOPSOIL] -0.1 4 Z -0.2 9 Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand, minor silt, grey, tightly packed, moist [RIVER DEPOSITS] 20 -0.3 -0.4 -0.5 0.5 0.5 -0.7 -0.8 Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, -0.9 brownish grey, tightly packed, moist, trace rounded to subrounded cobble -1.0 1.0 1.0 -1.1 -1.2 -1.3 -1.4 1.5 RIVER DEPOSITS 1.5 -1.5 -1.6 -1.7 NOT -1.8 -1.9 2.0 -2.0 2.0 -2.1 -2.2 -2.3 -2.4 -2.5 2.5 -2.6 -2.7 race rounded to subrounded boulder inclusion -2.8 -2.9 3.0 3.0 -3.0 -3.1 End of Testpit 3.0m [TARGET DEPTH] -3.3 3.5 -3.4 3.5 -3.5 -3.6 4.0 -3.7 -3.8 -3.9 -4.0 4.0 -4.1 -4.2 -4.3 -4.4 -4.5 -4.7 -4.8 -4.9

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



Testpit No. TP08
Sheet No. 1 of 1

Excavator Type: 9T Digger Project No: LTCL17312 Logged By: LStewart Excavated By: Francis Ward Ltd. Coordinates: NZTM2000 E1529430 N5184145 Shear Vane No: NA Date Started: 19-Dec-17 Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Date Finished: 19-Dec-17 Groundwater Level (m): Not Encountered Calibration Date: NA

Section Sect	Date Started: Date Finished:		vel/undula countered		asture	Calibration Calibration		NA NA
Silit minor first to medium tend, pallowish brown, very self to head, non-	Stratigraphy Depth (m) Graphic Log	Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society	ج. Froundwater Level (m)	Depth (m)	Peak:		Dynamic Co	Scala Blow Count / 100mm
Silly file to coarse rounded to subrounded GRAVEL, minor to some fire to coarse sandy ellowish brown and grey motities, sgirlly packed, most [RIVER DEPOSITS] The to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor motet to wet The to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor motet to wet The to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor motet to wet The to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor motet to wet The to coarse sandy fine to coarse rounded to subrounded ordinary motets and the motet motet to wet trace rounded to subrounded ordinary motets and the motet motet to wet trace rounded to subrounded ordinary motets and the motet motets are motetally motetal	SSS × × × ×	plastic, trace fine to coarse rounded to subrounded gravel inclusions [LOE		 -		-0.1 -0.2	5 5	0 5 10 15 20
2.7	0.5 0.5	coarse sand, yellowish brown and grey mottles, tightly packed, moist [RIVIDEPOSITS] trace rounded to subrounded cobble inclusions moist to wet Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, min silt, grey, tightly packed, moist to wet, trace rounded to subrounded cobble inclusions	eNCOUNTERED	1.0		-0.5 -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	20*	
35 33 34 35 35 36 36 37 38 39 40 40 40 41 41 42 43 43 44 44 45 45 46 47 48 49 50 50 50	3.0	End of Testpit 3.0m		3.0		-2.8 -2.9 -3.0		
	4.0	·		4.0	In-situ field testing in accordance with	-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	stards.	



Testpit No. TP09
Sheet No. 1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewar NZTM2000 E1529669 N5184102 NA NA Excavated By: Coordinates: Shear Vane No: Date Started: 19-Dec-17 Ground Conditions: Calibration Factor: Near level/undulating, pasture

