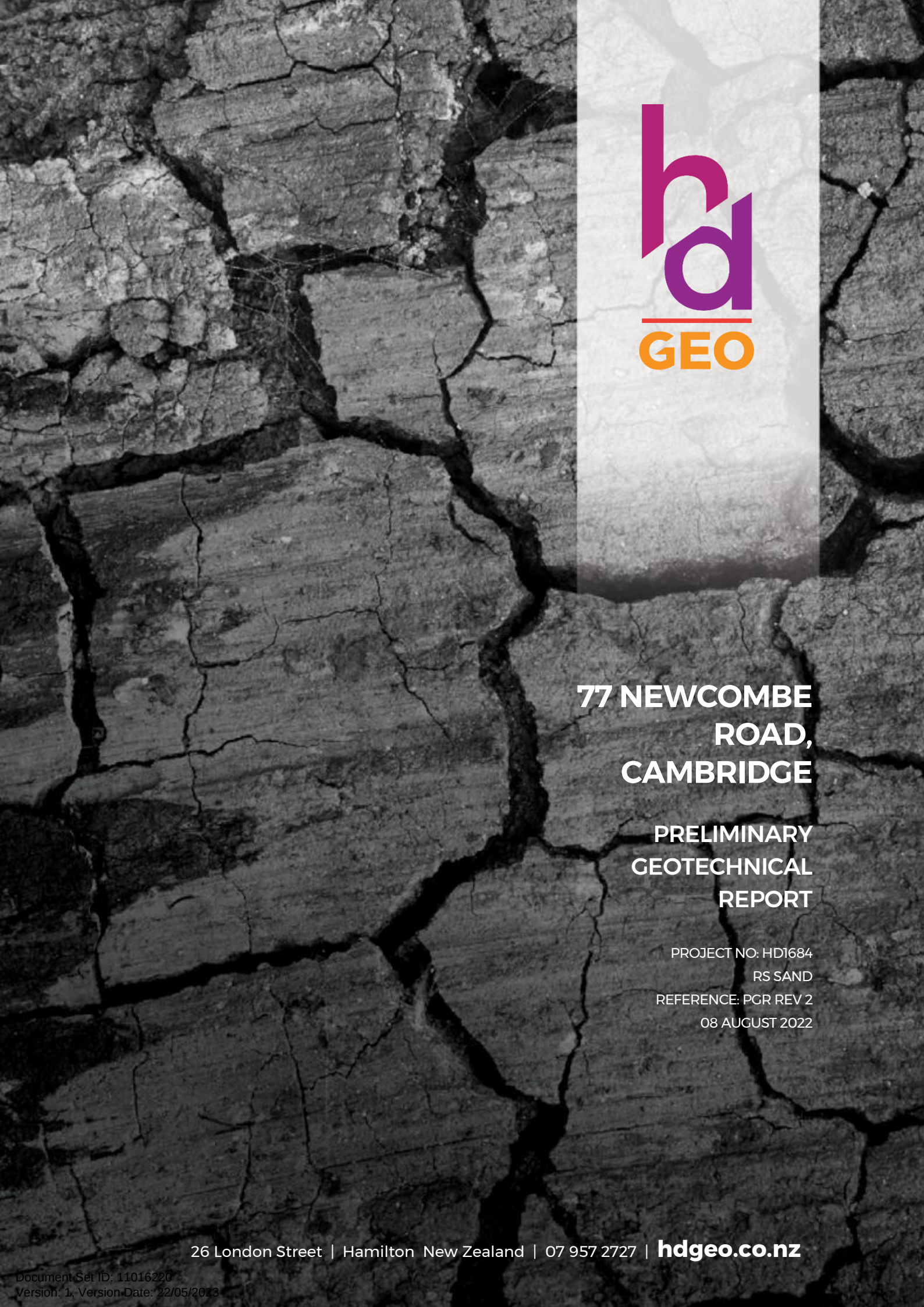


77 NEWCOMBE ROAD, CAMBRIDGE

PRELIMINARY GEOTECHNICAL REPORT

PROJECT NO: HD1684
RS SAND
REFERENCE: PGR REV 2
08 AUGUST 2022

26 London Street | Hamilton New Zealand | 07 957 2727 | **hdgeo.co.nz**

Executive summary

Introduction

RS Sand have engaged us to undertake a preliminary assessment for their site located at 77 Newcombe Road, Cambridge. They propose to develop the existing dairy farm into a sand quarry. This report is intended to be submitted to Waipa District Council and Waikato Regional Council in support of the resource consent application.

Our scope included

- desktop study of the site to review existing information, including historical aerial images, geology maps, contour maps, and the NZ Geotechnical Database (NZGD)
- site walkover by an engineering geologist
- 3 CPTs to 35.2, 30.9 and 29.9 m respectively (to assist with the slope stability assessment)
- assess the geotechnical effects resulting from the construction of the quarry
- determine slope setback for the final batters for the adjacent properties, Expressway and power lines

Our key findings were

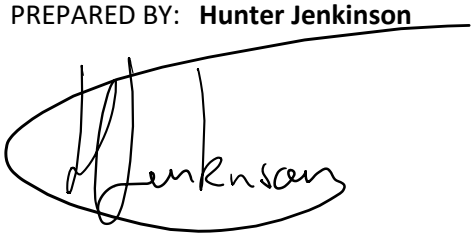
- ground conditions were consistent with the mapped geology
- interbedded silt and sand soils extended to between 15 and 17 m bgl and overlay constantly dense sand soils
- groundwater was dipped between 2.1 to 10.5 m bgl. The regional ground water level is assessed to be at approximately 40 m bgl.
- soakage testing indicates percolation rates vary over the site from 153 mm/hr to 718 mm/hr

Our assessment is

- no significant geotechnical hazards are present
- the proposed slopes are much flatter then the existing gully slopes and will be appropriately stable
- given the deep groundwater levels, the liquefaction hazard is low
- slope stability is assessed to be low risk for the current development plans
- the site is suitable for the proposed sand quarry
- a 10 m Building Restriction Zone (BRZ) should be applied from the top of final quarry batter slope
- additional assessment will be required if the bund size and or location is to change in the future
- the water pond in the processing plant must be lined with an impermeable membrane or similar so water does not soak away and affect the stability of the surrounding slopes
- additional assessment and design of the processing plant bund and stock pile locations should occur at the detailed design for the operations phase of the project

Contents

PREPARED BY: **Hunter Jenkinson**



ENGINEERING GEOLOGIST

Hunter@hdgeo.co.nz

Tel 027 355 3353

REVIEWED BY **Andrew Holland, CPEng**

TECHNICAL DIRECTOR, PRINCIPAL ENGINEER

Andrew@hdgeo.co.nz

Tel 022 048 8441

Revision	**Date issued**
Draft	10 February 2021
PGR – Final	2 July 2021
PGR – Final Rev 1	4 November 2021
PGR – Final Rev 2 (updated plans and bund)	8 August 2022

Introduction

RS Sand propose to develop a dairy farm located 2.5 km east of Cambridge on the north eastern side of the Waikato Expressway into a sand quarry. We have been engaged to undertake a preliminary geotechnical assessment to assess effects the development may have on surrounding infrastructure and property. The proposed sand quarry location is near rural residential buildings, power lines and the Waikato Expressway.

This report presents the results of our investigation and assessment for the proposed final batter construction of the quarry. A site plan showing the proposed quarry is included in Appendix A.

This report is intended to be submitted to the Waipa District Council and Waikato Regional Council in support of a resource consent application for the development of the quarry. The site is suitable for the proposed quarry, subject to the geotechnical recommendations within this report.

Scope

The scope of our assessment included:

- a desktop study of the site to review existing information, including historical aerial images, geology maps, contour maps, and the NZ Geotechnical Database (NZGD)
- a site walkover by an engineering geologist
- 3 CPTs to 35.2, 30.9 and 29.9 m respectively (to assist with the slope stability assessment)
- four soakage tests with the percolation results to be used by others
- an assessment of the geotechnical effects resulting from the construction of the quarry
- determining slope setback for the final batters for the adjacent properties, express way and power lines

Site description

The site is located on the northern side of Newcombe Road, Cambridge which is directly adjacent to the Waikato Expressway, 2.5 km east of Cambridge. The property is currently an active dairy farm and consists of near level pasture with associated farm buildings and houses.

The farm currently sits at RL 72 to 73 m on a near flat terrace above surrounding gullies. The Waikato River, 54 m below the current ground level of the farm, is located to the south of the site. Karapiro Stream, a major tributary to the Waikato River, is located immediately to the north of the site and is located about 35 m lower than the farm. The gully slopes are steep at 35 to 40 degrees. A tributary to this stream dissects the property and flows to the north. The tributary geomorphology appears to be created by natural dewatering of the near surface perched water tables.

A major power line runs east to west at the head of the major tributary with one pylon located directly north of the proposed yard area.

There is an adjacent property to the east that has a dwelling and farm shed located near the property boundary (15 to 20 m away).

Proposed development

RS Sand propose to develop a sand quarry on the site. The development is to be staged, with stage 5 (final stage) anticipated to occur 20.7 to 24.7 years from the start of works. The site will be cut down by about 35 m.

The current scheme plans indicate the final geometry of the quarry will be a flat base with 3:1 batter slopes up to the existing ground level[1]. RS Sand have indicated that a 8.0 m wide, 3.0 m high bund will be constructed at the top as a visual barrier. We have assumed that a 1 m wide top bench will also be constructed, creating 40 deg batters on each side. The Bund will be placed on the outside edge of the Building Restriction Zone (BRZ) defined in our assessment below.

A 3.9 ha area on the eastern site of the proposed quarry is proposed to be cut down 2 m and will be used as the processing area. It will include site offices and infrastructure. This will include a water storage pond, stockpiles and a 3 m high bund around the top of the eastern slope.

Desk study

We completed a desktop study prior to the site investigation to identify areas of interest. The desktop study consisted of a review of recent[2] and historic[3] aerial imagery, relevant geological maps[4] and existing nearby geotechnical data[5].

Geological setting

Geological mapping of the areas indicates the site is underlain by soils of the Hinuera Formation. The Hinuera formation is described as, *"cross-bedded pumice sand, silt and gravel with interbedded peat".*

The Hinuera Formation in this area is considerably deep >35 m and is documented to be as deep as 60 m below current surface level in areas of the Waikato[6]. Sand soils generally increase in density with depth due to confinement. The density and characteristics of these sand soils can change once they are unloaded during excavation.

Other deposits that may be at the site and are typically not shown on relevant geological maps include uncontrolled fill and thin lenses of recent alluvium.

Aerial photography

We reviewed images from 1943, 1966, and 2020 (attached in Appendix C for reference). Key observations from each image are presented in Table 1.

Table 1: Summary information for aerial images.

Date	Observations
1943	• The area is in pasture with farm buildings on the development site and adjacent properties. • Tributaries are present and mostly de-vegetated. • Part of the slope above the Karapiro Stream on the north western side of the site appears to have regressed in a circular shape. This indicates that instability on the gully slope has occurred and may be associated with local groundwater seepage in the face. • The rest of the tributaries have signs of minor slope regression. • The Waikato River is located to the south in the same position as seen today.

[1] Updated Quarry Plans and Plant Area (June 2022), supplied by Michael Briggs (Kinetic), email dated 30/06/2022
[2] Google Earth Pro. Accessed 7.12.20
[3] Sourced from http://retrolens.nz and licensed by LINZ CC-BY. Accessed 7.12.20
[4] 1:250 000 Geological Map 4 (Waikato) (QMAP). GNS Science, 2005. Accessed 7/12/2020
[5] New Zealand Geotechnical data base (NZGD). www.nzgd.org.nz.accessed 7/12/2020
[6] Alluvial sedimentology of the upper Pleistocene Hinuera Formation, Hamilton Basin, New Zealand. By Terry M. Hume, Alan M. Sherwood & Campbell S. Nelson. Published online, 21 December 2011.

	• The main road out of Cambridge has been constructed.
1966	• The area of regression described above does not appear to have progressed. • The tributaries are now slightly vegetated.
2020	• The area of regression described above does not appear to have progressed. • There is little change to the geomorphology of the slopes since 1966 • The Waikato Expressway has been constructed to the south.

NZGD

We reviewed the New Zealand Geotechnical Database (NZGD) in the vicinity of the site. The database has testing directly to the south and west of the property in the same geomorphic environment. We have assessed 2 CPTs and 4 rotary cored bore holes from NZGD. Tests RLs and depths are presented in Table 2. The proposed quarry site sits at an RL of approximately 72.0 m.

Table 2: NZGD summary table.

CPT ID	RL (m)	Depth (m)	Distance to site (m)
CPT_95097	Assumed 55	29.0	90
CPT_97760	Assumed 55	27.6	90
BH_92772	32.65	40.5	820
BH_92771	25.85	33.09	765
BH_92770	27.27	30.44	780
BH_98218	55	20.0	40

CPTs

These CPTs are conducted approximately 20 m lower then the recent CPTs completed during our investigation. The NZGD CPTs soil classification interprets alternating sand and silt with low to moderate cone resistances (<1 to 8 MPa) in the upper 8 m bgl at the test locations. Cone resistance increased to moderate to high values (5 to >30 MPa) in the deeper soils. The odd lower result is interpreted to be interbedded layers of silt. These results are characteristic of the Hinuera Formation that increasing density with depth. Ground water was dipped from 1.2 to 4.5 m bgl however we have assessed these measurements to represent perched water within the near surface silt and sand layers.

BH_98218

This rotary core bore hole confirms the results of the CPTs described above. The log displays interbedding of silt and sand with SPT N values generally between 0 and 12 in the upper 8 to 15 m. A insitu shear vane was completed in a thick silt layer at 7.5 m and record 12/1 kPa. N values increase at 9 m bgl to more than N = 19 for the remainder of the bore hole. The sand was also more consistent with the absence of interbedded silt from RL 46. Water level was dipped at 14.5 m bgl with the drill rods still installed BH_98218. This groundwater depth may not represent a true level due to fluid being used during the drilling process. There are no comments on the time this was recorded after drilling finished.

BH_92770 to BH_92772

These bore holes were completed in the base of the Karapiro Stream gully about 800 m west of the proposed quarry site. The results of these bore holes show a possible lithology change or unconformity at an RL between 5 and 12 m from the local datum. Evidence of this change is shown in the rapid increase of SPT results where they generally are all N=50+ with comments of 'bouncing'.

Site investigation

Our site investigation included a site walkover, 4 soakage tests and 3 CPTs to 35.2, 30.9 and 29.9 respectively (to assist with the slope stability assessment).

The testing locations are shown on the site plan attached in Appendix B.

Ground conditions - CPTS

The ground conditions at the site were typically consistent with the mapped geology (Hinuera Formation). All references to soil types and strength/density states from the CPTs are based on the soil behaviour types as interpreted by the results.

Ground conditions on site consisted of:

- topsoil assumed to be up to 0.4 m below ground level (bgl)
- interbedded layers of moderately dense silt and sand to at least 17 m depth
- consistently dense to very dense sand soils to at least 35 m bgl
- CPT refusal (>30 MPa cone tip) occurred at between 30 and 35 m due to the dense sands
- A summary of CPT indicated ground conditions at the site is provided in Table 3.

Table 3: CPT summary table.

Inferred geology	Average depth to bottom of unit (m bgl)	Soil behaviour type (SBT (Robertson, 2010)	Typical CPT qc (MPa)
Topsoil	Assumed to be 0.2 to 0.4 m	Silty sand	<1
Hinuera Formation (interbedded)	17	Interbedded clay/silt and sand/silty sands	<1 to 20
Hinuera Formation (Sand)	>35	Sand and silty sand	15 to 35

[1]: m below ground level

Ground conditions – Soakage tests (ST)

The near surface ground conditions were consistent with the Hinuera Formation and consisted of:

- 0.2 to 0.4 m of topsoil overlying
- alternating layers of silt, silty sand and sand to at least 4.0 m bgl
- perched ground water was observed in ST02 to ST04 at a depth of 1.9, 2.7 and 1.6 m respectively

Groundwater

Ground water was encountered at between 2.1 and 10.5 m below ground level in the recent CPTs and 1.6 to >4.0 m in the soakage tests. The depths and associated comments are shown in Table 4.

Table 4: Ground water summary table.

CPT No.	Ground water (m bgl)	Distance to gully top of slope (closed adjacent point) (m)
CPT01	10.5	14
CPT02	2.1	440
CPT03	3.5	120
ST01	n/a	65
ST02	1.9	250
ST03	2.7	250
ST04	1.6	115

[1]: m below ground level

The soakage test results indicate there is ground water perching within the sand soils on top of the silt layers.

