GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED LAND USE CHANGE

1234 West Coast Road, West Melton

Client: Marama Te Wai Limited

Project Reference:	LTC20375
Revision:	Revision B
Date:	16 December 2020

Documentation Control:

LandTech Consulting Ltd

Postal Address:

PO Box 119

Christchurch 8013

Christchurch Office:

Unit 6, 31 Carlyle Street

Sydenham

Christchurch 8023

Auckland Office:

17 Nils Anderson Road

Whenuapai

Auckland 0618

P. 03 390 1371 (Christchurch)

P. 09 930 9334 (Auckland)

E. info@landtech.nz

W. www.landtech.nz

Document Title:	**Geotechnical Report for Proposed Land Use Change**	
Address:	1234 West Coast Road, West Melton	
Revision:	Revision B	
Client:	Marama Te Wai Limited	
Project Reference:	LTC20375	
Author:		Luke Challies, Associate Geotechnical Engineer BEngTech (Civil), MEngNZ
Authorised:		Dwayne Wilson, Senior Geotechnical Engineer BEngTech (Civil), MEngSt (Geotechnical), CMEngNZ, CPEng, IntPE (NZ), Director

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1.0 Introduction

1.1 Project Brief

LandTech Consulting Ltd. (LandTech) were engaged by Marama Te Wai Limited (the Client) to carry out a geotechnical investigation at 1234 West Coast Road, West Melton (the Site). The geotechnical investigation is in relation to the proposal to change the land use within the investigated area.

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

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

1.2 Scope of Works

The geotechnical investigation for the proposed development included the following:

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

During the time of our investigation, we only had accesses to 1234 West Coast Road for intrusive field testing, while the remaining sites have been observed from the roadside for the purpose of identifying any geo-hazards.

2.0 Site & Project Description

The investigation site is located to the west of West Melton, between Halkett Road to the north, West Coast Road to the south, and Prestons and Shepherds Avenue to the east. The site is indicated in Figure 1 below. The site comprises several existing lots consisting of lifestyle residential sections on the eastern side of the area, with the remaining properties used primarily as general farm land.

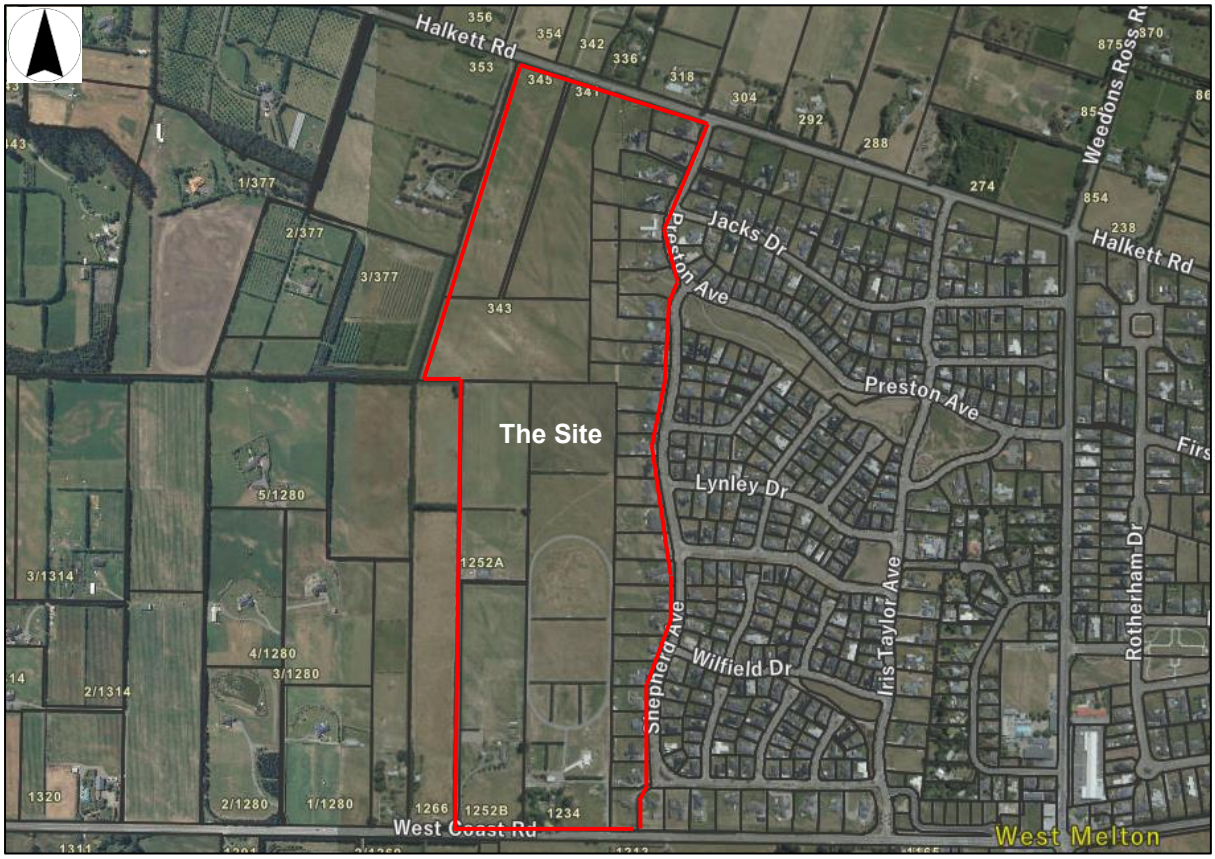


Figure 1: Aerial photograph of proposed land use change area (source: https://mapviewer.canterburymaps.govt.nz/, accessed 14 December 2020)

The site is generally flat within minor elevation changes throughout, most notably centrally near the western boundary. Some young and mature hedge rows are located along property boundaries and paddock fence lines. Existing dwellings and associated sheds are located within the majority of the lots. A water race flows centrally through the site from the west to east along the northern boundary of lots 1252A & 1234 West Coast Road. Currently this water race is leaking into the northern paddock of 1234 West Melton Road, and pooling within an old river channel. Historic stream / river channels are visible within aerial photographs of the site.

Lots along the eastern boundary are located on the outskirts of West Melton township and comprise residential lifestyle sections of up to around 3,000m^2.

3.0 Area Geology

Reference has been made to the *New Zealand Geology Web Map*, GNS Science, http://data.gns.cri.nz/geology/, website accessed 14 December 2020. The reviewed sources indicate that the site is underlain by Holocene Aged River Deposits. These materials generally comprise rounded to subrounded gravel and cobble sized particles within a matrix of silt and sand, deposited via the lateral and vertical migration of the past and present river systems, from the Southern Alps, out toward the east coast. Due to the depositional environment, the geotechnical characteristics of this material can be variable.

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

3.1 Nearby Faultline

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

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

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

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

The Greendale Fault and associated blind faults of the Darfield earthquake sequence have been defined by GNS Science via field inspection, aerial photograph interpretation and regional geologic mapping. The reference source indicates that these faults were unknown prior to 2010 and the ages of previous ruptures are also not known. This leaves the potential for further unmapped faults to exist within the locality of the investigation site. Fault rupture may be expressed as ripping, buckling, warping or permanent breaking of the ground on or near where the fault meets the ground surface. Fault rupture is a different hazard to the shaking associated with earthquakes.