Second content for any and record for the first processing Physicians. Not Considerated Today (Processing Physicians) Fig. 2 Second content for any and record for the first processing Physicians. Not Considerated Today (Processing Physicians) Fig. 2 Second content for any and record for any and record for the first processing Physicians. Not Considerated Today (Processing Physicians) Fig. 2 Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for the first processing Physicians (Processing Physicians) Second content for any and record for any and record for any any and any any any any any any any any and any		Starte		19-Dec-17 Ground Conditions: Near lev 19-Dec-17 Groundwater Level (m): Not Enc							
St. T. some fine to reclaim saids. Drown, very stiff non-classes; trace fine to receive counted to subrounded gravel inchance (TORSON) 0.2 5 6 0.3 5 6 0.4 19 0.0 5 6 0	γι	(Вc		vel (m)		In-situ Field Testing				
St. T. some fine to reclaim saids. Drown, very stiff non-classes; trace fine to receive counted to subrounded gravel inchance (TORSON) 0.2 5 6 0.3 5 6 0.4 19 0.0 5 6 0	igraph	th (m	hic Lo		c., le	th (m)	Shear Strength (kPa)		Oynamic Cor		
St. T. some fine to reclaim saids. Drown, very stiff non-classes; trace fine to receive counted to subrounded gravel inchance (TORSON) 0.2 5 6 0.3 5 6 0.4 19 0.0 5 6 0	Strat	Dep	Grap		ndwa	Dep	Peak:	Ē	onut		
Sill, some fine to reactive mands forward, very self increplates (Froce fine to course counded to subrounded graver inclusions (FOPSOL) Sill, some fine to reactive mands or inclusions (FOPSOL) Sill, some fine to course counded to subrounded graverily Sill, riviner to some fine to early manufacture or counded to subrounded GRAVEL, brown including and fine to counter sandy fine to course sandy fine to counte sandy fine to counte sandy fine to counte sandy fine to the counter sandy fine to counte sandy fine to counte sandy fine to the counter sandy fine to counte sandy fine to counte sandy fine to the counter sandy fine to counte sandy fine to counte sandy fine to the counter sandy fine to counte sandy fine sandy fine to counte sandy f					Grou		Remoulded:)epth	Š	0 5 10 15 20	
Section Sect			\wedge	SILT some fine to medium sand brown very stiff non-plastic trace fine to	+					0 3 10 13 20	
Pine to coarse rounded to subrounded gravely SiLT, minor to some tine to medium sand, grey, hard, most JCRSS DEPCSTS) 0.0	⊣	_	\times	coarse rounded to subrounded gravel inclusions [TOPSOIL]		-	-				
Pine to coarse rounded to subrounded gravely SiLT, minor to some tine to medium sand, grey, hard, most JCRSS DEPCSTS) 0.0	OPSC	_	$\langle \times \rangle$			-	1			 	
Medium sand, grey, hard, most LOCES DEPOSITS	ř	_	$\langle \rangle \langle \rangle$			-	1				
Transfer	<i>(</i> 0	0.5	× × × >	Fine to coarse rounded to subrounded gravelly SILT, minor to some fine to		0.5	1	-0.5	20+		
Fine to coanse samply fine to coanse rounded to subrounded GRAVEL, brown and your profiles, gifty parabotic most to wait, trace rounded to subrounded coache rounded reconstruction (PAR GRAVELS) 10	OES			medium sand, grey, nard, moist [LOESS DEPOSITS]				-0.6			
and grey motiles, lightly packed, moist to well, trace rounded to subrounded cobbin inclusions [RIVER GRAVELS] 10	_							-0.7			
10 1-1		_	200			l _	<u> </u>	-0.8			
1.1 1.2 1.3 1.4 1.5		_	DY.	cobble inclusions [RIVER GRAVELS]		-	4				
1-1		1.0				1.0					
1.5 1.6 1.1 1.8 1.9		-	197			-	1				
15 1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		-	N/A			1 -	1				
1.18 1.19		-			RED	l -	1				
1.18 1.19		1.5	(Y.X.		UNTE	1.5	1				
1.18 1.19			2019		NC O			-1.6			
1.18 1.19	S		200		OT E			-1.7			