The CPT pore water pressure results confirm that the groundwater is perching within the upper silty sand and silt layers across the site. The pore water pressure trace on the CPT results do not show evidence of ground water in the deeper sand soils for the entire depth of the tests. We have assessed the underlying regional ground water table to be located at approximately 35 to 40 m below the existing ground level and generally trend towards the Karapiro Stream. Localised near surface perched ground water tables are present in the interbedded sand and silt layers. These perched systems will be naturally draining towards Karapiro Stream and the Waikato River.

Soakage test results

We undertook 4 falling head permeability tests in general accordance with NZBS Verification method E1/VM1 to determine the soakage capacity of the near surface soils on site. Test locations were spread evenly over the site.

We have determined preliminary percolation rates and attached the outputs in Appendix B. We understand that this data is to be used by others for their own assessments. We recommend that they review the raw data (which we have supplied) and determine/confirm the soakage rates used. We have given our assessed percolation rates in table Table 5 below.

Table 5: Percolation testing summary table.

CPT No.	Depth of test	Ground water (m bgl)	Percolation rate (mm/hr)	Preliminary design soakage rate (mm/hr)*
ST01	4.0	0	1438	718
ST02	2.0	1.9	311	155
ST03	4.0	2.7	369	184
ST04	2.0	1.6	306	153
*a 50% reduction has been applied as per the RITS[7]				

Geotechnical Assessment

This assessment is a collection of general information and advice for the site. The site is suitable for the proposed sand quarry, subject to the geotechnical recommendations in this report.

Natural hazards

- **Earthquake:** The site subsoil class is D 'Deep or soft soils'. We calculated the design peak ground acceleration for the 1 in 500-year average recurrence interval earthquake event to be 0.25 g [8] for liquefaction assessment and 0.2 g [9] for stability assessment. Earthquake induced liquefaction and lateral spreading are low risk (see 'Liquefaction' and 'slope stability' sections below).
- **Tsunami, volcanic, geothermal, or sedimentation activity:** The site is not near any known sources of these risks.
- **Landslips:** The risk from landslips is assessed to be low for the site following construction. Consideration of the proximately of the final batter in relation to surrounding property and assets (express way and power poles) will be required.
- **Erosion:** No indications of erosion were observed during the site investigation and we consider the site to be at low risk of damage due to erosion. The risk of erosion will elevate during construction of the batters as we expect groundwater seepage to occur in the near surface perched water tables. This will be in the site and good construction management will mitigate the risk.
- **Subsidence/settlement:** Risk of the site to general subsidence is low.

Liquefaction assessment

We are unable to perform a full quantitative liquefaction assessment due to the regional groundwater table being approximately 40 m below current ground level and CPT data only extending to a maximum depth of 35 m below ground level.

To understand the risk we have performed a qualitative assessment of the risk from liquefaction at the site and how this impacts the stability of the proposed final batter slope. We have based our assessment on geological and professional knowledge in the Waikato area.

[7] 'Regional Infrastructure Technical Specification' v1.0, Waikato Local Authority Shared Services, dated May 2018

[8] PGA calculated in accordance with New Zealand Transport Agency (2018) Bridge Manual (SP/M/022), Third edition, Amendment 3.

[9] PGA calculated in accordance with NZS 1170.0:2002. *Structural Design Actions—General Principles. SANZ*

Liquefaction susceptibility

Liquefaction is unlikely to occur in the sand soils above 40 m due to the absence of a regional ground water table. The CPT and bore hole testing assessed within and around the site also indicate that the deeper, older sand soils (>30m depth) are of a density that is unlikely to liquefy.

Despite the assessed low risk, for the purpose of this assessment only, we have assumed a worst-case scenario where a 10 m thick profile of the very dense sands below the water table can liquefy. We have assumed an undrained shear strength from the CPT testing for these soils during a liquefying event and used this to assess the risk of lateral spreading (see 'slope stability' below).

Liquefaction risk summary

The risk of liquefaction is expected to be low using the proposed geometry of the quarry. Further assessment can occur once the quarry floor has been exposed allowing for CPT testing to be done from a lower RL. The development of the quarry should not significantly impact the liquefaction risk for the properties around the site. If the development has any effect it will be to drain the upper, perched ground water and so reduce the risk of near surface liquefaction in the area.

Slope stability

We have conducted a quantitative slope stability assessment using the proprietary software 'SLIDE' based on-site observations, aerial photography, a site-specific survey [10]and our experience in the area. Slope angles along the natural gully slope are between 35 and 40 degrees. Material parameters for our model were determined from site test information (CPT corelation), our experience in the area and from back assessment of the existing slopes. The parameters adopted are shown on the model outputs which are presented in Appendix D.

The Factor of Safety (FoS) requirements for the final geometry are:

- no less than 1.5 for long term, normal, static conditions
- no less than 1.2 for short term, seismic, and high groundwater conditions
- no less than 1.0 for liquefied (lateral spreading) conditions
    - >1.0 assumes no deformation has occurred

Aerial imagery assessment

The slopes adjacent to the site appear relatively stable with no signs of recent instability. Near surface soil creep is present.

Aerial images indicate that an area of historical instability is located to the west of CPT01. The surface expression (circular type scarp) and longer, shallower slope angles at the base of the slope indicted failures have occurred in the past (> 80 years, before the earliest aerial images available). The heavy vegetation that is now present may indicate this is where localised groundwater has been seeping and causing the slope to regress further compared to the surrounding slopes. This vegetation will now be providing additional stability to the shallow soils.

Back assessment

Aerial imagery, and the geomorphology (downcut stream gully in alluvial materials) indicates the slopes are marginally stable and may experience failures during higher ground water conditions or due to undermining of the slopes. By assessing the current slope geometry, we were able to iterate our model until representative FoS values were achieved. A FoS of just over 1.0 during long term,

[10] DWG file obtained via email. From Fulton Hogan, dated 8 December, file ref: 6359-01-ROT.dwg

normal ground water, conditions and slightly less than 1.0 in short term, high ground water, conditions was used as representative of the current slope conditions.

The results from this back assessment using the existing slope geometry provides validation on the soil parameters adopted for the assessment of the proposed batters.

Proposed final batter

The scheme plan[11] provided indicates that the final batter is 3H:1V and will be approximately 35 m high. The FoS values achieved for each assessment scenario are summarised in Table 6.

Table 6: Slope stability summary table - proposed final batter.

Scenario	FoS required (min)	FoS achieved (min)
Long term, normal GWT conditions	1.5	2.2
Short term, high GWT conditions	1.2	1.8
Short term, seismic, undrained	1.2	1.5
Short term, liquified (worst case)	1.0 (=no deformation)	1.0

The results above indicate that the proposed 3H:1V final batter has FoS values above those required in all scenarios.

Lateral spreading

We assessed the risk of lateral spreading for a worst-case scenario by adopting liquefied soil parameters for 10 m below and assumed groundwater level at 40 m. The undrained cohesion for these soils is a function of confining stress and therefore the model represents this.

We consider the site to have a low risk of lateral spreading as the liquefied model indicates a FoS of 1 is achieved using a qualitatively assessed conservative model. A FoS of 1 or greater indicates that instability from lateral spreading has not occurred.

Slope stability discussion

Main quarry excavation

We have completed the slope stability assessment for the site using on site and off site data with professional judgment used to determine the slope and subsurface geometry and soil parameters.

The results above indicate that the proposed 3H:1V final batter has FoS values above those required in all scenarios and therefore the risk from instability is low. The changes to the property are unlikely to affect any of the surrounding properties or infrastructure if the quarry is constructed as per the current scheme plans.

Due to the scale of excavation and assumptions made within this assessment, a BRZ of 10 m should still be applied to the top of final quarry batter. This BRZ should be applied to bunds, power poles

[11] Updated Quarry Plans and Plant Area (June 2022), supplied by Michael Briggs (Kinetic), email dated 30/06/2022

and other infrastructure. Any future development or earthworks proposed within this 10 m zone should be assessed by a geotechnical engineer.

We have assumed the bund will have steep (50 deg) batters. We recommend that the soils used are well compacted and the bund is re-vegetated to mitigate erosion. Small scale slumping may occur but can be remediated with an excavator when required. Any small-scale failures of the bund will not affect the quarry.

Our assessment does not include comment on the temporary batters and benches that are proposed during the construction of the quarry as this is beyond the scope of our works.

Processing area

The processing area is proposed to be located along the top of a side gully to the Karapiro Stream. The 3 m high bund will need to be set back from the top of the slope so it does not have a negative affect on the stability of the existing slope. The 10 m BRZ discussed above will be appropriate for preliminary planning. However, this can likely be reduced during the detailed design for the operations phase of the project.

The water storage pond must be lined with a impermeable membrane to stop any water soakage. If water is allowed to soak into the underlying sand soils, it may decrease the stability of the surrounding slopes.

Power pylon

A power pylon is located approximately 15 m from the existing top of slope at the head of the tributary to Karapiro Stream. The development plans show no modification to the slopes surrounding this pylon. The construction of the quarry will not have a negative effect on the power pylon.

Groundwater modification

The construction of the final batter is likely to cause the perched water system in the near surface silt and sand soils to drain. This may cause localised erosion and instability. However, the scale of any failure will be small and can be controlled with appropriate dewatering and or erosion control techniques during construction. Details will be determined during the detailed assessment and design stage of the quarry.

We expect that the regional ground water table will be lower than the base of the final quarry RL.

Settlement

During the construction of the quarry, de-watering of the perched water table system may occur. We have completed a settlement screening assessment to assess the potential effects of any draw down that may occur.

We have assessed a worst-case ground water draw down of 2 to 3 m may occur. This change equates to a change in effective stress of between 20 and 30 kPa. This change in stress may cause between 20 to 30 mm of settlement in the silt layer at between 7 to 9 m below the current ground level. Due to the current geometry of the area with gullies and tributaries present, it is expected that if any settlement does occur, it will be localised to the quarry property only.

Further work

Further assessment will be required if the geometry and or location of the batters and or bunds are moved during the detailed design stage of the project. Geotechnical input will be needed during operation of the quarry for staging and temporary batter slopes and for any structures.

Summary

Based on our assessment, the proposed sand quarry is unlikely to cause any adverse geotechnical effects on the adjacent properties, subject to the following recommendations:

- the final batters are constructed at 3H:1V or
- further assessment occurs for any change in geometry
- the slope geometry around the power paillon will remain unchanged and therefore current stability will be unaffected
- the bund should be well compacted and vegetated to mitigate erosion
- groundwater seepage must be controlled appropriately to avoid erosion
- the water storage pond in the processing area must be fully lined
- the processing plant bunds will need specific assessment to determine how close they can be constructed to the surrounding slopes

Limitation

This report has been prepared for our client, RS Sand, their professional advisers, and the relevant local authority for the purposes detailed above and may not be relied on by any other party for any other purposes. This report contains a preliminary assessment to establish any possible geotechnical end effects that may occur during the construction of a sand quarry based on a site walkover and testing in discrete locations. Inferences about the conditions at the site have been made based on the testing undertaken and our understanding of the highly variable geological environment in which the site lies.

Further geotechnical input will be required during the construction and operation or if any structures are to be built.

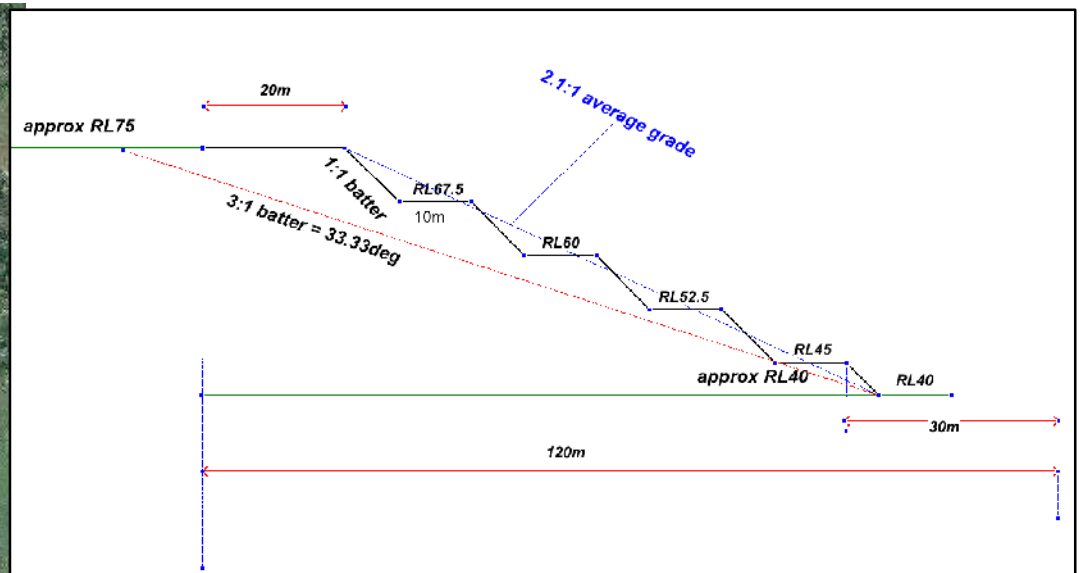
APPENDIX A – SITE PLANS

Site development plans

Newcombe Road entrance and Area A staging

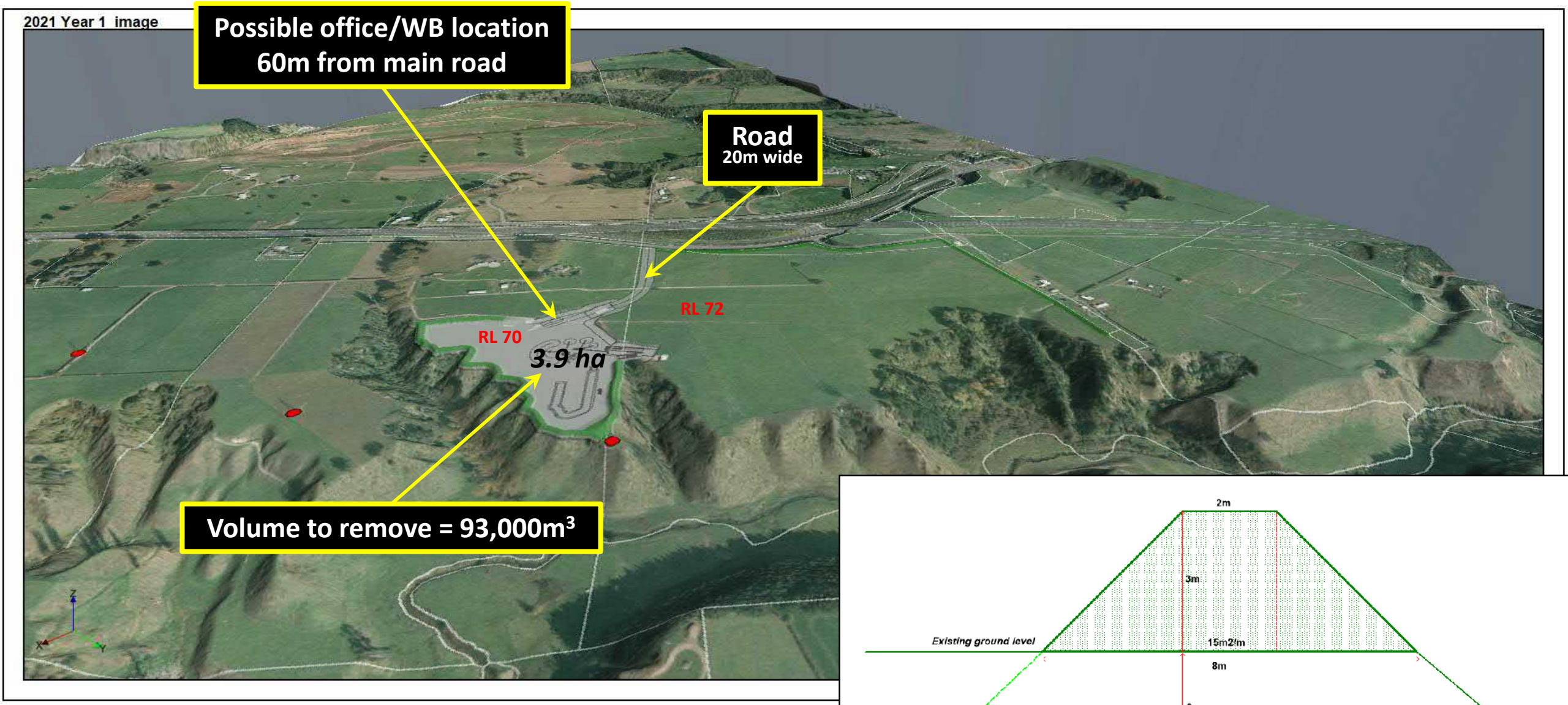
Key points

- Yellow lines indicative only
- Batters on the yellow lines reflect interim batters (see figure below)
- Batters on the outer edges which = the contours shown are 3:1
- Sales are estimated at 300,000tpa
- Sand density used = 1.8t/m^3
- Have assumed RL 67.5 = top of sand everything above this is a 50-50 split between overburden and pit sand
- Balance = concrete sand approx. 27.5m



