Appendix B

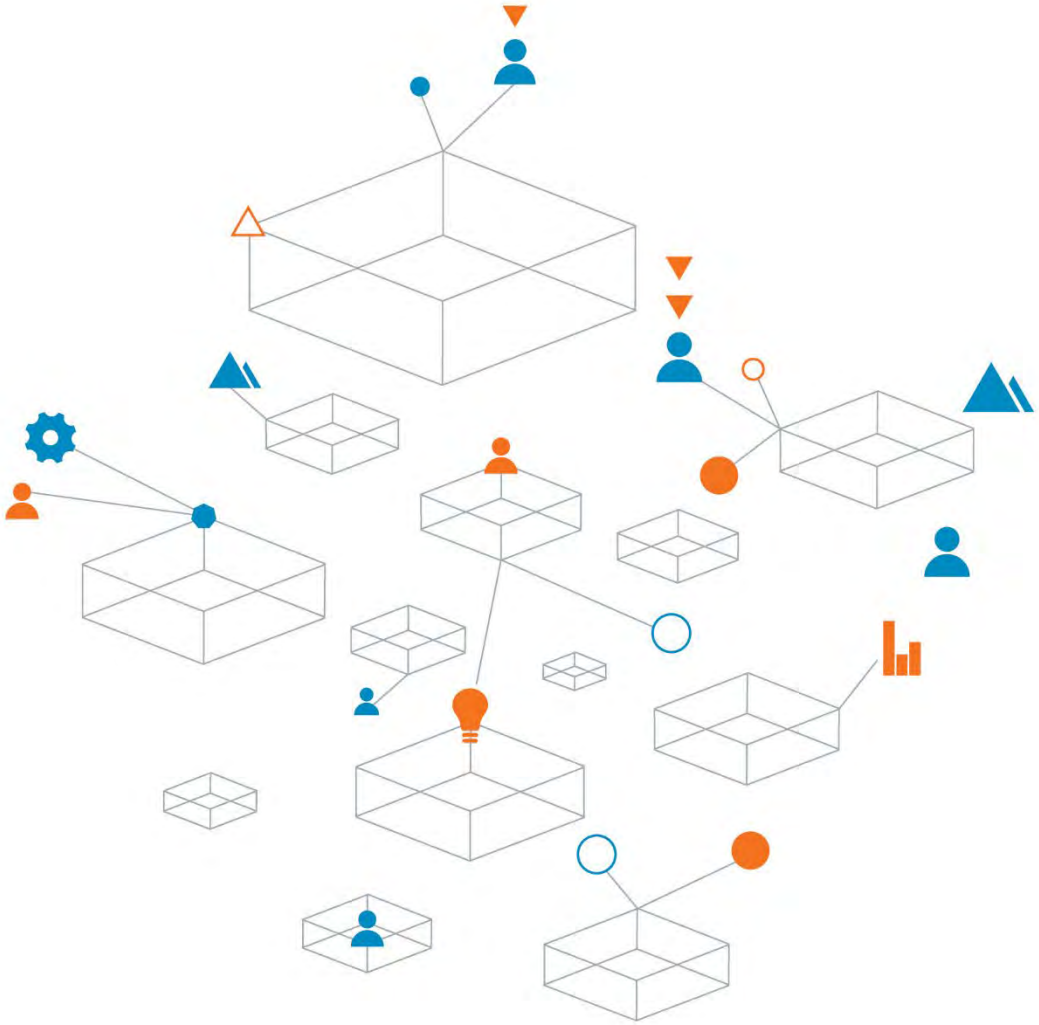
Updated Geotechnical Assessment

Rolleston Industrial Developments Ltd
1491 Springs Road, Lincoln

773-CHCGE280252

Geotechnical Assessment Report – Rev 2

28 January 2021



Trust is the cornerstone of all our projects

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28 January 2021

Our ref: 773-CHCGE280252

Rolleston Industrial Developments Ltd
ASB House, 166 Cashel Street
Christchurch Central

Attention: Tim Carter / Bruce Van Duyn

Executive Summary: 1491 Springs Road, Lincoln – Geotechnical Assessment to support a Plan Change application

Rolleston Industrial Developments Ltd has engaged Coffey Services (NZ) Limited to carry out a geotechnical investigation and assessment of suitability for the proposed Plan Change and future subdivision at 1491 Springs Road, Lincoln, Canterbury. The purpose of this report is to support a Plan Change application for the construction of approximately 2,000 new residential Lots at the site.

The site investigations and preliminary liquefaction assessment indicates that the site is predominantly TC1-like. Other geotechnical hazards (erosion, slippage and inundation) are considered low risk with appropriate future engineering design.

Our assessment has considered the items required by Section 106 of the RMA and in our opinion the site is considered geotechnically suitable for Plan Change and future subdivision. Further investigations and design will be carried out at the subdivision consent stage.

If you have any queries, please contact he undersigned.

For and on behalf of Coffey

Chris Thompson
BSc (Tech)
Associate Engineering Geologist

1491 Springs Road, Lincoln

Prepared for
Rolleston Industrial Developments Ltd

Prepared by
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NZBN 9429033691923

28 January 2021

773-CHCGE280252

Quality information

Revision history

Revision	Description	Date	Originator	Reviewer	Approver
V2	GAR	28/01/2021	CT	RB	CT
V1	GAR	20/10/2020	CT	RB	CT
V0	GAR	15/10/2020	CT	RB	CT

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Final	1	PDF	Bruce Van Duyn – Rolleston Industrial Developments	28/01/2021

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1. Introduction

Rolleston Industrial Developments Ltd has engaged Coffey Services (NZ) Limited to carry out a geotechnical investigation and assessment of suitability for a proposed Plan Change and future subdivision at 1491 Springs Road, Lincoln, Canterbury. The purpose of this report is to support a Plan Change application for the construction of approximately 2,000 new residential Lots at the site.

Our assessment has considered the items required by Section 106 of the RMA. In our opinion the site is considered geotechnically suitable for subdivision subject to further investigation and design at the subdivision consent stage.

2. Scope

An investigation methodology for the 178 Ha site was developed and carried out by Coffey, as outlined below:

- Review of previous geotechnical investigations including previous work on the site and surrounding area.
- Site walkover to assess geotechnical hazards.
- Completion of 20 piezocone penetration tests (CPTs). The CPT tests were a primary investigation tool used to develop the preliminary ground model at the site.
- Excavation of 16 test pits in the identified borrow area near the intersection of Springs and Collins roads.
- Three multi-channel analysis of surface waves (MASW) geophysical investigation lines with a total length of 2.6km were measured to supplement the CPTs and provide continuous profiles of information about soils below CPT refusal depths.
- Assessment of the geotechnical hazards at the site per Section 106 of the RMA.
- Geotechnical analyses and reporting.

Coffey have considered the following in the preparation of this report:

- Existing geotechnical investigation data available in the area from the New Zealand Geotechnical Database (NZGD).
- New geotechnical investigations data.
- Project correspondence with the wider Plan Change consultants engaged by Rolleston Industrial Developments Ltd.

Reference has also been made to the MBIE Guidance Part D: Subdivisions, to confirm that the requirements outlined in these documents have been incorporated in this report.

3. Proposed development

The proposed Plan Change area comprises a series of land parcels totalling 178 Ha located to the south of Lincoln, bordering the existing Te Whariki and Verdeco Park subdivisions. The overall site has a gentle downslope east from Springs Road towards the “L II” River. It also slopes gently down to the west from a high point just west of Springs Road.

There are a number of springs and associated drains / waterways located within the Plan Change area that will be incorporated into the overall development plan. The site is predominantly used for grazing and some cropping.

To the west of Springs Road, a small area has been used as a borrow area for sourcing gravel and was backfilled in the past 5 to 10 years. An older borrow pit is also located in this area.

4. Site investigation

The location of the geotechnical investigations carried out on the site to develop the ground model, along with the location of the MASW lines, are provided in Figure 1 (in Appendix A). The results are summarised below. Investigation results are presented in Appendix B (CPT traces), Appendix C (MASW report), Appendix D (test pits), and Appendix E (additional test data).

Table 1: CPT investigation summary

Reference	Depth of test (metres below ground level)	Depth to groundwater (as measured in CPT hole)	Termination criteria
CPT 01	7.5	2.78	Effective refusal
CPT 02	5.21	1.96	Effective refusal
CPT 03	5.83	2.17	Effective refusal
CPT 04	6.24	1.25	Effective refusal
CPT 05	4.37	1.37	Effective refusal
CPT 06	12.02	1.26	Effective refusal
CPT 07	4.15	0.90	Effective refusal
CPT 08	5.24	1.50	Effective refusal
CPT 09	4.94	1.52	Effective refusal
CPT 10	6.34	1.48	Effective refusal
CPT 11	5.91	2.58	Effective refusal
CPT 12	6.65	1.75	Effective refusal
CPT 13	7.82	1.50	Effective refusal
CPT 14	4.36	0.61	Effective refusal
CPT 15	4.91	0.46	Effective refusal
CPT 16	2.28	Not encountered	Effective refusal
CPT 17	5.60	2.50	Effective refusal
CPT 18	2.22	Not encountered	Effective refusal
CPT 19	7.62	3.40	Effective refusal
CPT 20	1.53	Not encountered	Effective refusal

Note: CPT20 was carried out through a fill area so is not indicative of the general area.

Table 2: Test pit investigation summary

Reference	Depth of test (metres below ground level)	Depth to groundwater (as measured)	Termination criteria
TP 01	0.85	Not encountered	Target depth
TP 02a	0.95	Not encountered	Target depth
TP 02b	0.8	Not encountered	Target depth
TP 02c	3.5	Not encountered	Target depth
TP 03	4.4	Not encountered	Target depth
TP 04a	3.85	Not encountered	Target depth
TP 04b	0.2	Not encountered	Target depth
TP 05	3.0	Not encountered	Target depth
TP 06	3.1	Not encountered	Target depth
TP 07	3.0	Not encountered	Target depth
TP 08a	0.45	Not encountered	Target depth
TP 08b	1.4	Not encountered	Target depth
TP 08c	2.6	Not encountered	Target depth
TP 09a	2.4	Not encountered	Target depth
TP 09b	2.2	Not encountered	Target depth
TP 10	2.75	Not encountered	Target depth

Table 3: Additional data summary

Reference	Depth of test (metres below ground level)	Depth to groundwater (as measured)	Termination criteria
CPT 113586	2.6	Not recorded	Effective refusal
BH 113495	15.2	4.2	Target depth
CPT 113582	1.7	Not recorded	Effective refusal
CPT 136840	5.3	1.5	Effective refusal
CPT 136850	6.0	0.7	Effective refusal
CPT 136855	6.7	2.4	Effective refusal
CPT 125194	5.9	Not recorded	Effective refusal
CPT 125215	6.4	Not recorded	Effective refusal
CPT 56181	6.7	0.7	Effective refusal
CPT 56182	4.1	0.7	Effective refusal
CPT 56183	4.5	0.6	Effective refusal
CPT 56184	8.3	0.7	Effective refusal
CPT 152915	7.7	Not recorded	Effective refusal
M36/7635	8.8	4.3	Target depth
M36/1419	30.2	Not recorded	Target depth
M36/2834	19.0	4.3	Target depth
M36/7531	24.0	3.2	Target depth
M36/5054	13.0	Not recorded	Target depth

4.1. MASW profiles results

The MASW geophysical survey was measured in three profiles totalling 2.6 km in length, two east-west across the site and one north-south as shown in Figure 1 (Appendix A) and in Figure 1 of the geophysics report (Appendix C). The MASW profiles are considered to be good data that can be calibrated in detail to the other geotechnical investigations data for the subdivision consent. It captures the ground profile and soil conditions below the generally shallow depth of refusal of the CPTs above. The MASW profiles show that non-liquefying gravels are consistently present over the site below the weaker upper soil layers whose properties have been measured in more detail by the CPTs, and that these gravels increase in density with depth.

5. Site performance

5.1. Ground motion

The site is not in an area mapped for ground damage effects as part of the Canterbury Earthquake Sequence response, however the nearby Lincoln University strong motion sensor recorded the following peak ground accelerations (PGA):

- 4 September 2010: 0.437g
- 22 February 2011: 0.12g
- Later 2011 earthquakes: <0.1g

Based on the above, we consider that the site was “sufficiently tested” to the serviceability limit state (SLS) level of earthquake demand during the 4 September 2010 earthquake of the Canterbury earthquake sequence (CES) using the MBIE[1] and Bradley & Hughes (2012)[2] procedures.

An assessment has been made regarding predicted earthquake-induced deformation that may occur in a design earthquake based on geological setting, site terrain, and the level of “test” previously experienced. It is considered that:

- An SLS earthquake event is likely to cause less damage to that experienced in the 4 September 2010 earthquake and to be similar to the February 2011 earthquake.
- Under ultimate limit state (ULS) conditions, the nature of land and building damage is likely to be similar to that already experienced in the 4 September 2010 earthquake of the CES.

[1] Ministry of Business, Innovation and Employment (MBIE), December 2012: Repairing and rebuilding houses affected by the Canterbury earthquakes
[2] Bradley & Hughes (2012) Conditional Peak Ground Accelerations in the Canterbury Earthquakes for Conventional Liquefaction Assessment. Report for DBH (MBIE), April 2012.

6. Ground model

6.1. Geology

The geological map[3] of the area indicates that the site is near the geological boundary of “Grey to brown alluvium, comprising silty sub-angular gravel and sand forming alluvial fans (Q1a)” (also known as colluvium) and “Grey river alluvium, comprising gravel, sand and silt, in active floodplains (Q1a).” of the Springston Formation.

6.2. Groundwater

Based on the observed groundwater levels recorded from the CPTs, the groundwater appears to be shallower in the eastern portions of the site and gradually deepens to the west. Conservatively, for the initial liquefaction assessment, we have used a groundwater level of 1.0mbgl for the eastern portion and 2.0m to 2.5mbgl for the western portion of the site. This can be refined later.

6.3. Investigation findings

Twenty CPTs, sixteen test pits, NZGD data and 2.6km of MASW geophysical investigation have been used to develop the ground model for the 1491 Springs Road subdivision. A summary of the ground model is provided below:

Table 4: Ground profile

Description		Strength/ consistency	Thickness (m)	Depth to top of layer (mbgl)
Springston Formation	Sandy silt and organic silt (topsoil)		0.3 to 0.4	0.0
	Interbedded alluvium: Silt, sandy silt and silty sand	Soft to very stiff	West of Springs Road – 1.0 to 2.2 East of Springs Road – 3.5 to 5.5	0.3 to 0.4
	Interbedded alluvium: typically sand and gravel deposits with some layers of silt, sandy silt and silty sand	Medium dense to dense, non-liquefiable	>20m	West of Springs Road – 1.0 to 2.2 East of Springs Road – 3.5 to 5.5

The above ground profile is simplified as an illustration; however, the actual ground profile includes a highly interbedded (interfingered) layering of silty alluvium and sandy / gravel alluvium. These layers have different geotechnical properties (strength) and are present in various thicknesses across the site, as shown in the CPT investigations. The eastern edge of the site has potentially organic deposits in the low-lying area, however, this will be further investigated during the subdivision consent stage once the overall development plan is confirmed.

[3] Forsyth, P.J.; Barrell, D.J.A.; Jongens, R. (compilers) 2008: Geology of the Christchurch area: scale 1:250,000. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 16. 67 p. + 1 folded map

The MASW geophysical investigation has confirmed that relatively dense non-liquefiable deposits are present below the termination depth of the CPTs conducted. The assessment of these deposits as being non-liquefiable is based on the shear wave velocities recorded being greater than 200m/s and increasing with depth. This assessment correlates with the well logs available on or near the site that indicate the presence of gravel layers (extending to at least 20mbgl) beneath the surficial fine-grained deposits.

The test pits were carried out across the two previously identified borrow areas to confirm the backfill materials and extents. The test pits have identified non-engineered fill that can predominantly be reworked and placed as engineered fill during subdivision construction.

6.4. Site sub-soil class

In accordance with NZS1170.5, Section 3.1.3, a subsoil classification of “Class D – Deep or soft soil sites” can be assumed for the site.

7. Geotechnical hazard assessment

7.1. Erosion

The site has relatively flat topography and is bounded by newly developed residential areas as well as grassed paddock land. Provided appropriate stormwater systems are installed as part of the development, there will be few viable sources of erosion at this site.

7.2. Falling debris

As there are no slopes or exposed hills or rock faces surrounding the site, there are no sources of falling debris at the site, or for the surrounding area.

7.3. Subsidence

7.3.1. Liquefaction induced settlement

Soils that are usually considered to be liquefiable comprise saturated geologically young (i.e. Holocene and late Pleistocene) loose sands and silts. With this in mind, we consider that the interbedded silt / sandy silt / silty sand overbank deposits of the Springston Formation may be susceptible to liquefaction and that a triggering analysis will determine which soil layers will liquefy when subjected to the SLS and ULS earthquake demands.

SLS and ULS design earthquake scenarios are assessed using the parameters provided by the MBIE Guidance for an Importance Level 2 (IL2) structure and a Class D subsoil site. The earthquake parameters adopted for design and for the liquefaction analysis are presented in Table 3.

Table 5: Earthquake scenario and parameters for analysis

Earthquake scenario	Moment magnitude (M_w)	α_{max} (g)
SLS	7.5	0.13
	6.0	0.19
ULS	7.5	0.35

The liquefaction triggering analysis was carried out for the CPTs shown on the site plan (Appendix A) using the Boulanger and Idriss (2014) method[4] and proprietary liquefaction assessment software[5], in accordance with the updates to the MBIE Guidance[1] (Issue 7 October 2014).

For a more accurate representation of the stratified soils in the CPT profiles, the auto transition layer detection (ATL) function was selected in the Geologismiki software. This function addresses the disparity between friction and end tip recordings of a CPT where the tip recordings are influenced by a softer layer above or beneath a harder / denser layer.

The liquefaction triggering analyses show that under SLS and ULS conditions, some of the interbedded silt / sandy silt / silty sand overbank deposits encountered at each CPT location are vulnerable to liquefaction whereas the clay-like soils in the eastern portion are considered unlikely to liquefy.

7.3.2. Free-field settlements

The type of settlement that is most commonly estimated when liquefaction analysis is conducted (refer to Section 6.3) is referred to as the *free-field settlement*. Free-field settlement is the component of land settlement that does not take account of foundation influences (e.g. loads and stiffness), or the effects of ground loss, lateral spread, strength degradation, sand ejecta and ground cracks.

According to the MBIE Guidance, an “Index Value” for categorising future expected land performance can be assigned by analysing the upper 10m of the soil profile. The rationale for this is that liquefaction in the upper 10m of the profile is known to be most manifested at the ground surface. Where CPTs refused before 10m, we have assigned Technical Categories based on the results of the MASW confirming dense non-liquefiable deposits below termination depths of the CPTs.

The estimated free-field settlement values and the correlated residential foundation Technical Category, as defined by Table 3.1 of the MBIE Guidance, are given in Table 4.

[4] Boulanger, R.W., Idriss, I.M., CPT and SPT liquefaction triggering procedures, Report No. UCD/CGM-14/01, April 2014, Centre for Geotechnical Modelling, Department of Civil and Environmental Engineering at the University of California, Davis, California
[5] Geologismiki Geotechnical Software, CLiq v.3.0.3.2 – CPT Liquefaction Assessment Software

Table 6: Estimated "free-field" post-liquefaction ground surface settlements and Technical Category[6]

CPT Location	Termination Depth (mbgl)	Free-field settlements to refusal depth (mm)		MBIE Technical Category
		SLS	ULS	TC
CPT01	7.5	~15	~25	TC1
CPT02	5.21	~10	~25	TC1
CPT03	5.83	<5	<10	TC1
CPT04	6.24	<15	~20	TC1
CPT05	4.37	<10	~20	TC1
CPT06	12.02	~15	~25	TC1
CPT07	4.15	<5	~10	TC1
CPT08	5.24	<15	~20	TC1
CPT09	4.94	<10	~15	TC1
CPT10	6.34	<10	~25	TC1
CPT11	5.91	~15	~40	TC2
CPT12	6.65	~15	~35	TC2
CPT13	7.82	~25	~50	TC2
CPT14	4.36	<10	~15	TC1
CPT15	4.91	<5	<5	TC1
CPT16	2.28	<5	~25	TC1
CPT17	5.60	<10	~25	TC1
CPT18	2.22	<5	~15	TC1
CPT19	7.62	~15	~25	TC1
CPT20	1.53	N/A	N/A	Not assessed

The CPT analyses show that the site is predominantly TC1-like with small areas that contain TC2-like ground. Once a groundwater monitoring programme has been carried out, we consider that an updated liquefaction analysis will generally reduce the predicted free-field settlements for the currently TC2-like locations as the groundwater measured in the CPT holes is generally deeper than that conservatively assumed for these analyses.

We note that the additional CPTs obtained from the NZGD correlate well with our assessment of the above locations, and these results have not been included in this Plan Change report. They will be included in future subdivision consent phase reports and analysis.

7.3.3. Static settlement

The presence of potentially organic soils in the low-lying eastern portion of the site increases the risk of static settlement in this area. It is likely that this area may be used for stormwater detention basins and as a result of this usage, residential buildings are unlikely. This risk will be assessed further once the overall development plan is confirmed. However, we do not anticipate this limiting development in the area with appropriate geotechnical design and construction.

[6] It should be noted that these settlement estimates only account for the free-field component of the expected settlement. Actual total settlements under SLS or ULS earthquake loading may be greater.

7.4. Slippage

We have not observed any sources of land instability on the site and due to the flat site topography, we consider the risk of slope failure to be very low. The appropriate design of batter slopes near waterways will mitigate this risk further.

7.5. Inundation

In relation to stormwater inundation, we recommend that drainage design and management be addressed by specialist consultants as it is beyond the scope of this report. We expect that with appropriate stormwater and flood control systems, the risk of inundation will be low.

8. Conclusions

The overall site is well covered with CPT probes, test pits and MASW profile investigations. Based on the on-site testing carried out to date, the majority of the site is TC1-like with some minor pockets of TC2-like performance.

We consider that the site is suitable for development subject to further investigation and design at the subdivision consent stage.

It is likely that additional geotechnical investigation will be required to refine the technical categories for the proposed Lots once a subdivision plan has been further developed. We also recommend that a groundwater monitoring programme is implemented to allow for more accurate liquefaction and ground settlement analyses.

9. Limitations

This report has been prepared solely for the use of our client, Rolleston Industrial Developments Ltd, their professional advisers and Selwyn District Council (SDC) in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity.

It is recommended that all other parties seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

As subsurface information has been obtained from discrete investigation locations, which by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report. If variations in the subsoils occur from those described or assumed to exist, then the matter should be referred to us immediately.

Please also refer to the enclosed *Important Information about Your Coffey Report*.

10. Closure

If you have queries or require further clarification regarding aspects of this report, please contact the undersigned.