2.5	LISO				z			-1.8			
2.5	Y DEF	_	<i>Q</i> (`			_	_	-1.9			
2.5	RIVER	2.0	/YX			2.0					
2.5		_	Y 74			-	4				
2.5		_	200			-	4				
25		_	D Sa			-	1				
2.6 2.7 2.8 2.9 3.0 3.0 3.0 3.1 3.1 [TARGET DEPTH] 3.0m [TARGET DEPTH] 3.5 3.5 3.6 3.7 3.5 3.8 3.9 4.0 4.0 4.1 4.1 4.2 4.2 4.3 4.4 4.5 4.5 4.6 4.7 4.8 4.9 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0		2.5	201			2.5	-				
2.8 2.9 3.0 3.0 3.1 [TARGET DEPTH] 3.2 3.3 3.4 3.5 3.6 3.6 3.7 3.8 3.9 4.0 4.0 4.1 4.2 4.3 4.4 4.4 4.4 4.5 4.5 4.6 4.6 4.7 4.8 4.9 5.0 5.0 State Index and accordance with the Mahmara Standards: State Preventmentar Testing NUSS 4002 1988, Test 6.5.2 Dynamic Coore Perustrometer		2.0	/ Y X			2.5					
Comparison of Testing No.		_				-	1	-2.7			
3.0								-2.8			
End of Testpit 3.0m [TARGET DEPTH] 3.1 3.2 3.3 3.3 3.4 3.4 3.5 3.6 3.6 3.7 3.7 3.7 3.9 4.0 4.0 4.1 4.1 4.2 4.2 4.3 4.4 4.4 4.4 4.5 4.5 4.6 4.7 4.8 4.8 4.9 5.0 Institutibility stating in succedance with the Molernia Structurias: Scala Perenterendent Testing NZS 44021698. Test 6.5.2. Dynamic Cone Prestromator								-2.9			
[TARGET DEPTH]		3.0	\$ \\ \\			3.0		-3.0			
3.5 3.6 3.6 3.7 3.8 3.9 4.0 4.0 4.0 4.1 4.5 4.5 4.5 4.6 4.7 4.8 4.9 5.0 Inable field besing in accordance with the billowing Standards: Scale Penetrometer Testing NZS 4402:1988, Test 6.5.2. Dynamic Cone Penetrometer		_		End of Testpit 3.0m		-	4				
3.5 3.5 3.6 3.6 3.7 3.8 3.9 4.0 4.0 4.1 4.2 4.3 4.4 4.5 4.5 4.6 4.7 4.8 4.9 5.0 In-satu field testing in accordance with the following Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2. Dynamic Cone Penetrometer		_		[TARGET DEPTH]		1 -	4				
3.5 3.6 3.7 3.8 3.9 4.0 4.0 4.1 4.2 4.3 4.4 4.5 4.5 5.0 Shalls field testing in accordance with the following Standards: Scala Prinetrometer Testing: NZS 44021988, Test 6.5.2, Dynamic Cone Penetrometer		—				-	1				
4.0 4.0 4.0 4.0 4.1 4.5 4.5 4.5 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		2.5					1				
4.0 4.0 4.0 4.1 4.5 4.5 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		3.5				3.5					
4.0 4.0 4.0 4.1 4.2 4.3 4.4 4.5 4.5 4.6 4.7 4.8 4.9 5.0 Insitu field testing in accordance with the billowing Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2. Dynamic Cone Penetrometer		_				l ⁻	1				
4.0 4.0 4.0 4.1 4.2 4.3 4.4 4.5 4.5 4.6 4.7 4.8 4.9 5.0 Insitu field testing in accordance with the billowing Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer						l		-3.8			
4.5 4.5 4.5 -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 billowing Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer						1 =		-3.9			
4.5 4.5 -4.6 -4.7 -4.8 -4.9 -5.0 Insitu field testing in accordance with the billowing Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer		4.0				4.0		-4.0			
4.5 4.5 4.5 4.6 4.7 4.8 4.9 5.0 Insitu field testing in accordance with the billowing Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer		_				1 -	4				
4.5 4.5 -4.6 -4.7 -4.8 -4.9 -5.0 Insitu field testing in accordance with the following Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer		_				l –	4				
4.5 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		_				l -	-				
-4.6						-	1				
-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		4.5				4.5	1				
5.0 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		_				l -	1				
5.0 -5.0 -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		_				l ⁻	1	-4.8			
In-situ field testing in accordance with the following Standards: Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer						1 -		-4.9			
Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer		5.0				5.0		_			
										Penetrometer	