RS Sand – Quarry Planning
As surveyed June 2020

RS Sand – Quarry Planning
Processing area and bunds

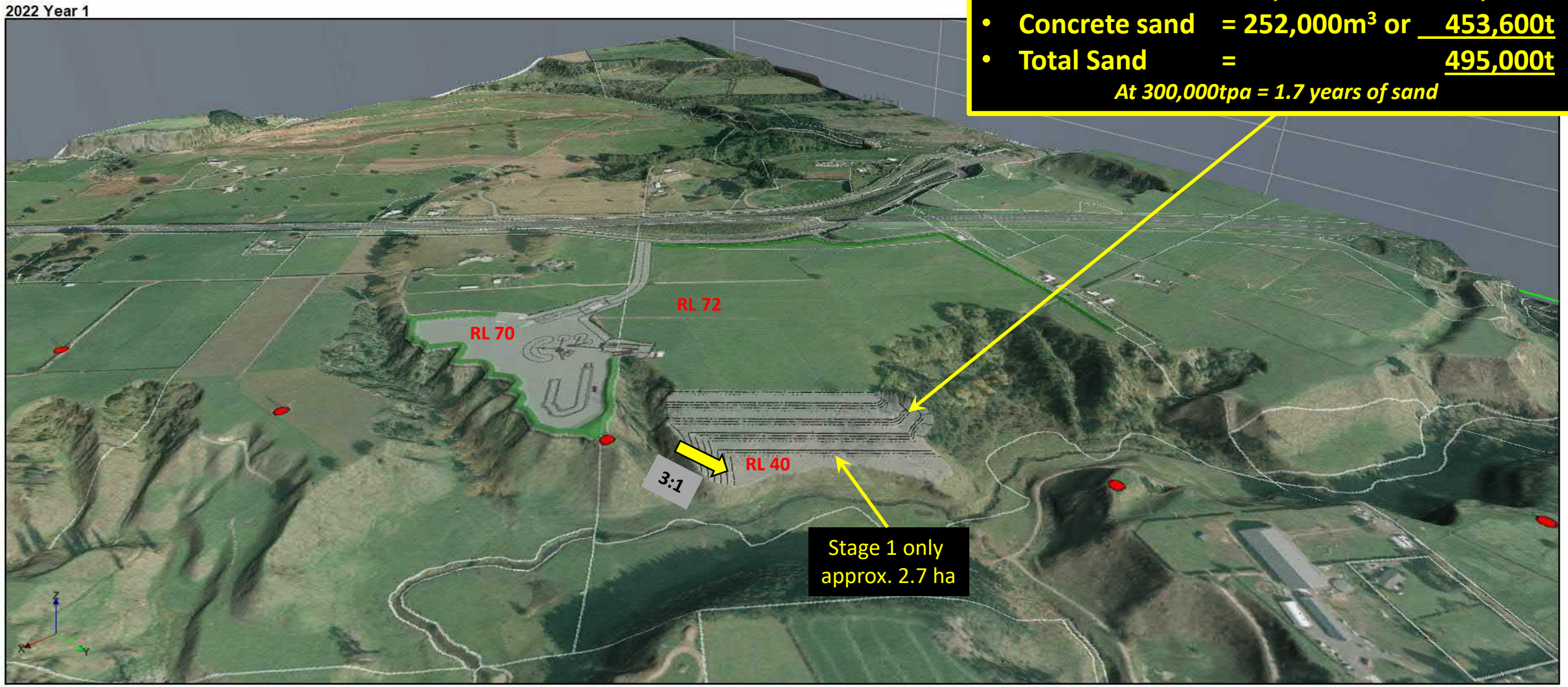


RS Sand – Quarry Planning

Stage 1 – **Years 1 to 1.7**

- **Overburden = 23,000m³**
- **Pit sand = 23,000m³ or 41,4000t**
- **Concrete sand = 252,000m³ or 453,600t**
- **Total Sand = 495,000t**

At 300,000tpa = 1.7 years of sand



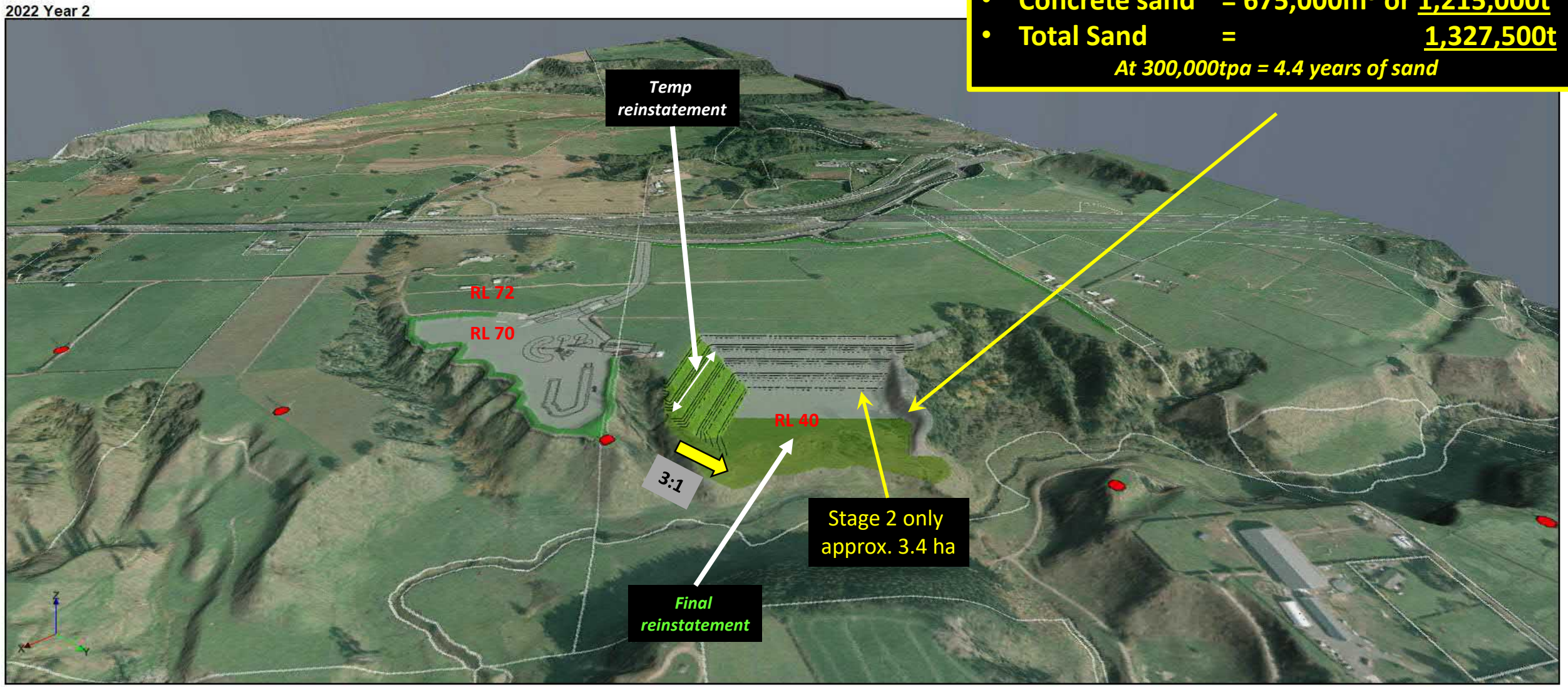
Viewpoint at the end of each stage – including reinstatement

RS Sand – Quarry Planning

Stage 2 – **Years 1.7 to 6.1**

- **Overburden = 62,500m³**
- **Pit sand = 62,500m³ or 112,500t**
- **Concrete sand = 675,000m³ or 1,215,000t**
- **Total Sand = 1,327,500t**

At 300,000tpa = 4.4 years of sand

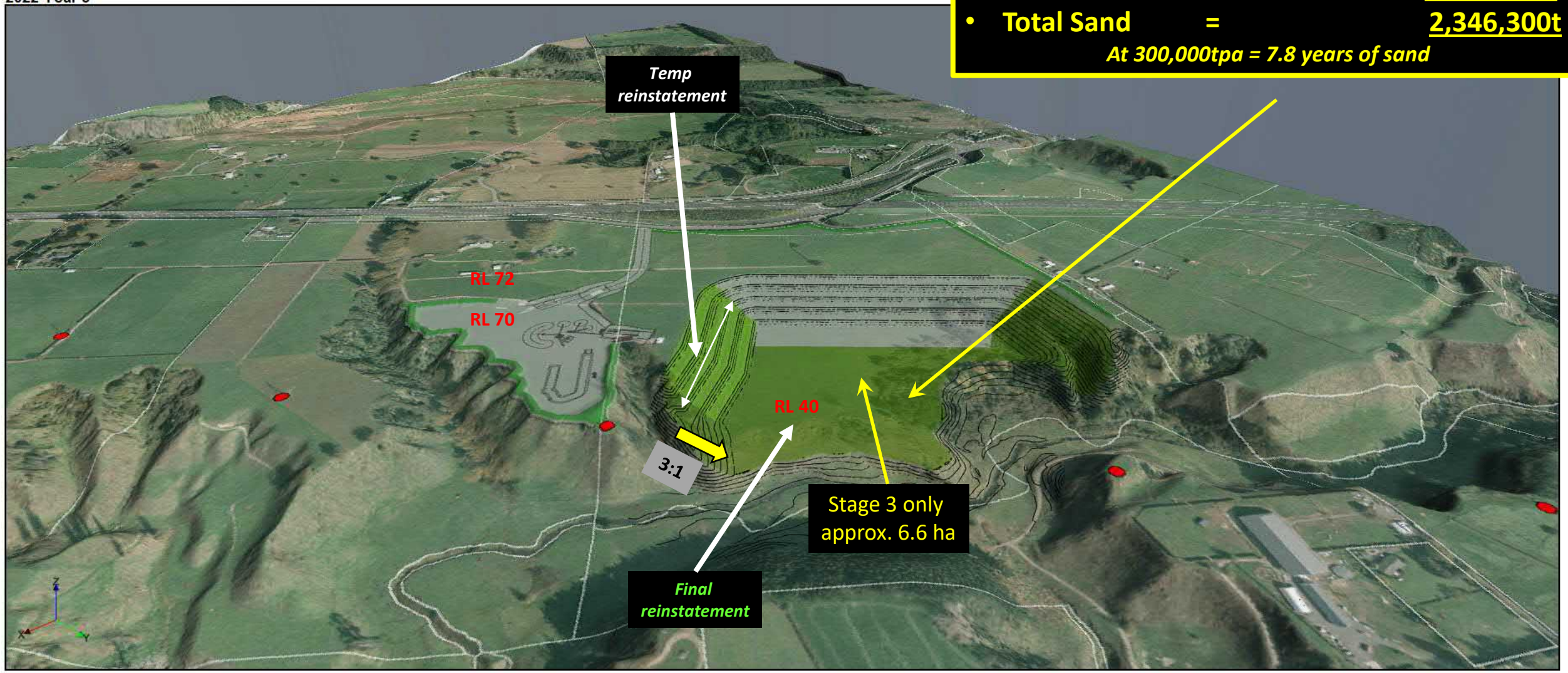


Viewpoint at the end of each stage – including reinstatement

RS Sand – Quarry Planning
Stage 3 – **Years 6.1 to 13.9**

- **Overburden = 105,500m³**
- **Pit sand = 105,500m³ or 189,900t**
- **Concrete sand = 1,198,000m³ or 2,156,400t**
- **Total Sand = 2,346,300t**

At 300,000tpa = 7.8 years of sand

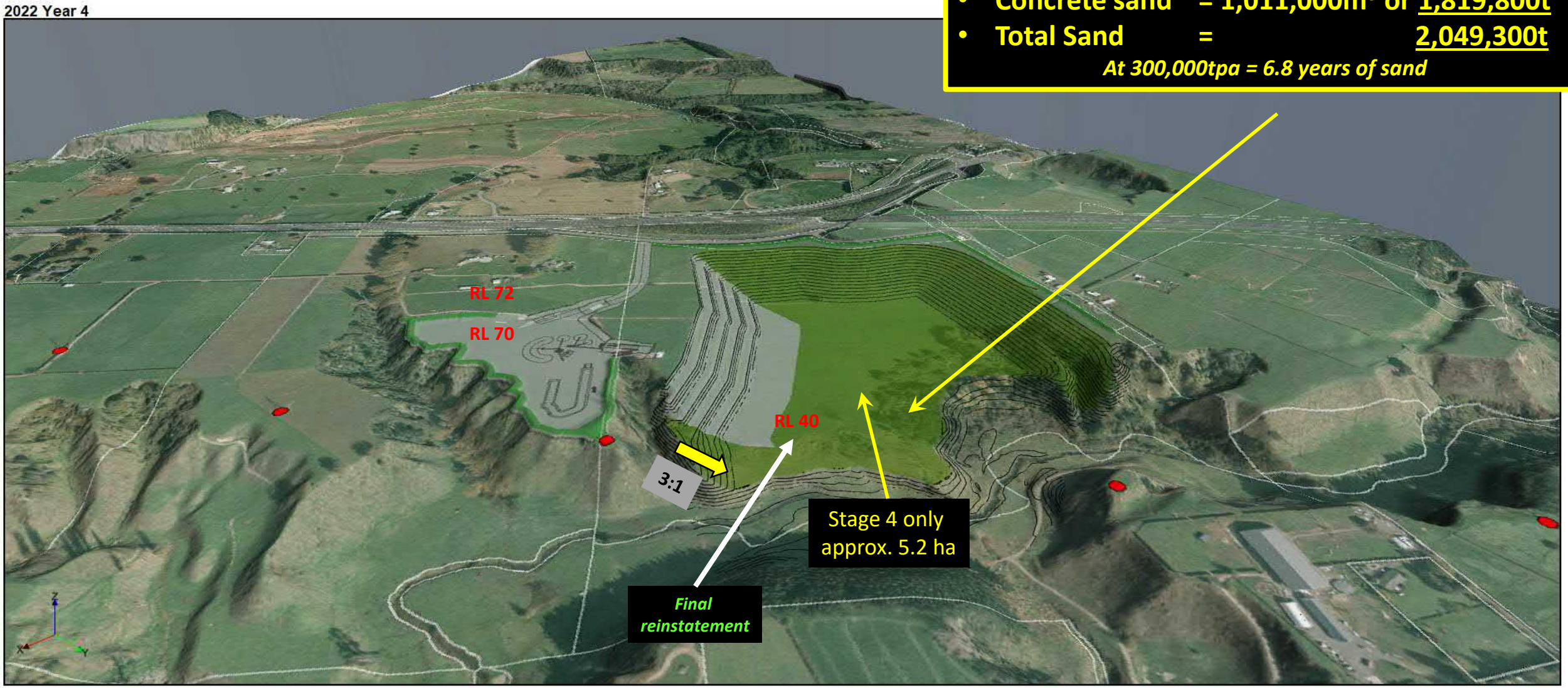


Viewpoint at the end of each stage – including reinstatement

RS Sand – Quarry Planning
Stage 4 – **Years 13.9 to 20.7**

- **Overburden = 127,500m³**
- **Pit sand = 127,500m³ or 229,500t**
- **Concrete sand = 1,011,000m³ or 1,819,800t**
- **Total Sand = 2,049,300t**