For and on behalf of Coffey

Prepared by

Chris Thompson
BSc (Tech)
Associate Engineering Geologist

Reviewed by

Richmond Beetham
BSc MSc Eng BE CMEngNZ CPEng PEngGeol
Principal Geotechnical Engineer

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

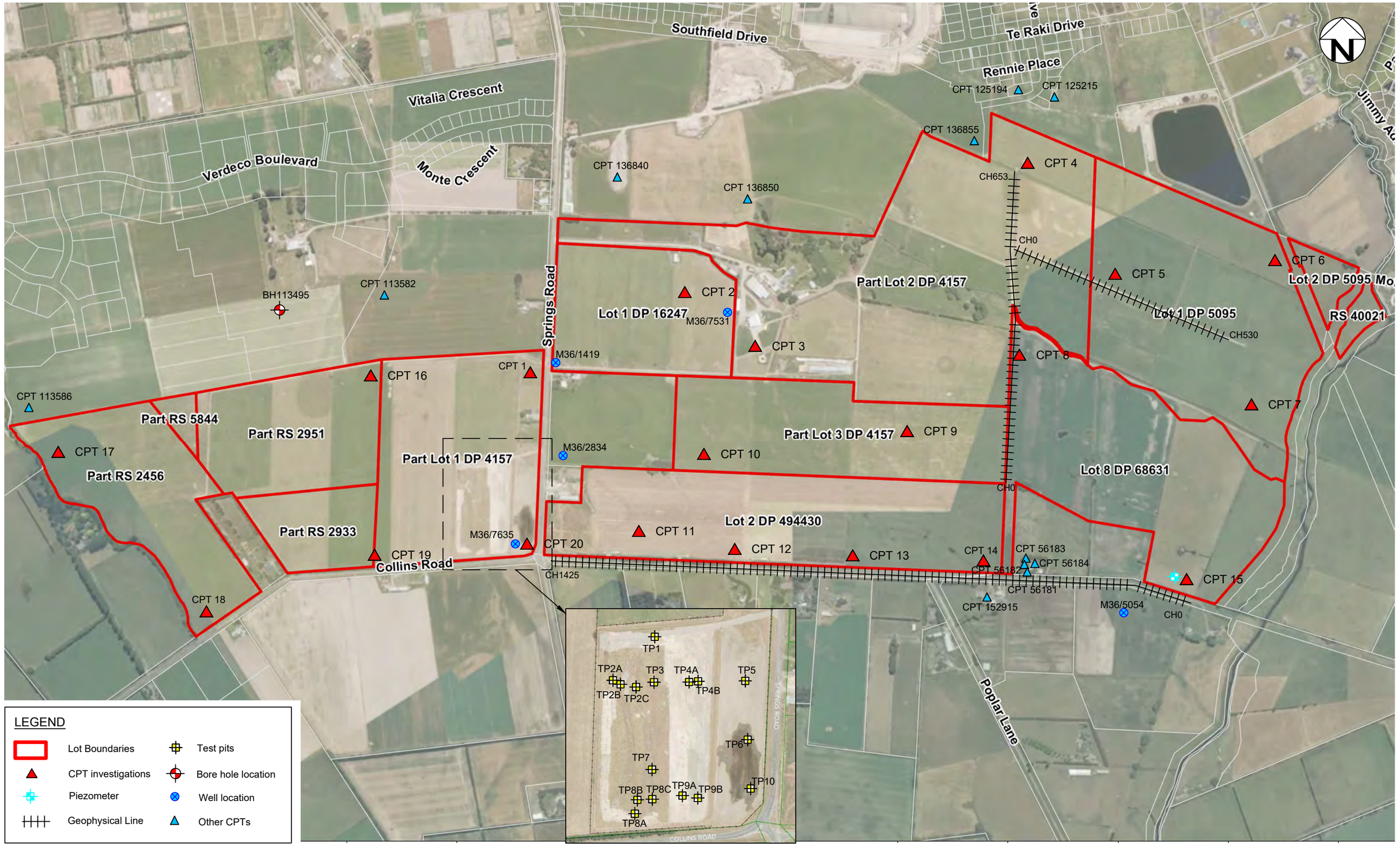
Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Appendix A - Site Plan



LEGEND

- Lot Boundaries
- CPT investigations
- Piezometer
- Geophysical Line
- Test pits
- Bore hole location
- Well location
- Other CPTs

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	LM	CT	13/10/2020
	B	INVESTIGATION LOCATIONS ADDED	RZ	CT	20/01/2021

100 0 100 200 300 400

Scale (metres) 1:8000

drawn	LM/RZ
approved	CT
date	20/01/2021
scale	1:8000
original size	A3

coffey
A TETRA TECH COMPANY

client: ROLLESTON INDUSTRIAL DEVELOPMENTS LIMITED

project: 1491 SPRINGS ROAD
LINCOLN, CHRISTCHURCH

title: SITE INVESTIGATION PLAN

project no: 773-CHCGE280252 | figure no: Figure1 | rev: B

PLOT DATE: 20/01/2021 12:31:05 PM DWG FILE: \\TTS808FS2.TT.LOCAL\S809\GEN\ZPROJECTS\03 TETRALINX PROJECTS\280000 - 289999\280252 - 1491 SPRINGS ROAD, LINCOLN\06 DRAWINGS\CNZ DRAWINGS\SITE PLAN_RZ - STANDARD\SITE PLAN_RZ.DWG

Appendix B - CPT traces

Coffey
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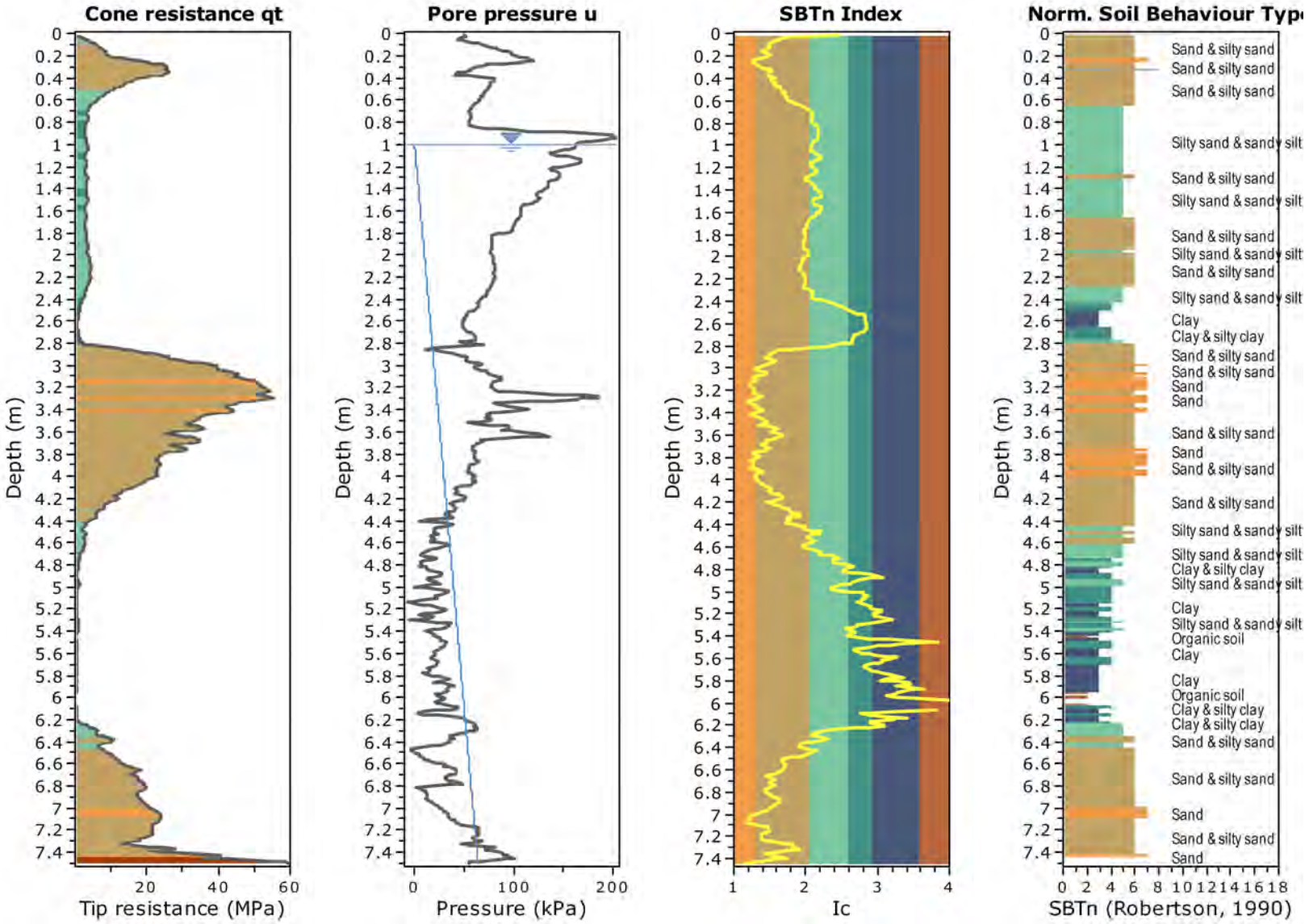
CPT: CPT 1
Total depth: 7.50 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

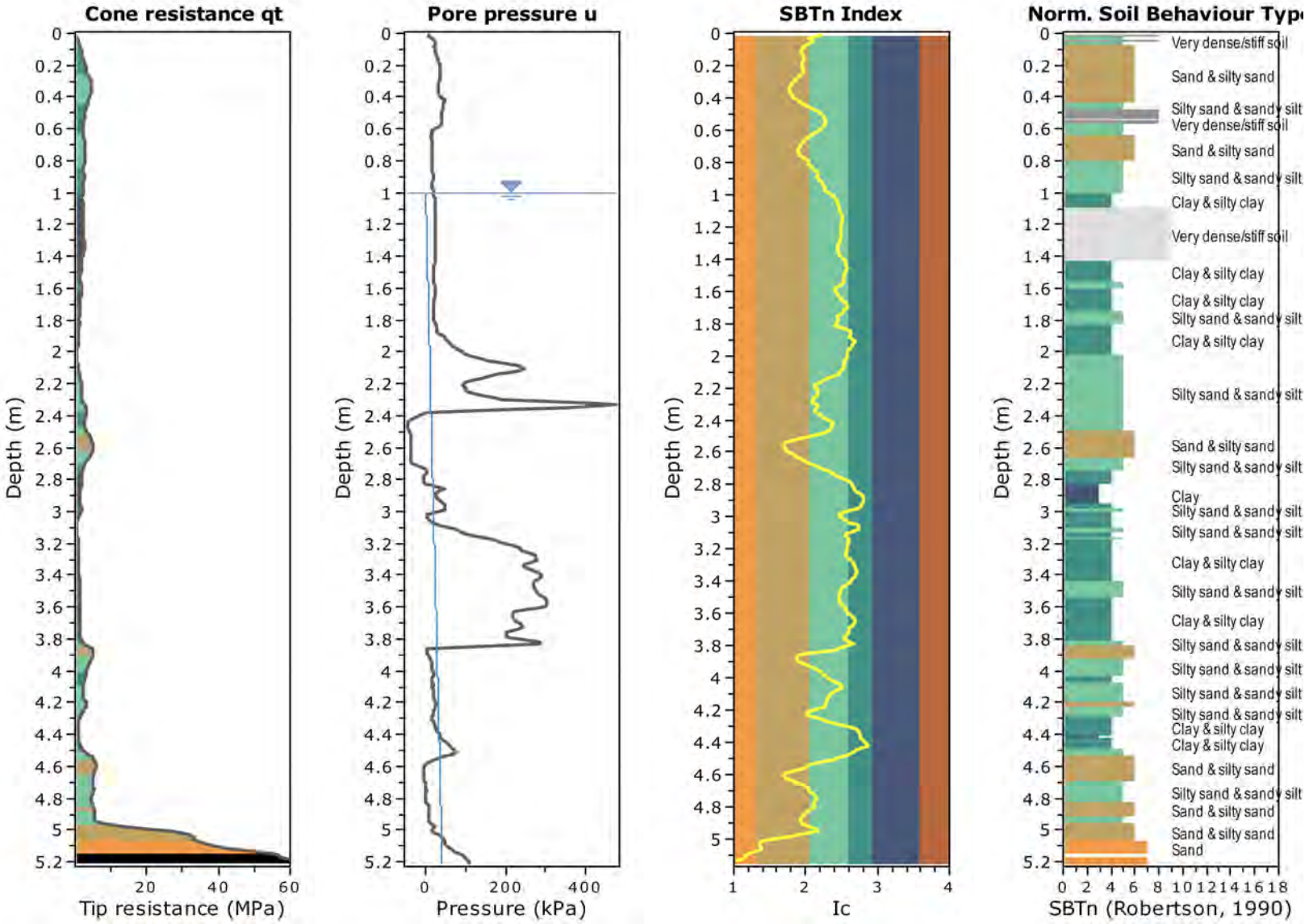
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 2
Total depth: 5.21 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

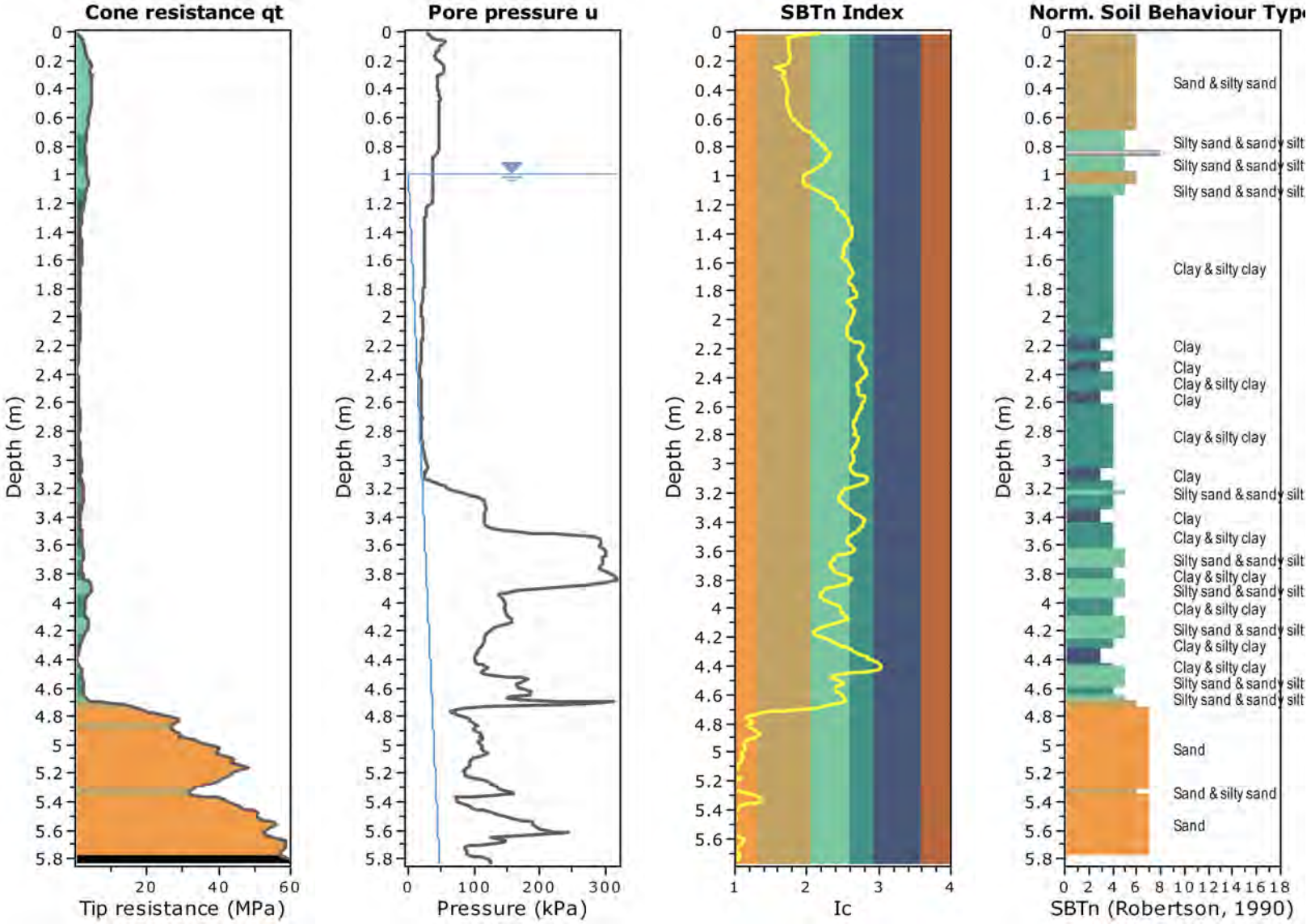
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 3
Total depth: 5.83 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

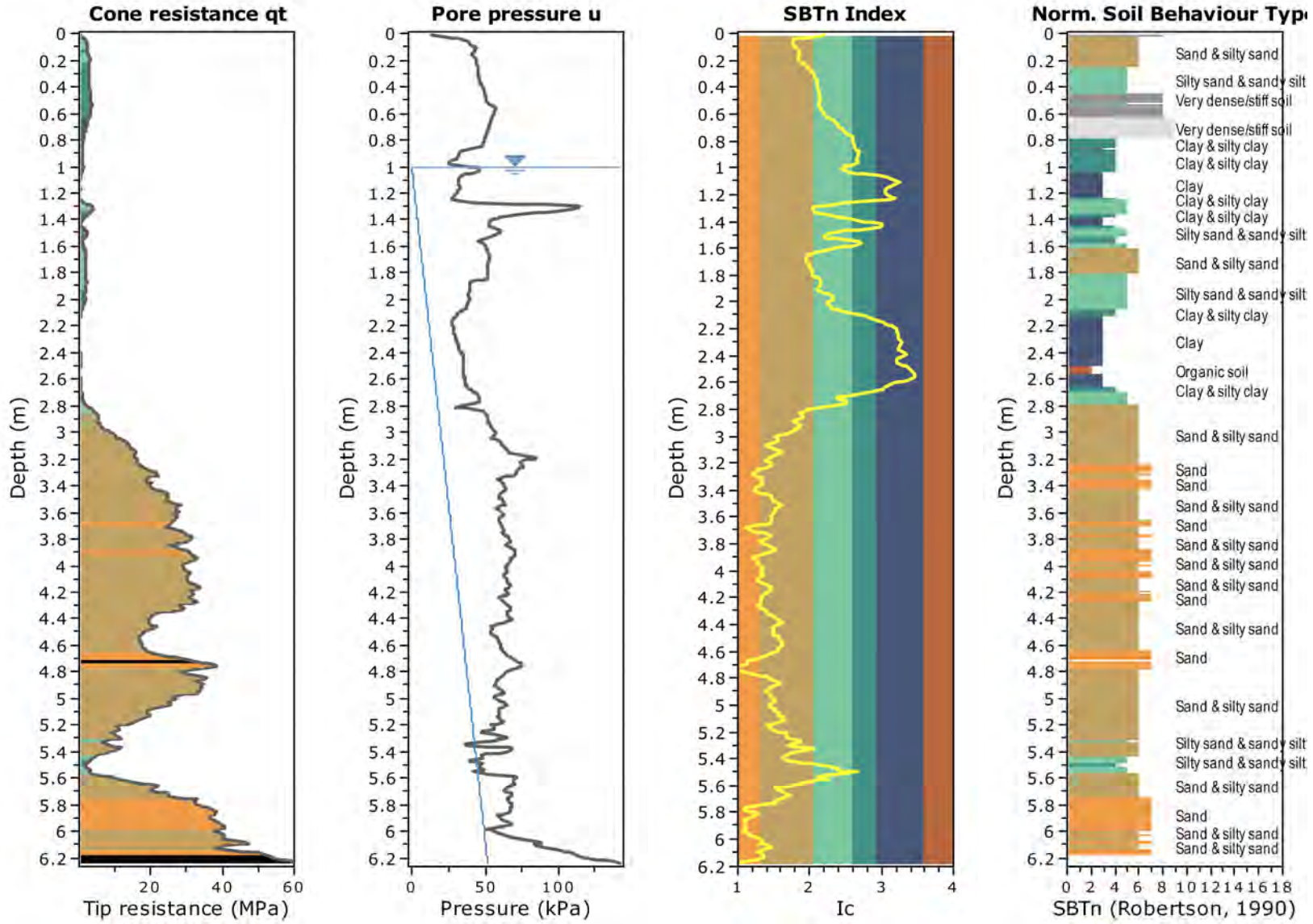
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 4
Total depth: 6.24 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

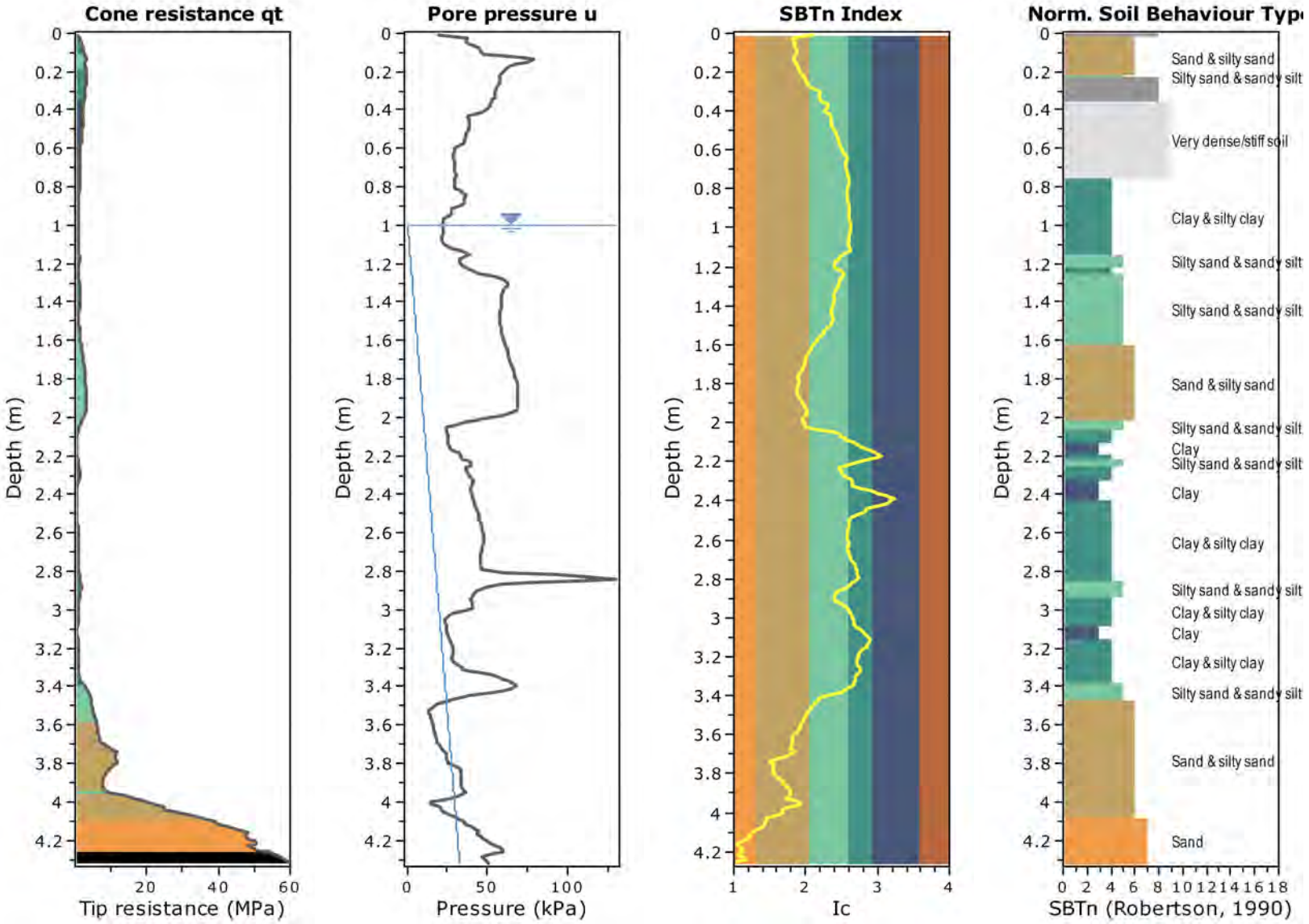
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 5
Total depth: 4.32 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

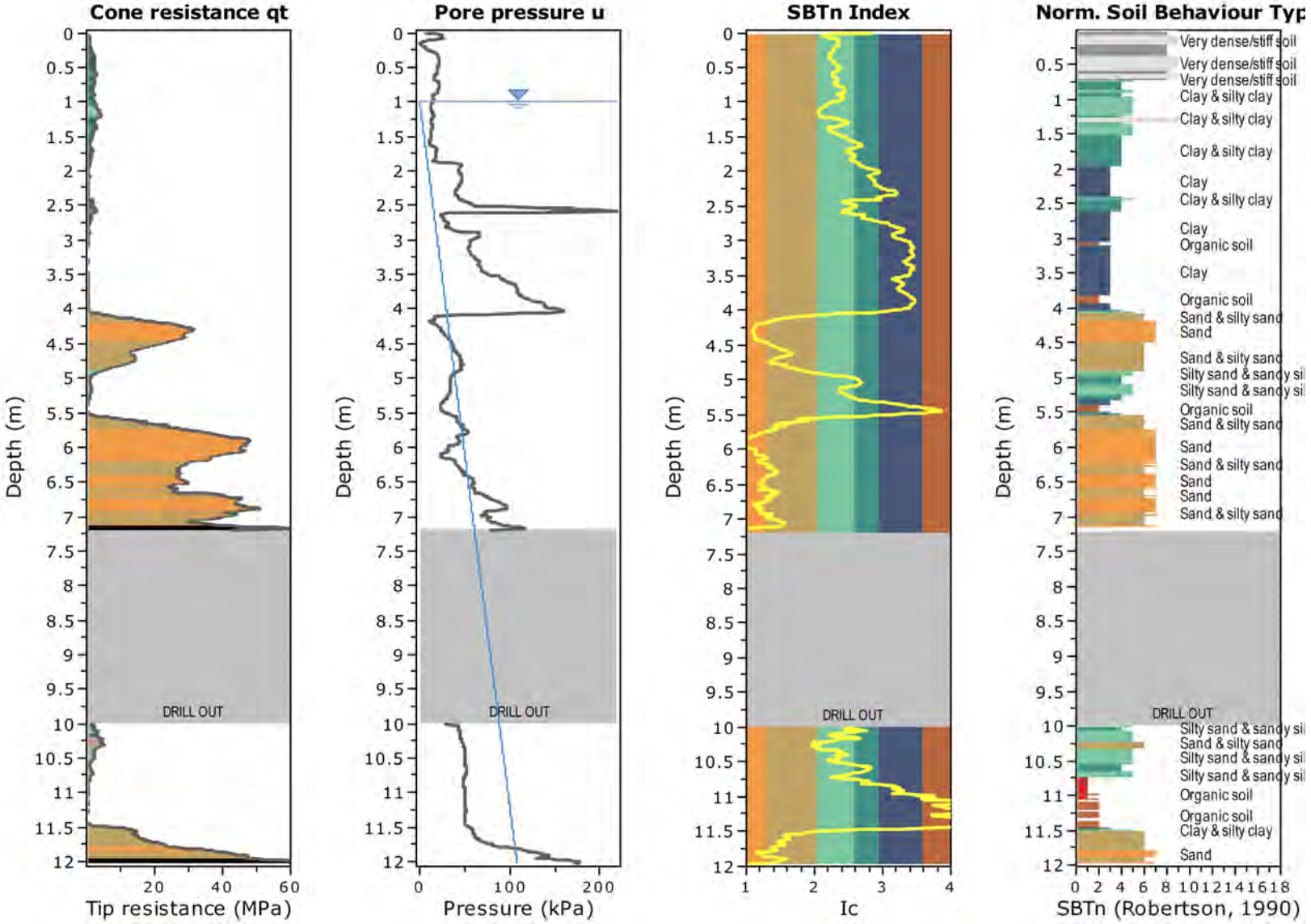
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 6
Total depth: 12.02 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

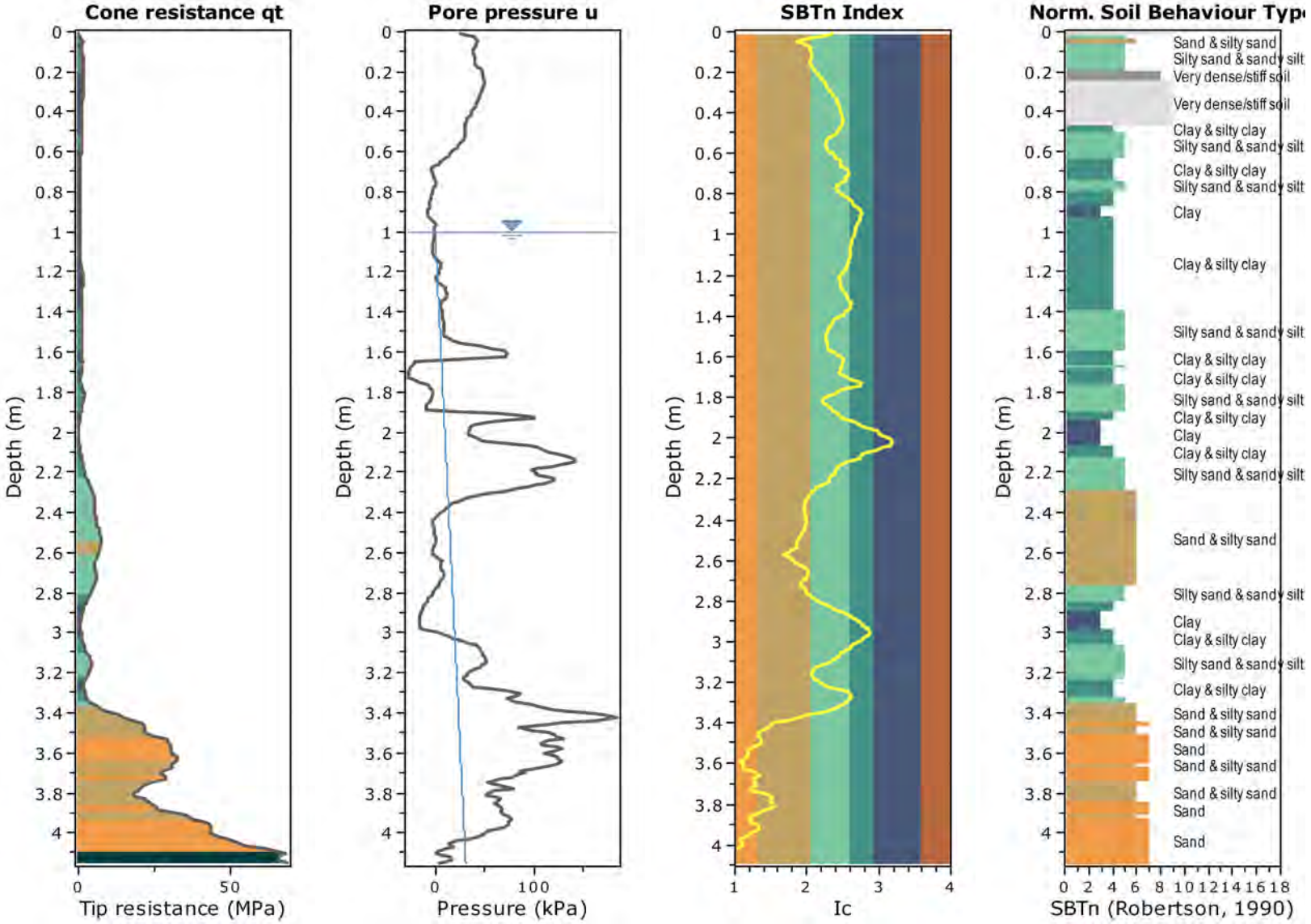
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 7
Total depth: 4.15 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