4.0 Geotechnical Data Review

Reference has been made to sources including the New Zealand Geotechnical Database (NZGD): http://www.nzgd.org.nz/ and Environment Canterbury (ECan): http://canterburymaps.govt.nz/ (accessed 14 September 2020). The following text summaries the findings of our data review:

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

- The *Eastern Canterbury Liquefaction susceptibility (2012)* map, shows the site and surrounding areas mapped as liquefaction damage being unlikely.

- According to Canterbury Maps there are a series of Ecan wells within, and in close proximity to the site. The associated bore logs for the following ECan wells have been reviewed and are attached with Appendix B:
    - M35/6939, drilled to 52.0m and located at the southern end of the 1252B West Coast Road property, within the proposed land use change area. The borelog for the well shows soil and clay to 0.3m depth underlain by large stones and claybound sandy gravel to the drill depth. the Initial water levels from 1994, indicate a groundwater level of 30.0m below ground level.

    - M35/10935, drilled to 60.0m and located to the west of the 1252A West Coast Road property, outside the proposed land use change area. The borelog for the well shows earth and sandy gravels 3.0m depth underlain by claybound gravel to 42.0m depth, where sandy water-bearing gravels are recorded to the drill depth. the Initial water levels from 2005, indicate a groundwater level of 31.9m below ground level.

    - BX23/0853, drilled to 60.0m within the proposed land use change area at 345 Halkett Road. The borelog for the well shows brown topsoil to 0.6m depth underlain by grey sandy gravel to 12.0m depth, where alternative layers of clayey gravels and sandy gravels are recorded to the drill depth. The Initial water levels from 2018, indicate a groundwater level of 24.6m below ground level.

- M35/17757, drilled to 102.0m east of the proposed land use change area at the end of Jacqueline Drive. Shows 0.7m of topsoil over clay bound gravels to 36.0m, underlain by water-bearing gravels, to 52.0m. Below 52.0m layers of claybound gravels, sandy gravels, and water bearing gravels have been logs to the termination depth (102.0m).

- M35/5509, drilled at the southern end of 1234 West Coast Road has groundwater monitoring carried out from 1999 to Oct 2020 (latest reading). The Groundwater readings fluctuate from 16.4m and 35.8m below the measuring point, with a median groundwater level of 27.0m below the measuring point.

- According to the Environment Canterbury Soil Type map, the site is mapped with several different soil types. Generally comprising a *Typic Immature Plallic Soils* with a moderately deep silt, described as having *moderate over slow* permeability over the southern half of the site. Over the majority of the northern portion of the site *Weathered Orthic Recent soils* are shown, described as having *moderate over rapid* permeability.

- According to the Environment Canterbury Soil Depth to Hard Soil/Gravel/Rock map, the site capping of soil above hard soil/gravel/rock depths vary from shallow (20-45cm), and Deep (<100cm). This map closely resembles the boundaries of the aforementioned soil types above.

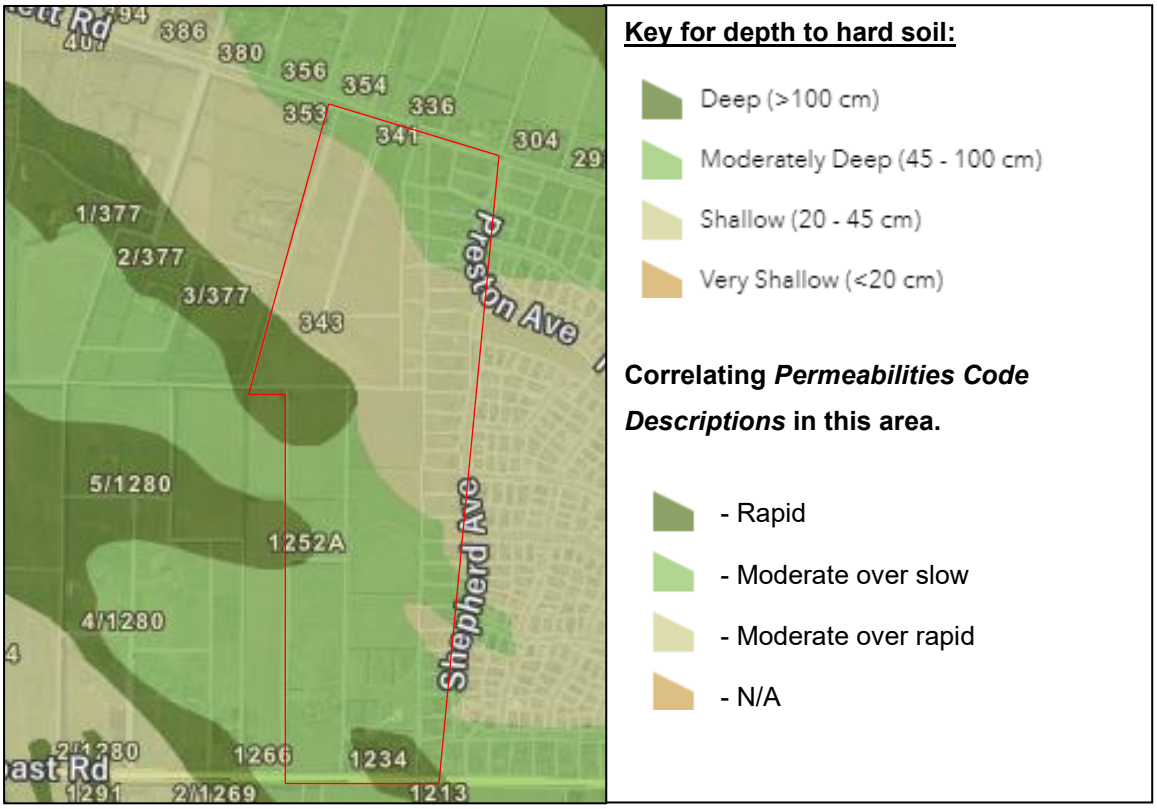


Figure 3: shows excerpt from Canterbury maps Soil Type Map

- A review of historical photograph of the site from between 1940 and 2004 has been carried out on Canterbury Maps. Imagery from 1940 to 1944 (shown below in Figure 3), shows evidence of paleo river channels throughout the site, it is possible additional channels are present within the investigation site. Some historic infilling of these paleo channels could have taken place as part of farming activities. However, our investigation found limited evidence of filling having taken place across the general land use change area.

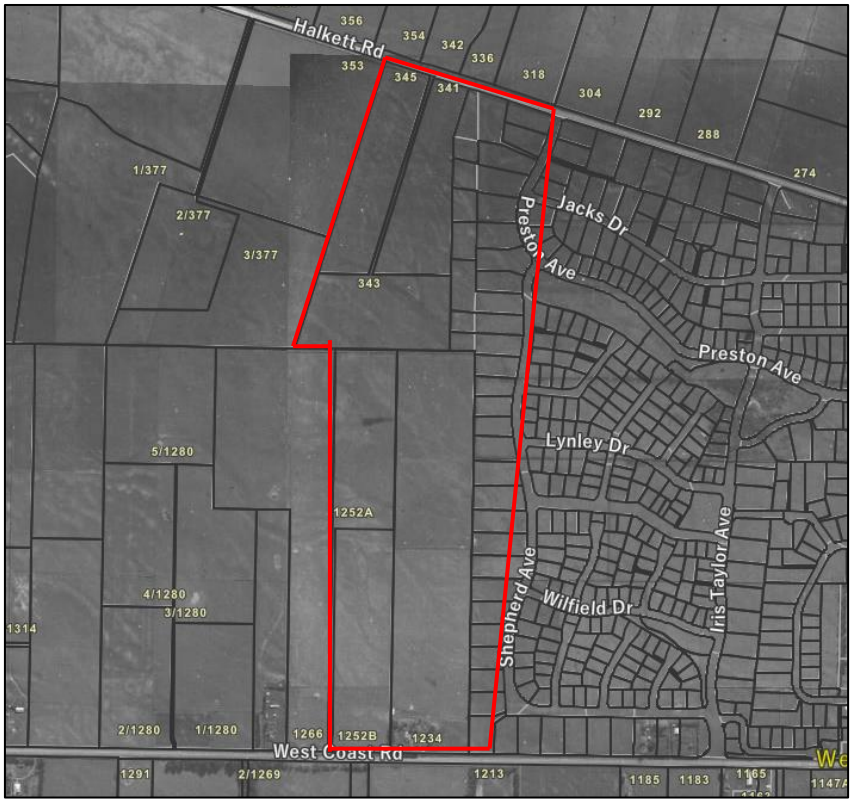


Figure 4: Aerial photograph of investigation site (source: https://mapviewer.canterburymaps.govt.nz/, accessed 14 December 2020)