At 300,000tpa = 6.8 years of sand



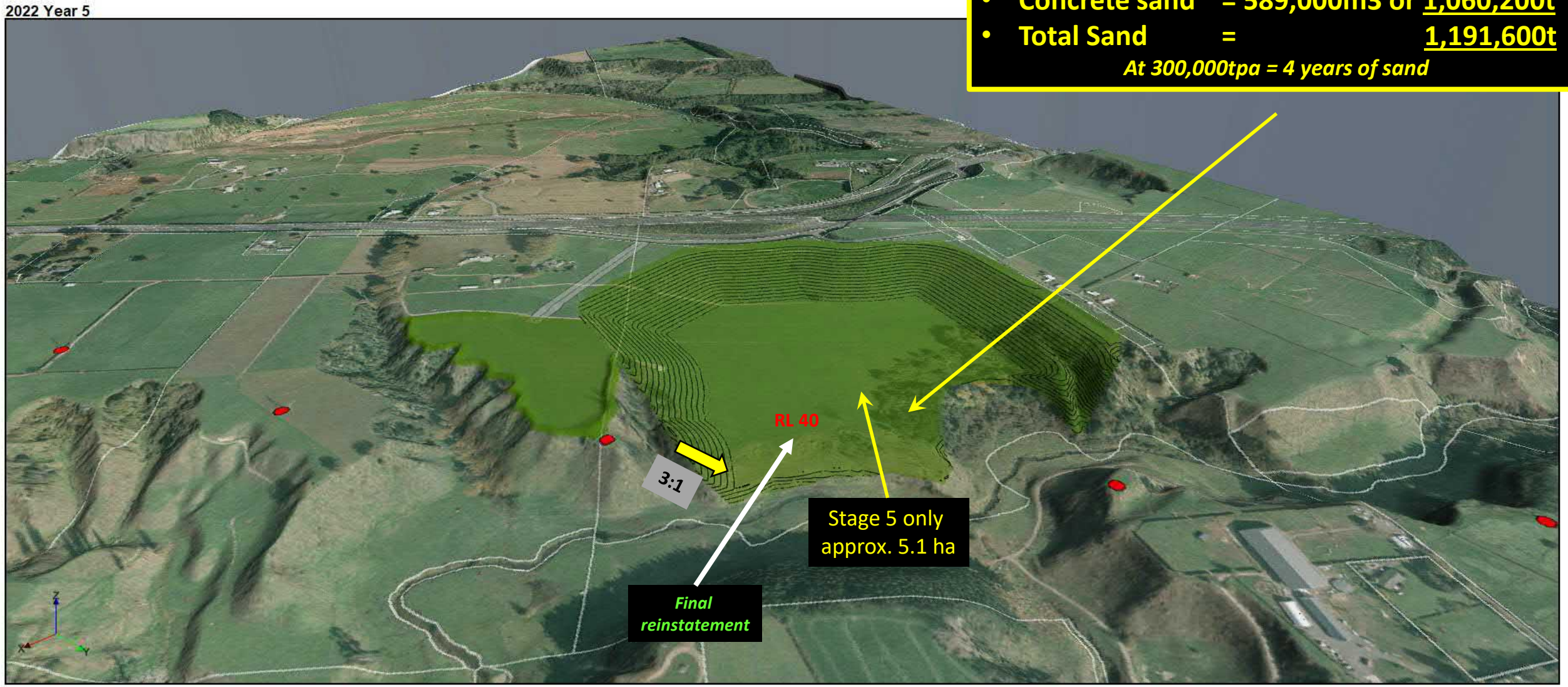
Viewpoint at the end of each stage – including reinstatement

RS Sand – Quarry Planning

Stage 5 – **Years 20.7 to 24.7**

- **Overburden = 73,000m³**
- **Pit sand = 73,000m3 or 131,400t**
- **Concrete sand = 589,000m3 or 1,060,200t**
- **Total Sand = 1,191,600t**

At 300,000tpa = 4 years of sand



Viewpoint at the end of each stage – including reinstatement

Summary

	m3			t			years
	Overburden	Pit sand	Concrete Sand	Pit sand	Concrete Sand	Subtotal	
Stage 1	23,000	23,000	252,000	41,400	453,600	495,000	1.65
Stage 2	62,500	62,500	675,000	112,500	1,215,000	1,327,500	4.43
Stage 3	105,500	105,500	1,198,000	189,900	2,156,400	2,346,300	7.82
Stage 4	127,500	127,500	1,011,000	229,500	1,819,800	2,049,300	6.83
Stage 5	73,000	73,000	589,000	131,400	1,060,200	1,191,600	3.97
Sub total	391,500	391,500	3,725,000	704,700	6,705,000	7,409,700	24.70
Totals			**4,508,000**		**7,409,700**		**24.70**

APPENDIX B – SITE INVESTIGATION

Site plan

CPTs (recent)

Soakage testing (ST)

CPTs (NZGD)

Bore Holes (NZGD)

LEGEND

Bore Hole (BH)

Cone Penetrometer test (CPT)

Soakage test

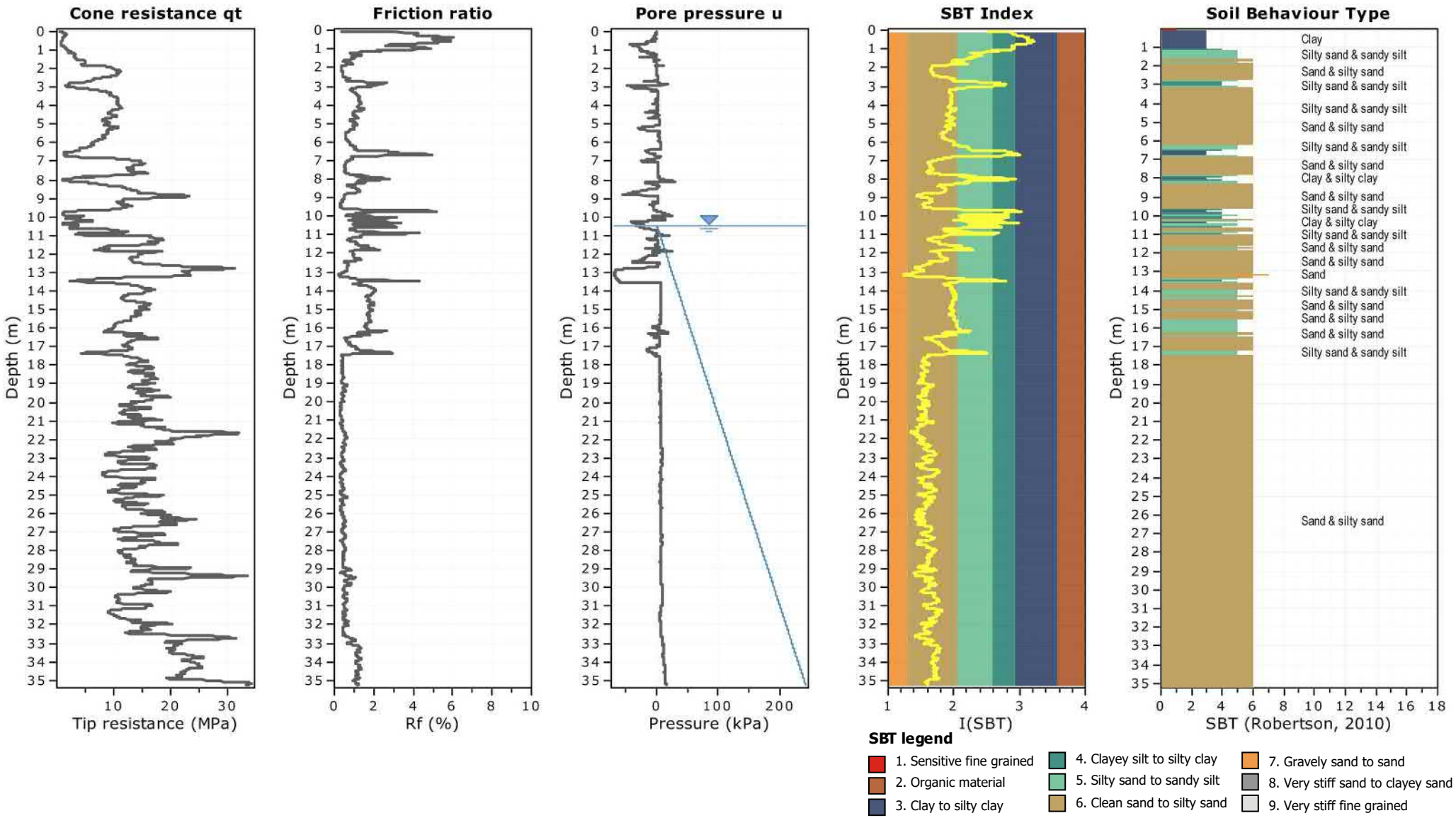
Notes:
1) Site plan supplied by RS Sand

PROJECT: 77 Newcombe Road, Cambridge	
PROJECT No: HD1684	
CLIENT: RS Sand	
TITLE: Site investigation plan	
SCALE: N/A	
Drawing No: 01	
Drawing By: HJ	
Rev no:	
1	updated– 08.08.2022

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

CPT: HD1684 - CPT01
Total depth: 35.25 m, Date: 4/12/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1684 - RS Sand**
Location: **77 Newcombe Road, Cambridge**

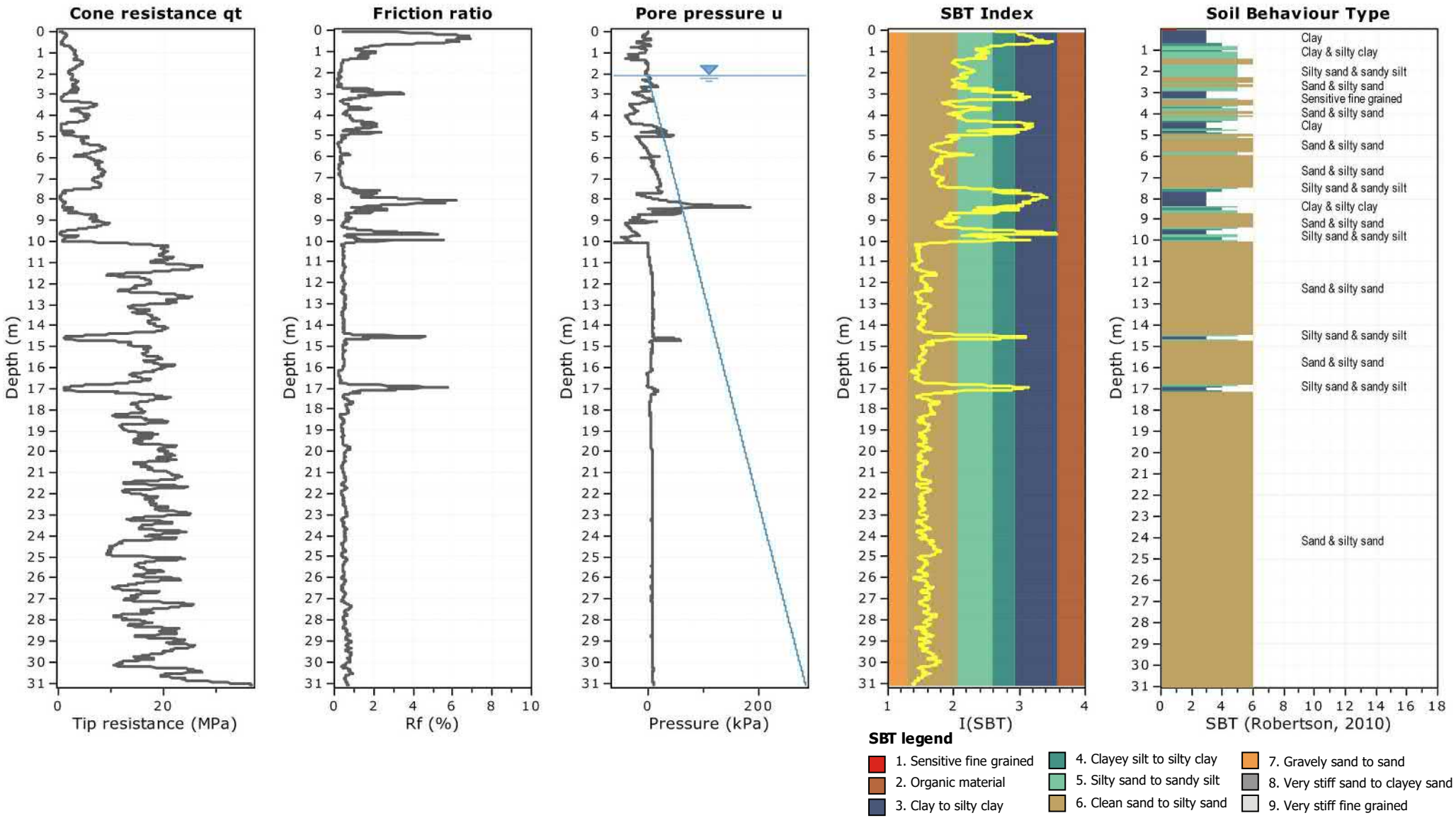


Project file: C:\Users\HunterJenkinson\HD Geo\HD1684 77 Newcombe Rd Cambridge - Documents\04 Assessment and design\CPET\HD1684 - 77 Newcombe Road, Cambridge.cpt

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

CPT: HD1684 - CPT02
Total depth: 31.10 m, Date: 4/12/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1684 - RS Sand**
Location: **77 Newcombe Road, Cambridge**

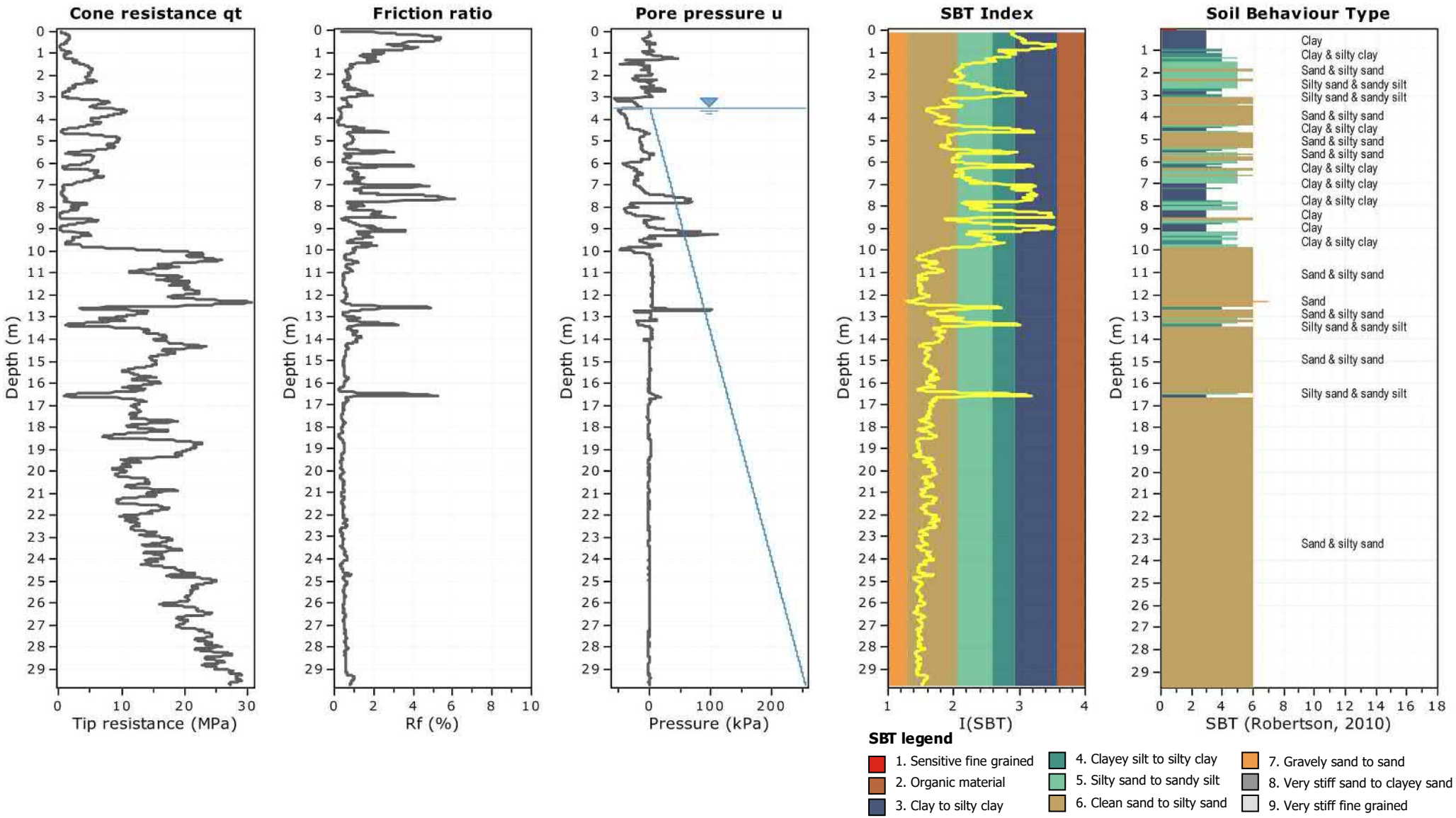


Project file: C:\Users\HunterJenkinson\HD Geo\HD1684 77 Newcombe Rd Cambridge - Documents\04 Assessment and design\CPET\HD1684 - 77 Newcombe Road, Cambridge.cpt