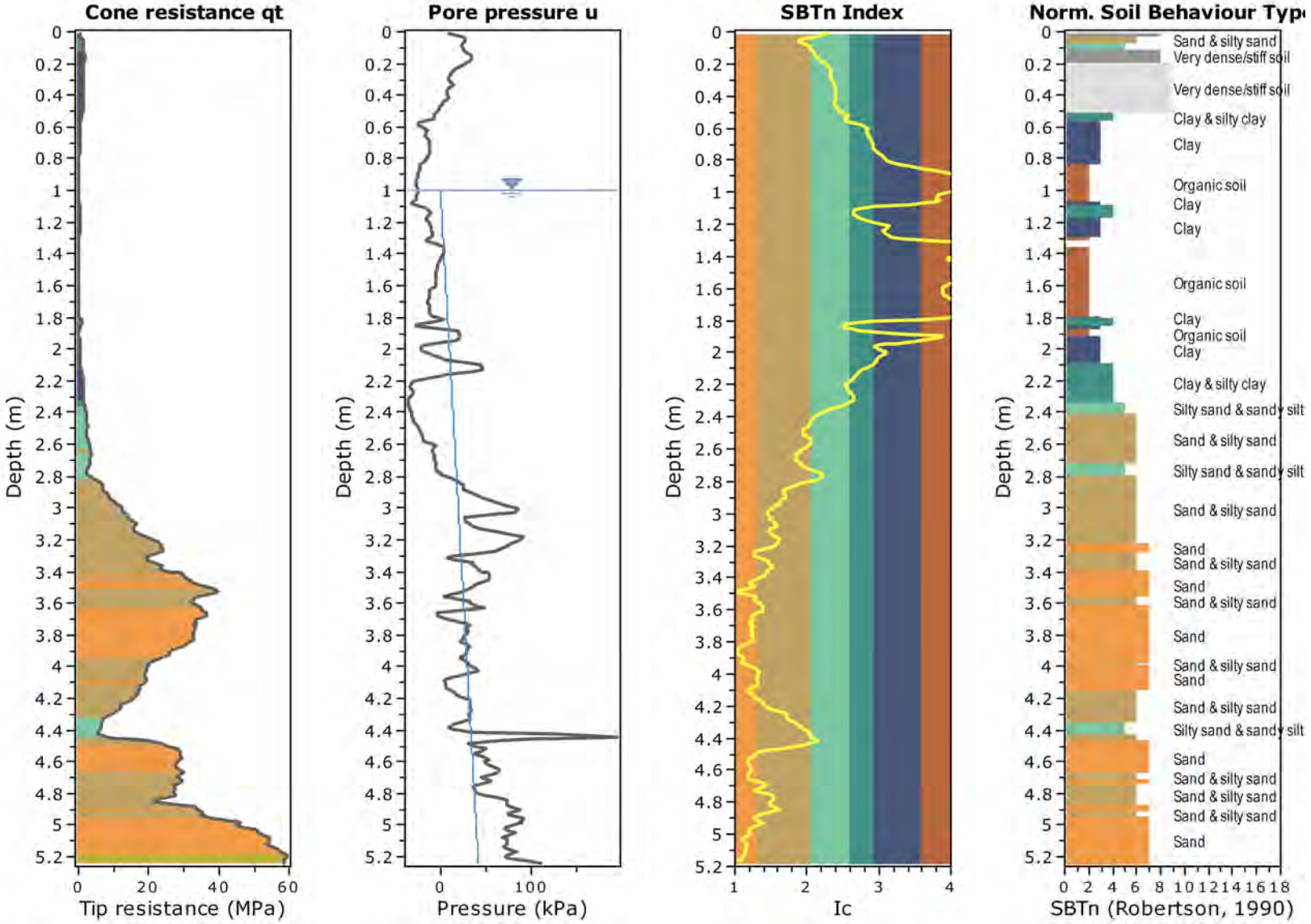
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 8
Total depth: 5.24 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

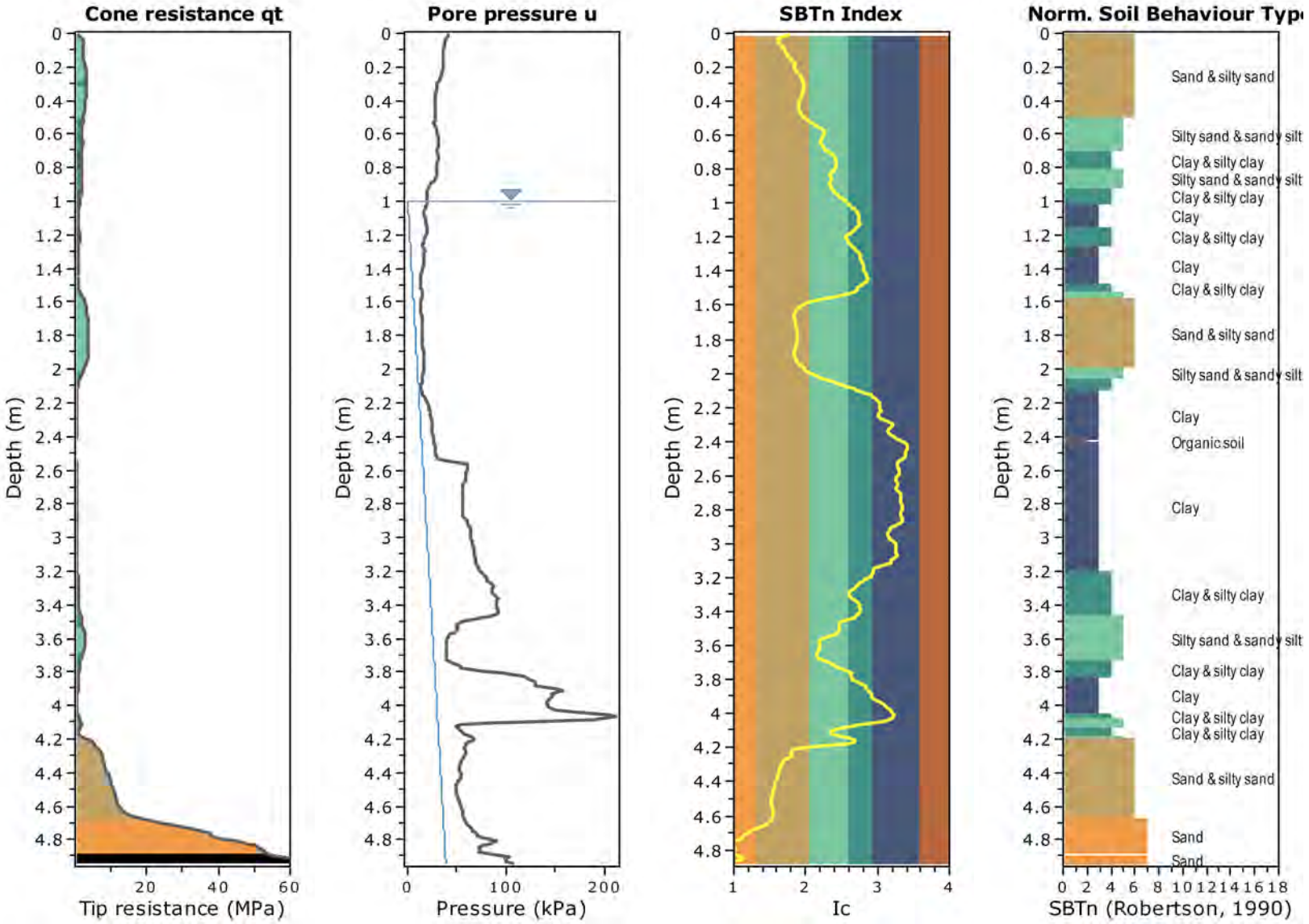
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 9
Total depth: 4.94 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

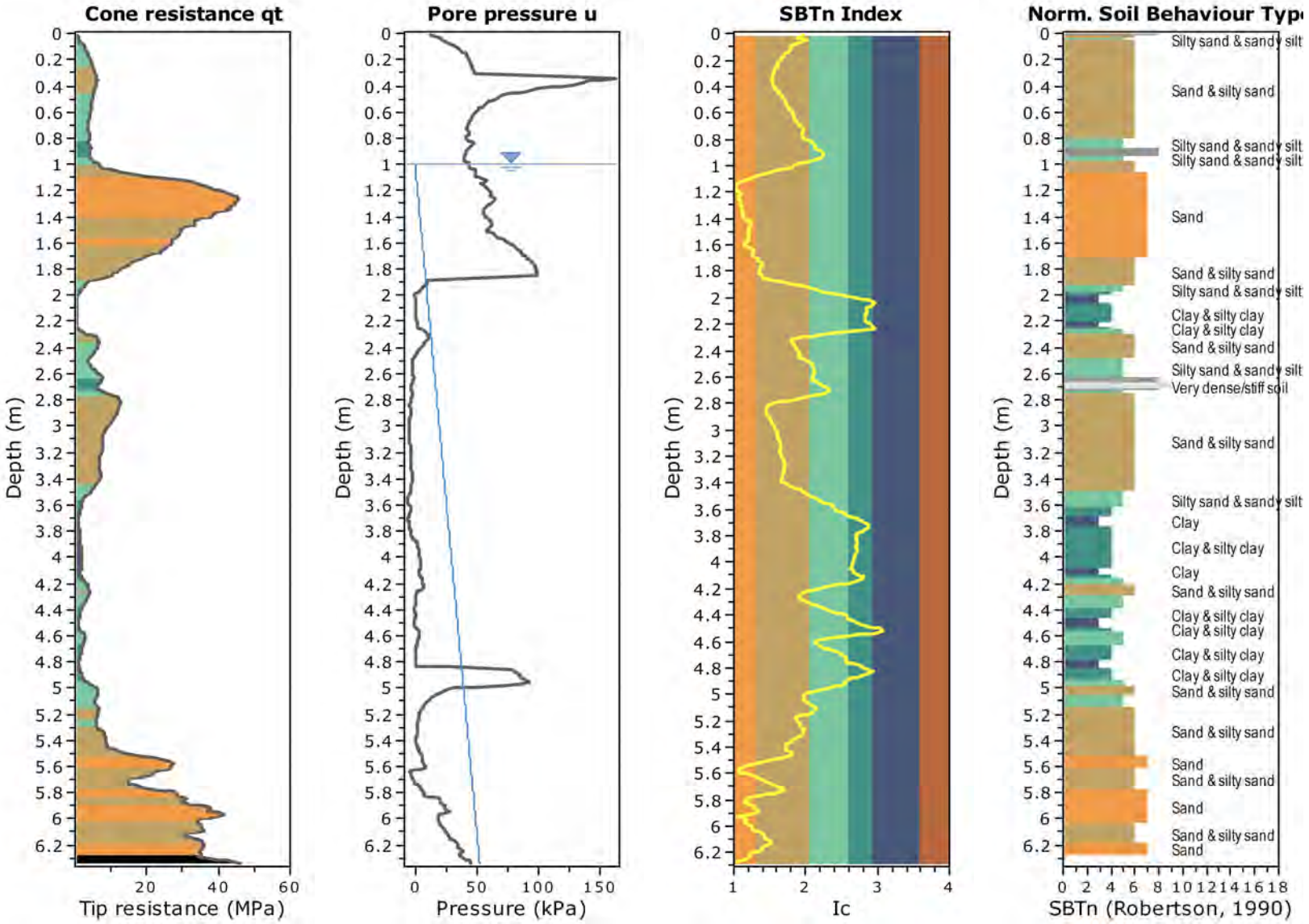
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 10
Total depth: 6.34 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

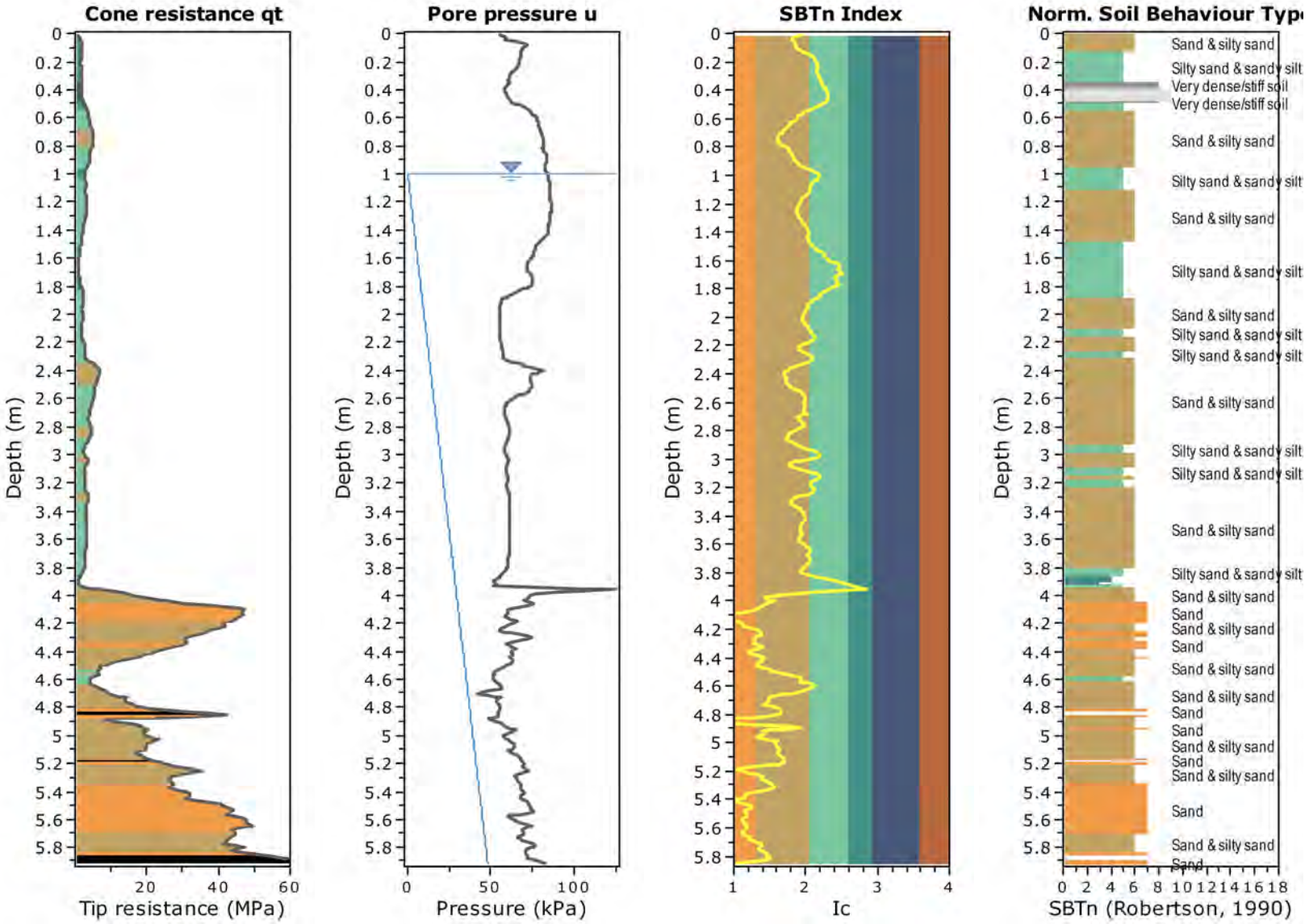
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

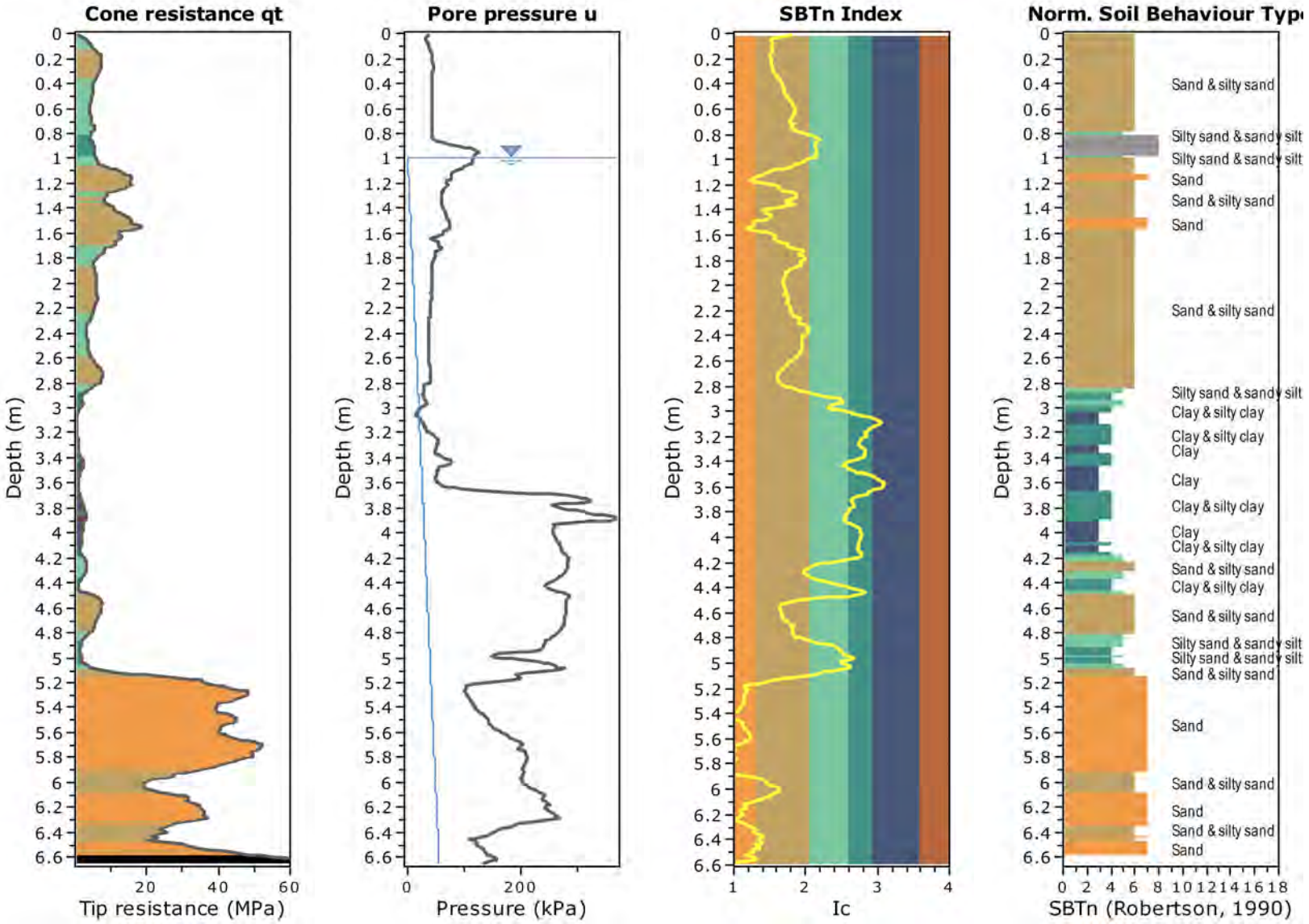
CPT: CPT 11
Total depth: 5.91 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 12
Total depth: 6.65 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

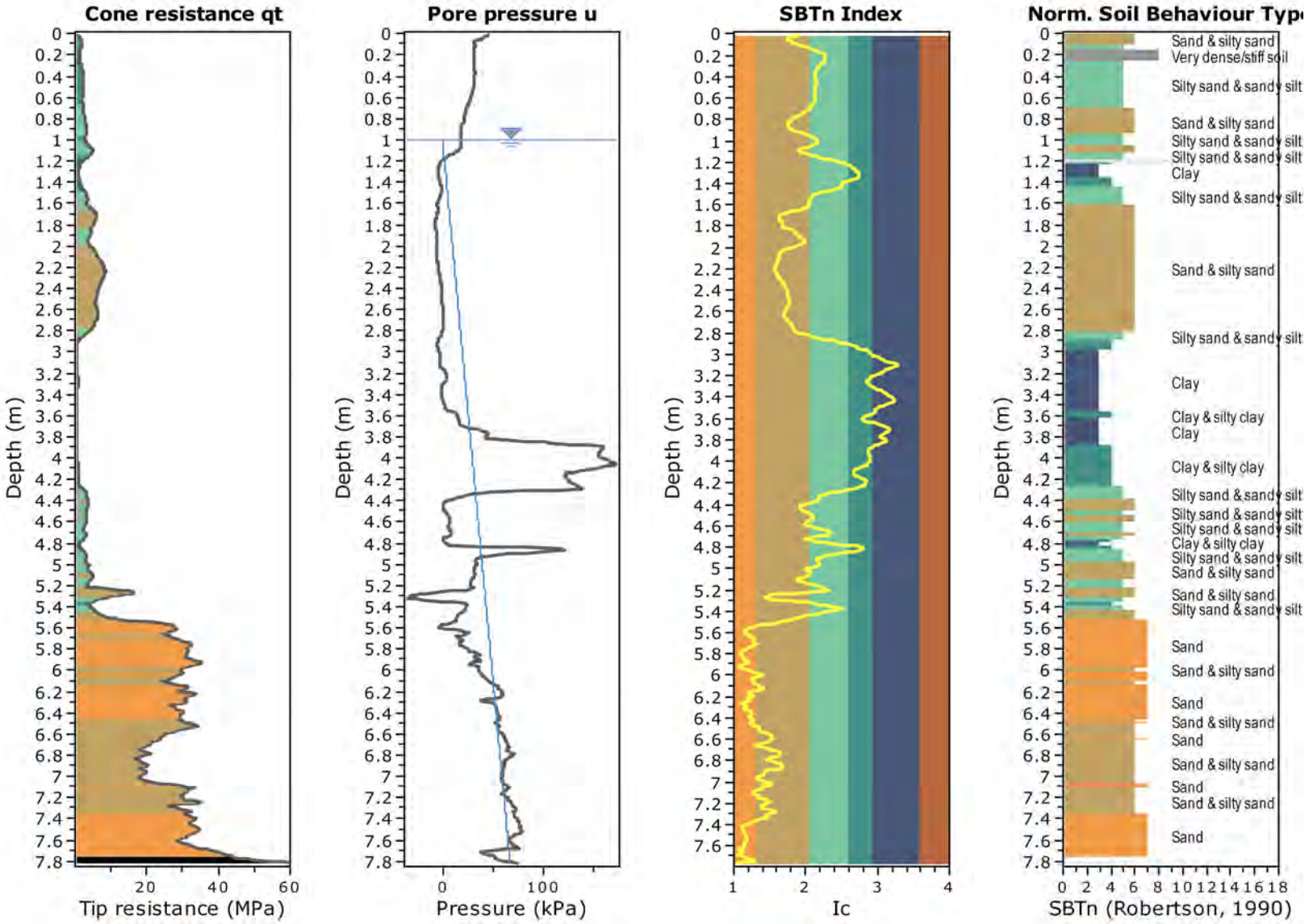
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

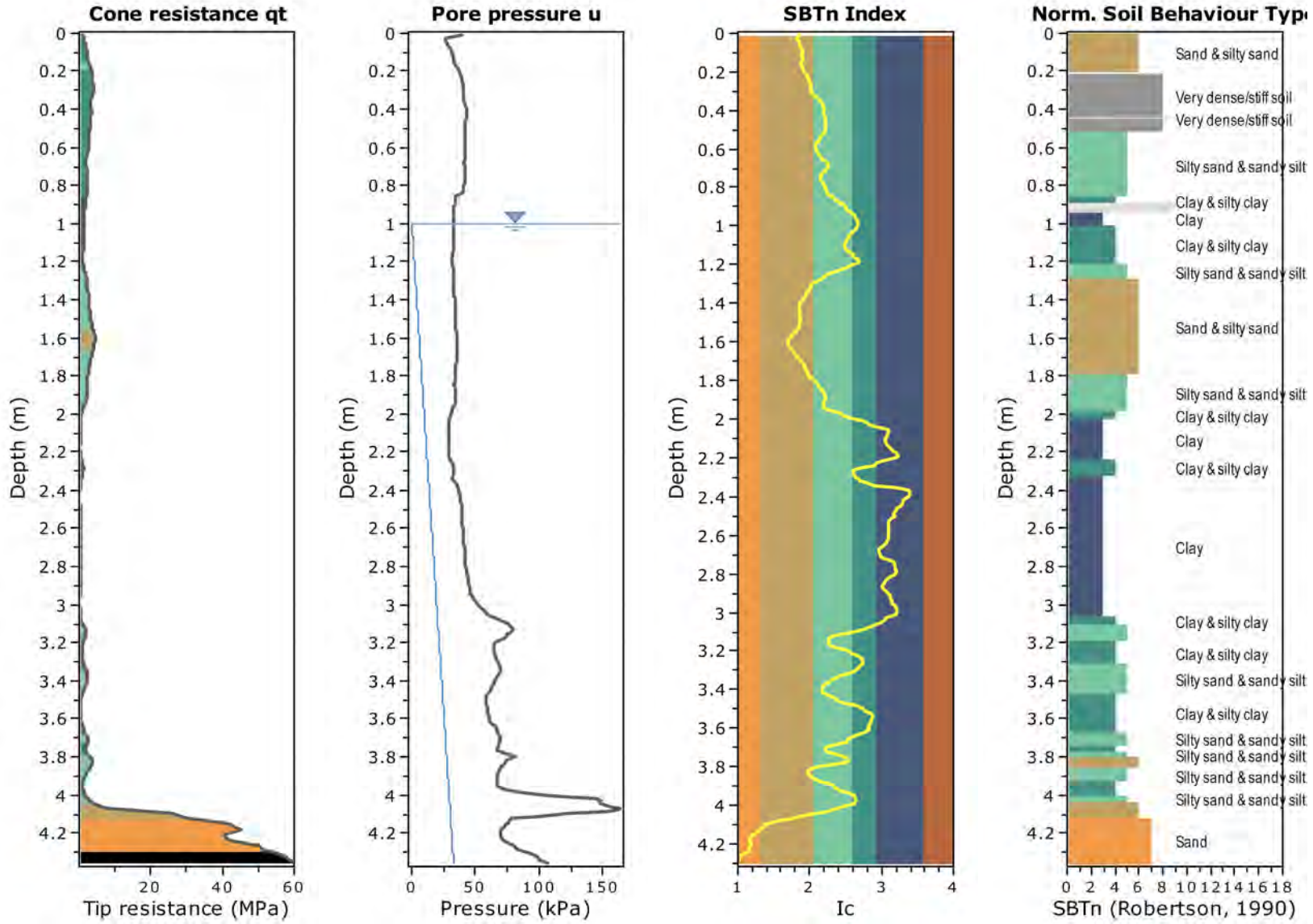
CPT: CPT 13
Total depth: 7.82 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