- According to the *Mapped Liquefaction – Sept 2010 map*, liquefaction occurred along with flooding to the east of the site. A review of aerial images over this time shows no evidence of liquefaction or flooding post September 2010. The mapping shows earthworks being carried out in the general mapped area, likely the start of the one of the West Melton subdivisions.

5.0 Field Investigation

Our field investigation took place on 10 December 2020 and comprised the following components:

- Detailed walkover inspection;
- Excavation of Eight test pits (TP01 – TP08) and associated Scala penetrometer testing; and
- Two Soakage tests (ST01 & ST02) within TP02 & TP07.

Each test was positioned evenly across the site away from infrastructure and animals, with test locations shown on the LandTech *Test Location Plan*, Drawing No. LTC20375/ 1, (attached in Appendix A). The positions have been located via a hand-held GPS without survey control and are therefore approximate only.

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

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

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

6.0 Subsurface Conditions

The sites subsurface conditions generally comprised a surficial layer of topsoil underlain by a sequence of Loess / Alluvial deposits followed by River Deposits. This is consistent with the geology described in Section 3.0 (Area Geology). A subsurface summary is given in Table 1 and detailed descriptions are given in the subsequent sections.

Table 1: Subsurface summary

Test pit ID	Test Pit Depth	Topsoil Depth	Depth to Gravel	Scala Depth
TP01	2.6	0.4	0.9	1.3
TP02 / ST01	2.6	0.3	0.8	1.9
TP03	2.2	0.4	0.8	0.7
TP04	2.2	0.3	0.6	0.6
TP05	2.2	0.4	0.4	0.5
TP06	2.2	0.3	0.8	0.8
TP07 / ST02	2.5	0.3	0.3	0.4
TP08	2.4	0.4	0.4	0.5

Table notes: Measurements are in metres (m) below present ground level
Scala penetrometer refusal considered when an excess of 25 blows /100mm penetration occurs

6.1 Topsoil

Topsoil was encountered from the surface at all test locations and ranged between the depths of 0.3m and 0.4m below present ground level (bpgl). This mostly comprised dark brown silt with minor fractions of fine to coarse grained sand. The topsoil is not considered suitable for the support of building foundations.

6.2 Alluvial / Loess Deposits

Soil deposits comprising either alluvial soils or loessal soils where present above the river deposits at depth. The depth of these soils ranged from between 0.6m (TP04) and 0.9m (TP01) below ground level, and typically comprised silt with minor fine sand (Loess) or a sand with minor silt (Alluvial Deposits). No soil capping was encountered within TP05, TP07 and TP08, where topsoil on top of gravel was found.

Scala penetrometer testing within the soils ranged from 1 and 20 Blows / 100mm penetration. Higher blow counts may be due to gravels within the soil at the test location. Typically, the Scala blow counts ranged from between 6 and 13 Blows / 100mm of penetration indicating a medium dense soil.

6.3 River Deposits

River Deposits were encountered below the surficial layer of sands, silts or topsoil to the termination depth of all test locations (TP01 – TP08). The River Deposits generally comprised sandy fine to coarse subrounded gravel. The gravel deposits where typically described as moist in the test locations, while larger cobbles were also encountered at depth.

Scala penetrometer testing was unable to penetrate the gravels with refusal typically being achieved in contact with the underlying gravels.

Photos 1: ***from left to right*** **(1) Shows typical Test Pit excavation (2.6m deep), with loess and topsoil capping. (2) shows blocky excavated loess soils. (3) shows excavated river gravels.**

6.4 Soakage

The soakage capacity of the gravel was tested within TP02 and TP07, the results of the soakage testing are attached in Appendix C, while the respective soil profile logs are attached within Appendix B. A summary of the calculated average soakage rates is shown in Table 3 below:

Table 3: Average soakage rates

	TP02 / ST01	TP07 / ST02
Average Soak Rate (mm/hour)	443	7,200
Percolation Rate ($L/m^2/min$)	12	319

The soakage testing was carried out in locations identified in the data review as having rapid or moderate over rapid permeability (TP07 / ST02) and moderate over slow permeability (TP02 / ST01), which correlates somewhat to the soakage rates observed in our two tests.

We understand that the permeability code takes into consideration of the ground profile from the surface so may not give an accurate representation of the subsoil's capacity for soakage testing and consequent design. Subsequent testing during the sub-division and construction phases will be required to determine final design soakage rates.

6.5 Site Seismicity

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

7.0 Qualitative Liquefaction Analysis

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

Based on our desktop study and field investigation, we have established that the site is generally underlain by Holocene Age horizons of tightly packed gravel (i.e. River Deposits) with groundwater average ground water levels of around 27.0m. In addition to this ECan (2012) liquefaction susceptibility maps has indicated that the site is unlikely to be damaged via earthquake induced liquefaction.

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

Based on our assessment of the investigation site, the preliminary categorization of the existing properties is likely to be Technical Category 1 (TC1) with damaging liquefaction unlikely and consider the site suitable for residential development from a geotechnical perspective.

8.0 Geotechnical Hazard Evaluation

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

8.1 Erosion

The surface of the property is near level to slightly undulating, with several old river channels throughout. During our field investigation, we did not observe any obvious signs of erosion from concentrated surface runoff. Furthermore, we do not consider the proposed site development will increase the erosion potential provided stormwater is disposed of in a controlled manner subject to usual Council Consenting procedures.

8.2 Inundation

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

8.3 Subsidence

It is discussed in previous sections of this report, liquefaction is not likely to occur within the investigation site. This is due to the shallow depth to gravel and gravelly sand layers (between 0.5m and 0.9m below the site) and the ECan well logs indicating that groundwater in the area is at an average of around 27.0m below ground level.

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

8.4 Falling Debris

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

8.5 Slippage

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

8.6 Contamination

Whilst not a requirement of Section 106 of the RMA 1991, soil contamination is a potential geotechnical hazard that should be considered when making Consent applications to territorial authorities where ground disturbance works are proposed (i.e. foundation excavations etc.).

The six main properties (i.e. excluding residential lots to the east) within the land use change have been searched and have no recorded information registered against them. This indicates no HAIL activities are recorded to have taken place at the site, according to the register. This does not confirm the site has no soil contamination, but only indicates the Regional Council does not have records of potentially hazardous activities taking place the site that could lead to soil contamination.