HD Geo
PO Box 9266
Waikato Mail Centre, Hamilton
www.hdgeo.co.nz

CPT: HD1684 - CPT03
Total depth: 29.73 m, Date: 4/12/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1684 - RS Sand**
Location: **77 Newcombe Road, Cambridge**



Project file: C:\Users\HunterJenkinson\HD Geo\HD1684 77 Newcombe Rd Cambridge - Documents\04 Assessment and design\CPET\HD1684 - 77 Newcombe Road, Cambridge.cpt

INVESTIGATION LOG

Client:	RS Sand	**Job No.:**	HD1684
Project:	77 Newcombe Road, Cambridge	**No.:**	ST01
Location:	North of center of site	**Date:**	09.12.21
Co-ordinates:	1820564mE, 5803184mN	**Logged By:**	JS/SW
Elevation:	Ground	**Checked By:**	MM

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL (TS); dark blackish brown. Moist; trace rootlets.	0.2
Hinuera Formation	SILT, with minor sand; brown. Moist; uniformly graded; sand, fine. 0.4 m - 0.9 m: light brown.	0.4
		0.6
		0.8
	SILT, with minor sand; orangeish brown. Moist; uniformly graded; sand, fine. 0.9 m - 1.1 m: iron staining.	1.0
	Silty SAND; light brownish grey. Moist; uniformly graded; sand, fine.	1.2
		1.4
	SAND, with minor silt; grey. Moist; uniformly graded; sand, fine.	1.6
		1.8
		2.0
		2.2
	SAND, with trace silt; greyish. Moist; uniformly graded; sand, fine.	2.4
	Silty SAND; grey mottled orange. Wet; uniformly graded; sand, fine.	2.6
		2.8
		3.0
	SILT; grey, mottled orange. Moist; high plasticity. 3.3 m: slight iron staining.	3.2
		3.4
	SAND, with trace silt; grey. Moist; uniformly graded; sand, fine.	3.6
		3.8
	EOH: 4.00 m	4.0

Legend

Scala Penetrometer (Blows / 100 mm): 2 4 6 8 10 12 14 16 18

Vane Shear Strength (kPa) — Vane: 50 100 150 200 250

Water: Groundwater Not Encountered

Photo

Remarks

End of borehole at 4.0 meters_ target depth achieved

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD1684
No.:	ST02
Client:	RS Sand
Project:	77 Newcombe Road, Cambridge
Location:	South east of center of site
Co-ordinates:	1820501mE, 5803012mN
Elevation:	Ground
Date:	09.12.21
Logged By:	JS/SW
Checked By:	MM

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark blackish brown. Moist; trace rootlets.	0.2
Hinuera Formation	SILT, with minor sand; brown. Moist; uniformly graded; sand, fine.	0.4
		0.6
	Silty SAND; light grey. Moist to wet; uniformly graded; sand, fine.	0.8
		1.0
		1.2
		1.4
	SAND; brown. Wet, sensitive; well graded; sand, fine to coarse.	1.6
	1.5 m - 1.6 m: iron staining.	
		1.8
	1.9 m: saturated.	
	EOH: 2.00 m	2.0

Legend

Scala Penetrometer (Blows / 100 mm): 2 4 6 8 10 12 14 16 18

Vane Shear Strength (kPa) Vane: 50 100 150 200 250

Water: 1.9 m

Photo

Remarks

End of borehole at 2.0 meters_ target depth not achieved_ repeated hole collapse_ collapsed to 1.8 meters

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD1684
Client:	RS Sand
No.:	ST03
Project:	77 Newcombe Road, Cambridge
Location:	South west of center of site
Date:	09.12.21
Co-ordinates:	1820403mE, 5803082mN
Logged By:	JS/SW
Elevation:	Ground
Checked By:	MM

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark blackish brown. Moist; trace rootlets.	0.2
Hinuera Formation	SILT, with minor sand; light brownish orange. Dry to moist; non-plastic; sand, fine to medium.	0.4
		0.6
	SAND, with minor silt; light brown yellow. Moist; uniformly graded; sand, fine.	0.8
		1.0
	SAND, with trace gravel; light brown. Moist; well graded; sand, fine to coarse; gravel, fine, subangular.	1.2
		1.4
	SILT, with minor sand; whiteish grey, mottled orange. Wet; low plasticity; sand, fine.	1.6
		1.8
	SAND, with minor silt; grey. Wet to saturated; uniformly graded; sand, fine.	2.0
		2.2
		2.4
		2.6
	2.7 m: saturated	2.8
		3.0
		3.2
		3.4
		3.6
		3.8
	EOH: 4.00 m	4.0

Legend

Scala Penetrometer (Blows / 100 mm): 2 4 6 8 10 12 14 16 18

Vane Shear Strength (kPa) Vane: 50 100 150 200 250

Water: 2.7 m

Photo

Remarks

End of borehole at 4.0 meters_ target depth achieved_ due to hole collapse separate borehole drilled to 2.0 meters for soakage test

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

INVESTIGATION LOG

Job No.:	HD1684
No.:	ST04
Client:	RS Sand
Project:	77 Newcombe Road, Cambridge
Location:	South eastern side of site
Co-ordinates:	1820241mE, 5803136mN
Elevation:	Ground
Date:	09.12.21
Logged By:	JS/SW
Checked By:	MM

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend
Topsoil	TOPSOIL; light brown. Dry to moist. 0.2 m: becomes dark blackish brown	0.2 0.4	TS
Hinuera Formation	Silty SAND; light greyish brown. Moist; uniformly graded; sand, fine.	0.6 0.8 1.0	
	SAND, with minor silt; light greyish brown. Moist to wet; uniformly graded; sand, fine.	1.2 1.4 1.6	
	SAND, with trace gravel; grey. Saturated; well graded; sand, fine to coarse; gravel, fine, subrounded.	1.8	
	SAND, with minor silt, with trace gravel; grey. Saturated; uniformly graded; sand, fine to coarse; gravel, fine, subrounded.		
	SAND, with trace gravel; grey. Saturated; well graded; sand, fine to coarse; gravel, fine, rounded to subrounded, pumice.	2.0	
	EOH: 2.00 m		

Scala Penetrometer (Blows / 100 mm): 2, 4, 6, 8, 10, 12, 14, 16, 18

Vane Shear Strength (kPa) Vane: 50, 100, 150, 200, 250

Water: 1.6 m

Photo

Remarks

End of borehole at 2.0 meters_ target depth not achieved_ saturation and ground water causing collapse

Shear Vanes
- Peak
- Remoulded

Water
- Standing Water Level
- Out flow
- In flow

Investigation Type
- [x] Hand Auger
- [ ] Investigation Pit
- [ ] Machine Borehole

Job name	77 Newcombe Road
Job number	HD1684
Date	13/12/2021
Plotted by	JS
Reviewed by	TY

Perc test results

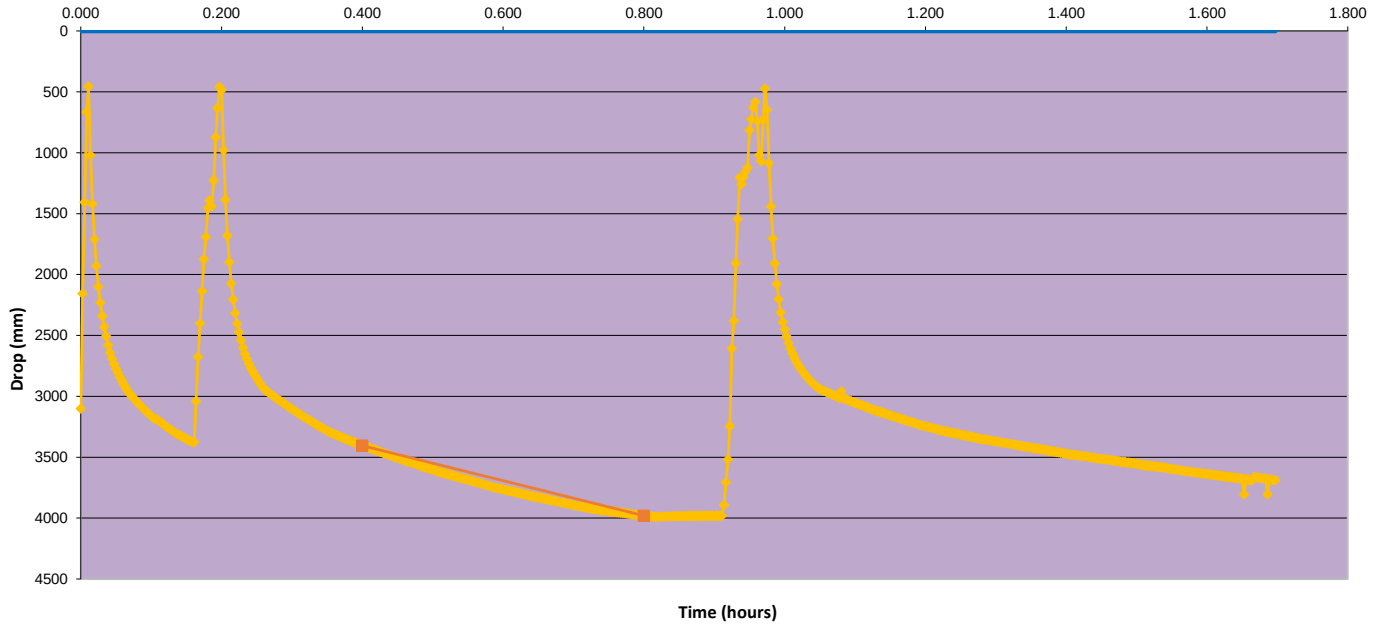
ST01

Calculated in general accordance with E1/VM1 - Surface Water, Section 9.0

Hole depth: 4.000 m

Ground water depth: m

Notes:



Percolation rate calculation:

Time (Hour)	Drop (mm)	
0.40	3405	Minimum slope (lower)
0.80	3980	Minimum slope (upper)

Percolation rate = 1438 mm/hr

50% Percolation rate = **718 mm/hr**

Job name	77 Newcombe Road
Job number	HD1684
Date	13/12/2021
Plotted by	JS
Reviewed by	TY

Perc test results

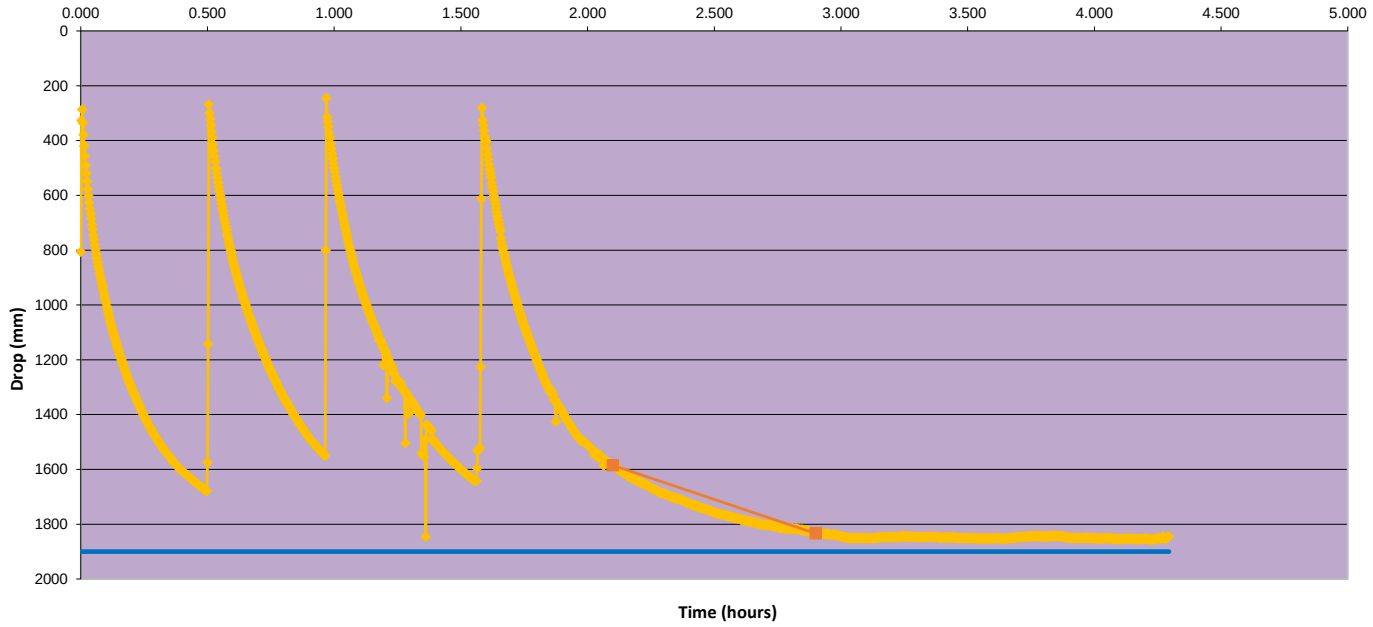
ST02

Calculated in general accordance with E1/VM1 - Surface Water, Section 9.0

Hole depth: 1.850 m

Ground water depth: 1.9 m

Notes:



Percolation rate calculation:

Time (Hour)	Drop (mm)	
2.10	1585	Minimum slope (lower)
2.90	1834	Minimum slope (upper)

Percolation rate = 311 mm/hr

50% Percolation rate = **155 mm/hr**

Job name	77 Newcombe Road
Job number	HD1684
Date	13/12/2021
Plotted by	JS
Reviewed by	TY

Perc test results

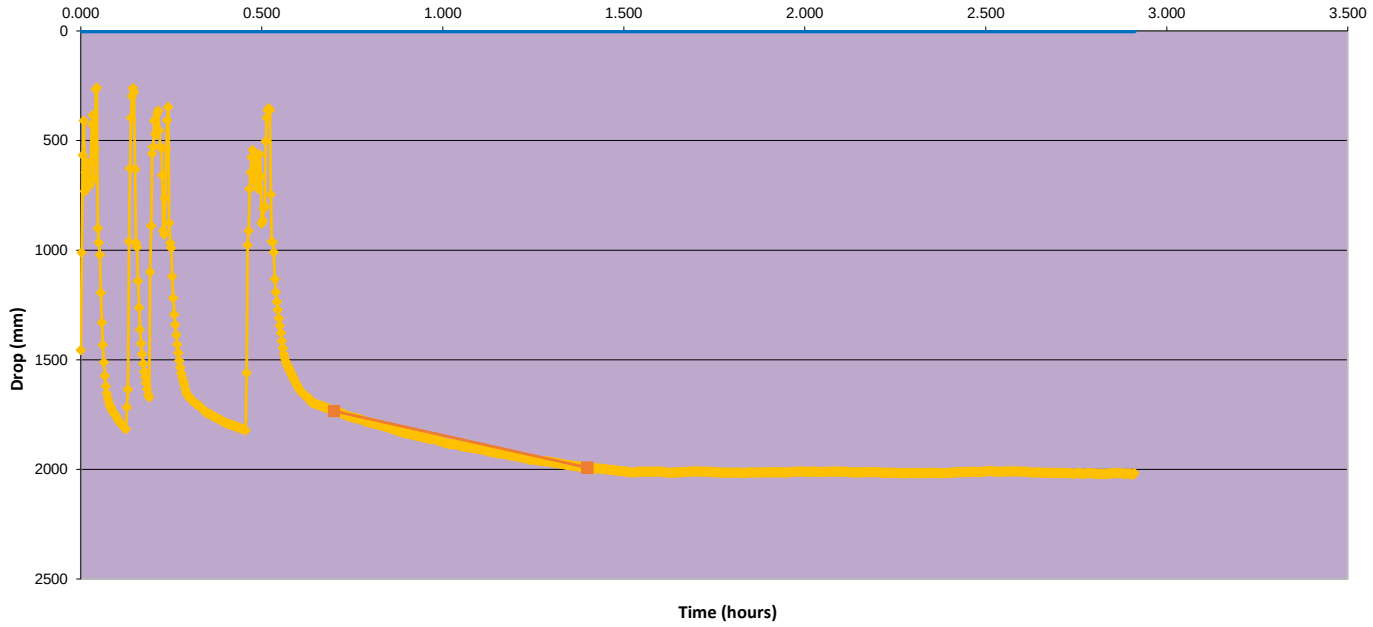
ST03

Calculated in general accordance with E1/VM1 - Surface Water, Section 9.0

Hole depth: 2.000 m

Ground water depth: m

Notes:



Percolation rate calculation:

Time (Hour)	Drop (mm)	
0.70	1734	Minimum slope (lower)
1.40	1992	Minimum slope (upper)

Percolation rate = 369 mm/hr

50% Percolation rate = **184 mm/hr**

Job name	77 Newcombe Road
Job number	HD1684
Date	13/12/2021
Plotted by	JS
Reviewed by	TY

Perc test results

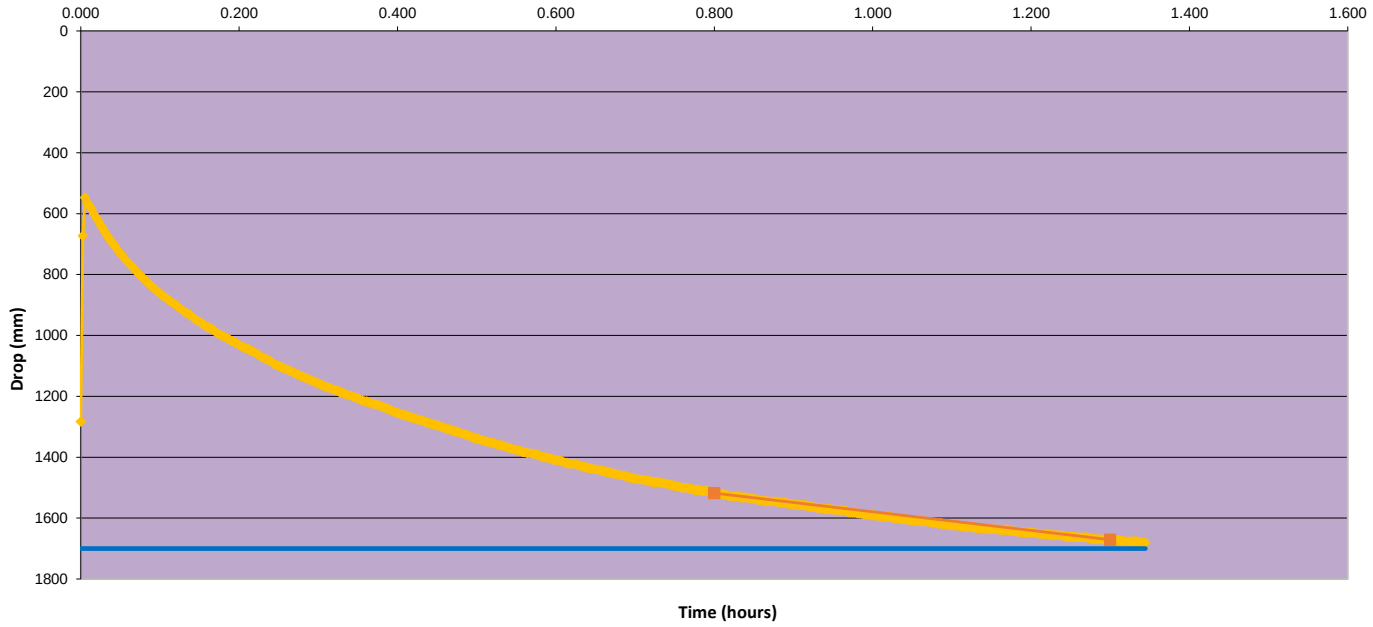
ST04

Calculated in general accordance with E1/VM1 - Surface Water, Section 9.0

Hole depth: 2.000 m

Ground water depth: 1.7 m

Notes:

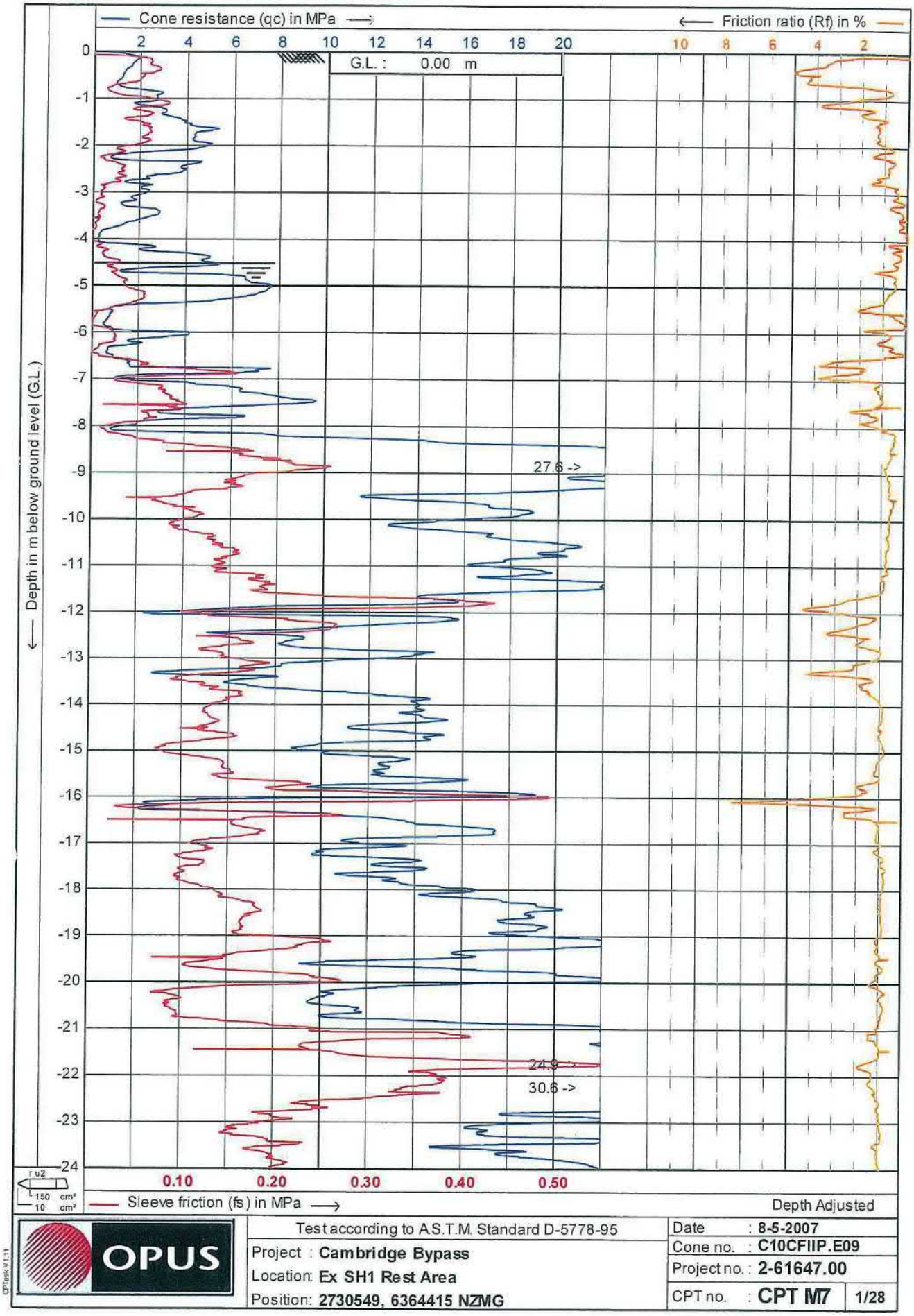


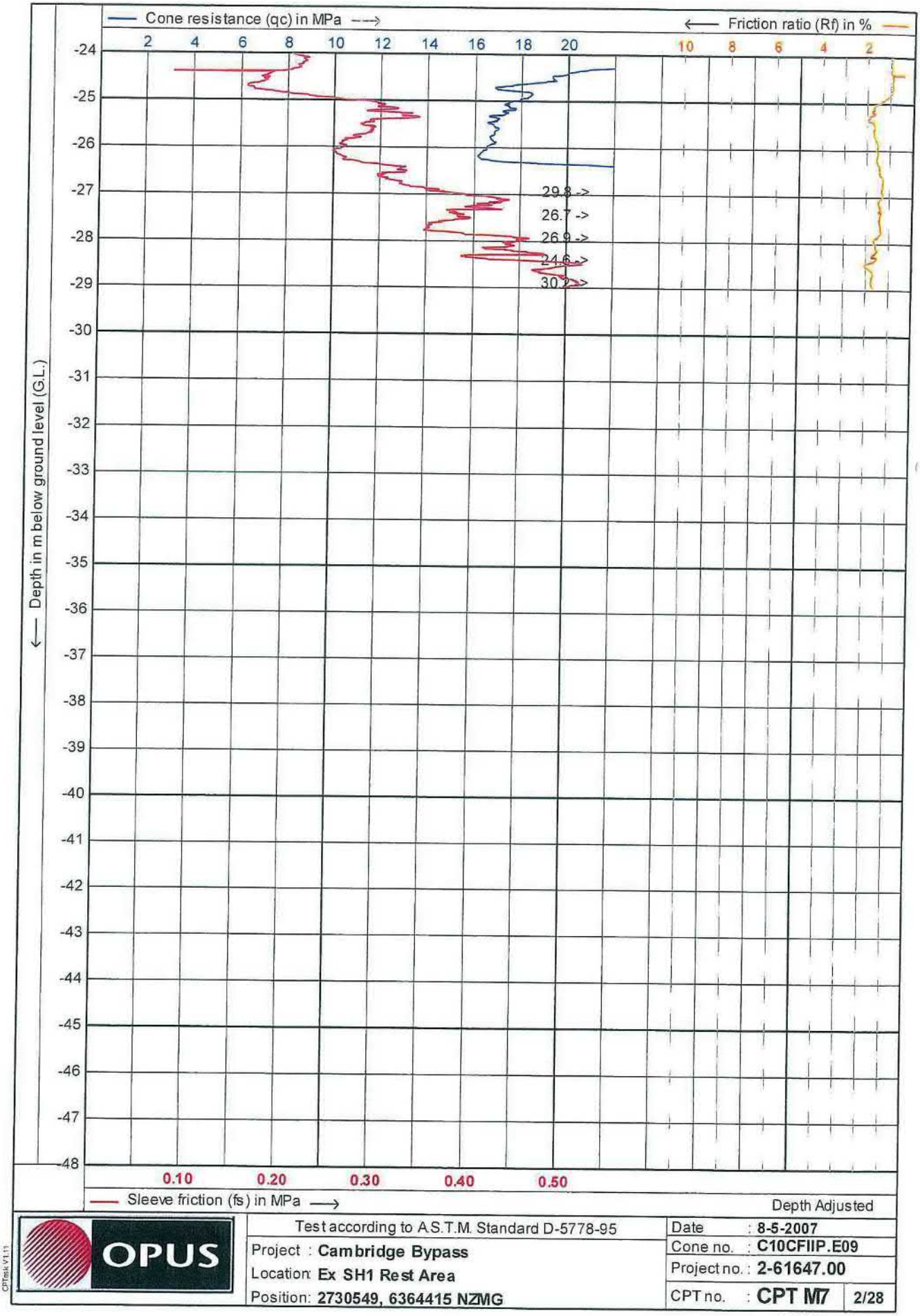
Percolation rate calculation:

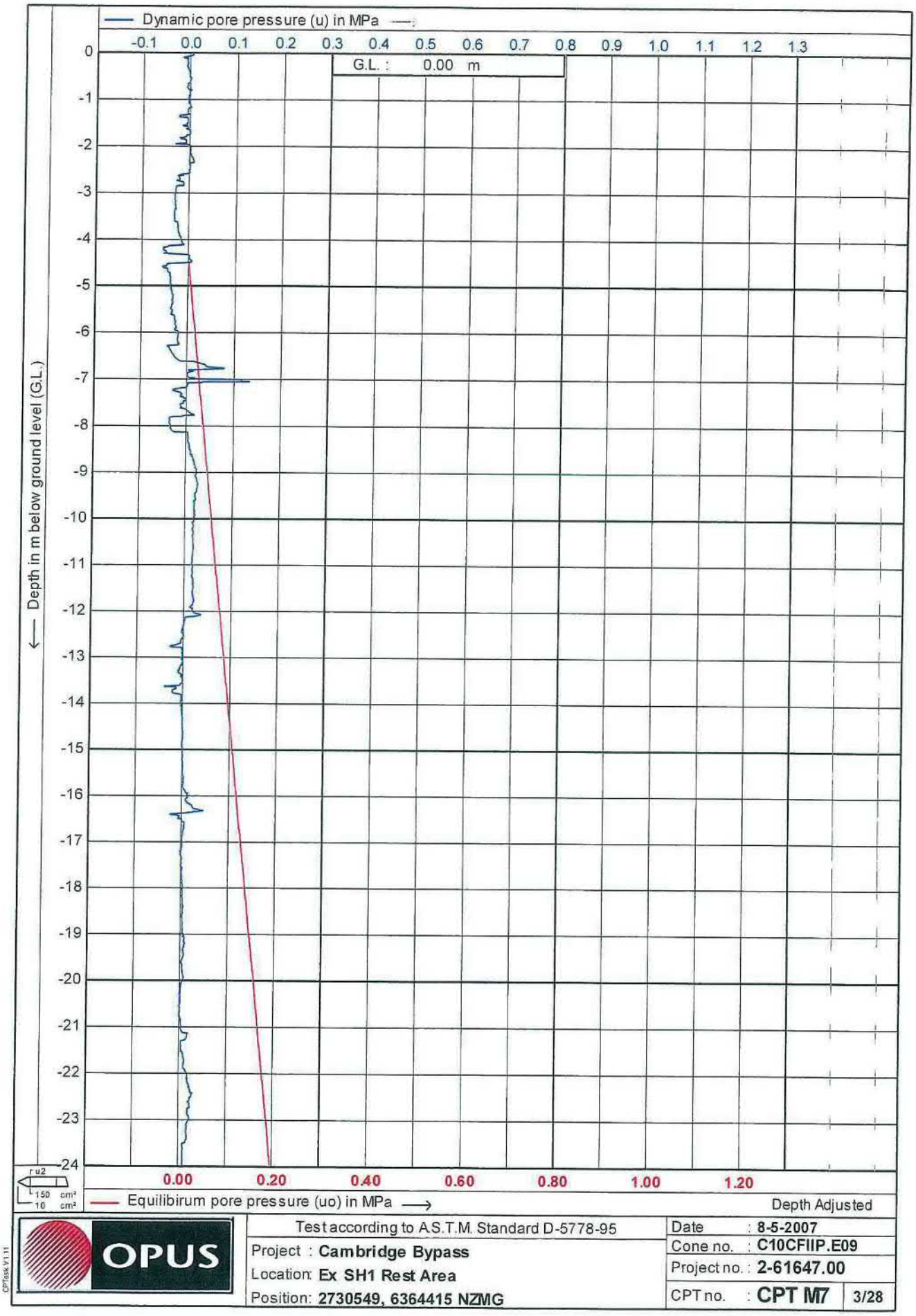
Time (Hour)	Drop (mm)	
0.80	1518	Minimum slope (lower)
1.30	1671	Minimum slope (upper)