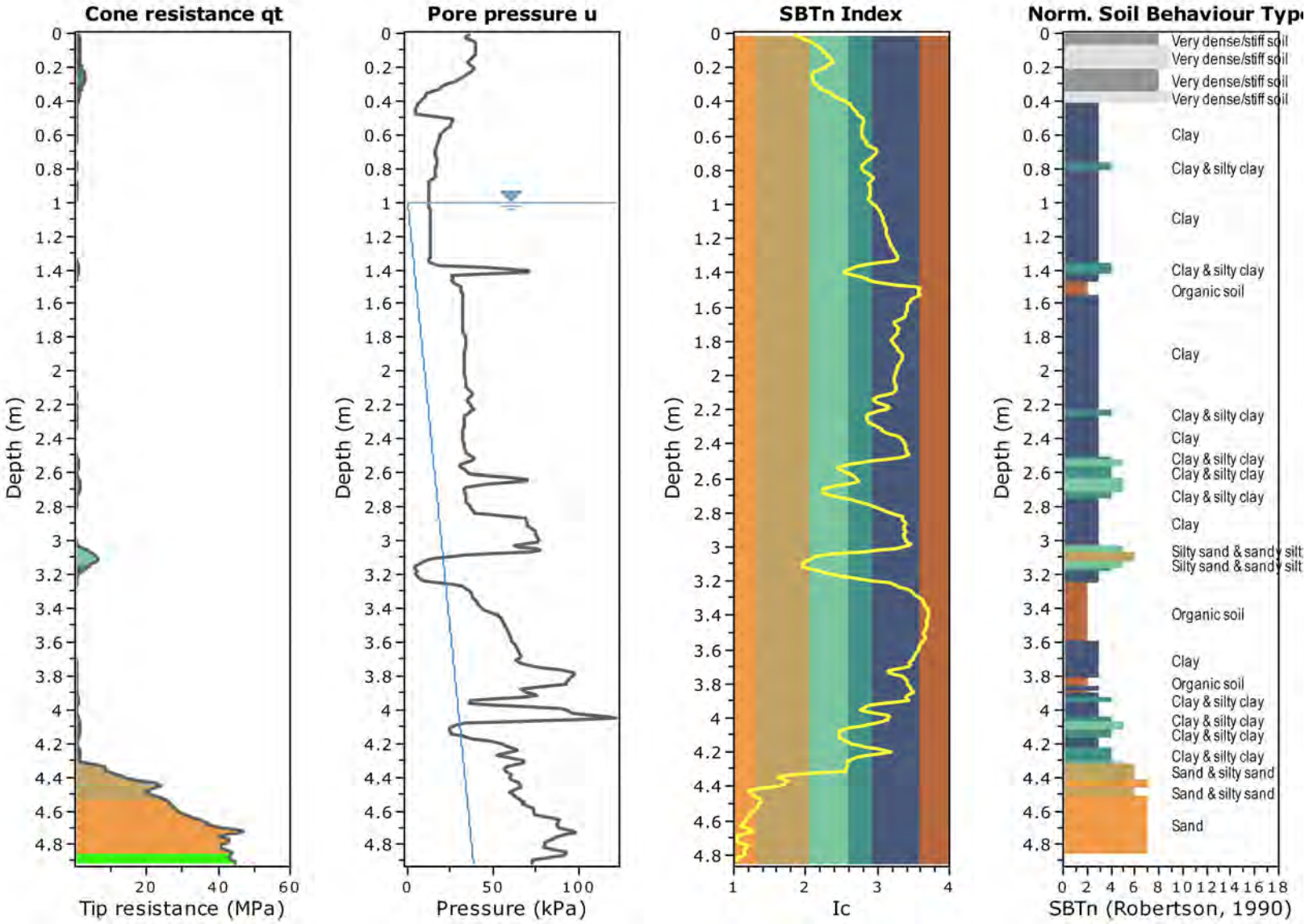
CPT: CPT 14
Total depth: 4.36 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

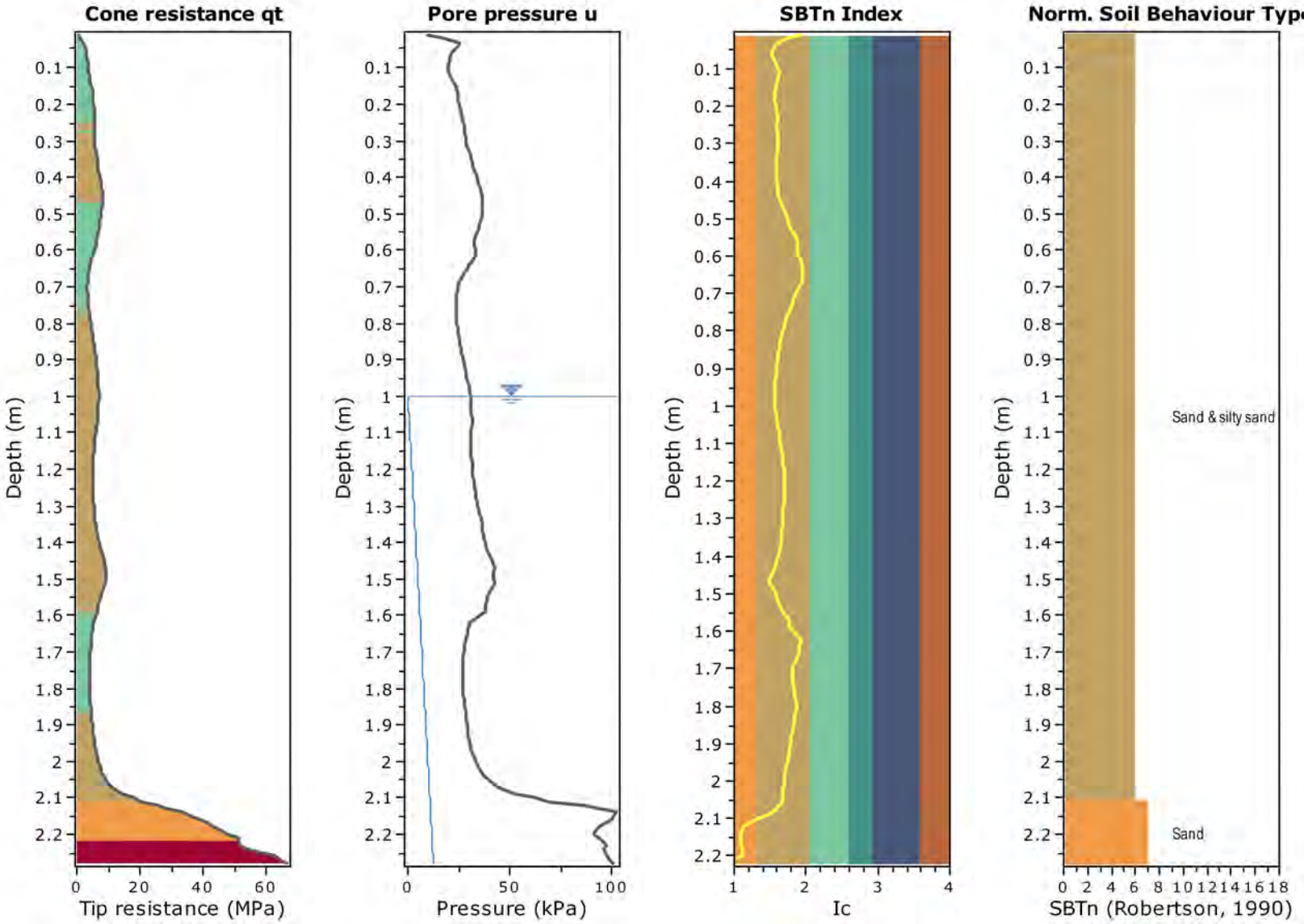
CPT: CPT 15
Total depth: 4.91 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 16
Total depth: 2.28 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

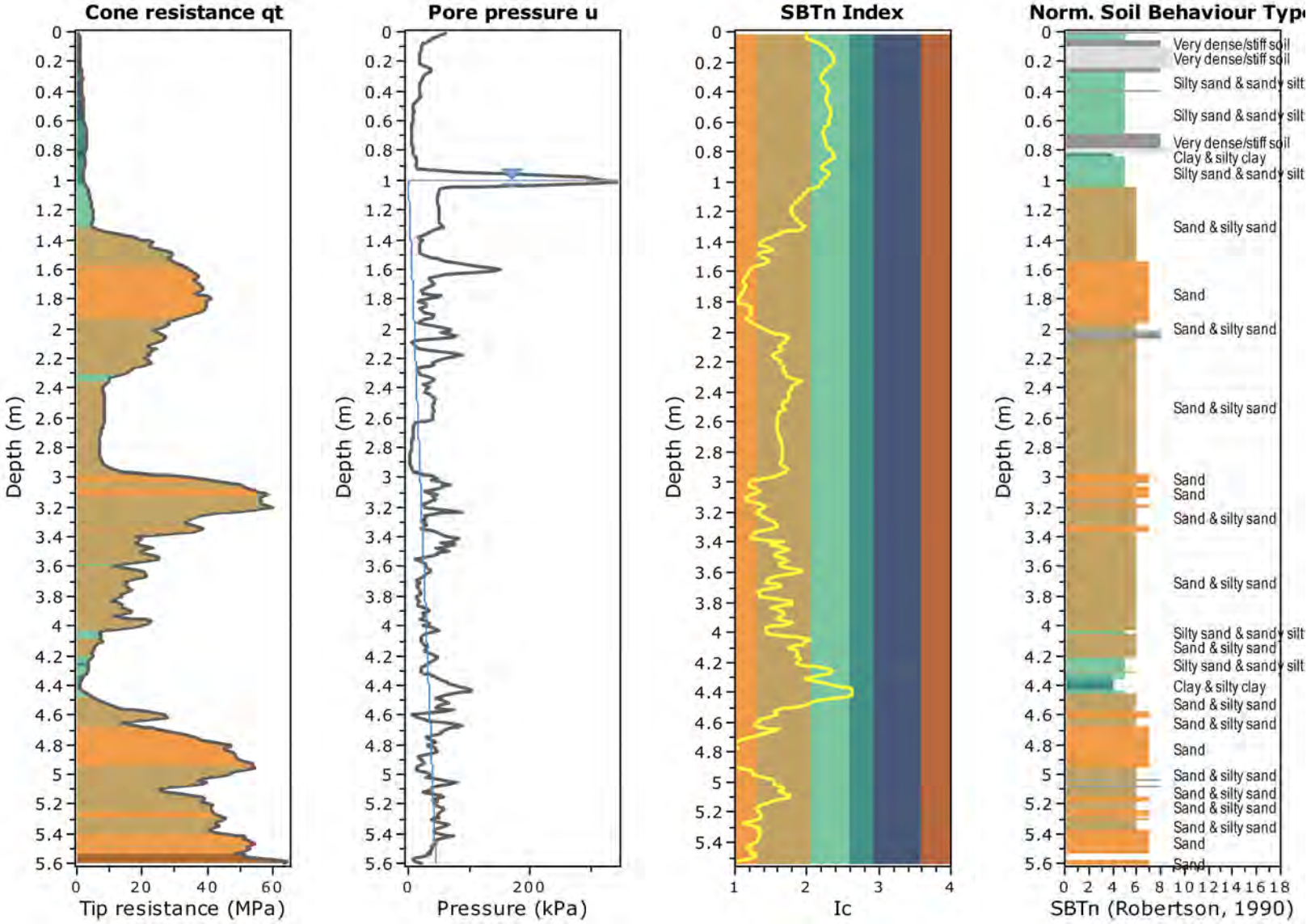
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

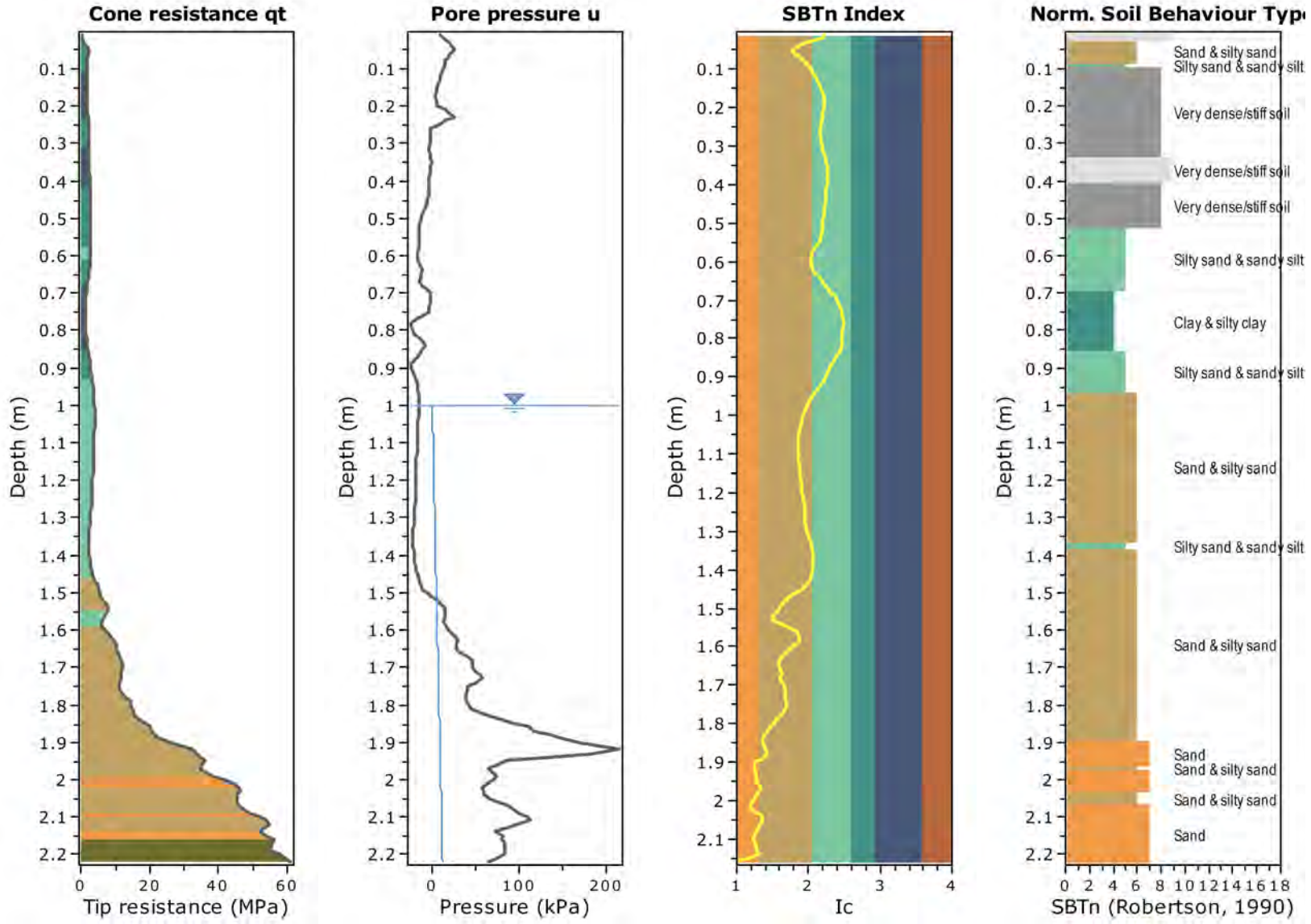
CPT: CPT 17
Total depth: 5.60 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

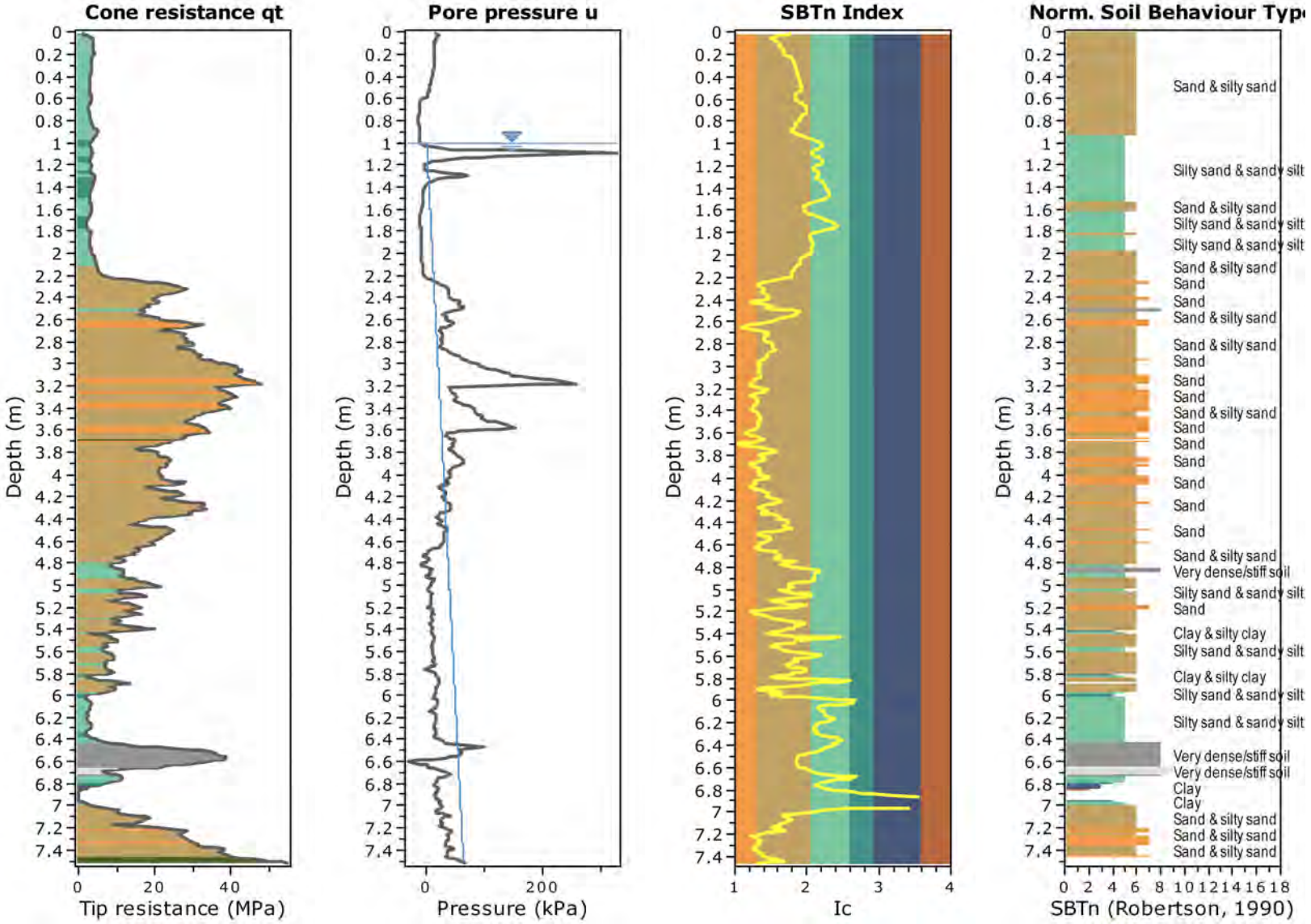
CPT: CPT 18
Total depth: 2.22 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 19
Total depth: 7.52 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

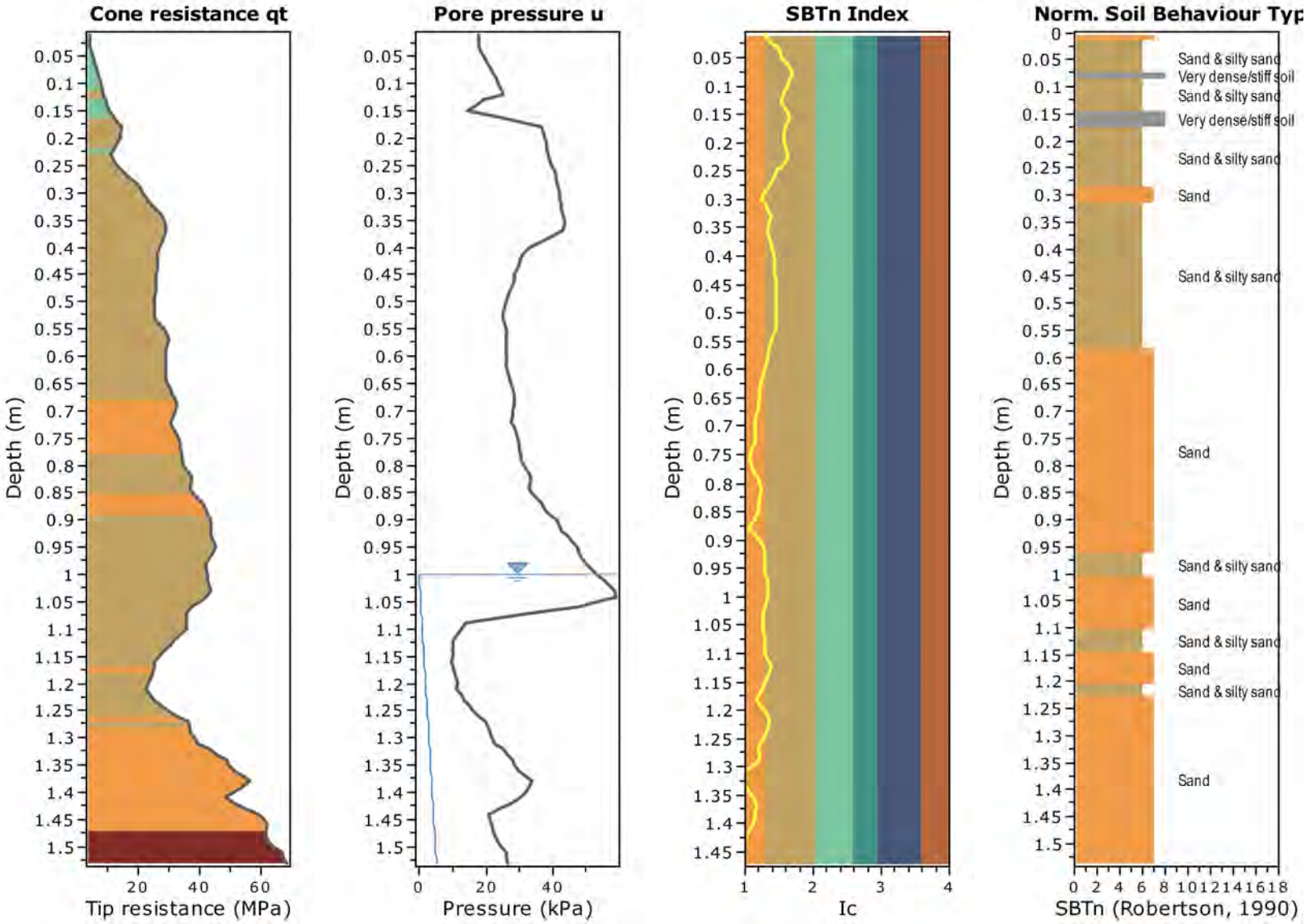
Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **Lincoln South**
Location: **1491 Springs Road, Lincoln**

CPT: CPT 20
Total depth: 1.53 m, Date: 13-Oct-20
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Appendix C - Geophysical Report

October 2020

GEOPHYSICAL REPORT

1491 Springs Road, Lincoln:

MASW Survey

Report prepared for Coffey Services (NZ) Ltd

Southern Geophysical Ltd

3/28 Tanya St, Bromley, Christchurch 8062

Ph: 03 384 4302

Web: www.southerngeophysical.com

Data collected and report prepared for Southern Geophysical Ltd by:

Christian Rüegg, MSc, Senior Geophysicist

Nick McConachie, BSc, Geophysicist

Internal review by:

Mike Finnemore, PhD, Senior Geophysicist

Table of Contents

SGL Reference: 2054

Report Version 1

Summary:

Southern Geophysical Ltd was contracted to undertake a geophysical survey using Multi-channel Analysis of Surface Waves (MASW) at a site at 1491 Springs Road, Lincoln, Christchurch. The survey was conducted on October 9, 2020, and included three MASW lines (Figure 1). The aim of the survey was to assess the shear-wave velocities of the subsurface to a depth of over 20 m. The results show shear-wave velocities (V_s) varying across the site. The depth to velocities consistent with gravels (180 m/s to 220 m/s) ranges from very near the surface to approximately 15 m depth.

Methodology:

MASW is a geophysical technique that uses the dispersive nature of surface waves to model shear-wave velocity versus depth.

A MASW survey is undertaken as a series of lines or points across the surface of the site. The MASW lines in this survey were acquired using a 24-channel towed seismic array, with 4.5 Hz geophones. The geophone spacing was 1 m and the source offset was 10 m. The seismic source was an 8 lb sledgehammer impacting an aluminium plate. Recording parameters for the MASW survey were set with a 0.125 ms sample interval, 1.5 s record length, 24 dB gains, and a geophone trigger system. Shot records were acquired at 10 m spacing along the MASW lines.

The shot records were processed using the Kansas Geological Survey software package SurfSeis6++ ©. The geometry for each shot record was set according to the survey parameters and the dispersion curves were generated and edited. The inversions were run using a 10 layer variable depth model. The velocity data was interpolated into 2D profiles showing V_s variations with depth (Figures 2 to 6). The output shear-wave velocity data is included as data files (CSV format), supplementary to this report.

Survey positions were recorded using a Geo 7X Trimble GNSS system with a Tornado antenna. The GNSS positions were differentially corrected using a local GeoNet base station. The GNSS points were output in the Mt Pleasant 2000 datum, with heights in Mean Sea Level (MSL). The accuracy of the survey positions is +/- 0.1 m. The site had minor changes in topography (heights ranging from 3.07 to 9.96 MSL), but the changes were very gradual across a large area.