9.0 Geotechnical Recommendations

It is stated in the previous sections that the site likely to be classified as equivalent TC1; based on our desktop study, the underlying geology and qualitative liquefaction assessment. Although testing was only carried out within 1234 West Coast Road, geologic conditions are not considered likey to vary considerable from those encountered during the field investigation. This is based on the reviewed depth of soil maps, surrounding well logs and general lay of the land.

Following our assessment, we consider the site suitable land use change to residential zoning from a geotechnical perspective. Our recommendations with regard to site development and preliminary foundation design follow subsequently.

9.1 Preliminary Foundation Recommendations

Due to the low risk of liquefaction at the subdivision we have classified the investigation site as TC1, and conclude the River Deposits beneath any surficial soils meet the criteria for “good ground” as defined by NZS3604:2011.

Some areas of weak upper surficial soils may require foundations to be subject to specific engineering design due to low bearing capacities. Alternatively, earthworks during subdivision may compact any weak upper layers so standard foundations can be utilised without engineering design input. The extent of any weak upper soils can be determined with further shallow soil testing as part of the subdivision design/consenting stage.

9.2 Preliminary Earthwork Recommendations

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

10.0 Future Geotechnical Involvement

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

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

11.0 Limitations

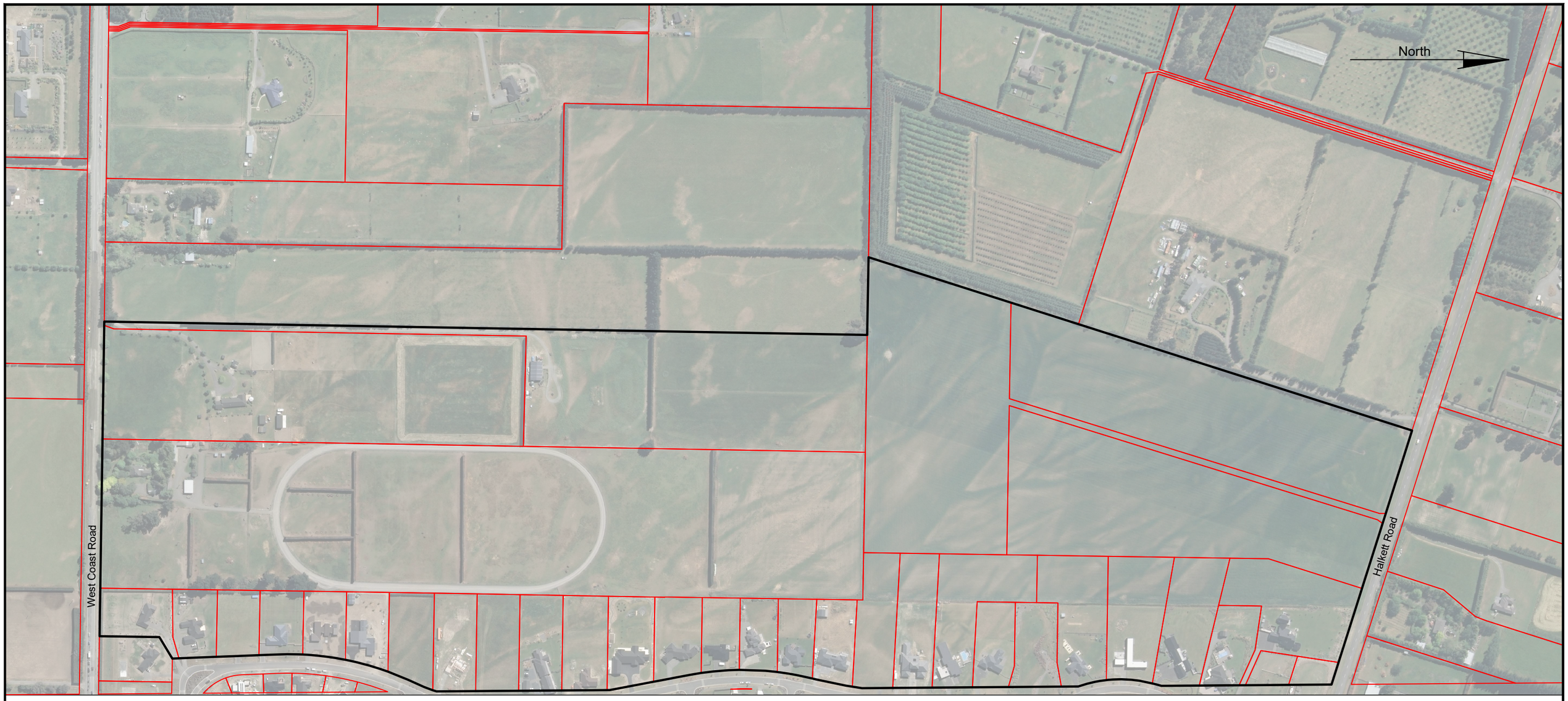
This geotechnical report has been prepared for our Client, Marama Te Wai Limited, for the purposes of supporting a Land Use Change application to the Selwyn District Council. This report shall not be extrapolated for other nearby sites or used for any other purposes without the express approval of LandTech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

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

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

END OF REPORT

APPENDIX A
LandTech Drawings



KEY:

Existing Boundaries

Proposed Land Use Change Area

NOTES:

Locations of features approximate only

Original sheet size A3

Boundary information on this *Test Location Plan* adapted from LINZ website: www.data.linz.govt.nz
(accessed 9 December 2020)

AMENDMENTS		
DATE	REV	DESCRIPTION
11/12/2020	A	Initial drafting - L Challies

Overall Land Use Change Area

1234 West Coast Road
WEST MELTON

LandTech CONSULTING

Christchurch Office:
Unit 6, 31 Carlyle Street, Sydenham, Christchurch 8023

Auckland Office:
17 Nils Andersen Road, Whenuapai, Auckland 0618

Postal Address:
PO Box 119, Christchurch 8013

Website: www.landtech.nz Email: info@landtech.nz

Drawing No.	Drawn by:	Date:
LTC20375/ 1	L Challies	11 December 2020
Scale:	Drawn by:	Revision:
1: 4,000 (A3)	D Wilson	A

Filename: LTC20375 - Drawings.dwg

KEY:

TP01 — LandTech Consulting Ltd. Test Pit locations, carried out on 10 December 2020

Existing Boundaries

Proposed Land Use Change Area

NOTES:

Locations of features approximate only

Original sheet size A3

Boundary information on this *Test Location Plan* adapted from LINZ website: www.data.linz.govt.nz (accessed 9 December 2020)

AMENDMENTS		
DATE	REV	DESCRIPTION
11/12/2020	A	Initial drafting - L Challies

Test Location Plan

1234 West Coast Road
WEST MELTON

LandTech CONSULTING

Christchurch Office:
Unit 6, 31 Carlyle Street, Sydenham, Christchurch 8023

Auckland Office:
17 Nils Andersen Road, Whenuapai, Auckland 0618

Postal Address:
PO Box 119, Christchurch 8013

Website: www.landtech.nz Email: info@landtech.nz

Drawing No.	Drawn by:	Date:
LTC20375/ 2	L Challies	11 December 2020
Scale:	Drawn by:	Revision:
1: 2,500 (A3)	D Wilson	A