Testpit No. TP10
Sheet No. 1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewart Excavated By: NZTM2000 E1529948 N5184090 Coordinates: Shear Vane No: NA Calibration Factor:
Calibration Date: 19-Dec-17 19-Dec-17 NA NA Date Started: Date Finished: Near level/undulating, pasture Ground Conditions:

Date	Finish	ned:	19-Dec-17 Groundwater Level (m): Not End	counter	ed			Calibration [Date:	NA
ohy	(F	go-	Soil description in accordance with Guideline for the Field Classification and		Death (m)	(II)		In-situ Fie	eld Testing	
Stratigraphy	Depth (m)	Graphic Log	Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society I	nc.,	Jenth (m))	Shear Strength (kPa)	I	Dynamic Con	e Penetrometer Scala Blow Count /
Stra	De	Gra	2005	-		2	Peak:	(E)	ount	100mm
				d	5		Remoulded:	Depth (m)	Blow Count	0 5 10 15 20
H		$\wedge \wedge$	SILT, minor fine to medium sand, trace fine to coarse rounded to subround	ed	╁			-0.1	3	
TS	_	$\times \times$	gravel, brown, very stiff, moist, non-plastic [TOPSOIL]			=		-0.2	3	†
	_	ALL	Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand	Ι,		T		-0.3	5	†
	_		minor silt, yellowish grey, tightly packed, moist [RIVER DEPOSITS]					-0.4	20+	
	0.5	ZZ4			0.	.5		-0.5		
		200	trace rounded to subrounded cobble inclusions					-0.6		
	_							-0.7		
	_	A 24	E			_		-0.8		
	_	/*\Y\	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, brownish grey, tightly packed, moist, trace rounded to subrounded cobble			4		-0.9		
	1.0		inclusions		1.	.0		-1.0		
	—	046			-	+		-1.1 -1.2		
	—				. -	+		-1.2		
	-			i i	. PED	7		-1.4		
SE	1.5	294			1	.5		-1.5		
POS				9	2			-1.6		
RIVER DEPOSITS				ŀ	5			-1.7		
RIVE				- 2	2			-1.8		
	_							-1.9		
	2.0	2404	Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand brownish grey, tightly packed, moist, trace rounded to subrounded cobble	١,	2.	.0		-2.0		
	_		inclusions			_		-2.1		
	_					4		-2.2		
	_				-	\dashv		-2.3 -2.4		
	2.5				,	_		-2.5		
	2.5	14(2)	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL,		2.	.5		-2.6		
	_		brownish grey, tightly packed, moist to wet			T		-2.7		
	_							-2.8		
								-2.9		
	3.0	S)7/ā			3.	.0		-3.0		
	_		End of Testpit 3.0m			4		-3.1		
	_		[TARGET DEPTH]		-	4		-3.2		
	_				-	-		-3.3 -3.4		
	2.5				_	_		-3.5		
	3.5				3.	.5		-3.6		
	_					٦		-3.7		
								-3.8		
						\Box		-3.9		
	4.0				4.	.0		-4.0		
	_					4		-4.1		
	—					4		-4.2		
	—					4		-4.3 -4.4		
	4.5					_		-4.5		
	4.5				4.	.5		-4.6		
	-					٦		-4.7		
								-4.8		
								-4.9		
Ш	5.0				5.	.0		-5.0		
							In-situ field testing in accordance with Scala Penetrometer Testing: NZS 440			Penetrometer
							Shear Vane Testing: Guideline for Ha			



Testpit No. TP11
Sheet No. 1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewart Excavated By: NZTM2000 E1530221 N5184042 Coordinates: Shear Vane No: NA NA NA 19-Dec-17 Calibration Factor: Date Started: Ground Conditions: Near level/undulating, pasture 19-Dec-17 Calibration Date: Date Finished: Groundwater Level (m): Not Encountered