Results:

Three MASW lines were acquired at the site with a total line length of 2.6 kilometres (Figure 1). The ground conditions were farm tracks and roads for MASW 1 and 2, and a roadside grass verge for MASW 3.

The MASW profiles have been plotted at a 1:2000 scaling ratio in order to show all the data in one display (Figure 2), as well as at a 1:700 scaling ratio to show more detail along each MASW line (Figures 3 to 6).

In homogenous soils, with gradually increasing shear-wave velocities and no sharp lateral discontinuities, the accuracy of the shear-wave velocities derived from the MASW processing is considered to be +/- 10%.[1] The quality of the seismic data and the dispersion curves used in this report is excellent, with a good signal-to-noise ratio. If there is a velocity inversion present in the shear-wave profile (decreasing velocity with depth), the shear-wave velocity of the reduced velocity zone and the thickness of that zone can often be underestimated by the inversion process.

Conclusions:

While the limitations of the MASW method should be considered when evaluating these results, the quality of the data collected at the site and the confidence in the shear-wave velocities derived from the MASW data is high. It is suggested that the 200 m/s shear-wave velocity contour likely correlates with a gravel surface, however the results should be correlated with intrusive ground tests to confirm the site geology.

[1] Stephenson, W.J., Louie, J.N., Pullammanappallil, S., Williams, R.A., and Odum, J.K. 2005. Blind Shear-wave Velocity Comparison of ReMi and MASW Results with Boreholes to 200 m in Santa Clara Valley: Implications for Earthquake Ground-Motion Assessment. *Bulletin of the Seismological Society of America*, Vol. 95, pp. 2506-2516.

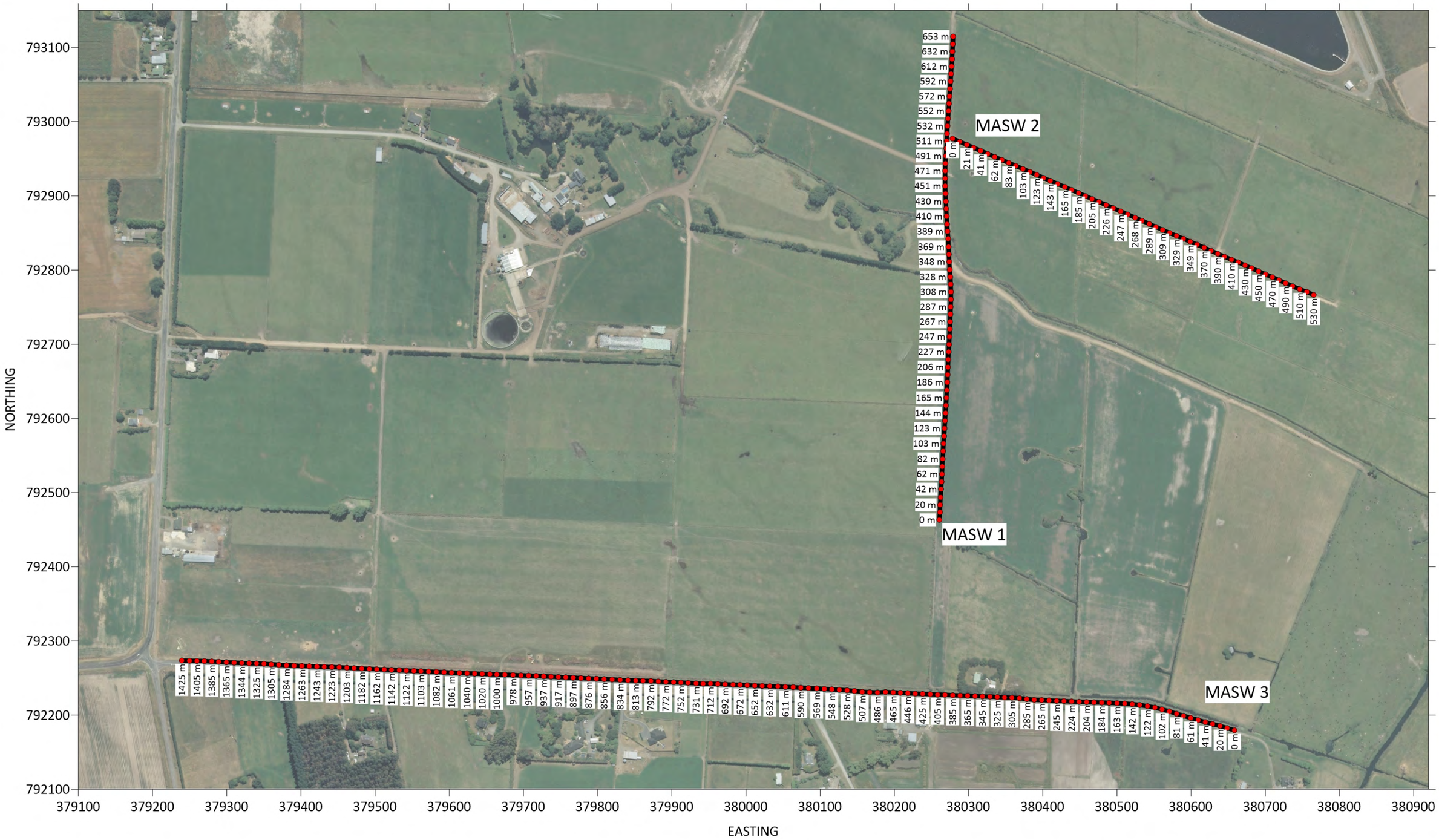
Disclaimer:

This document has been provided by Southern Geophysical Ltd subject to the following:

Non-invasive geophysical testing has limitations and is not a complete source of testing. Often there is a need to couple non-invasive methods with invasive testing methods, such as drilling, especially in cases where the non-invasive testing indicates anomalies.

This document has been prepared for the particular purpose outlined in the project proposal and no responsibility is accepted for the use of this document, in whole or in part, in other contexts or for any other purpose. Southern Geophysical Ltd did not perform a complete assessment of all possible conditions or circumstances that may exist at the site. Conditions may exist which were undetectable given the limited nature of the enquiry Southern Geophysical Ltd was retained to undertake with respect to the site. Variations in conditions often occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account. Accordingly, additional studies and actions may be required by the client.

We collected our data and based our report on information which was collected at a specific point in time. The passage of time affects the information and assessment provided by Southern Geophysical Ltd. It is understood that the services provided allowed Southern Geophysical Ltd to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes for whatever reason. Where data is supplied by the client or other sources, including where previous site investigation data have been used, it has been assumed that the information is correct. No responsibility is accepted by Southern Geophysical Ltd for incomplete or inaccurate data supplied by others. This document is provided for sole use by the client and is confidential to that client and its professional advisers. No responsibility whatsoever for the contents of this document will be accepted to any person other than the client. Any use which a third party makes of this document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Southern Geophysical Ltd accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.



DRAWING- **Figure 1: Geophysical Site Investigation**

LOCATION- **1491 Springs Road, Lincoln**

NOTES-

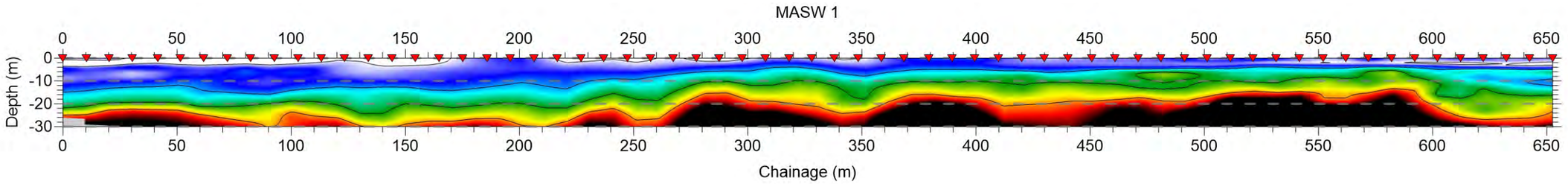
Coordinates Mount Pleasant 2000 TM Grid.
Aerial photograph sourced from LINZ, Crown Copyright ©
Every second MASW point is labelled with chainage along the line.

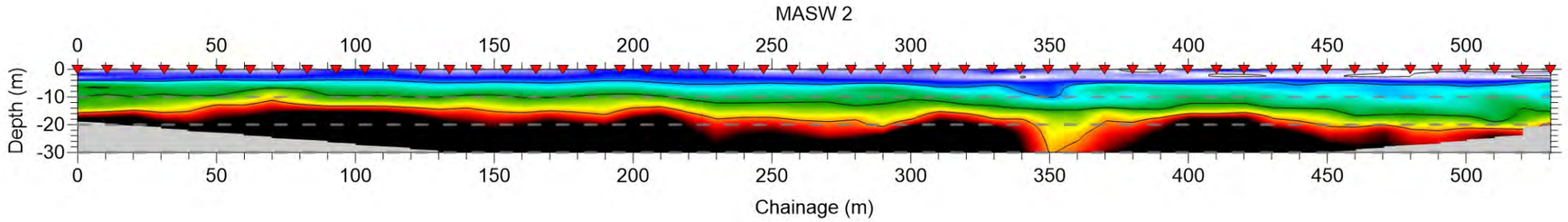
SCALE (m)
0 100 200 300 400

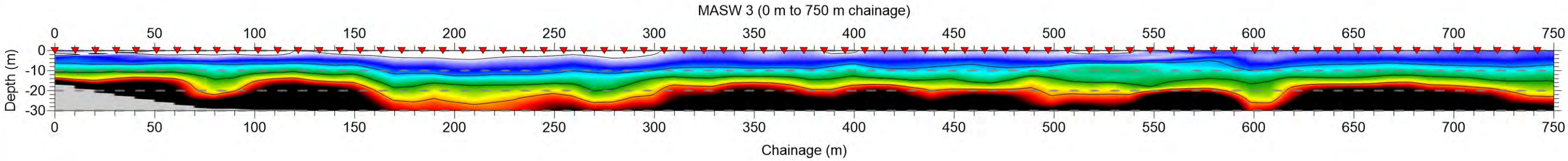
N

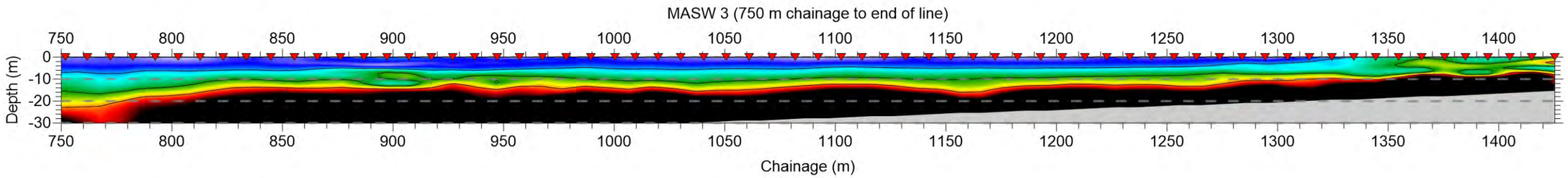
A3

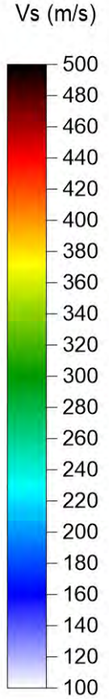
Southern Geophysical Ltd
www.southerngeophysical.com











DRAWING- **Figure 2: All MASW Profiles (1:2000 scaling ratio)**

LOCATION- **1491 Springs Road, Lincoln**

NOTES MASW Vs profiles have contour intervals of 100 m/s (Vs).

See site map for location of points.

▼ Surface position of MASW shot records (contours interpolated between data points)

No data (insufficient depth imaging with MASW)

A3

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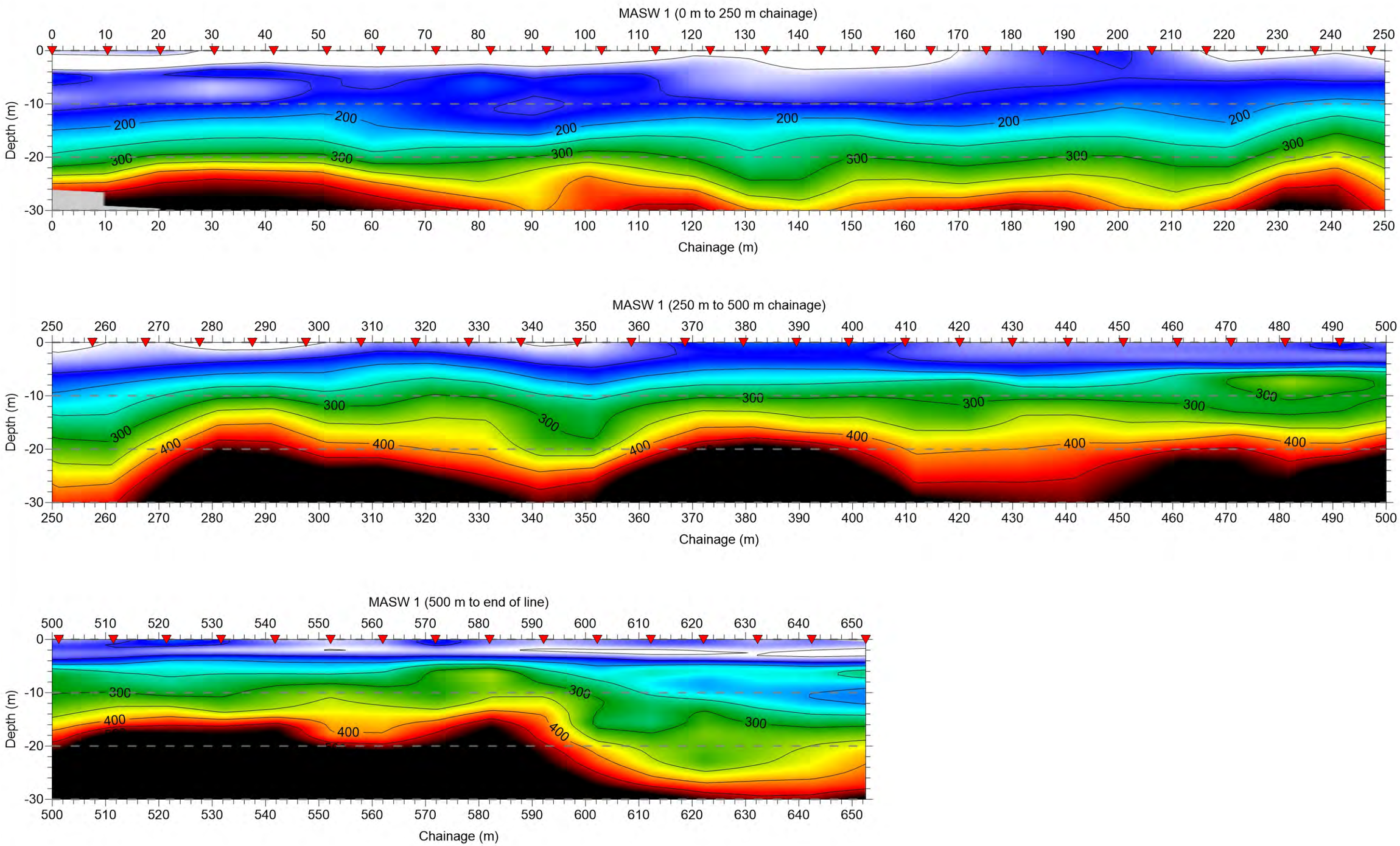

DRAWING- **Figure 3: MASW 1 (1:700 scaling ratio)**

LOCATION- **1491 Springs Road, Lincoln**

NOTES MASW Vs profiles have contour intervals of 50 m/s (Vs).

See site map for location of points.

Surface position of MASW shot records (contours interpolated between data points)

No data (insufficient depth imaging with MASW)

A3

Southern Geophysical Ltd

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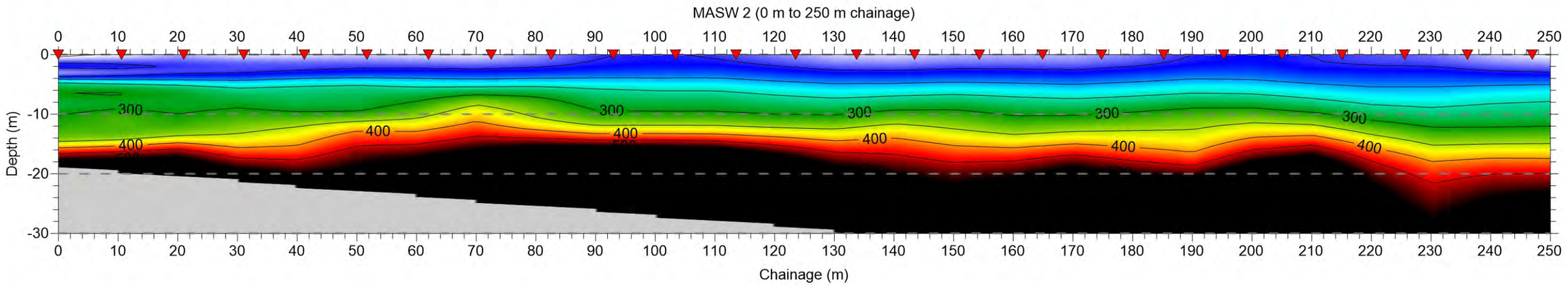

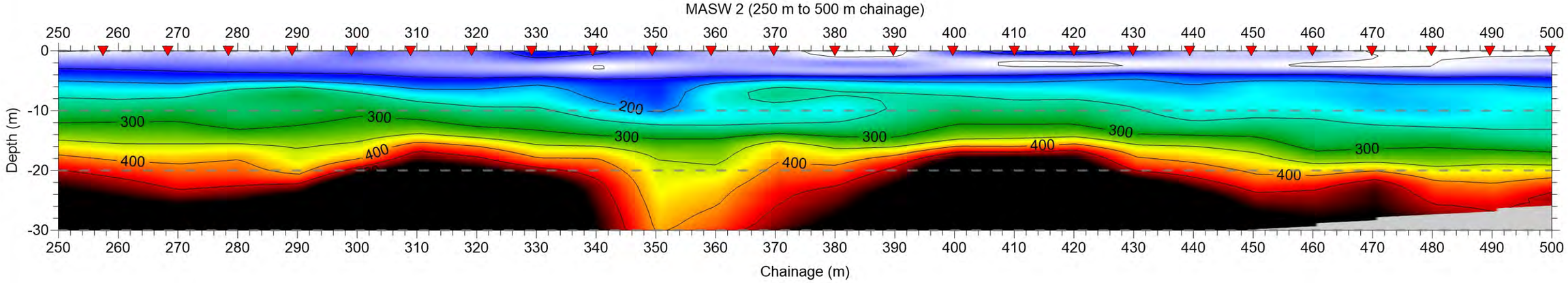

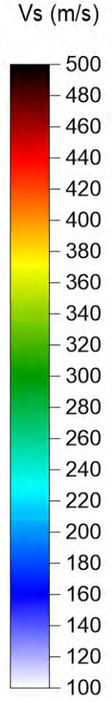

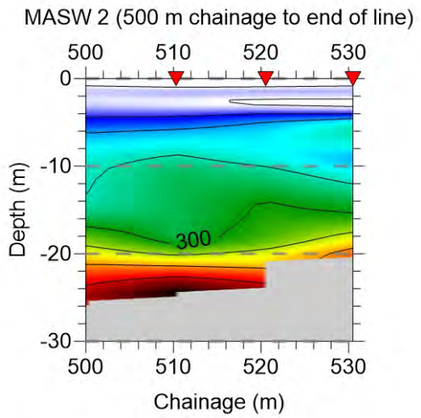

DRAWING- **Figure 4: MASW 2 (1:700 scaling ratio)**

LOCATION- **1491 Springs Road, Lincoln**

NOTES MASW Vs profiles have contour intervals of 50 m/s (Vs).

See site map for location of points.

Surface position of MASW shot records (contours interpolated between data points)

No data (insufficient depth imaging with MASW)

A3

Southern Geophysical Ltd

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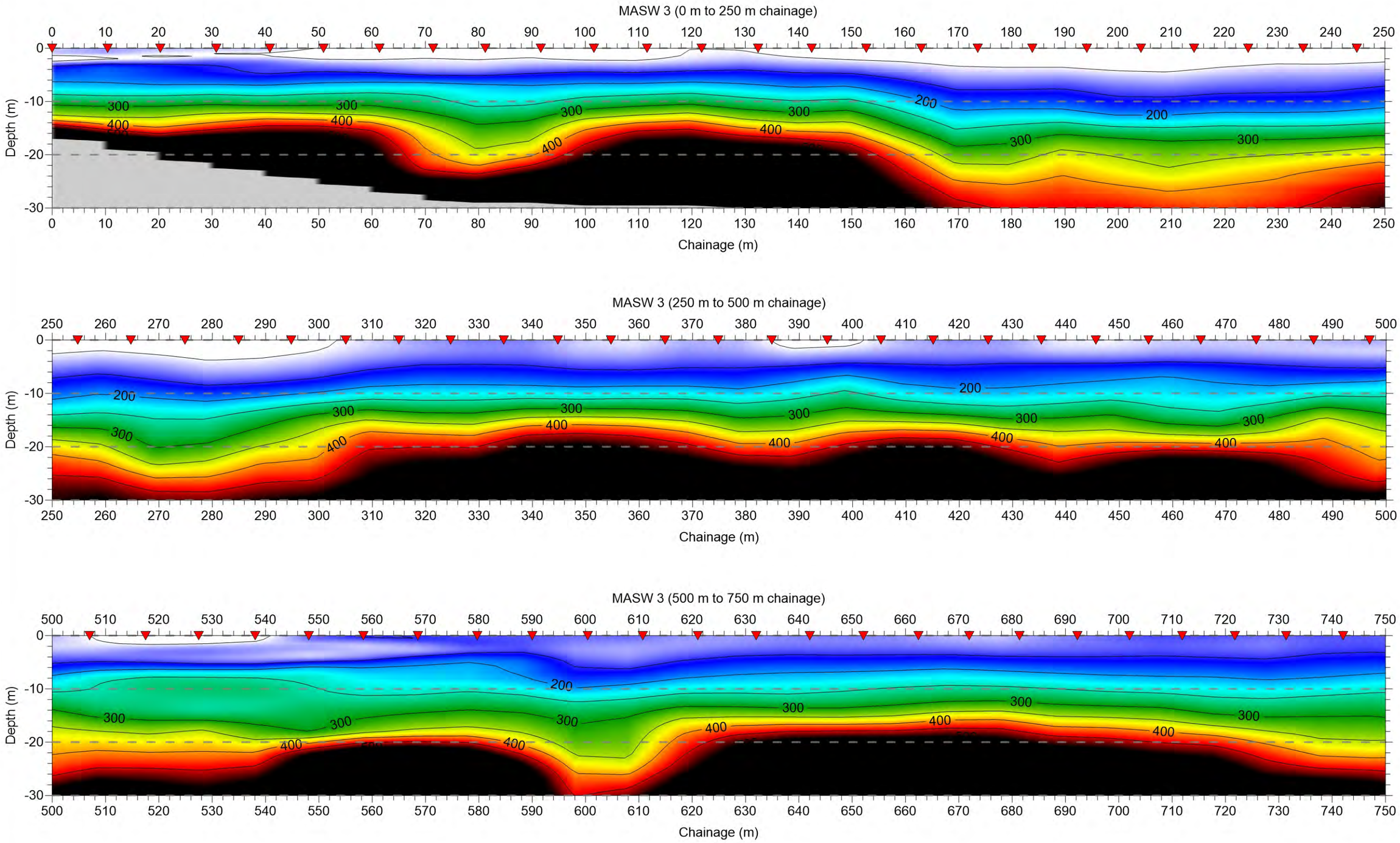
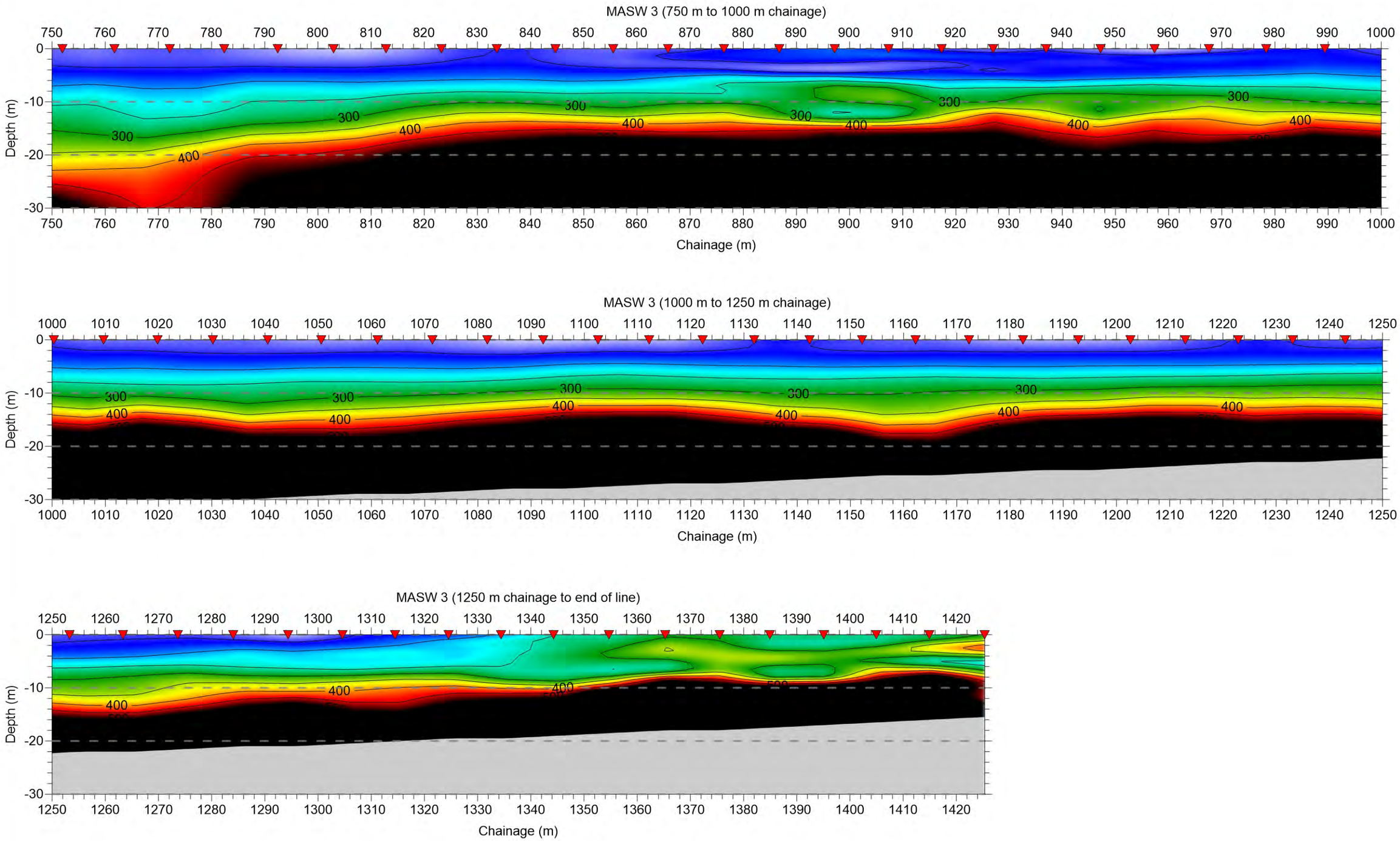


DRAWING- **Figure 5: MASW 3 (1:700 scaling ratio)**	NOTES MASW Vs profiles have contour intervals of 50 m/s (Vs).	▼ Surface position of MASW shot records (contours interpolated between data points)	**Southern Geophysical Ltd**
LOCATION- **1491 Springs Road, Lincoln**	See site map for location of points.	No data (insufficient depth imaging with MASW)	www.southerngeophysical.com
		A3	



DRAWING- **Figure 6: MASW 3 (1:700 scaling ratio)**

LOCATION- **1491 Springs Road, Lincoln**

NOTES MASW Vs profiles have contour intervals of 50 m/s (Vs).