Filename: LTC20375 - Drawings.dwg

APPENDIX B

Environment Canterbury Well Logs

canterbury maps

Canterbury Maps

N

0 0.1 0.2 0.3 0.4 Kilometres

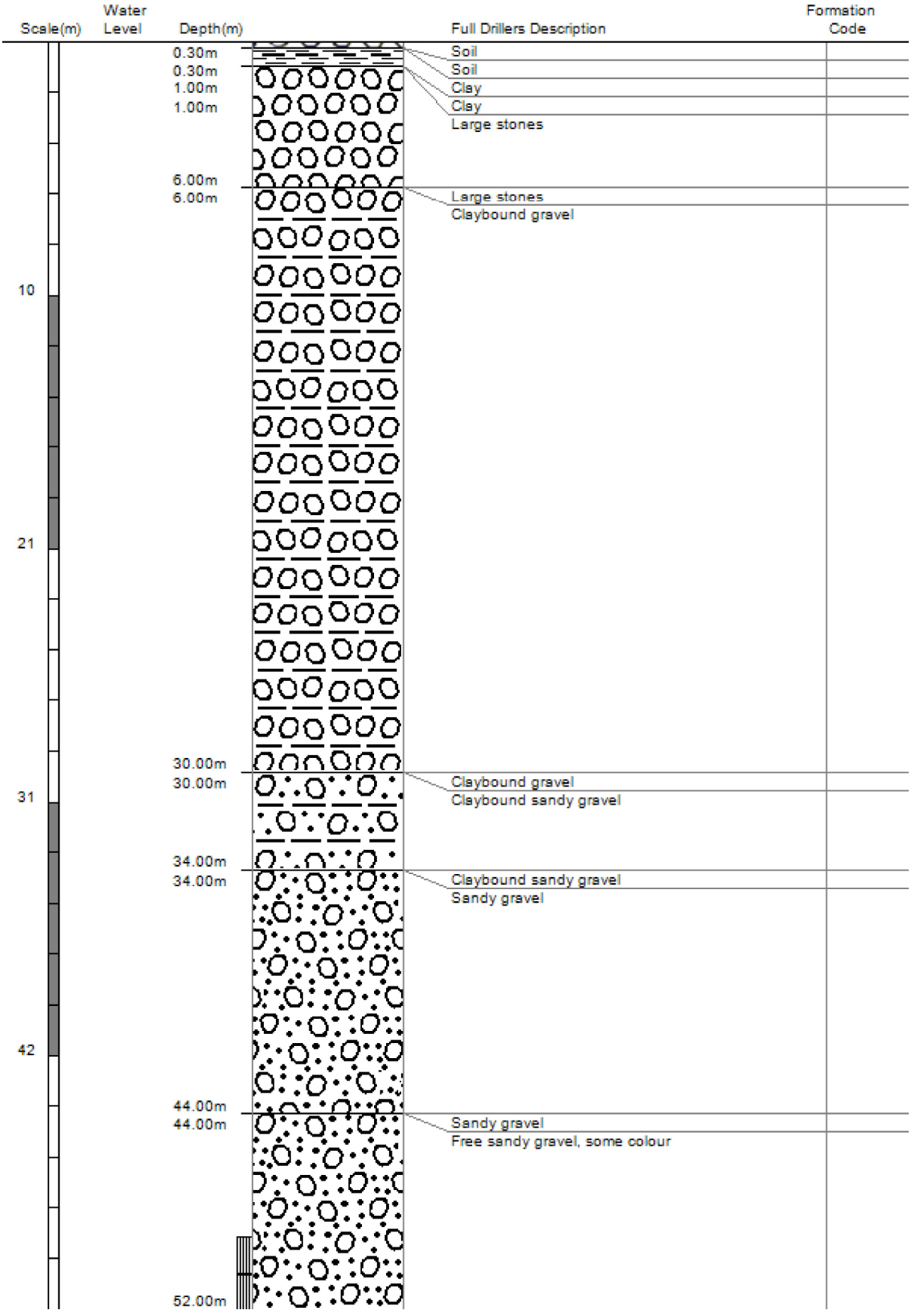
Scale: 1:9,028 @A3

Map Created by Canterbury Maps on 14/12/2020 at 2:26 PM

Borelog for well M35/6938

Grid Reference (NZTM): 1548010 mE, 5180902 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 94.5 m +MSD Accuracy: < 0.5 m
Driller: Smiths Welldrilling
Drill Method: Rotary Rig
Borelog Depth: 52.0 m Drill Date: 23-Jun-1994

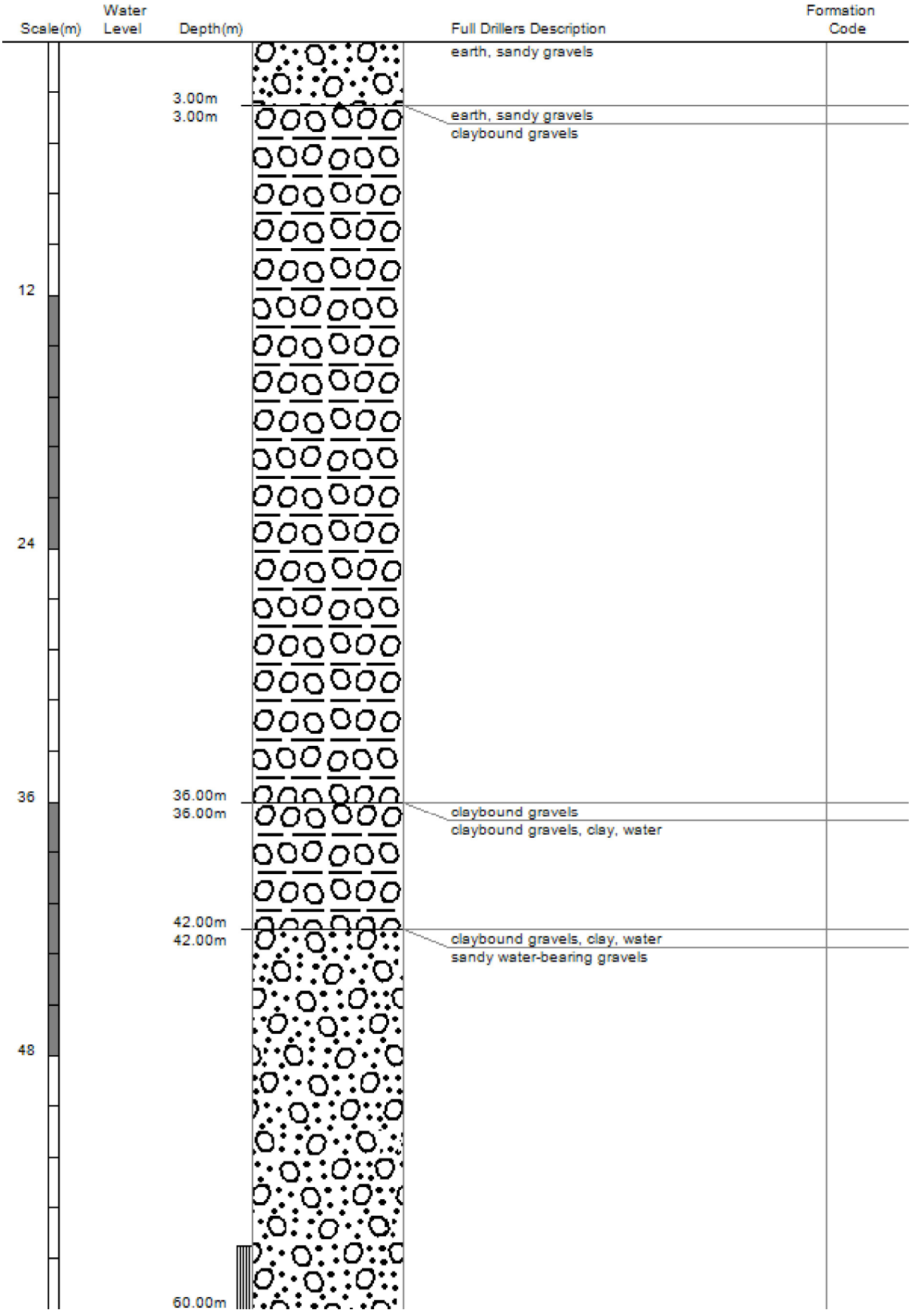
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M35/10935