Date Finished:		iea:	19-Dec-17 Groundwater Level (m): Not Encountered Calibration Date:					NA		
				Groundwater Level (m)		Insitu Field Testing				
ş	(6	бо				In-situ Field Testing				
igrap	Depth (m)	hic L	Soil description in accordance with Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc.,	ter Le	Depth (m)	Shear Strength (kPa)	[Dynamic Con	e Penetrometer	
Stratigraphy	Dep	Graphic Log	2005	dwa	Dep	Peak:	Ê	ru unt	Scala Blow Count / 100mm	
				Groun		Remoulded:	Depth (m)	Blow Count		
				Ŭ		0	ă	Bio	0 5 10 15 20	
		$\langle \times \rangle$	SILT, some fine to medium sand, brown, very stiff, dry, non-plastic, trace fine to coarse rounded to subrounded gravel inclusions [TOPSOIL]		_		-0.1	3		
TOPSOIL	_	$\langle \rangle \langle \rangle$			_		-0.2	5		
TOF	_	$\times \times$			_		-0.3	6)	
	_	$\vee\vee$	00.7	ļ	_		-0.4	5	 	
SS	0.5	× × × >	SILT, minor fine to medium sand, yellowish brown, very stiff to hard, moist, non-plastic, trace fine to coarse rounded to subrounded gravel inclusions		0.5		-0.5	6		
LOESS	_	× × × >	[LOESS DEPOSITS]		_		-0.6	20	•	
	_	, , , , ,	City fine to copyed rounded to subrounded CDAVEL valleying grow tighthy	ł	_		-0.7			
	_	200	Silty fine to coarse rounded to subrounded GRAVEL, yellowish grey, tightly packed, moist, trace rounded to subrounded cobble inclusions [RIVER		_		-0.8			
	_	()(4)	DEPOSITS]		_		-0.9			
	1.0		Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, minor	ł	1.0		-1.0			
	-	74 9 ~	silt, grey, tightly packed, moist		-		-1.1			
	-	196			l –		-1.2 -1.3			
	-			ŒD	-		-1.3 -1.4			
	-	/4VY		NOT ENCOUNTERED	-		-1.4 -1.5			
	1.5			COU	1.5		-1.6			
	-	<i>\$4</i>		Ž	_		-1.7			
SITS	-			8	_		-1.8			
RIVER DEPOSITS	-		trace rounded to subrounded boulder inclusion		_		-1.9			
ER D	_				_		-2.0			
RIVE	2.0				2.0		-2.0			
	_	2074			_		-2.2			
	-	2004			_		-2.3			
	_				_		-2.4			
	2.5	207			2.5		-2.5			
	2.0	/ V Y			2.0		-2.6			
	_				_		-2.7			
		<i>X</i> .			_		-2.8			
					_		-2.9			
	3.0				3.0		-3.0			
			End of Testpit 3.0m				-3.1			
			[TARGET DEPTH]				-3.2			
							-3.3			
							-3.4			
	3.5				3.5		-3.5			
	_				_		-3.6			
	_			Ī	l		-3.7			
	_				_		-3.8			
	_			Ī	_		-3.9			
	4.0				4.0		-4.0			
				Ī	l –		-4.1			
	-				-		-4.2			
	-			Ī	-		-4.3			
	-				l –		-4.4			
	4.5			Ī	4.5		-4.5 -4.6			
	-				-		-4.6 -4.7			
	-				-		-4.7			
	-				l —		-4.9			
	_			Ī			-5.0			
\vdash	5.0			\vdash	5.0	In-situ field testing in accordance with		dards:		
						Scala Penetrometer Testing: NZS 440				
						Shear Vane Testing: Guideline for Ha	nd Held Shear Var	ne Test, NZGS, Au	igust 2001	



Testpit No. Sheet No. 1 of 1

Excavator Type: Project No: LTCI 17312 Logged By: L Stewar NZTM2000 E1529232 N5184036 Excavated By: Coordinates: Shear Vane No: N/ Date Started: Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Date Finished: Groundwater Level (m): Not Encountered Calibration Date: NA In-situ Field Testing Stratigraphy $\widehat{\Xi}$ Soil description in accordance with Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc. 2005 $\widehat{\mathbb{E}}$ Dynamic Cone Penetrometer Shear Strength (kPa) Groundwater Depth Scala Blow Count / 100mm $\widehat{\mathbf{E}}$ Depth Remoulded: 10 15 20 SILT, trace fine to medium sand, brown, very stiff, moist, non-plastic [TOPSOIL] -0.1 3 -0.2 5 6 -0.3 12 -0.4 Silty fine to coarse rounded to subrounded GRAVEL, minor fine to coarse -0.5 20 0.5 0.5 sand, yellowish grey, tightly packed, moist [RIVER DEPOSITS] -0.7 Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, -0.8 brownish grey, tightly packed, moist, trace rounded to subrounded cobble -0.9 -1.0 1.0 1.0 -1.1 -1.2 -1.3 -1.4 1.5 -1.5 RIVER DEPOSITS -1.6 -1.7 NOT -1.8 -1.9 2.0 -2.0 2.0 -2.1 -2.2 -2.3 -2.4 -2.5 2.5 -2.6 -2.7 -2.8 -2.9 3.0 3.0 -3.0 -3.1 End of Testpit 3.0m [TARGET DEPTH] -3.3 3.5 -3.4 3.5 -3.5 -3.6 4.0 -3.7 -3.8 -3.9 -4.0 4.0 -4.1 -4.2 -4.3 -4.4 -4.5 -4.7 -4.8 -4.9 Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer

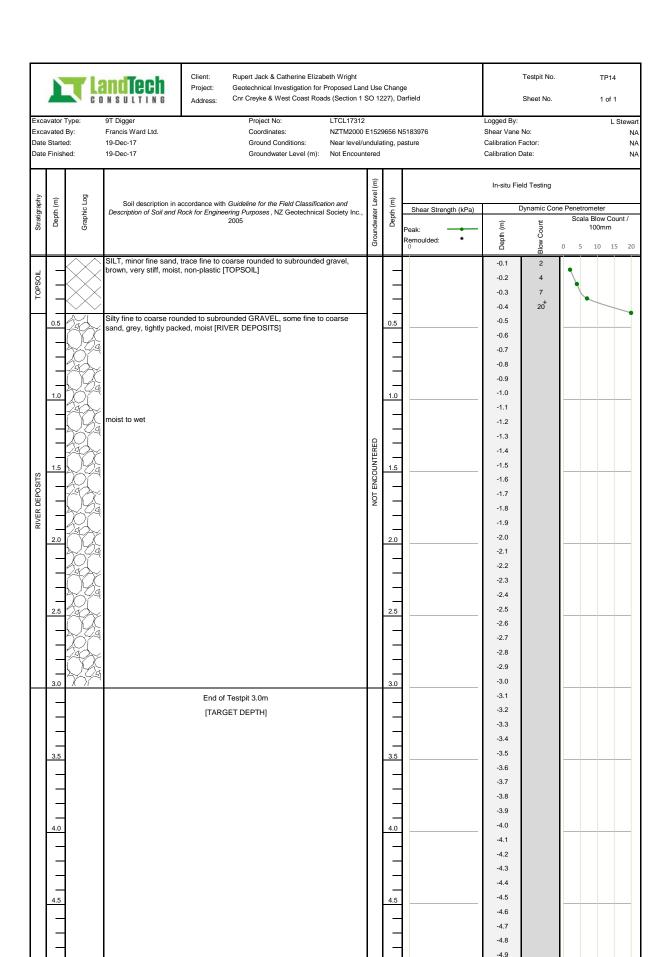
Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001



Testpit No. TP13
Sheet No. 1 of 1

Excavator Type: 9T Digger Francis Ward Ltd. Project No: LTCL17312 Logged By: L Stewart Excavated By: NZTM2000 E1529431 N5184006 NA NA Coordinates: Shear Vane No: Date Started: 19-Dec-17 Ground Conditions: Calibration Factor: Near level/undulating, pasture