See site map for location of points.

Surface position of MASW shot records (contours interpolated between data points)

No data (insufficient depth imaging with MASW)

A3

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Appendix D - Test pit logs

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Engineering Log - Excavation

Excavation ID.	***TP01***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered			0.0		ML	**Sandy SILT**: low plasticity, brown, with some gravel.	D			**TOPSOIL**
								ML	**Sandy SILT**: low plasticity, brown-grey, with some gravel and trace of wood.				**FILL**
						0.5		GW	**Sandy GRAVEL**: fine to coarse grained, well graded, sub-rounded, brown-grey.				**SPRINGSTON FORMATION**
						1.0			Test pit TP01 terminated at 0.85 m Target depth				
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP02A***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered			0.0		ML	**Sandy SILT**: low plasticity, brown, with minor gravel.	D			**TOPSOIL / FILL**
						0.5		ML	**Sandy SILT**: low plasticity, brown.				**SPRINGSTON FORMATION**
								ML	**SILTY SAND**: fine grained, low plasticity, pale brown.				
								GW	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, yellow-brown.				
						1.0			Test pit TP02A terminated at 0.95 m Target depth				
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP02B***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered			0.5		ML	**Sandy SILT**: brown, with minor gravel.	D			**TOPSOIL / FILL**
								GW	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded to sub-angular, brown-grey.				**SPRINGSTON FORMATION**
						1.0			Test pit TP02B terminated at 0.8 m Target depth				
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP02C***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
								ML	**Sandy SILT**: low plasticity, brown, with minor gravel.	D			**TOPSOIL**
						0.5		ML	**Sandy SILT**: low plasticity, brown, with some gravel, trace of wood fragments and organics.	M			**FILL**
			Not Encountered			1.5		ML	**Clayey SILT**: medium plasticity, blue-grey, trace of wood fragments and minor organics.				
						2.0							
						2.5							
						3.0							
						3.5		GW-GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, pale brown.	D			**SPRINGSTON FORMATION**
									Test pit TP02C terminated at 3.5 m Target depth				

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP03***		
sheet:	1 of 2		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
								ML	**Sandy SILT**: low plasticity, brown.	D			**TOPSOIL**
			Not Encountered			0.5		ML	**Clayey SILT**: medium plasticity, pale blue-grey, with trace of wood fragments, organics, and gravel.	M			**FILL**
						1.0							
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP03***		
sheet:	2 of 2		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered					ML	**Clayey SILT**: medium plasticity, pale blue-grey, with trace of wood fragments, organics, and gravel. *(continued)*	M			**FILL**
								GW-GM	**Sandy GRAVEL**: fine - medium grained, well graded, sub-rounded, pale brown.	D			**SPRINGSTON FORMATION**
						4.5			Test pit TP03 terminated at 4.4 m Target depth				
						5.0							
						5.5							
						6.0							
						6.5							
						7.0							
						7.5							

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shearpeak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
W_P plastic limit
W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP04A***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
						0.0		ML	**Sandy SILT**: low plasticity, pale brown.	D			**TOPSOIL**
						0.5		ML	**Clayey SILT**: low plasticity, grey-pale brown, with some gravel and wood fragments.	M			**FILL**
			Not Encountered			1.0							
						1.5							
						2.0		SM	**Sandy SILT**: low plasticity, pale brown, with some wood fragments.	D			
						2.5							
						3.0							
						3.5			**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, brown.				**SPRINGSTON FORMATION**

Test pit TP04A terminated at 3.85 m
Target depth

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

client:	***Rolleston Industrial Developments Limited***	Excavation ID.	***TP04B***
principal:	***-***	sheet:	1 of 1
project:	***1491 Springs Road***	project no.	***773-CHCGE280252***
location:	***Lincoln***	date excavated:	***14 Jan 2021***
		date completed:	***14 Jan 2021***
		logged by:	***C. Thompson***
		checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered					ML	**SILTY SAND**: low plasticity, brown.	D			**TOPSOIL**
								GM	**Sandy SILT**: pale brown-grey.				**SPRINGSTON FORMATION**
									Test pit TP04B terminated at 0.2 m Target depth				
						0.5							
						1.0							
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey
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Engineering Log - Excavation

Excavation ID.	***TP05***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
						0.0		ML	**SILTY SAND**: low plasticity, pale brown.	D			**TOPSOIL**
						0.5		SP	**Sandy SILT**: low plasticity, pale brown, with minor gravel.				**FILL**
			Not Encountered			1.0		ML	**SILT**: low plasticity, brown, with minor gravel, contains remnants of building material and organic fragments.	M			
						1.5							
						2.0							
						2.5							
						3.0		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, low plasticity, blue-grey.	M			**SPRINGSTON FORMATION**
									Test pit TP05 terminated at 3.0 m Target depth				
						3.5							

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF EXCAVATION CHCGE280252 GINT LOGS.GPJ <<DrawingFile>> 28/01/2021 08:39

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey
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Engineering Log - Excavation

Excavation ID.	***TP06***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information							material substance						
method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	structure and additional observations
			Not Encountered					ML	**Sandy SILT**: low plasticity, brown.	D			**TOPSOIL**
						0.5		ML	**SILT**: low plasticity, blue-grey, with minor gravel, contains remnants of building material and organic fragments.	W			**FILL**
						1.0							
						1.5							
						2.0							
						2.5							
						3.0		GM	**Sandy GRAVEL**: fine - coarse grained, sub-rounded, brown.				**SPRINGSTON FORMATION**
									Test pit TP06 terminated at 3.1 m Target depth				
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey
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Engineering Log - Excavation

Excavation ID.	***TP07***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
						0.0		ML	**SILTY SAND**: low plasticity, pale brown.	D			**TOPSOIL**
								ML	**SILT**: low plasticity, grey, with minor gravel, traces of wood and organic fragments.	M			**FILL**
			Not Encountered			0.5							
						1.0							
						1.5							
						2.0							
						2.5							
						3.0		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, blue-grey.				**SPRINGSTON FORMATION**
									Test pit TP07 terminated at 3.0 m Target depth				
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP08A***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered					ML	**Sandy SILT**: low plasticity, pale brown.	D			**TOPSOIL**
								ML	**SILT**: low plasticity, pale brown.				**SPRINGSTON FORMATION**
						0.5		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, low plasticity, brown.	D			
									Test pit TP08A terminated at 0.45 m Target depth				
						1.0							
						1.5							
						2.0							
						2.5							
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP08B***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered			0.0		ML	**SILTY SAND**: low plasticity, pale brown.	D			**TOPSOIL**
								ML	**SILT**: low plasticity, pale brown.				**SPRINGSTON FORMATION**
						0.5		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, brown.				
						1.0							
						1.5			Test pit TP08B terminated at 1.4 m Target depth				
						2.0							
						2.5							
						3.0							
						3.5							

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP08C***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	structure and additional observations
								ML	**SILTY SAND**: low plasticity, pale brown.	D			**TOPSOIL**
			Not Encountered			0.5		ML	**SILT**: low plasticity, brown-grey, with traces of gravel, wood and organic fragments.	M			**FILL**
						1.0							
						1.5							
						2.0							
						2.5		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, yellow-brown.	M			**SPRINGSTON FORMATION**
									Test pit TP08C terminated at 2.6 m Target depth				
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP09A***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
			Not Encountered			0.0		ML	**SILTY SAND**: low plasticity, pale brown.	D			**TOPSOIL**
						0.5		ML	**SILT**: low plasticity, blue-grey, with some gravel, traces of organic and fibres.	M			**FILL**
						1.0							
						1.5							
						2.0		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, yellow-brown.				**SPRINGSTON FORMATION**
						2.5			Test pit TP09A terminated at 2.4 m Target depth				
						3.0							
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

client:	***Rolleston Industrial Developments Limited***	Excavation ID.	***TP09B***
principal:	***-***	sheet:	1 of 1
project:	***1491 Springs Road***	project no.	***773-CHCGE280252***
location:	***Lincoln***	date excavated:	***14 Jan 2021***
		date completed:	***14 Jan 2021***
		logged by:	***C. Thompson***
		checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:
equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
						0.0		ML	**Sandy SILT**: low plasticity, brown.	D			**TOPSOIL**
			Not Encountered			0.5		ML	**SILT**: low plasticity, yellow-brown, with some gravel and traces of organic fragments.	M			**FILL**
						2.0		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, yellow-brown.				**SPRINGSTON FORMATION**
						2.2			Test pit TP09B terminated at 2.2 m Target depth				
						2.5							
						3.0							
						3.5							

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method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper
E excavator

support
N none
S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shearpeak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
W_P plastic limit
W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Excavation

Excavation ID.	***TP10***		
sheet:	1 of 1		
project no.	***773-CHCGE280252***		
client:	***Rolleston Industrial Developments Limited***	date excavated:	***14 Jan 2021***
principal:	***-***	date completed:	***14 Jan 2021***
project:	***1491 Springs Road***	logged by:	***C. Thompson***
location:	***Lincoln***	checked by:	***B.Chau***

position: Not Specified | surface elevation: Not Specified | pit orientation:

equipment type: Hitachi 16t Track | excavation method: Swamp Bucket | excavation dimensions: 3.0 m long 1.2 m wide

excavation information | **material substance**

method	support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
						0		ML	**SILTY SAND**: low plasticity, brown.	D			**TOPSOIL / FILL**
						0.5		ML	**SILT**: low plasticity, brown, with some gravel.	M			**FILL**
			Not Encountered			1.0		ML	**SILT**: low plasticity, brown, with minor gravel, contains remnants of building material and organic fragments.	W			
						1.5							
						2.0							
						2.5		GM	**Sandy GRAVEL**: fine - coarse grained, well graded, sub-rounded, blue-grey.	M			**SPRINGSTON FORMATION**
						3.0			Test pit TP10 terminated at 2.75 m Target depth				
						3.5							

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method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- N none
- S shoring

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
- U## undisturbed sample ##mm diameter
- D disturbed sample
- B bulk disturbed sample
- E environmental sample
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shearpeak/remouded (uncorrected kPa)
- R refusal

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- W_P plastic limit
- W_L liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Appendix E - Additional test data

DAVIS OGILVIE
Davis Ogilvie & Partners Limited
Level 1, 24 Moorhouse Avenue,Addington, Christchurch 8140
Office 0800 999 333 Email hello@do.nz
www.do.nz

DEEP INVESTIGATION RESULTS

Job Nº / **37441**
Test Nº / **BH 04**

PROJECT: 1484 - 1506 Springs Road, Lincoln (Various lots and DPs)
CLIENT: Lincoln Developments Limited
LOCATION: Refer to attached Geotechnical Site Plan (G02a).

Date: 05/07/18
Time: 9:00 AM
Excavation Method: Geoprobe 8140LC - track

COORDINATES: East 2466609 North 5727964
GRID: NZTM
RL GROUND:
DATUM: Ground
INCLINATION: Vertical
ORIENTATION:
HOLE DEPTH: 15.2m

Ground Water	USCS	Description	Weathering (SW, MW, HW, CW)	Graphic Log	Depth (m)	TCR (%)	SPT N-value (Uncorrected)	Sample	Backfill & Installation
	TS	Fine sandy SILT; dark brown. Moist, non-plastic contains rootlets (TOPSOIL)			0.00				Sand
	ML	Fine sandy SILT; greyish brown. Non-plastic.			0.50	100			
	SM	Silty fine SAND; greyish brown.			1.00				
	ML	Fine sandy SILT; grey mottled orange brown. Non plastic.			1.50	100		3, 8 / 8, 8, 9, 20 N = 45	
	GW	Fine sandy GRAVEL; greyish brown. Gravel is sub-rounded to sub-angular greywacke, densely compacted.			2.00	100			Bentonite
	GW	Fine to coarse GRAVEL with minor clay; grey. Gravel is sub-rounded greywacke, densely compacted.			2.50				
	GW	Fine to coarse sandy silty, fine to coarse GRAVEL with trace cobbles; grey.			3.00	100		8, 12 / 15, 20, 20, 5 N = 60	
					3.50	100			
					4.00	100			
					4.50			8, 7 / 8, 10, 7, 11 N = 36	
					5.00	100			
					5.50				
	GW	Fine to coarse GRAVEL; grey. Gravel is sub-rounded to sub-angular greywacke.			6.00			8, 18 / 13, 13, 13, 11 N = 50	
	GW	Fine to coarse sandy, fine to coarse GRAVEL with trace silt and trace boulders; grey.			6.50	50			
					7.00				
					7.50	100		3, 5 / 9, 10, 9, 10 N = 38	
					8.00	100			
					8.50				
	GW	Fine to coarse sandy silty, fine to coarse GRAVEL with trace cobbles; greyish brown. Densely compacted.			9.00	100		10, 17 / 23, 37 N = 60	Surrounding ground collapse
					9.50				
					10.00	100			
					10.50			14, 18 / 19, 20, 21 N = 60	
	GW	Fine to coarse sandy, fine to coarse GRAVEL with trace silt; greyish brown. Densely compacted.			11.00	100			
					11.50				
					12.00	100		13, 17 / 18, 18, 20, 4 N = 60	
					12.50				
					13.00	100			
					13.50				
					14.00	100		6, 6 / 12, 17, 23, 8 N = 60	
		EOH: 15.20m			14.50				
					15.00	100		18, 18 / 18, 15, 20, 7 N = 60	

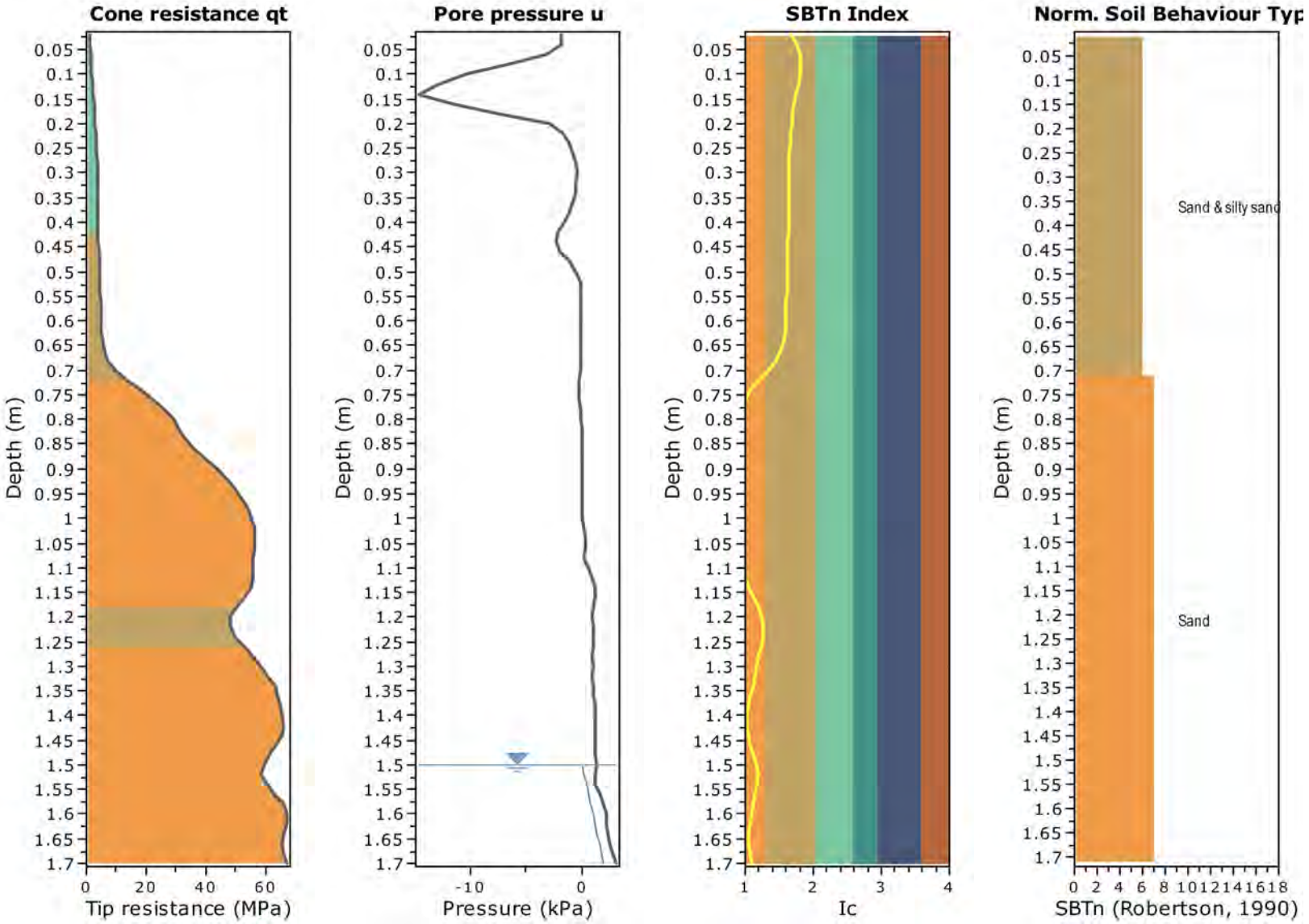
Logged By:	Start Date:	Remarks
KT	05/07/2018	
Plotted By:	**End Date:**	
KL	05/07/2018	
Checked By:	**Driller:**	
KT	McMillan Drilling	

NZGD ID: BH_113495

Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 113582
Total depth: 1.70 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

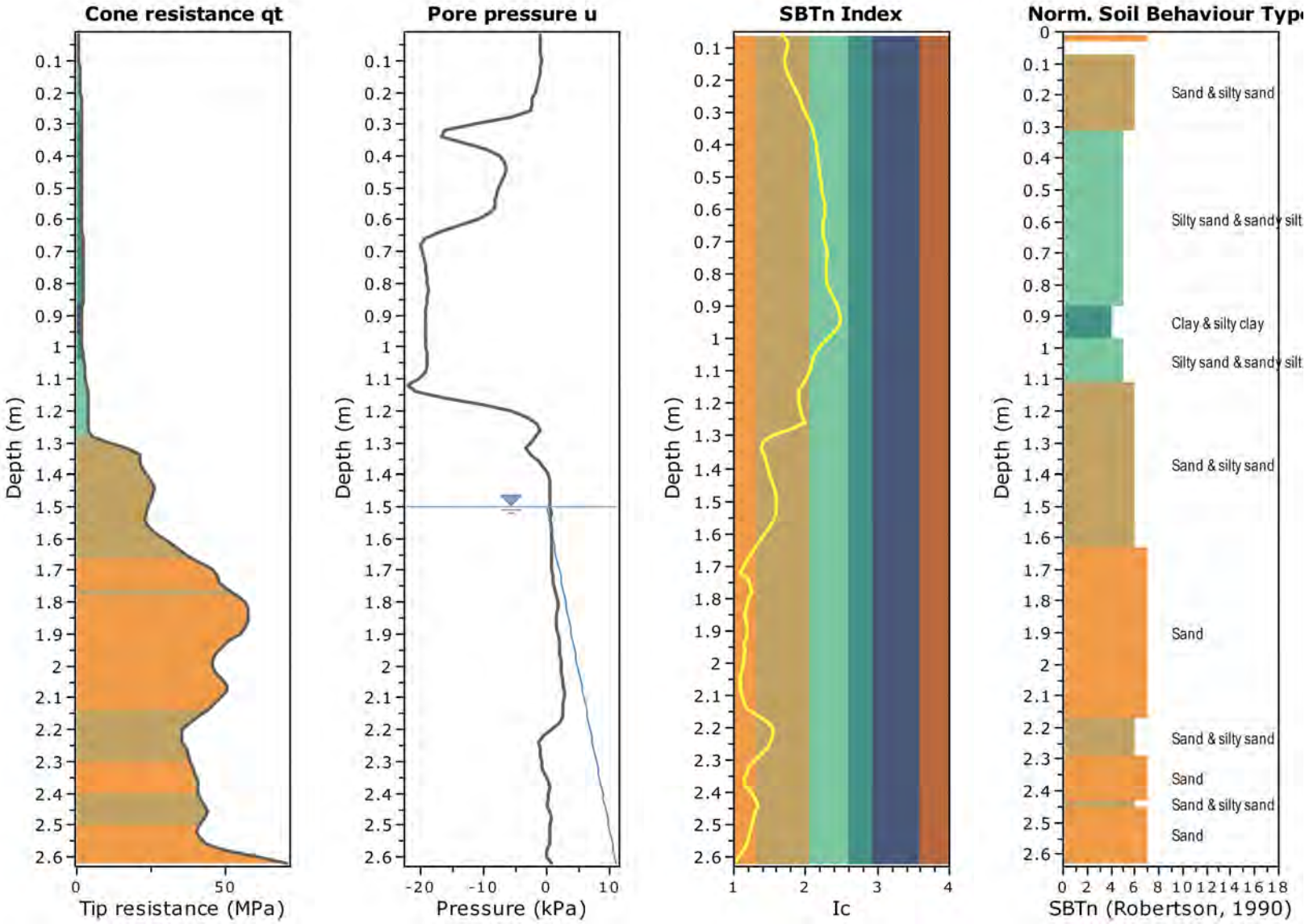
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 113586
Total depth: 2.62 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

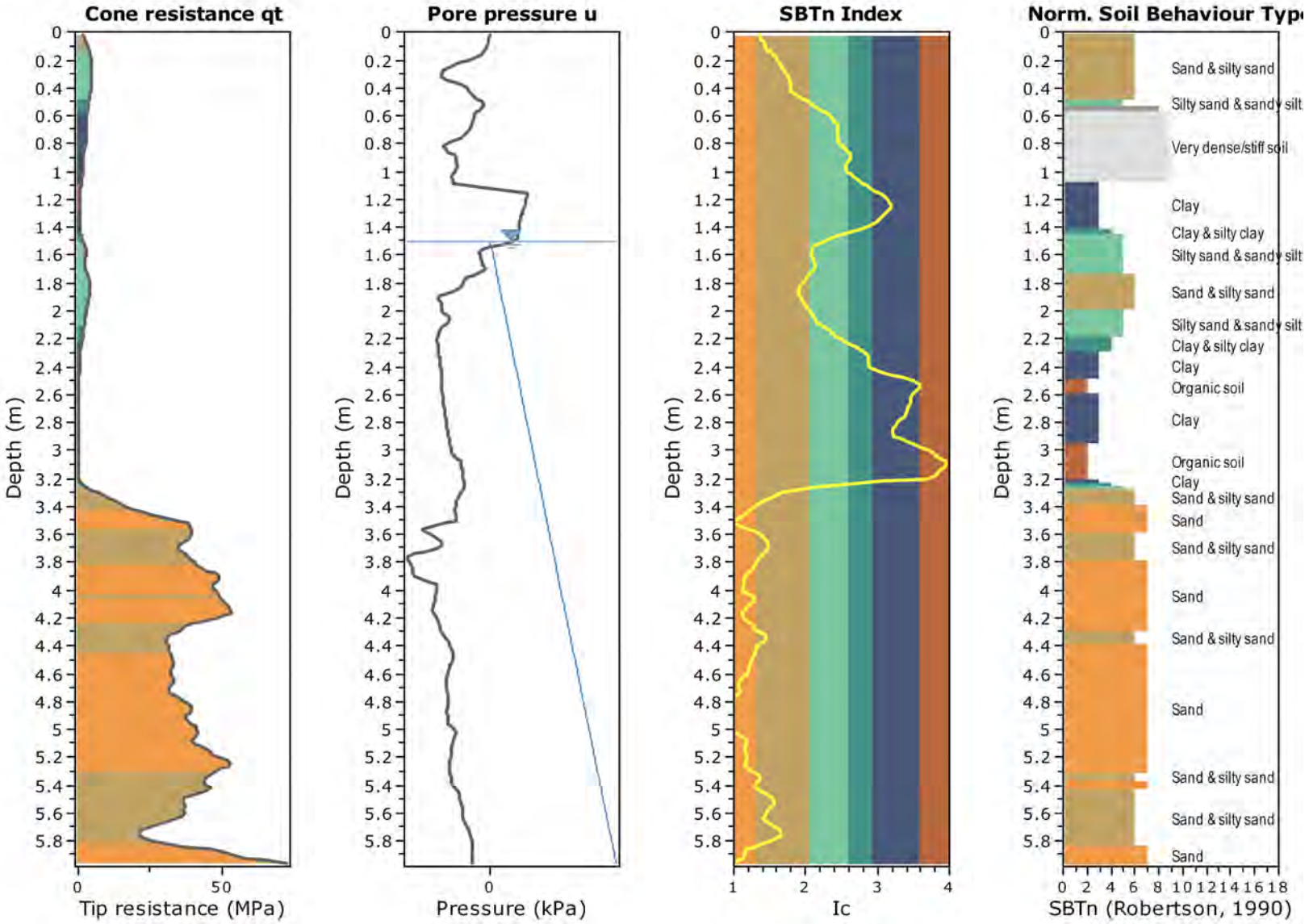
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **1491 Springs Road Lincoln**
Location:

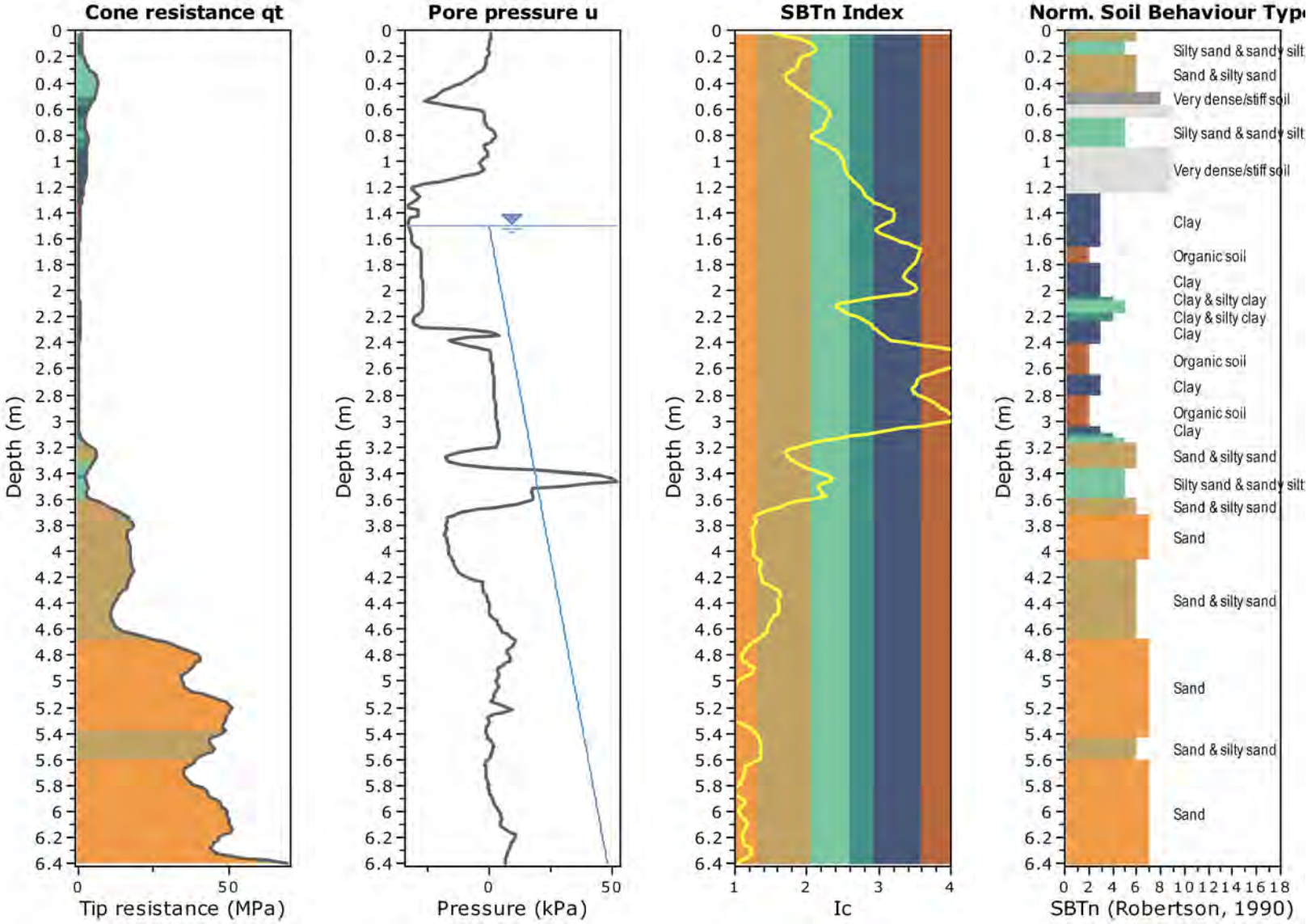
CPT: CPT 125194
Total depth: 5.96 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 125215
Total depth: 6.40 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

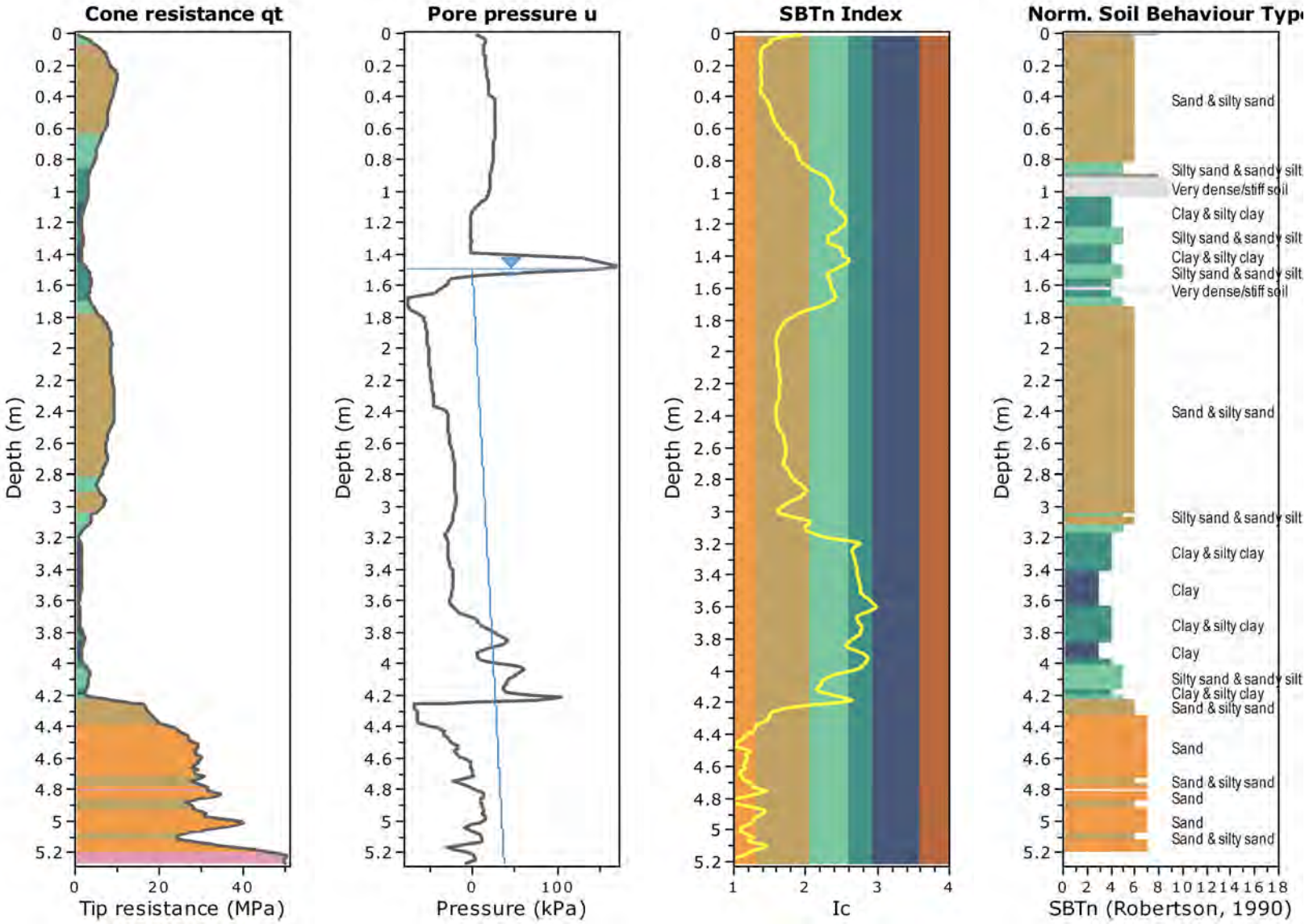
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 136840
Total depth: 5.27 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

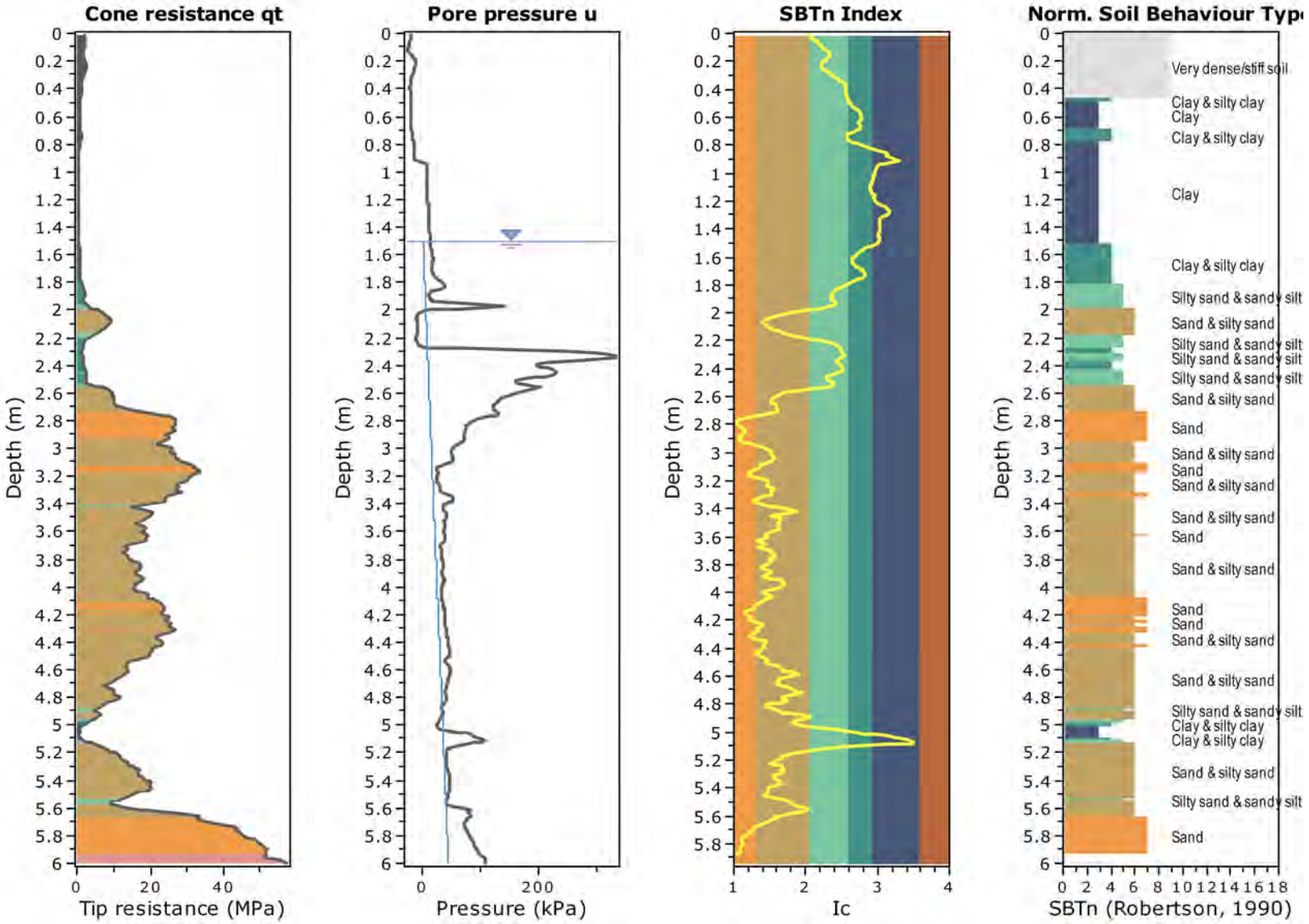
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 136850
Total depth: 6.00 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

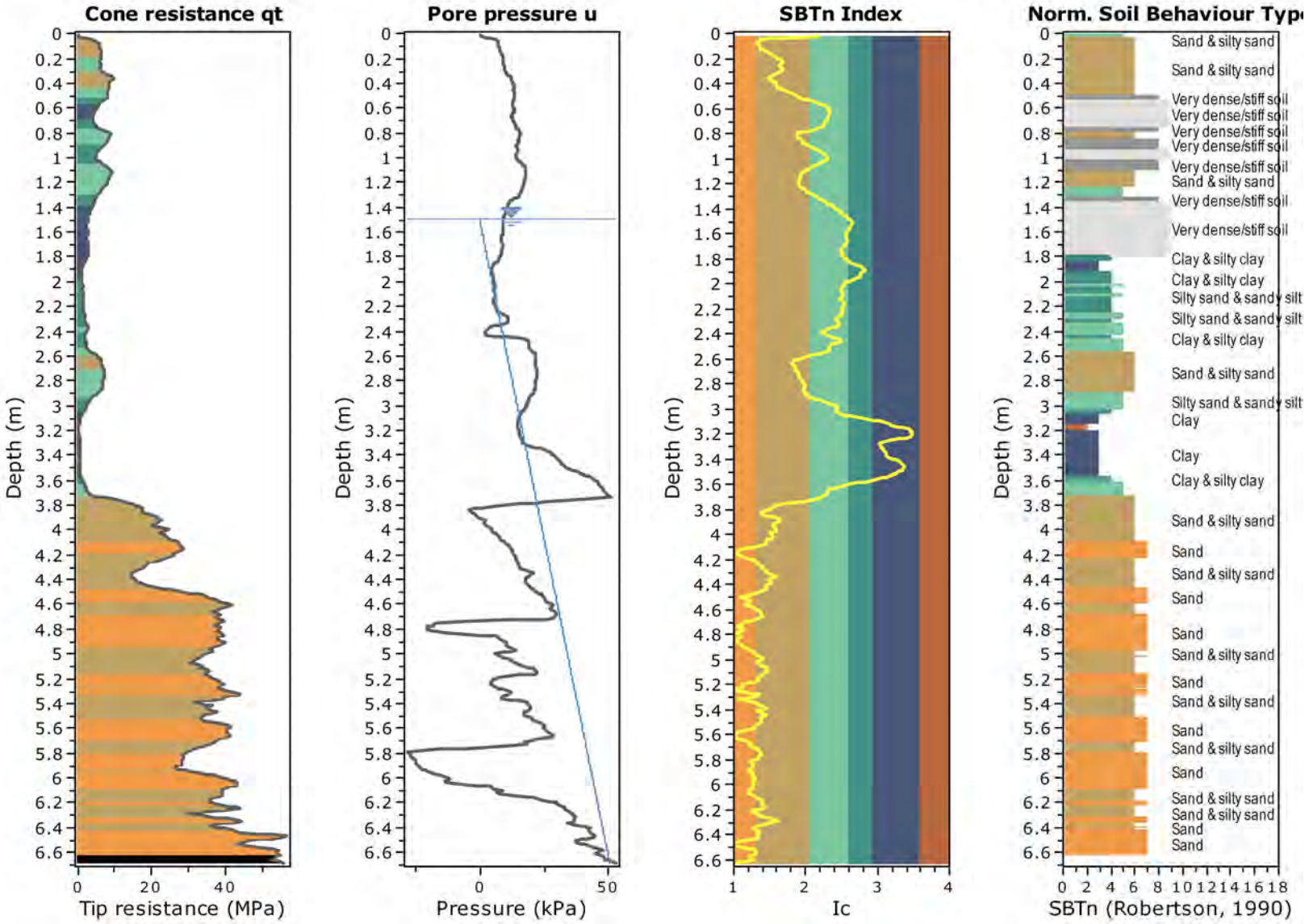
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **1491 Springs Road Lincoln**
Location:

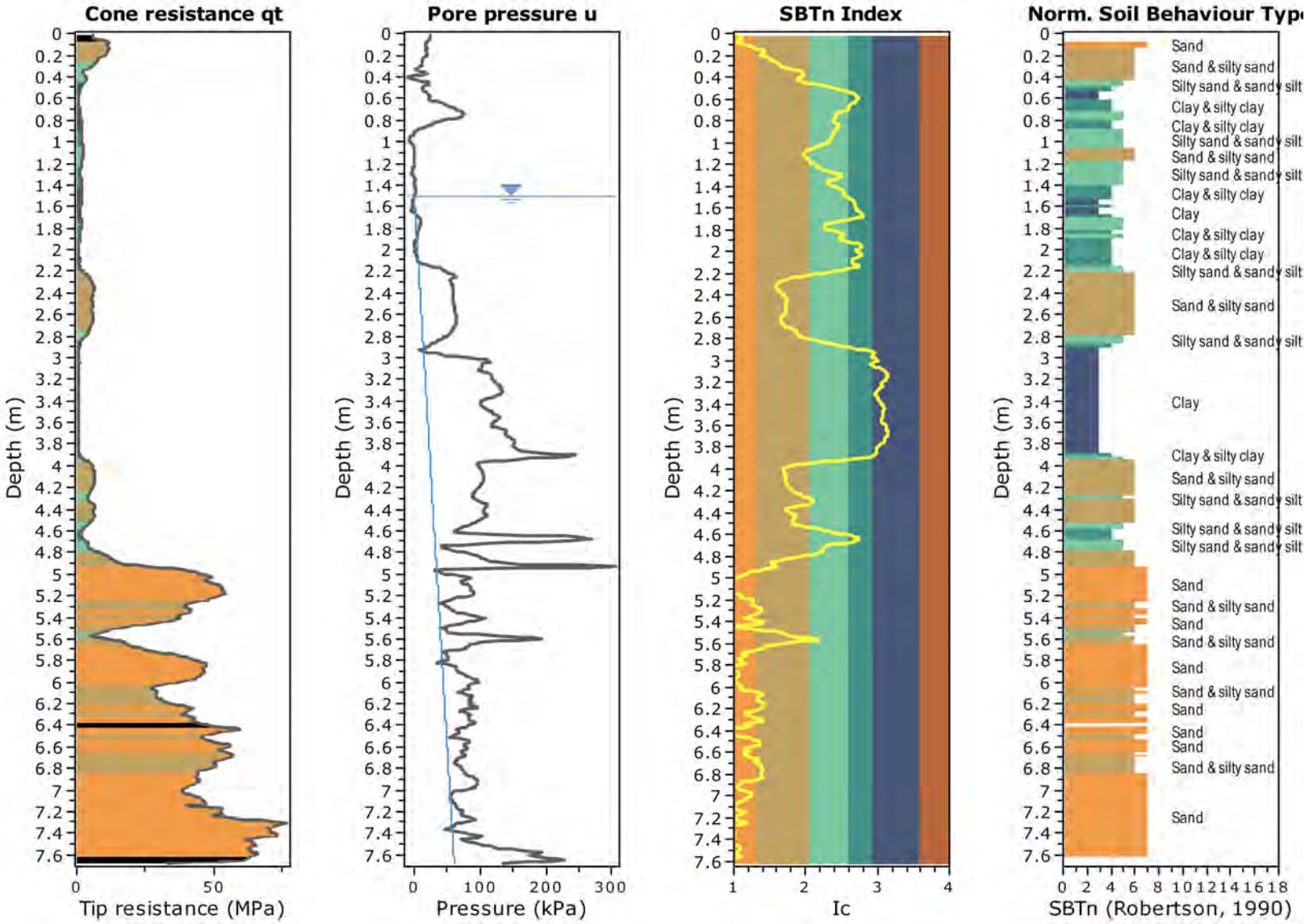
CPT: CPT 136855
Total depth: 6.69 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 152915
Total depth: 7.68 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

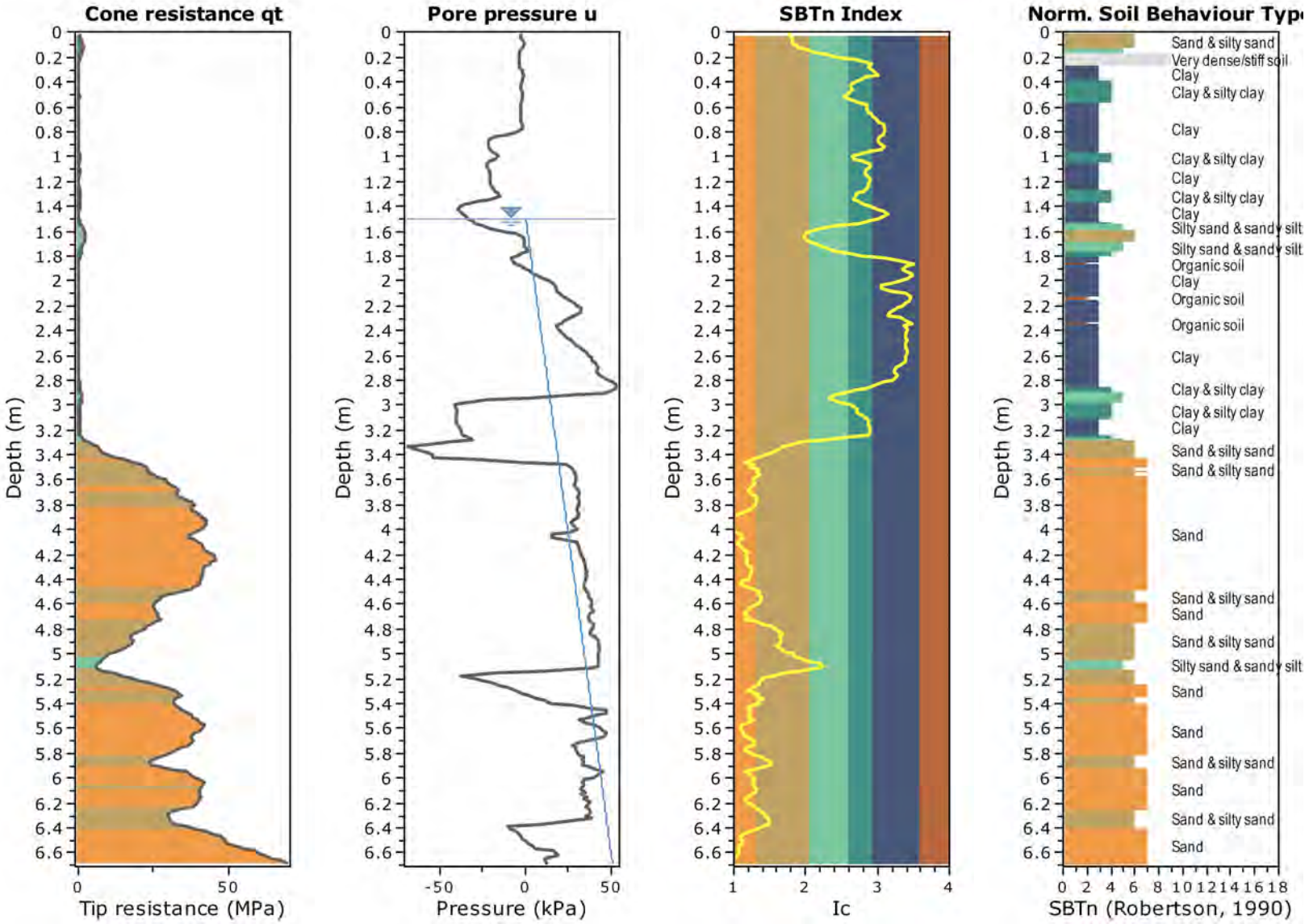
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

Project: **1491 Springs Road Lincoln**
Location:

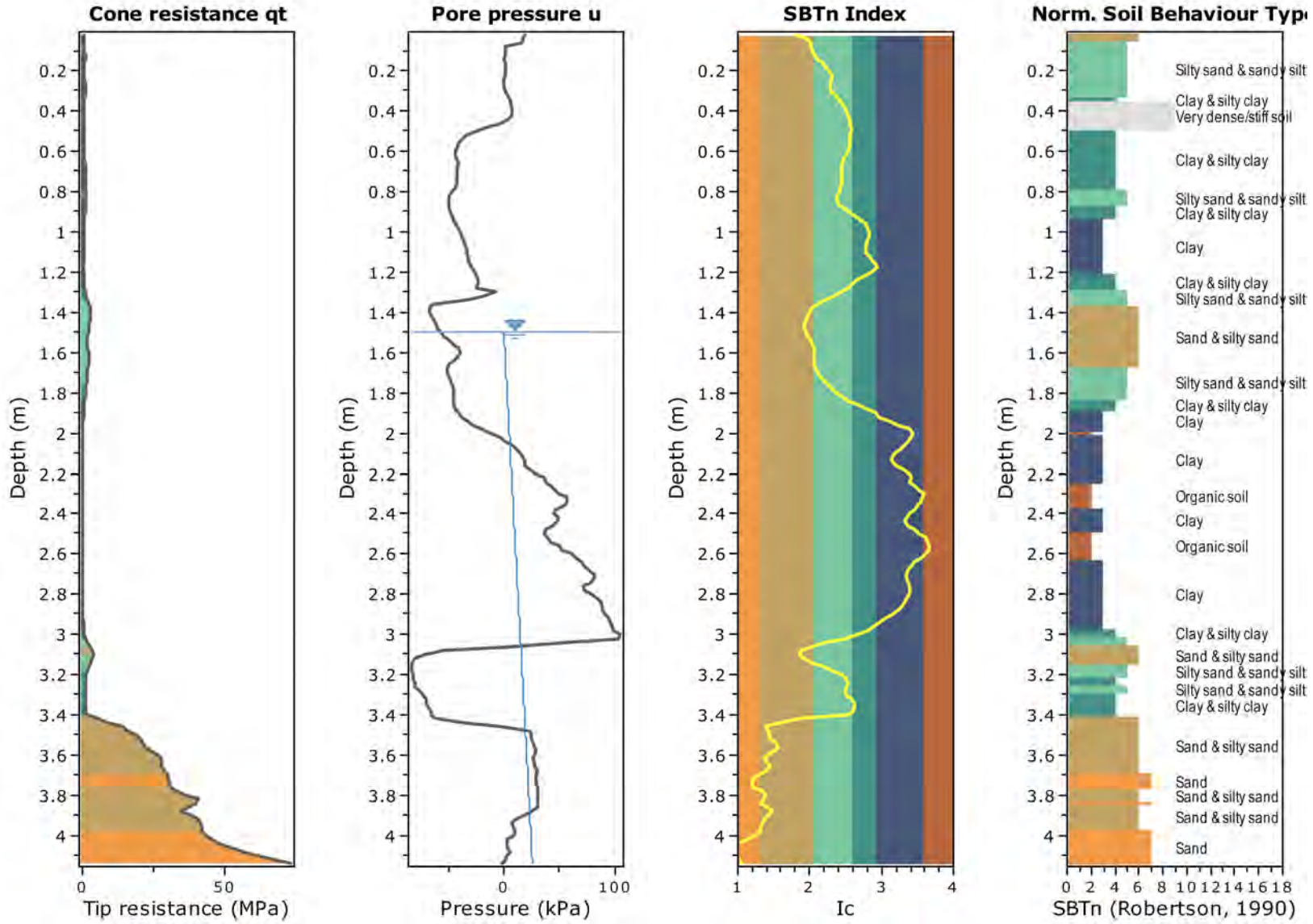
CPT: CPT 56181
Total depth: 6.69 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 56182
Total depth: 4.14 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