Grid Reference (NZTM): 1547620 mE, 5181447 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 98.7 m +MSD Accuracy: < 0.5 m
Driller: East Coast Drilling
Drill Method: Rotary Rig
Borelog Depth: 60.0 m Drill Date: 07-Nov-2005

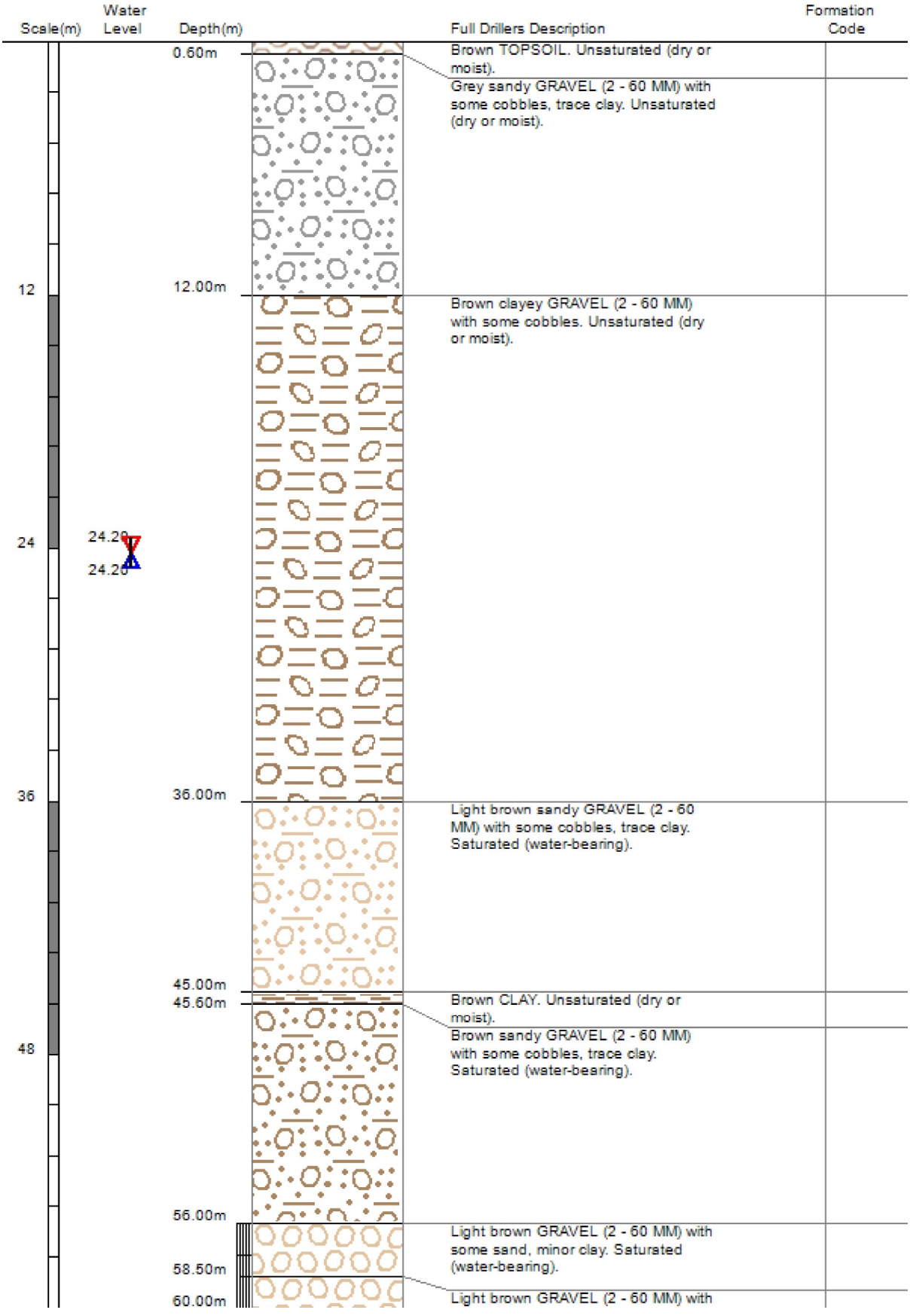
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well BX23/0853

Grid Reference (NZTM): 1548088 mE, 5181960 mN
Location Accuracy: 10 - 50m
Ground Level Altitude: m +MSD Accuracy:
Driller: East Coast Drilling
Drill Method: Air Rotary
Borelog Depth: 60.0 m Drill Date: 17-Aug-2018

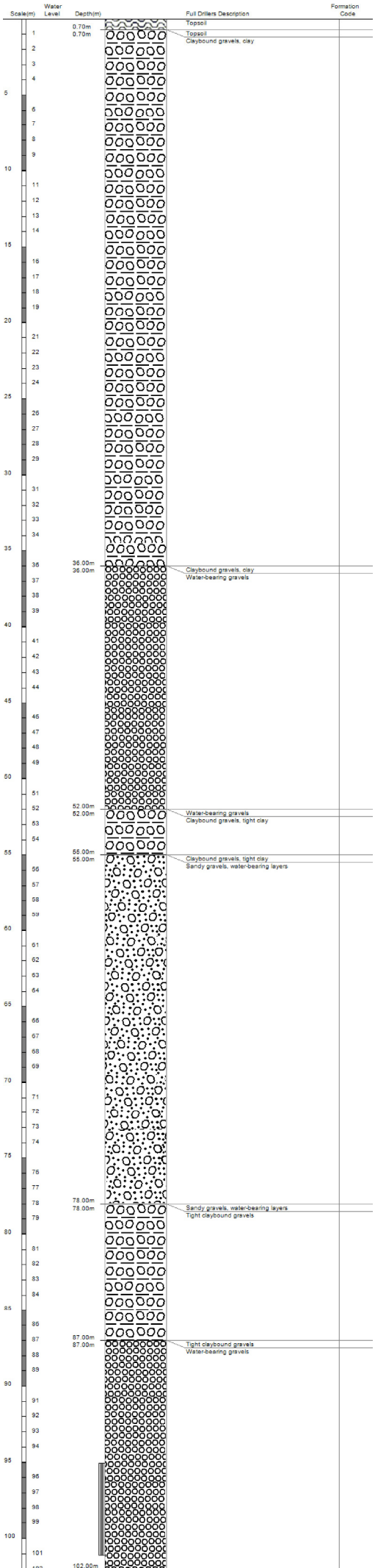
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M35/17757

Grid Reference (NZTM): 1548668 mE, 5181587 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 95.1 m +MSD Accuracy: < 0.5 m
Driller: East Coast Drilling
Drill Method: Rotary/Percussion
Borelog Depth: 102.0 m Drill Date: 28-Jul-2008