	Date Started: Date Finished:		19-Dec-17 Ground Continuous. Near reventinguishing, pasture 19-Dec-17 Groundwater Level (m): Not Encountered					Calibration I		NA NA
,		_		്. Groundwater Level (m)		In-situ Field Testing				
Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with Guideline for the Field Classification and	r Lev	(m)	Shear Strer	orth (kPa)		Ovnamic Con	e Penetrometer
ratig	Jepth	raphi	Description of Soil and Rock for Engineering Purposes , NZ Geotechnical Society Inc 2005	wate	Depth (m)	Sileai Silei	igiri (Kr a)			Scala Blow Count /
Š		Ö		puno		Peak:	-	Depth (m)	Coul	100mm
				Ģ		Remoulded:	-	Dep	Blow Count	0 5 10 15 20
		× × × >	SILT, minor fine to medium sand, trace fine to coarse rounded to subrounded				_	-0.1	5	
SS		× × × >	gravel, yellowish brown, very stiff, moist, non-plastic [LOESS DEPOSITS]		_			-0.2	4	Ī
LOESS		× × × >			_			-0.3	8	
	_	× × × >			_			-0.4	13	
	0.5	24	Silty fine to coarse rounded to subrounded GRAVEL, yellowish grey, tightly		0.5			-0.5	20+	
		/4YX	packed, moist, trace rounded to subrounded cobble inclusions [RIVER DEPOSITS]					-0.6		
					_			-0.7		
	_		Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, grey,		-			-0.8		
	_	I XLA			-			-0.9		
	1.0		tightly packed, moist to wet, trace rounded to subrounded cobble inclusions		1.0	1	-1.0			
		26						-1.1		
		()(L)			-	1		-1.2		
		70/9		_	-	1		-1.3		
		200		EREC		1		-1.4		
	1.5			LNN	1.5			-1.5		
RIVER DEPOSITS		2077		NOT ENCOUNTERED				-1.6		
POS	_	29Y		OT E	_			-1.7		
R DE	_			ž	-			-1.8		
SIVE	_				_			-1.9		
-	2.0	199Y			2.0			-2.0		
								-2.1		
		<i>X</i> 4.			_			-2.2		
	_				_			-2.3		
	_				_			-2.4		
	2.5	5	trace rounded to subrounded boulder inclusion		2.5			-2.5		
								-2.6		
		7574						-2.7		
		200						-2.8		
		L) 46a						-2.9		
	3.0				3.0			-3.0		
			End of Testpit 3.0m		_			-3.1		
			[TARGET DEPTH]		_			-3.2		
	_				_			-3.3		
	_				_			-3.4		
	3.5				3.5			-3.5		
	_				l –	4		-3.6		
	_			1	l –	1		-3.7		
	_			1	-	1		-3.8		
	_				-	1		-3.9		
	4.0				4.0	-		-4.0		
	_				-	1		-4.1		
	_			1	l –	1		-4.2 -4.3		
	-			1	l –	1		-4.4		
	4.5			1	<u>-</u>	1		-4.5		
	4.5				4.5	1		-4.6		
	-			1	1 -	1		-4.7		
	_				l –	1		-4.8		
	-				-	1		-4.9		
	F.0					1		-5.0		
Н	5.0			+	5.0	In-situ field testing in	accordance with		dards:	
					I	Scala Penetrometer				
Ш					I	Shear Vane Testing	Guideline for Ha	ınd Held Shear Var	ne Test, NZGS, Au	igust 2001



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



Client: Rupert Jack & Catherine Elizabeth Wright Geotechnical Investigation for Proposed Land Use Change Testpit No.

Project: Cnr Creyke & West Coast Roads (Section 1 SO 1227), Darfield Sheet No. 1 of 1 Address: Excavator Type 9T Digger Project No: LTCI 17312 Logged By: L Stewar Francis Ward Ltd. NZTM2000 E1529948 N5183939 Excavated By: Coordinates: Shear Vane No: N/ 19-Dec-17 Date Started: Ground Conditions: Near level/undulating, pasture Calibration Factor: NA Date Finished: 19-Dec-17 Groundwater Level (m): Not Encountered Calibration Date: NA In-situ Field Testing Stratigraphy $\widehat{\underline{\epsilon}}$ Soil description in accordance with Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc. 2005 $\widehat{\Xi}$ Dynamic Cone Penetrometer Shear Strength (kPa) Groundwater Depth Scala Blow Count / Ξ Depth Remoulded: 10 15 20 Fine to medium sandy SILT, trace fine to coarse rounded to subrounded gravel, brown, very stiff, dry, non-plastic [TOPSOIL] -0.1 2 Z -0.2 4 Fine to coarse rounded to subrounded gravelly SILT, some fine to medium and, yellowish brown, very stiff to hard, dry to moist, non-plastic [LOESS 5 -0.3 LOESS 20 -0.4 DEPOSITS] -0.5 0.5 0.5 Fine to coarse rounded to subrounded GRAVEL, some silt, minor to some fine to coarse sand, grey, tightly packed, moist [RIVER DEPOSITS] -0.7 some fine to coarse sand to sandy, minor silt -0.8 -0.9 -1.0 1.0 1.0 trace cobble inclusions, moist to wet -1.1 -1.2 -1.3 -1.4 1.5 1.5 -1.5 -1.6 RIVER DEPOSITS -1.7 NOT -1.8 minor fine to coarse sand, trace silt -1.9 -2.0 2.0 2.0 -2.1 -2.2 some fine to coarse sand to sandy -2.3 -2.4 -2.5 2.5 -2.6 -2.7 -2.8 -2.9 3.0 3.0 -3.0 -3.1 End of Testpit 3.0m [TARGET DEPTH] -3.3 3.5 -3.4 3.5 -3.5 -3.6 4.0 -3.7 -3.8 -3.9 -4.0 4.0 -4.1 -4.2 -4.3-4.4 -4.5 -4.7 -4.8 -4.9