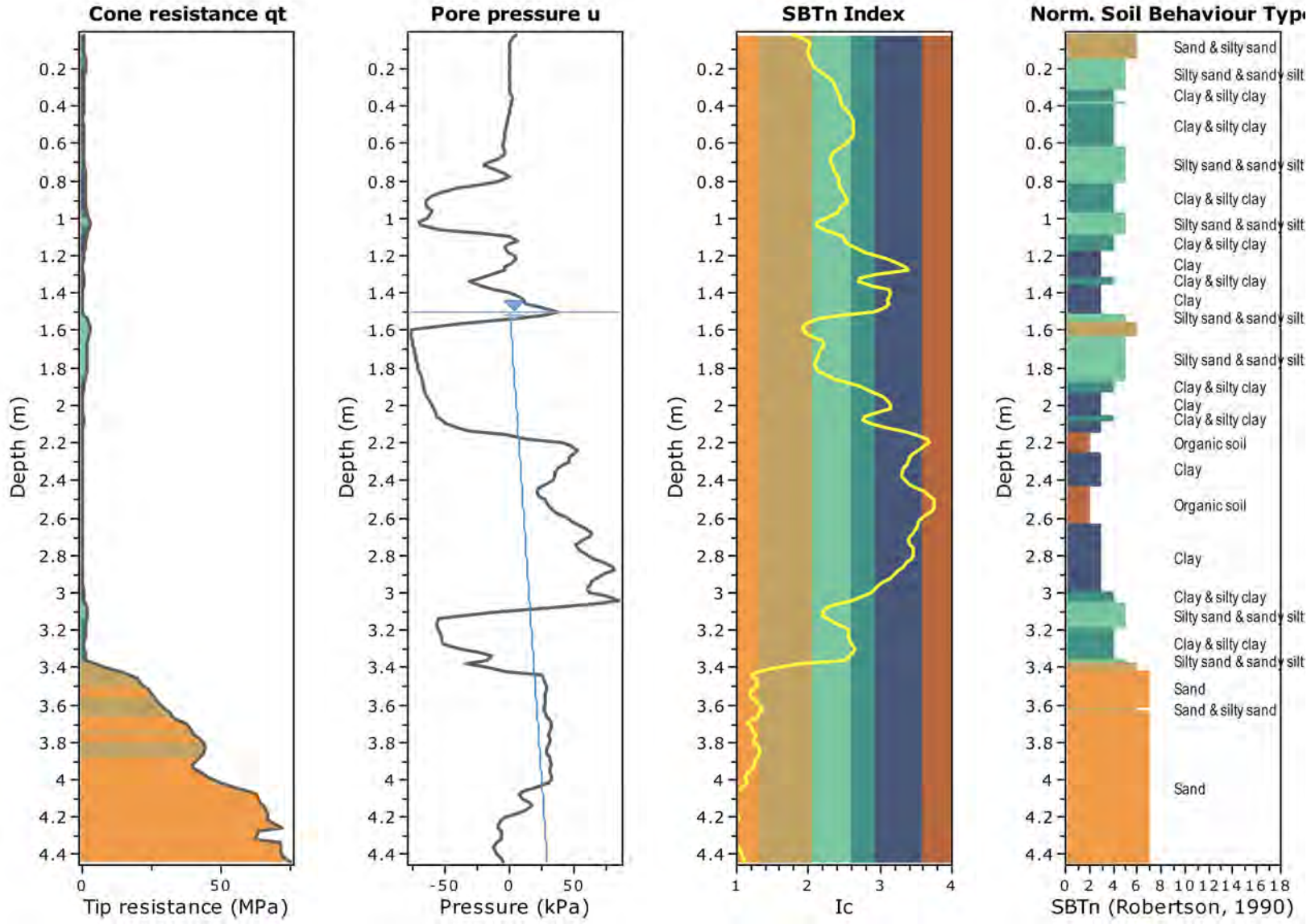
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 56183
Total depth: 4.44 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

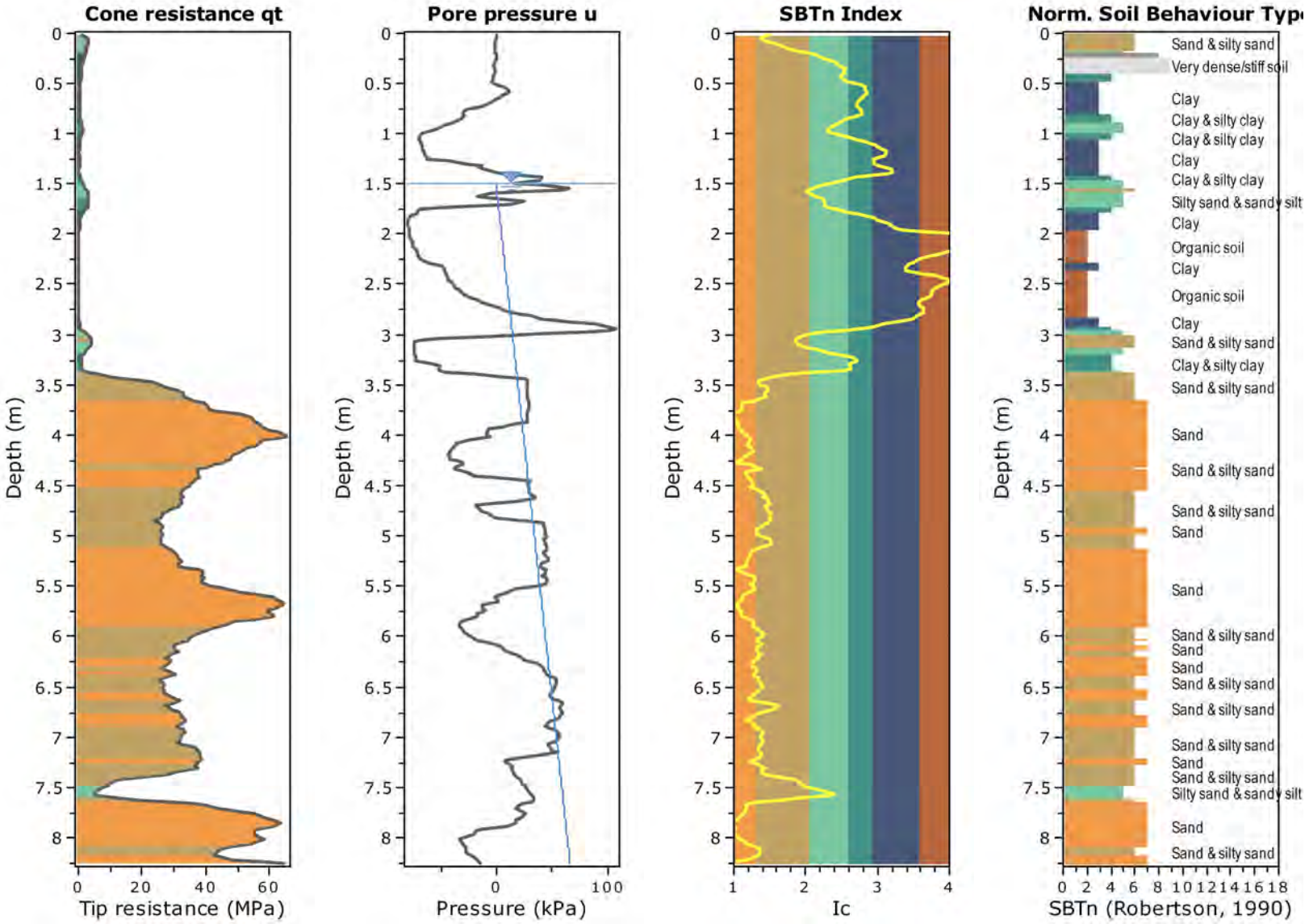
Project: **1491 Springs Road Lincoln**
Location:



Coffey
1/254 Montreal Street
Christchurch 8013
www.coffey.com

CPT: CPT 56184
Total depth: 8.26 m, Date: 27-Jan-21
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

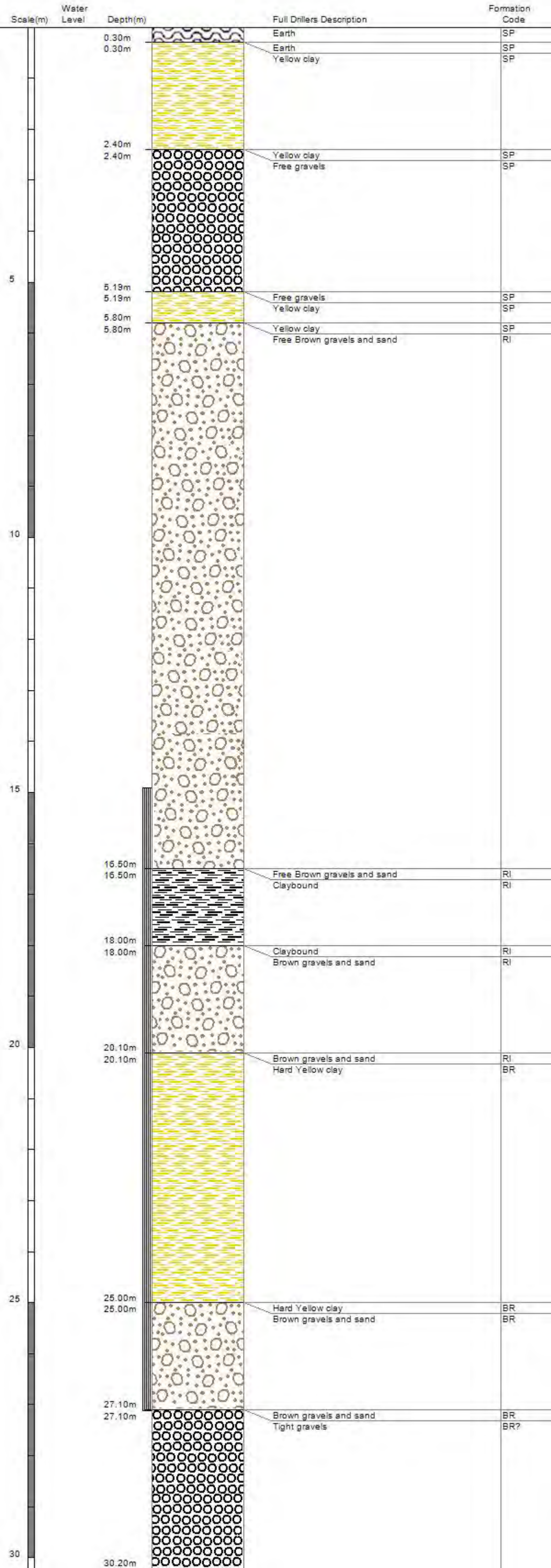
Project: **1491 Springs Road Lincoln**
Location:



Borelog for well M36/1419

Grid Reference (NZTM): 1557218 mE, 5166208 mN
Location Accuracy: 2 - 15m
Ground Level Altitude: 7.7 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Cable Tool
Borelog Depth: 30.2 m Drill Date: 06-Dec-1974

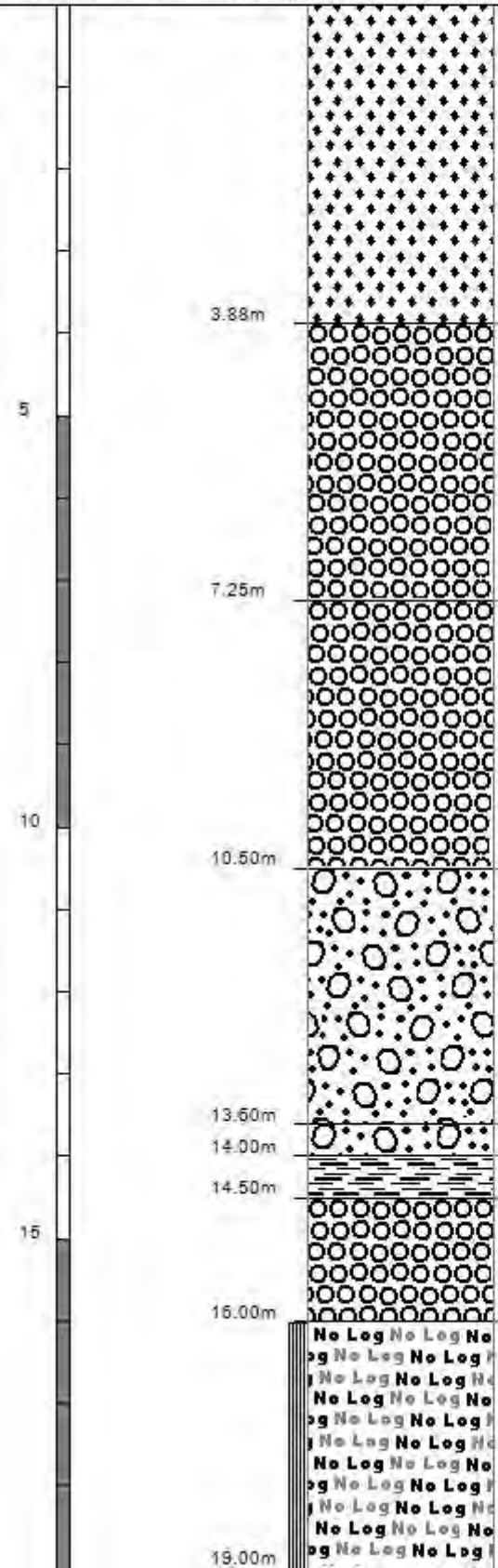
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/2834

Grid Reference (NZTM): 1557245 mE, 5166013 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 9.6 m +MSD Accuracy: < 2.5 m
Driller: Smith, J R & I G
Drill Method: Cable Tool
Borelog Depth: 19.0 m Drill Date: 06-Jul-1982

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

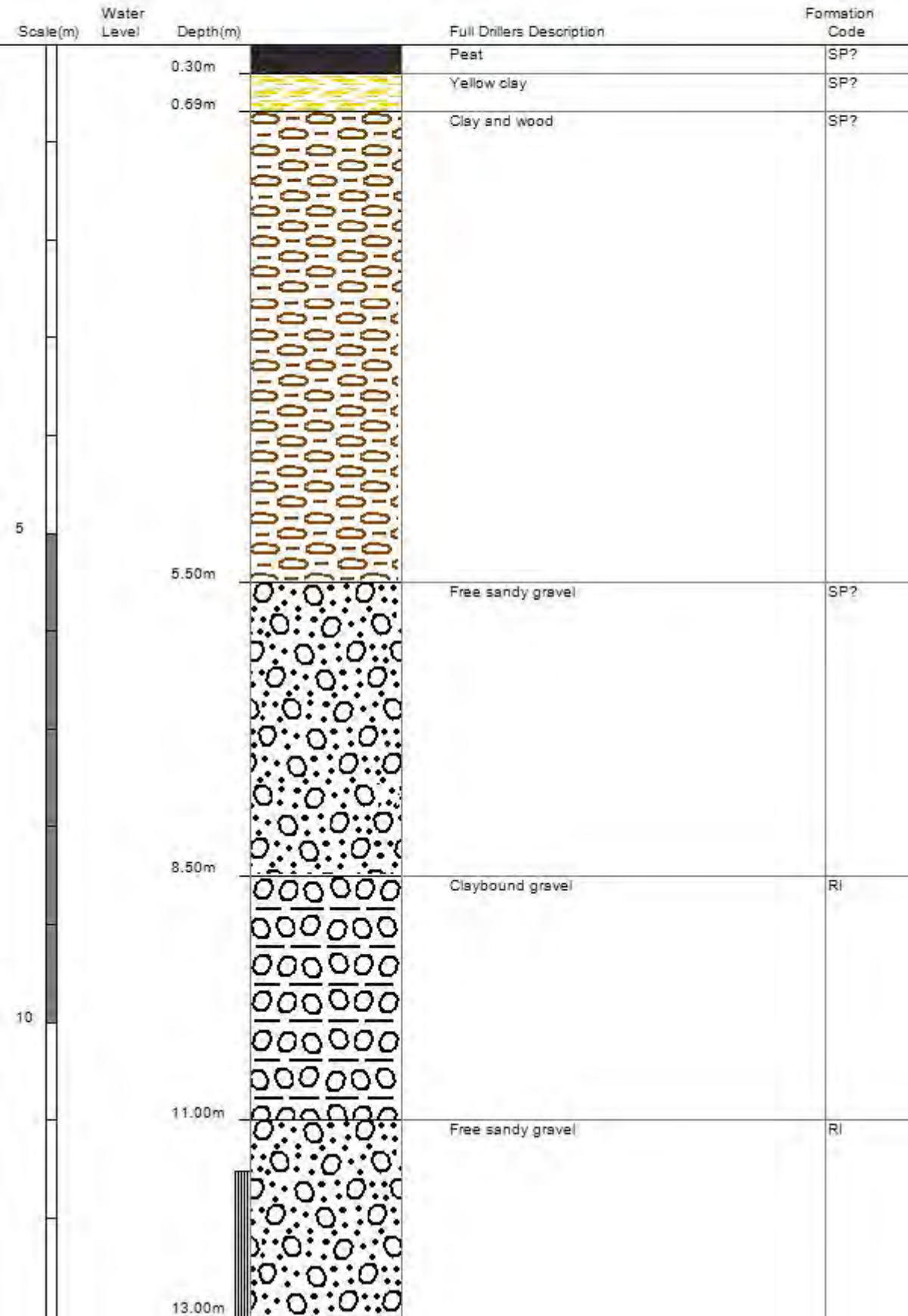


Full Drillers Description	Formation Code
Sand	SP
Free gravel	SP
Free gravel	SP
Free gravel and sand	RI
Tighter gravel and sand	RI
Clay	RI
Free gravel	RI
No log	RI

Borelog for well M36/5054

Grid Reference (NZTM): 1558545 mE, 5165643 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 7.9 m +MSD Accuracy: < 2.5 m
Driller: Smiths Welldrilling
Drill Method: Cable Tool
Borelog Depth: 13.0 m Drill Date: 20-Nov-1993

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Borelog for well M36/7531

Grid Reference (NZTM): 1557605 mE, 5166323 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 8.0 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Rotary Rig
Borelog Depth: 24.0 m Drill Date: 01-Mar-2004

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Earth	SP
		0.60m		
		0.60m	Earth	SP
			moist brown clay	SP
		3.80m		
		3.80m	moist brown clay	SP
			very moist silty blue clay	SP
5		5.50m		
		5.50m	very moist silty blue clay	SP
			free very wet sandy gravel	RI
		8.40m		
		8.40m	free very wet sandy gravel	RI
			free lightly stained water-bearing sandy gravel	RI
		9.50m		
		9.50m	free lightly stained water-bearing sandy gravel	RI
10			free lightly stained water-bearing sandy gravel	RI
		11.00m		
		11.00m	free lightly stained water-bearing sandy gravel	RI
			very free lightly stained water-bearing sandy gravel	RI
		13.80m		
		13.80m	very free lightly stained water-bearing sandy gravel	RI
			clay-bound sandy gravel	RI
15		15.00m		
		15.00m	clay-bound sandy gravel	RI
			sand, few gravels	RI
		16.70m		
		16.70m	sand, few gravels	RI
			lightly stained, water-bearing, very sandy gravel	RI
20		20.60m		
		20.60m	lightly stained, water-bearing, very sandy gravel	RI
		21.20m	claybound gravel	RI
		21.20m	claybound gravel	RI
			lightly stained water-bearing sandy gravel	RI
		23.95m		

Borelog for well M36/7635

Grid Reference (NZTM): 1557146 mE, 5165803 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: 6.4 m +MSD Accuracy: < 0.5 m
Driller: McMillan Drilling Ltd
Drill Method: Rotary Rig
Borelog Depth: 8.8 m Drill Date: 14-Apr-2004

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Earth	SP
		0.20m		
		0.20m	Earth	SP
			moist sandy gravel	SP
1		1.00m		
		1.00m	moist sandy gravel	SP
			dark brown peat and glass	SP
		1.70m		
		1.70m	dark brown peat and glass	SP
			moist dark brown sandy peat	SP
2		2.10m		
		2.10m	moist dark brown sandy peat	SP
			very moist very sandy gravel	SP
		2.60m		
		2.60m	very moist very sandy gravel	SP
			wet sandy gravel	SP
3				
		4.50m		
		4.50m	wet sandy gravel	SP
			sandy gravel	SP
5				
6				
7		7.30m		
		7.30m	sandy gravel	SP
			water-bearing sandy gravel	SP
8		8.00m		
		8.00m	water-bearing sandy gravel	SP
			free water-bearing stained sandy gravel	SP
		8.80m		

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Design Review Sheet (DRS)

Details of project being reviewed			Review	
Project Name: 1491 Springs Road			**Reviewer Name:** Ian McCahon – Geotech Consulting	
Design Review Stage: Plan Change	**Review Due Date:** N/A			
Report No: 773-CHCGE280252	**Revision Date:** 20/10/20	**Revision No:** 1	**Revision Date:**	**Revision No:**
Report Title: Geotechnical Assessment Report for 1491 Springs Road, Lincoln	Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.
Project Manager: Chris Thompson	Click here to enter text.	Click here to enter text.	Click here to enter text.	Click here to enter text.

This package comprises:			Comment Type	
☐ Specifications	☐ Spreadsheets	☐ Calculations	1	Critical issue – to be resolved
☐ Drawings	☐ Supplier data	☒ Reports	2	Important issue – request change
☐ Other:			3	Discussion item – potential change (address during next stage)
			4	Note to originator – no change necessary

Item No.	Referenced Document	Comments	Date	Comment type	Responses	Date	Comment Closed (Y/N)
1	773-CHCGE280252 GAR Rev 1	Point #2 – Site testing - comment The MBIE guidance suggests 0.2 to 0.5 deep tests per hectare at plan change stage to characterize the soil profile to a depth of at least 15m. This gives a range	20/11/20	3	After the initial review, additional investigation has been carried out, and nearby data available from the NZGD and ECan well records has been added. This bring the number of investigations to 54 locations (plus MASW) which is in	28/01/21	

		35 to 89 tests for the 178 ha area as given in the Coffey report, or about twice the number actually made. The western part west of Springs Road has only six tests with spacing up to 0.7 km apart. The MASW surveys help, but they are along part of one side of the site and in the eastern quarter. The number and depth of testing is questionable (refer to comments in (2), below). More testing is essential at subdivision consent stage, if the plan change proceeds.			the range suggested by MBIE. We note that the western portion of the site appears to be geologically consistent so for this plan change the test density in this area is considered acceptable.		
2	""	Point #3 – Subsurface Conditions - comment The MASW profiles do not correlate particularly well with the stratigraphy inferred from the CPT tests. Our experience with MASW profiling on other sites in the Christchurch area has also highlighted a need for caution with their interpretation. The report does not refer to any geotechnical information other than the CPTs and MASW made as part of this investigation, and therefore there is no confirmation of soil types below the depth of the CPT tests, many of which are relatively shallow and with an average depth of only 5.5m. We have checked several bores on the Ecan well data base. The four looked at do show gravel soils	20/11/20	3	Coffey reviewed the NZGD and ECan boreholes as part of the initial assessment and concluded that the majority of the site was underlain (at varying depths) by dense gravel soils hence the choice of CPTs to confirm the upper soil profile (borehole and well logs appended to updated report for reference). For subdivision consent, we expect to carry out several machine drilled boreholes to confirm this layer on the site. Due to time constraints, the MASW was not able to be calibrated with the on site CPTs, this will be carried out during the subdivision consent phase. We note that the MASW did consistently identify shear wave velocities in excess of	28/01/21	

		from a depth similar to that shown in the closest CPT tests, and it does appear that the soils below about 5m are dense enough and of a grading such that liquefaction is not an issue. However, we recommend that Coffey research publicly available borehole information (Ecan well data base and NZ Geotechnical Database) to verify the deeper profile. This will probably also increase the number of locations where ground conditions are known, particularly along the northern side, and thus enhance confidence in the overall geotechnical model. The soil profile as described is generally consistent with that determined for the subdivisions along the north side. We note that the area to the northeast does contain significant amounts of organics in places, such that careful consideration had to be given to how these more compressible soils would respond to filling and building loads. Without any sampling by test pit or borehole in this plan change area, there is a possibility that organic soils will be more widespread than anticipated.			200m/s, indicating dense materials that are unlikely to liquefy at depth. As shown in the ODP, the eastern area is proposed to comprise stormwater management areas and Living X (large Lot residential sites) due to the potential increased risk of poor ground conditions (yet to be determined prior to subdivision consent stage). We expect the northeastern and eastern areas of the site will require the most intensive investigation to confirm ground conditions.		
3	“”	Point #4 – Liquefaction Potential - comment	20/11/20	2	Agreed, lateral spread / stretch risk will be assessed once a subdivision plan is further developed. Initially, we consider	28/01/21	

		The analysis is by the MBIE standard procedure with appropriate input parameters. The use of a 1m water table depth for the eastern part is probably conservative. As no liquefaction outputs are provided, it is not known at what depths the liquefaction is predicted to occur. There is no discussion of evidence of ground damage in the 2010-11 earthquakes. It is noted that the site has certainly been well tested to in excess of SLS shaking and probably in excess of ULS shaking in the September 2010 earthquake, yet the closest residential land at the time of the earthquakes – further north with generally more sandy soils - was all classified Foundation Technical Category TC1 by MBIE, suggesting little to no ground damage. The recent subdivisions adjacent to the north side also considered liquefaction. The land north of the subject land and west of Springs Road was concluded to be mostly TC1 with two small areas of equivalent TC2, similar to the conclusions in this report. The Te Whariki subdivision has had numerous reports comp0lied for it and the various stages. For one stage on the east side of Springs Road, an early report designated the whole area as			that potential TC2 foundations, on Lots adjacent to waterways (dependent on their distance from such waterways), will mitigate any risk associated with lateral spread / stretch.		

		requiring TC2 foundations, to address both peat consolidation issues as well as some areas of higher liquefaction hazard. A later report by another consultant amended this to TC1 for most of the area with TC2 restricted to only 6% of the lots where proximity to natural springs or detention basins increased lateral spread hazard. Therefore, the current report is consistent in general conclusion with the work done on adjacent areas, which are on very similar ground conditions. Lateral spread has not been assessed. This will need to be addressed at subdivision consent stage for land along all waterways, either natural or formed, and around stormwater detention ponds and the like. Our conclusion is that the analysis and conclusions are probably appropriate, but that Coffey need to comment on lateral spread as a potential hazard.					
4	SDC PC200069 RFI dated 10 December 2020 [Erratum 16 December 2020] item #68	It is also noted that the geotechnical assessment provided does not cover all of the plan change area – excluding 208 Collins Road, 1521 and 1543 Springs Road. While the reviewer has not made comment on this matter, please provide	10/12/20 & 16/12/20	2	Coffey consider that the ground conditions for the three land parcels mentioned, along with 36 Collins Road, to be consistent with surrounding investigations already completed for the larger areas. 208 Collins Road, 1521 and 1543 Springs Road are considered to be	28/01/21	

		advice on the appropriateness of land conditions of these parcels.			low risk geotechnically. 36 Collins Road has more potential geotechnical risk however 4 CPTs are present on this site that can be incorporated into the subdivision consent stage investigations. The CPT traces are included in the updated report (CPTs 56181 to 56184)		
END OF COMMENT							