Environment Canterbury Regional Council
Kaunihera Taiao Ki Waitaha



APPENDIX C

Test Pit Logs

LandTech CONSULTING	Client: Marama Te Wai Limited Project: Proposed Land Use Change Address: 1234 West Coast Road, West Melton	Test Pit No.	TP01
		Sheet No.	1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548262 N5170867	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL		SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL]
LOESS	0.5	SILT, minor fine sand, light brown, very stiff, moist, non-plastic [LOESS]
RIVER DEPOSITS		Fine to coarse SAND, minor to some silt, grey, medium dense, moist [RIVER DEPOSITS]
	1.0	Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, moist.
	1.5	fine to medium gravel
		fine to coarse gravel
	2.0	
		minor subrounded to round cobbles
	2.5	
		End of Test Pit 2.6m
		[TARGET DEPTH]
	3.0	
	3.5	
	4.0	
	4.5	
	5.0	

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer — Scala Blow Count / 100mm — 0 5 10 15 20

Depth (m)	Blow Count
-0.1	2
-0.2	2
-0.3	4
-0.4	4
-0.5	6
-0.6	9
-0.7	8
-0.8	7
-0.9	7
-1.0	8
-1.1	6
-1.2	18
-1.3	20 +
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

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

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

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

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

LandTech CONSULTING	Client: Marama Te Wai Limited Project: Proposed Land Use Change Address: 1234 West Coast Road, West Melton	Test Pit No.	TP02
		Sheet No.	1 of 1

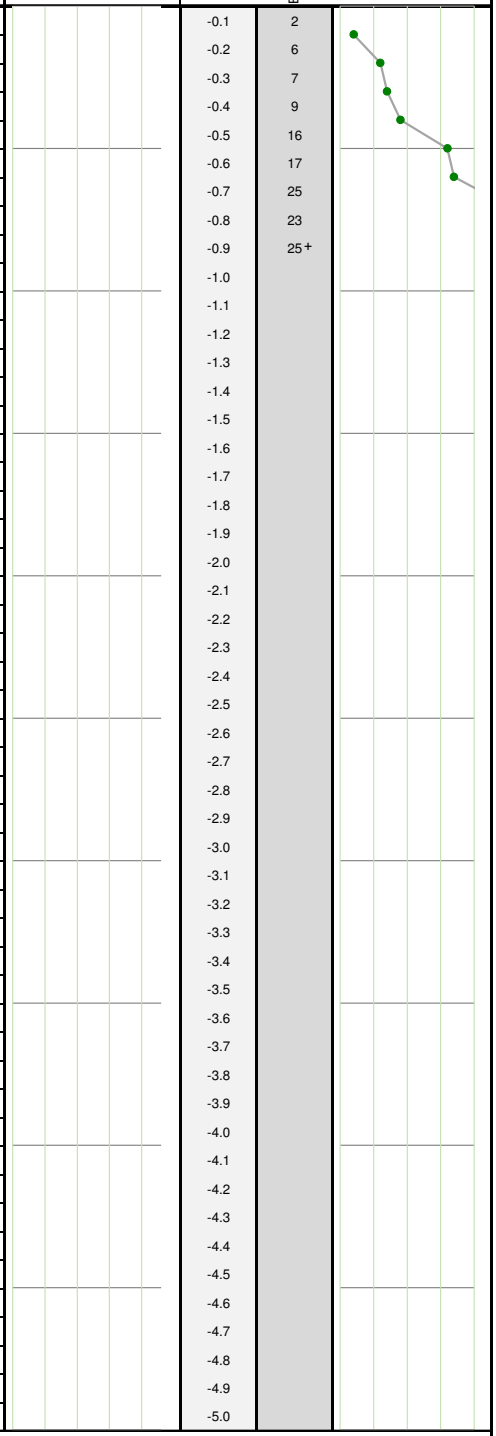
Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548158 N5180937	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL	0.0	SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL] minor roots
LOESS	0.5	SILT, trace to minor fine sand, light brown, dry, very stiff [LOESS]
RIVER DEPOSITS	1.0	Fine to coarse subrounded to rounded GRAVEL, minor fine sand, brownish grey, very dense, moist [RIVER DEPOSITS]
	1.5	minor subrounded to rounded cobbles
	2.0	some fine to coarse sand Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, moist.
	2.5	
	3.0	End of Test Pit 2.6m [TARGET DEPTH]
	3.5	
	4.0	
	4.5	
	5.0	

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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



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

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

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

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Client:	Marama Te Wai Limited	Test Pit No.	TP03
Project:	Proposed Land Use Change		
Address:	1234 West Coast Road, West Melton	Sheet No.	1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548252 N5181123	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL	0.0		SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL] minor fine to medium gravel
LOESS	0.5		SILT, minor fine sand, light brown, very stiff, moist, non-plastic [LOESS]
RIVER DEPOSITS	1.0		Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, moist [RIVER DEPOSITS] minor subrounded to rounded cobbles
	2.0		
	2.5		End of Test Pit 2.2m [TARGET DEPTH]
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

Shear Strength (kPa)

Peak:

Remoulded:

0 50 100 150 200

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	10
-0.2	8
-0.3	14
-0.4	9
-0.5	17
-0.6	18
-0.7	25+
-0.8	
-0.9	
-1.0	
-1.1	
-1.2	
-1.3	
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Scala Blow Count / 100mm

0 5 10 15 20

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

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

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

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

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Client: Marama Te Wai Limited
Project: Proposed Land Use Change
Address: 1234 West Coast Road, West Melton

Test Pit No. TP04
Sheet No. 1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548112 N51811286	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL			SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL]
LOESS	0.5		SILT, trace to minor fine sand, light brown, stiff, moist, non-plastic [LOESS]
RIVER DEPOSITS	1.0		Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, moist [RIVER DEPOSITS]
	1.5		trace to minor subrounded to rounded cobbles
	2.0		
	2.5		End of Test Pit 2.2m
	3.0		[TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	4
-0.2	10
-0.3	8
-0.4	5
-0.5	6
-0.6	25+
-0.7	
-0.8	
-0.9	
-1.0	
-1.1	
-1.2	
-1.3	
-1.4	
-1.5	
-1.6	
-1.7	
-1.8	
-1.9	
-2.0	
-2.1	
-2.2	
-2.3	
-2.4	
-2.5	
-2.6	
-2.7	
-2.8	
-2.9	
-3.0	
-3.1	
-3.2	
-3.3	
-3.4	
-3.5	
-3.6	
-3.7	
-3.8	
-3.9	
-4.0	
-4.1	
-4.2	
-4.3	
-4.4	
-4.5	
-4.6	
-4.7	
-4.8	
-4.9	
-5.0	

Scala Blow Count / 100mm
0 5 10 15 20

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

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

LandTech CONSULTING	Client: Marama Te Wai Limited Project: Proposed Land Use Change Address: 1234 West Coast Road, West Melton	Test Pit No.	TP05
		Sheet No.	1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548255 N5181398	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL	0.0		SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL]
RIVER DEPOSITS	0.5		Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, dry [RIVER DEPOSITS]
	1.0		moist
	1.5		minor subrounded to rounded cobbles
			moist to wet
	2.0		200mm band of fine to medium grevel with minor to some sand
	2.5		End of Test Pit 2.2m [TARGET DEPTH]
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	4
-0.2	6
-0.3	7
-0.4	8
-0.5	25+

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

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

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

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

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

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Client: Marama Te Wai Limited
Project: Proposed Land Use Change
Address: 1234 West Coast Road, West Melton