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



Testpit No. TP16
Sheet No. 1 of 1

9T Digger Francis Ward Ltd. Excavator Type: Project No: LTCL17312 Logged By: L Stewart NZTM2000 E1530108 N5183969 NA NA Excavated By: Coordinates: Shear Vane No: Date Started: 19-Dec-17 Ground Conditions: Calibration Factor: Near level/undulating, pasture

Date Started: Date Finished:			19-Dec-17 Groundwater Level (m): Not Encou	ountered				Calibration Date: NA			
_		_		Groundwater Level (m)		In-situ Field Testing					
Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with Guideline for the Field Classification and	Lev	Depth (m)	Chaor Strongth	(IrDo)	Г	Ovnamic Cor	ne Penetrometer	
atigr	əpth	aphic	Description of Soil and Rock for Engineering Purposes, NZ Geotechnical Society Inc 2005	, ater	epth	Shear Strength	(кРа)			Scala Blow Count /	
Str	ă	25	2003	Apur	ă	Peak:	•	(E)	onul	100mm	
				Grou		Remoulded:	•	Depth (m)	Blow Count	0 5 10 15 20	
			017	_	_	-				0 3 10 13 20	
이	_	$\langle \times \rangle$	SILT, minor fine to medium sand, brown, very stiff, dry, non-plastic, trace fine to coarse rounded to subrounded gravel inclusions [TOPSOIL]					-0.1	4	•	
TOPSOIL		\times	,					-0.2	5		
ĭ		$\times \times$						-0.3	4		
	0.5	× × × >	SILT, some fine to medium sand, trace fine to coarse rounded to subrounded]		-0.4	3		
SS		× × × >	Idravel, vellowish prown, nard, moist, non-plastic ILOESS DEPOSITS		0.5	1		-0.5	3	1 7	
LOESS	0.0	× × × >			0.0			-0.6	10		
-	_	× × × >			_	1		-0.7	20		
	_		Fine to coarse rounded to subrounded GRAVEL, some fine to coarse sand, some silt, trace rounded to subrounded cobbles, grey, tightly packed, moist	-	_	•		-0.8	20	•	
	_	74 9 ~			_	•					
	_		[RIVER DEPOSITS]		_			-0.9			
	1.0	2077			1.0			-1.0			
	_	20×		1	l –			-1.1			
	_	L)/			l _			-1.2			
	l _			٩	l _			-1.3			
	_	200		NOT ENCOUNTERED	l _			-1.4			
	1.5	I XA	Fine to coarse sandy fine to coarse rounded to subrounded GRAVEL, grey, tightly packed, moist, trace rounded to subrounded cobble inclusions [RIVER DEPOSITS]	Ĭ	1.5			-1.5			
		XX		SO				-1.6			
S		200		T E		1		-1.7			
SIT	_			ž	_			-1.8			
EPC	_	XXX			_	1		-1.9			
ER D	_	200			_	1		-2.0			
RIVER DEPOSITS	2.0	(Y.S.	minor silt		2.0						
	_	7 /4			_			-2.1			
	_	000						-2.2			
	_	í Vá						-2.3			
	_	X						-2.4			
	2.5				2.5			-2.5			
								-2.6			
								-2.7			
		030 2.]		-2.8			
	_	í Vá				1		-2.9			
	3.0				3.0	1		-3.0			
	0.0	K 77	End of Testpit 3.0m		5.0			-3.1			
	_	1			-	1		-3.2			
	_	1	[TARGET DEPTH]		-	1		-3.3			
	_				_	•		-3.4			
	-				-	1					
	3.5			1	3.5			-3.5			
	_				l –	-		-3.6			
	_				I -			-3.7			
	_			1	l _			-3.8		<u> </u>	
	l _				l _			-3.9			
	4.0				4.0			-4.0			
				1	l _			-4.1		<u> </u>	
					l _			-4.2			
				1	_]		-4.3			
	_]		1	l –	1		-4.4		<u> </u>	
	15				4.5	1		-4.5			
	4.5			1	4.5	1		-4.6			
	-				-	1					
	-			1	l –			-4.7		<u> </u>	
	_				_			-4.8			
	_			1	l _			-4.9		<u> </u>	
	5.0				5.0			-5.0			
					I	In-situ field testing in acco				Panatromator	
					I	Scala Penetrometer Testi Shear Vane Testing: Guid					
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