Test Pit No. TP06
Sheet No. 1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548115 N5181406	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL			SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL]
LOESS	0.5		SILT, minor fine sand, light brown, dry to moist, very stiff, non-plastic [LOESS]
RIVER DEPOSITS	1.0		Fine to coarse sandy fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, moist [RIVER DEPOSITS]
	1.5		trace subrounded to rounded cobbles
	2.0		moist to wet
	2.5		End of Test Pit 2.2m
	3.0		[TARGET DEPTH]
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Depth (m)	Blow Count	Scala Blow Count / 100mm (0 5 10 15 20)
-0.1	3	
-0.2	7	
-0.3	9	
-0.4	12	
-0.5	11	
-0.6	13	
-0.7	20	
-0.8	25 +	
-0.9		
-1.0		
-1.1		
-1.2		
-1.3		
-1.4		
-1.5		
-1.6		
-1.7		
-1.8		
-1.9		
-2.0		
-2.1		
-2.2		
-2.3		
-2.4		
-2.5		
-2.6		
-2.7		
-2.8		
-2.9		
-3.0		
-3.1		
-3.2		
-3.3		
-3.4		
-3.5		
-3.6		
-3.7		
-3.8		
-3.9		
-4.0		
-4.1		
-4.2		
-4.3		
-4.4		
-4.5		
-4.6		
-4.7		
-4.8		
-4.9		
-5.0		

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

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

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

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

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Client: Marama Te Wai Limited
Project: Proposed Land Use Change
Address: 1234 West Coast Road, West Melton

Test Pit No. TP07
Sheet No. 1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548115 N5181587	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

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

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	3
-0.2	5
-0.3	10
-0.4	25+

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

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

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

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

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

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Client: Marama Te Wai Limited
Project: Proposed Land Use Change
Address: 1234 West Coast Road, West Melton

Test Pit No. TP08
Sheet No. 1 of 1

Drill Type:	6T Hydaulic Excavator	Project No:	LTC20375	Logged By:	LC
Drilled By:	BM Contracting	Coordinates:	NZTM E1548260 N5181611	Shear Vane No:	N/A
Date Started:	10-Dec-20	Ground Conditions:	Near Level Grass	Calibration Factor:	N/A
Date Finished:	10-Dec-20	Groundwater Level (m):	Not Encountered (10-December-20)	Calibration Date:	N/A

Stratigraphy	Depth (m)	Graphic Log	Soil description in accordance with *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*, NZ Geotechnical Society Inc., 2005
TOPSOIL	0.0		SILT, trace fine sand, dark brown, stiff, moist, non-plastic [TOPSOIL]
RIVER DEPOSITS	0.5		Fine to coarse sandy, fine to coarse subrounded to rounded GRAVEL, brownish grey, very dense, dry to moist [RIVER DEPOSITS]
	1.0		moist
	1.5		trace to minor subrounded cobbles
	2.0		moist to wet
	2.5		End of Test Pit 2.4m [TARGET DEPTH]
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		

Groundwater Level (m): Not Encountered (10-Dec-20)

In-situ Field Testing

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

Dynamic Cone (Scala) Penetrometer

Depth (m)	Blow Count
-0.1	4
-0.2	4
-0.3	5
-0.4	9
-0.5	25+

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

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

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

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

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

APPENDIX D

Soakage Test Results

	Client:	Marama Te Wai Limited	
	Project:	Proposed Land Use Change	
	Address:	1234 West Coast Road, West Melton	
Test Type:	On-site soakage test	Project No:	LTC20375
Tested By:	L Challies	Test Date:	10-Dec-20

Test ID:	TP02/ST01
Coordinates:	NZTM E1548158 N5180937
Groundwater level:	Not Encountered
Method:	In general accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual
Pre soak:	2000L - drained in around 1 hour
Test Pit Dimensions:	
2 m	length
1 m	wide
1.60 m	equivalent diameter

1) Test Details

Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	1.4	-
90	1.50	1.3	0.067
200	3.33	1.2	0.055
310	5.17	1.1	0.055
440	7.33	1.0	0.046
590	9.83	0.9	0.040
870	14.50	0.8	0.021
1190	19.83	0.7	0.019
1840	30.67	0.6	0.009
2720	45.33	0.5	0.007
3520	58.67	0.4	0.008
4420	73.67	0.3	0.007
5160	86.00	0.2	0.008

2) Calculate Minimum Gradient

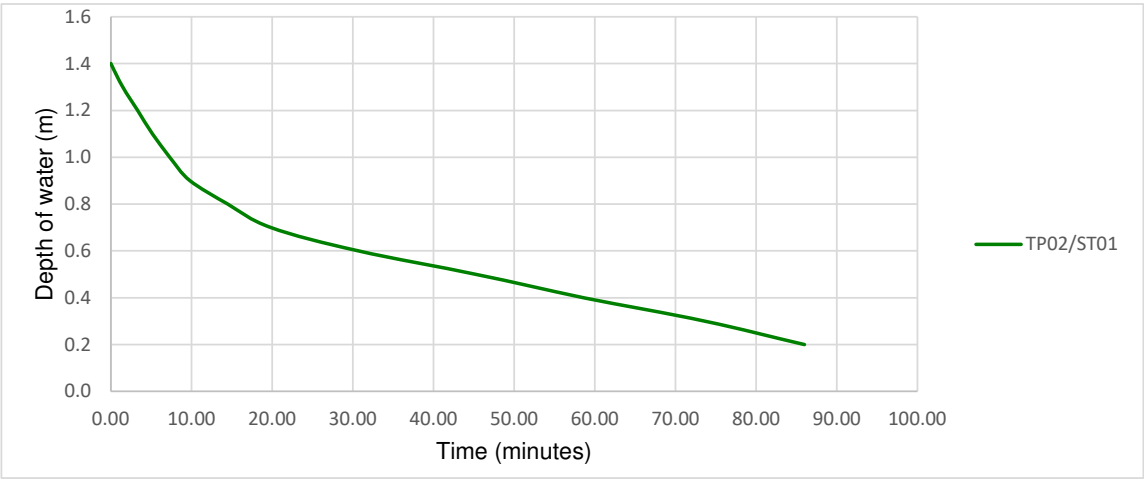
0.01 m/min 443 mm/h

3) Calculate percolation rate

12 L/m2/min

707 L/m2/hr

Graph of Soakage Test ST01 : Depth of water vs time



Client:	Marama Te Wai Limited		
Project:	Proposed Land Use Change		
Address:	1234 West Coast Road, West Melton		
Test Type:	On-site soakage test	Project No:	LTC20375
Tested By:	L Challies	Test Date:	10-Dec-20

Test ID:	TP07/ST02
Coordinates:	NZTM E1548115 N5181587
Groundwater level:	Not Encountered
Method:	In general accorandance with W1: Falling-head percolation Test of the Auckland soakage design manual
Pre soak:	2000L - in less than 2 minutes
Test Pit Dimensions	
2 m	length
1 m	wide
1.60 m	equivalent diameter

1) First Test

Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	0.4	-
30	0.50	0.3	0.200
60	1.00	0.2	0.200
90	1.50	0.1	0.200
108	1.80	0.0	0.333

2) Calculate Minimum Gradient

0.20 m/min 12000 mm/h

3) Calculate percolation rate

532 L/m2/min

31915 L/m2/hr

2) Second Test

Time (Sec)	Time (min)	Depth (m)	Soak Rate (m/min)
0	0.00	0.6	-
30	0.50	0.5	0.200
60	1.00	0.4	0.200
105	1.75	0.3	0.133
155	2.58	0.2	0.120
205	3.42	0.1	0.120

2) Calculate Minimum Gradient

0.12 m/min 7200 mm/h

3) Calculate percolation rate

319 L/m2/min

19149 L/m2/hr

Graph of Soakage Test (ST02), Test 1 and 2: Depth of water vs time