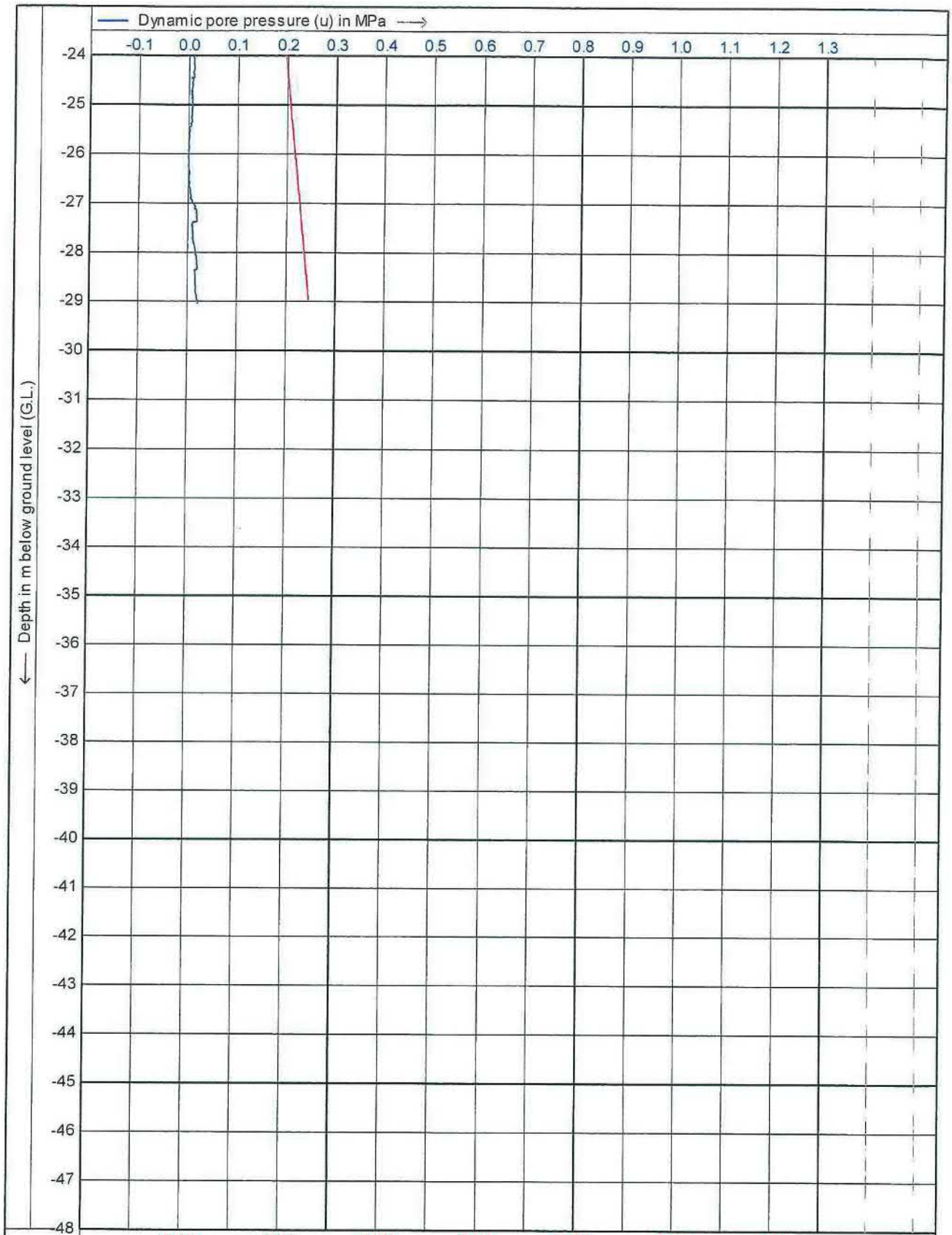
Percolation rate = 306 mm/hr

50% Percolation rate = **153 mm/hr**









OPUS

Test according to A.S.T.M. Standard D-5778-95

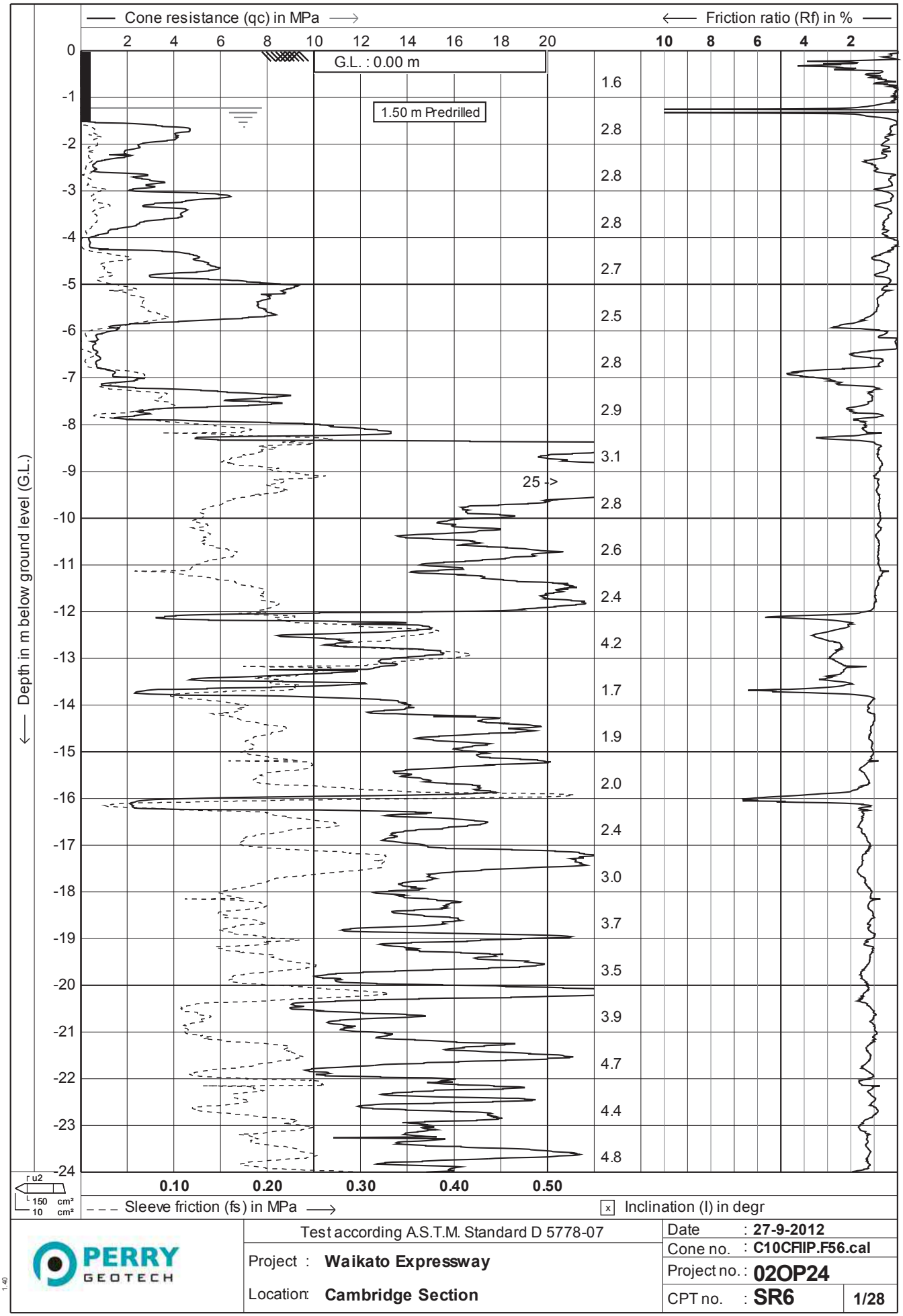
Project : **Cambridge Bypass**

Location: **Ex SH1 Rest Area**

Position: **2730549, 6364415 NZMG**

Date	: **8-5-2007**
Cone no.	: **C10CFIIP.E09**
Project no.	: **2-61647.00**
CPT no.	: **CPT M7** 4/28

CPTask V1.11



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

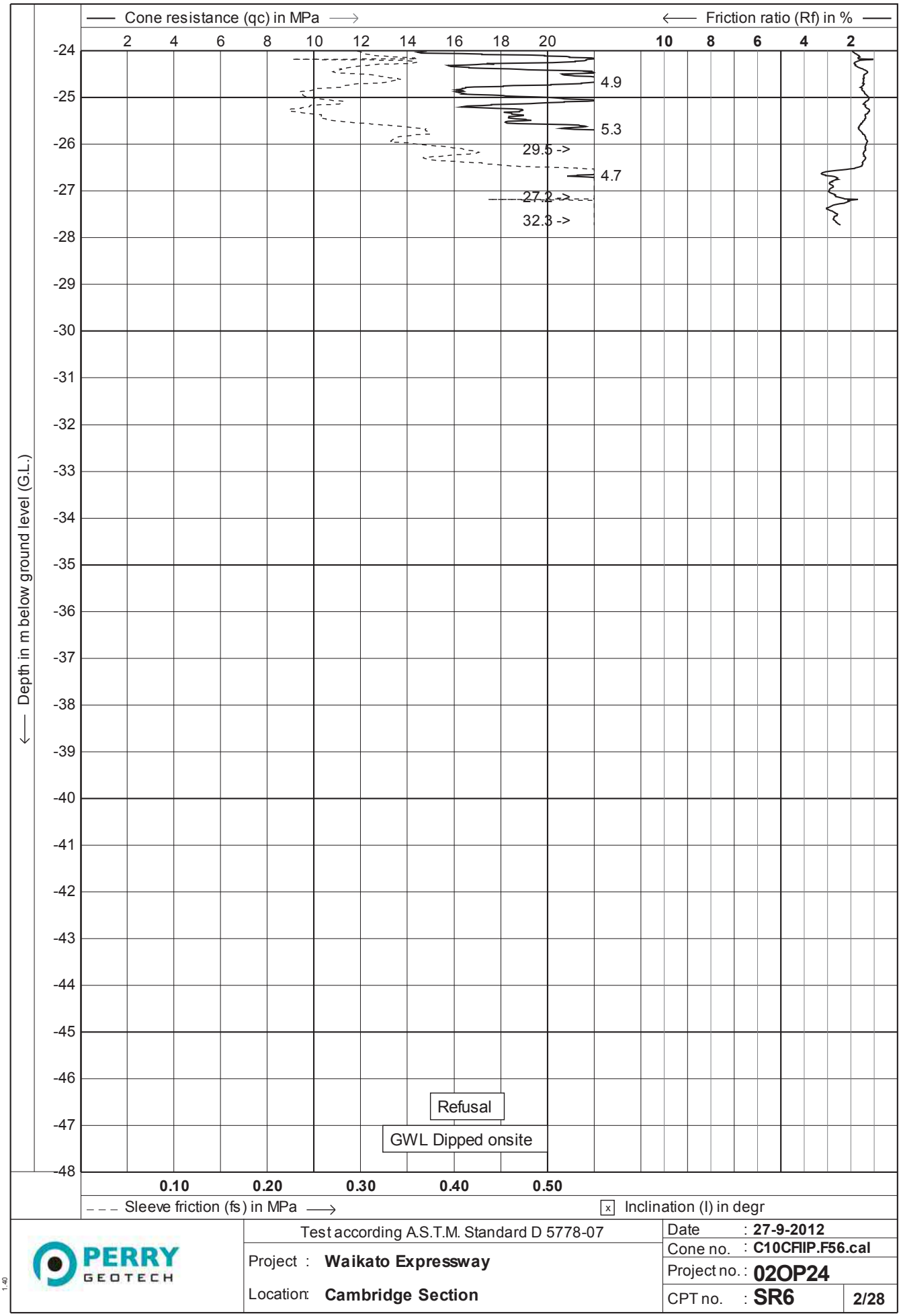
Location: **Cambridge Section**

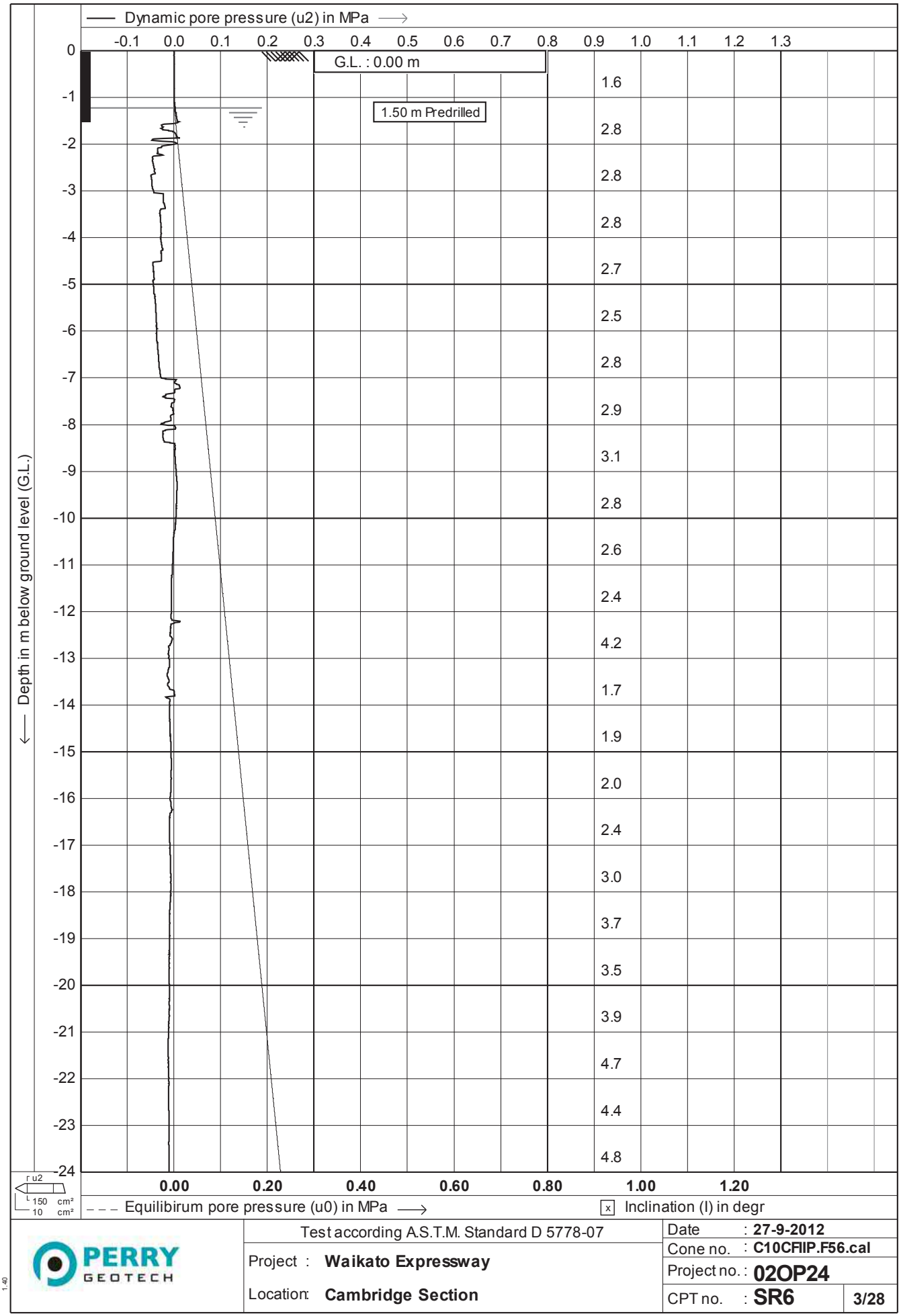
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** 1/28





PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

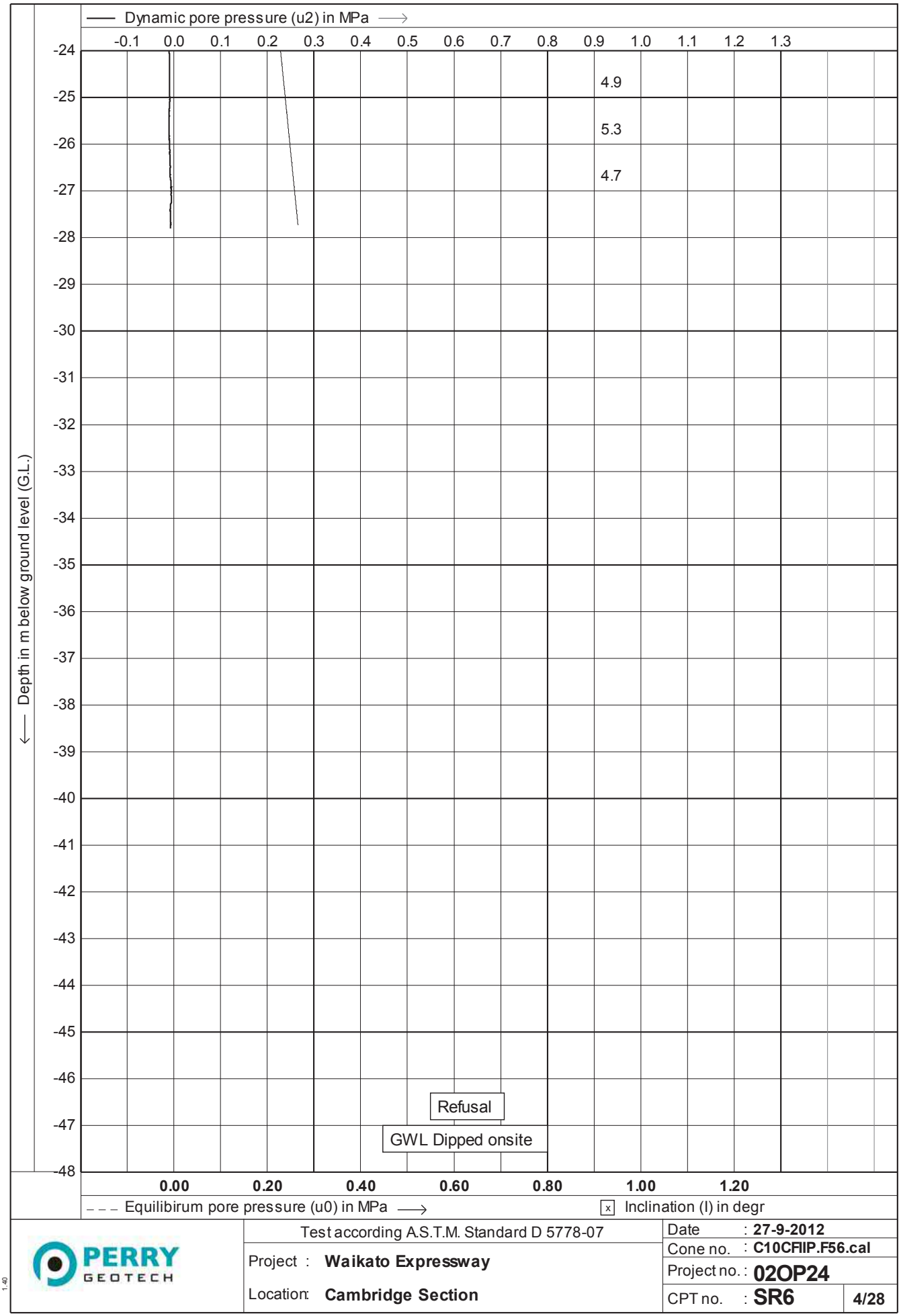
Date : **27-9-2012**

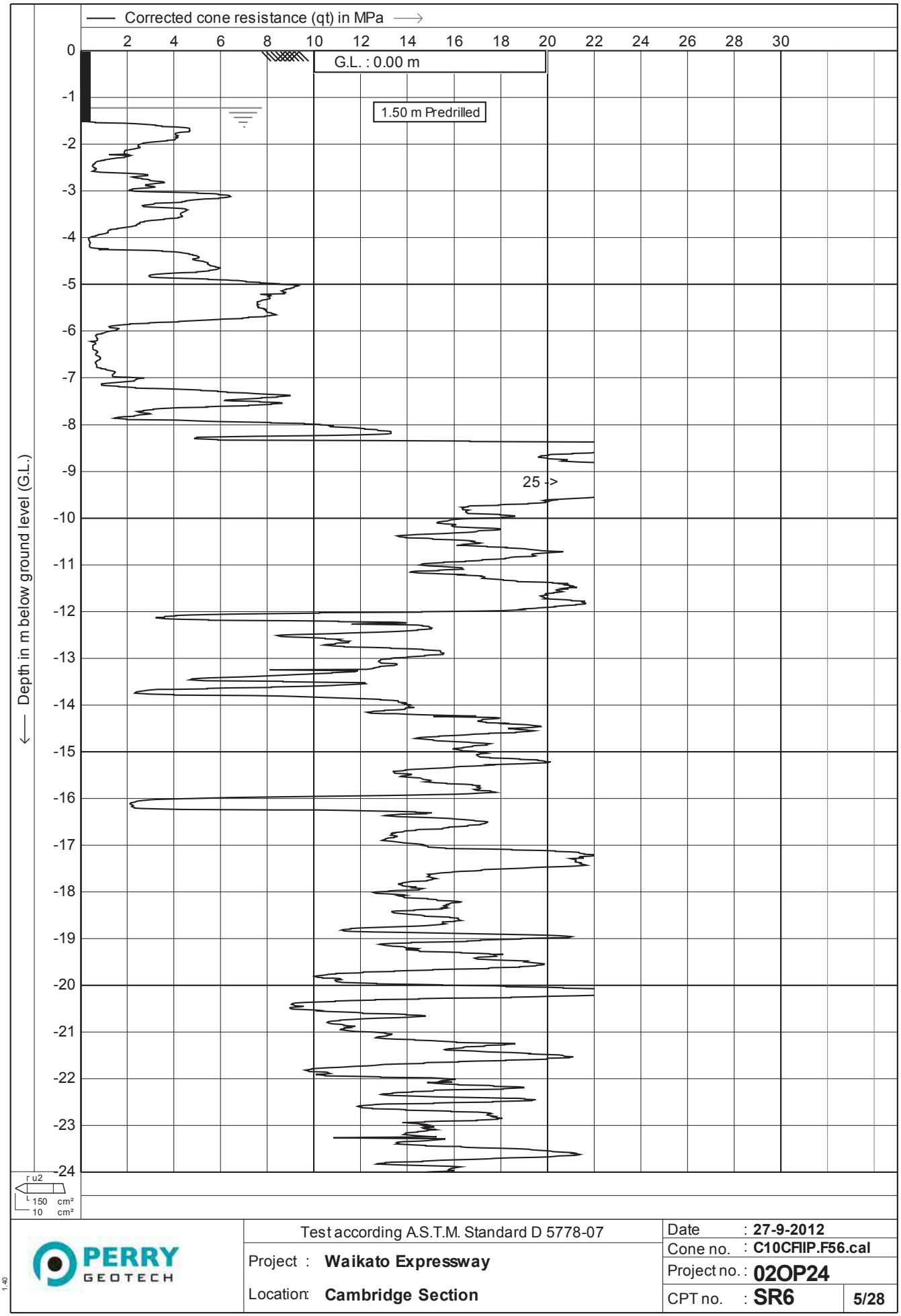
Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **3/28**

1.40





PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

Date : **27-9-2012**

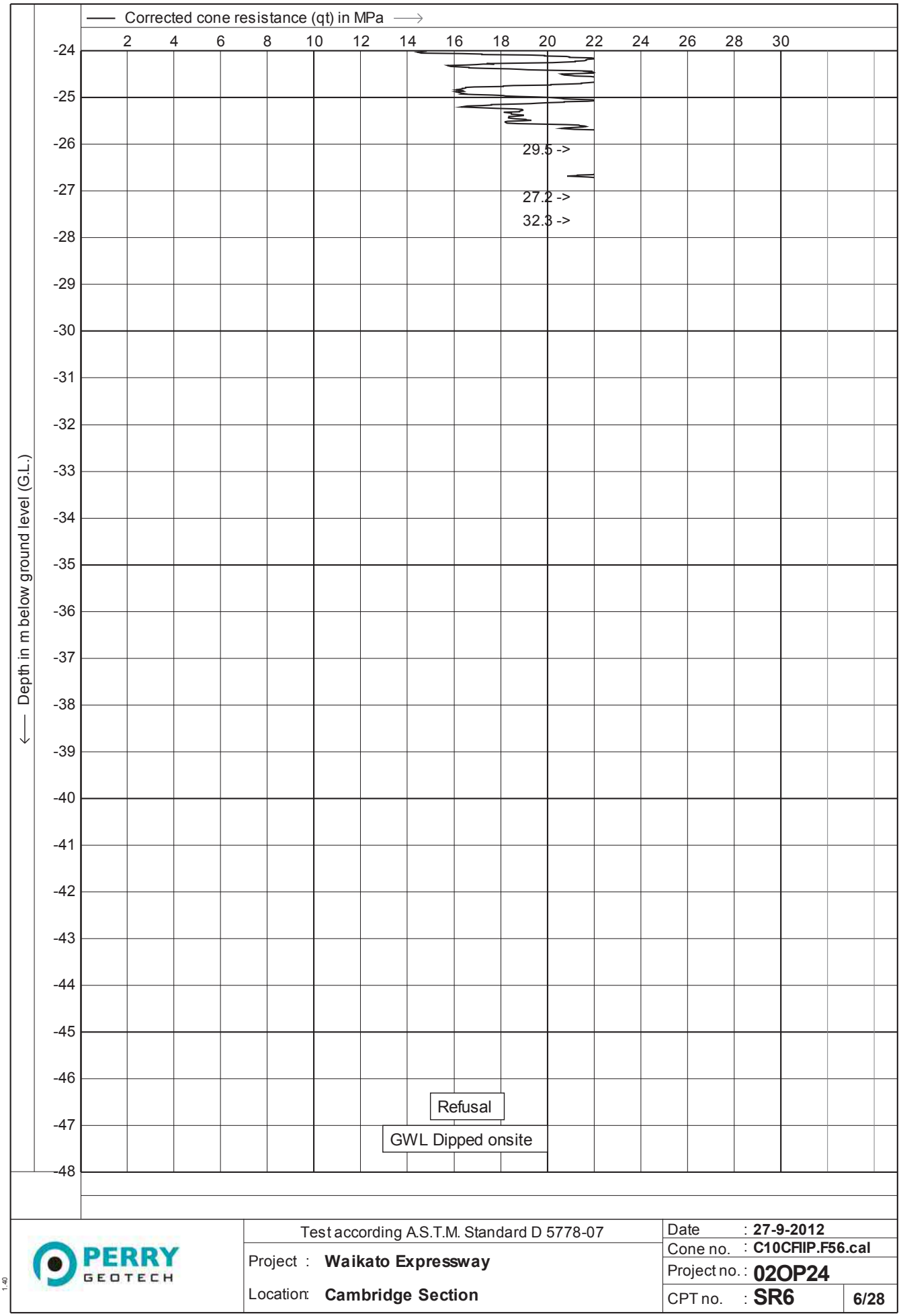
Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6**

5/28

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

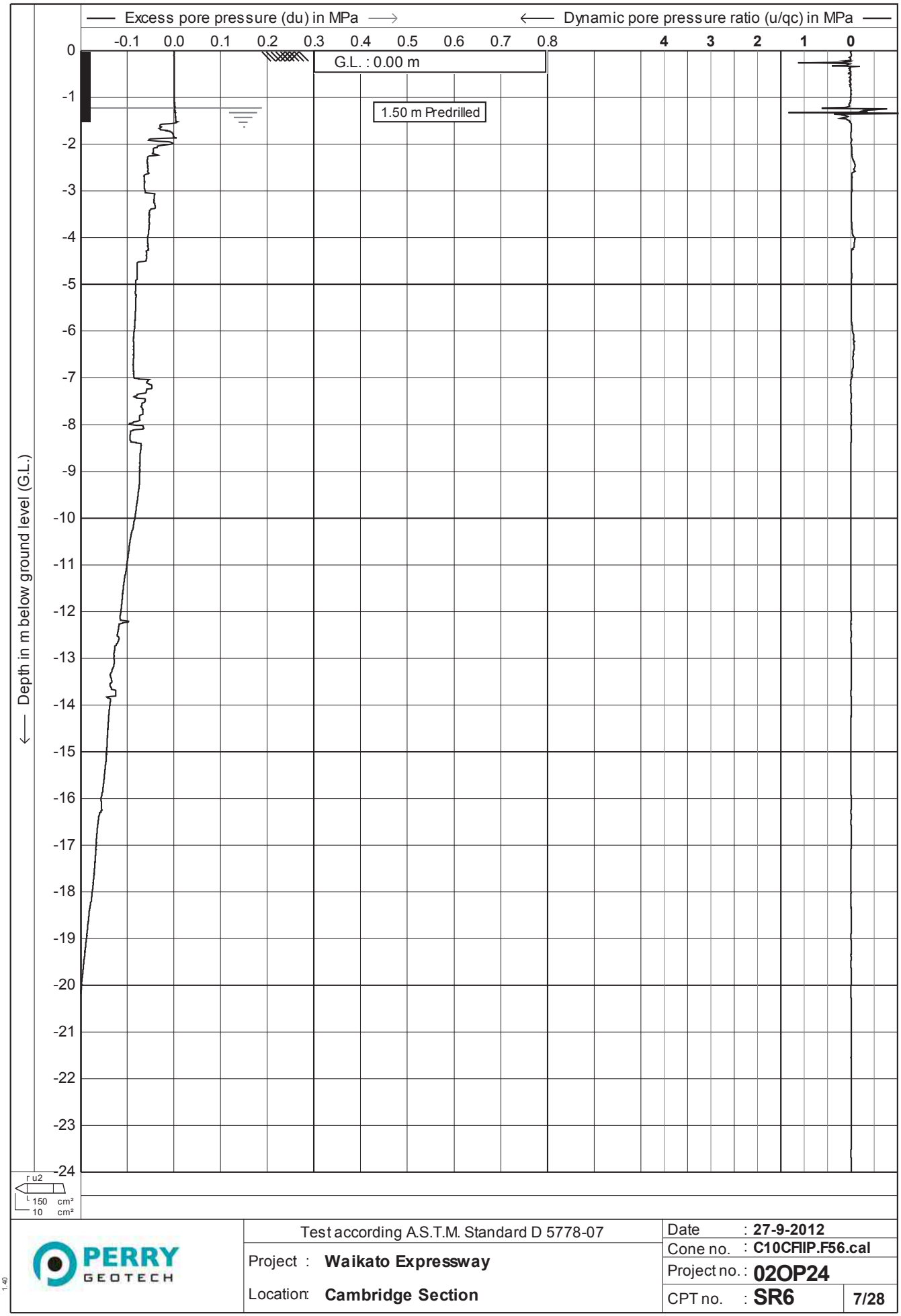
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **6/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

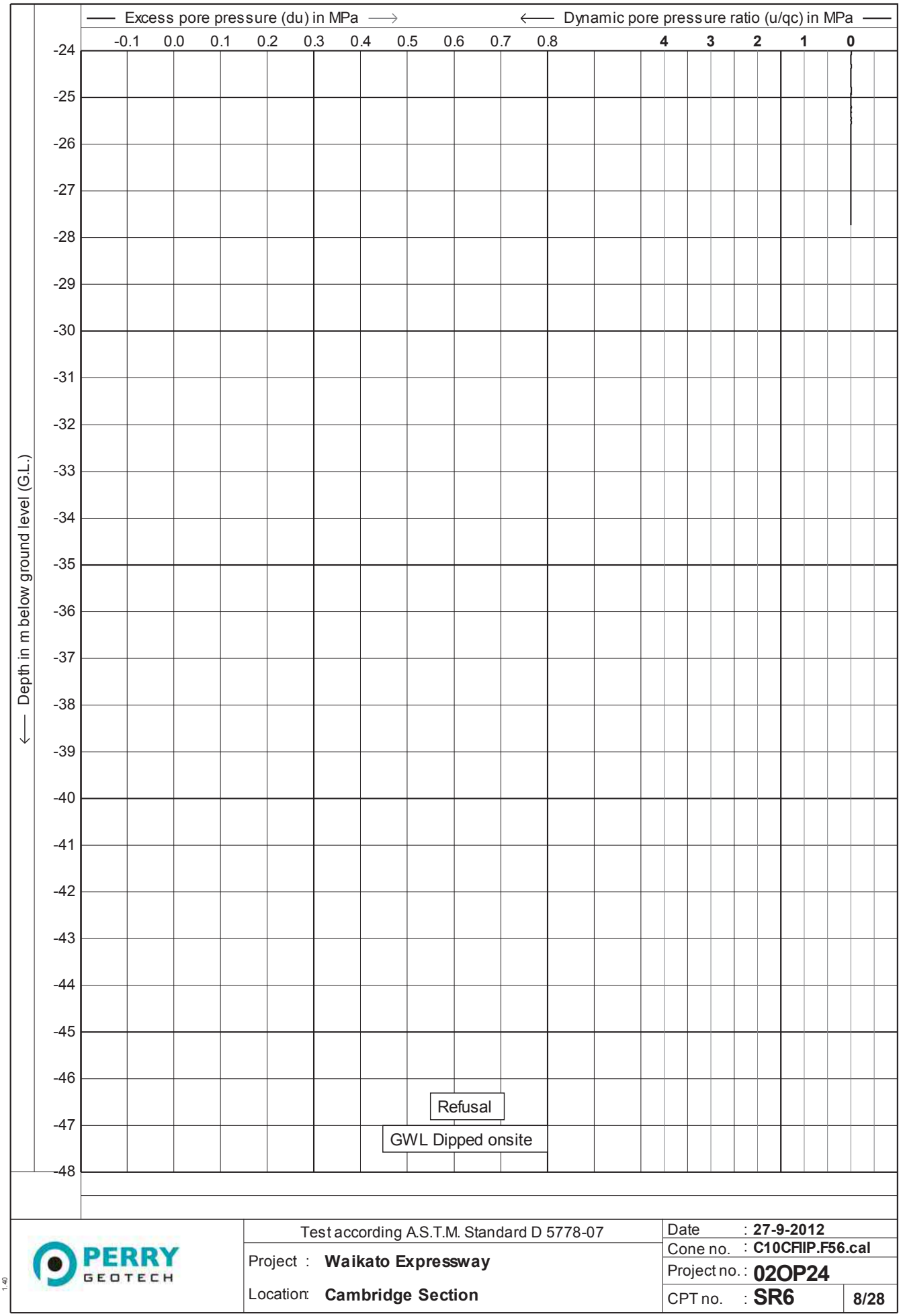
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **7/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

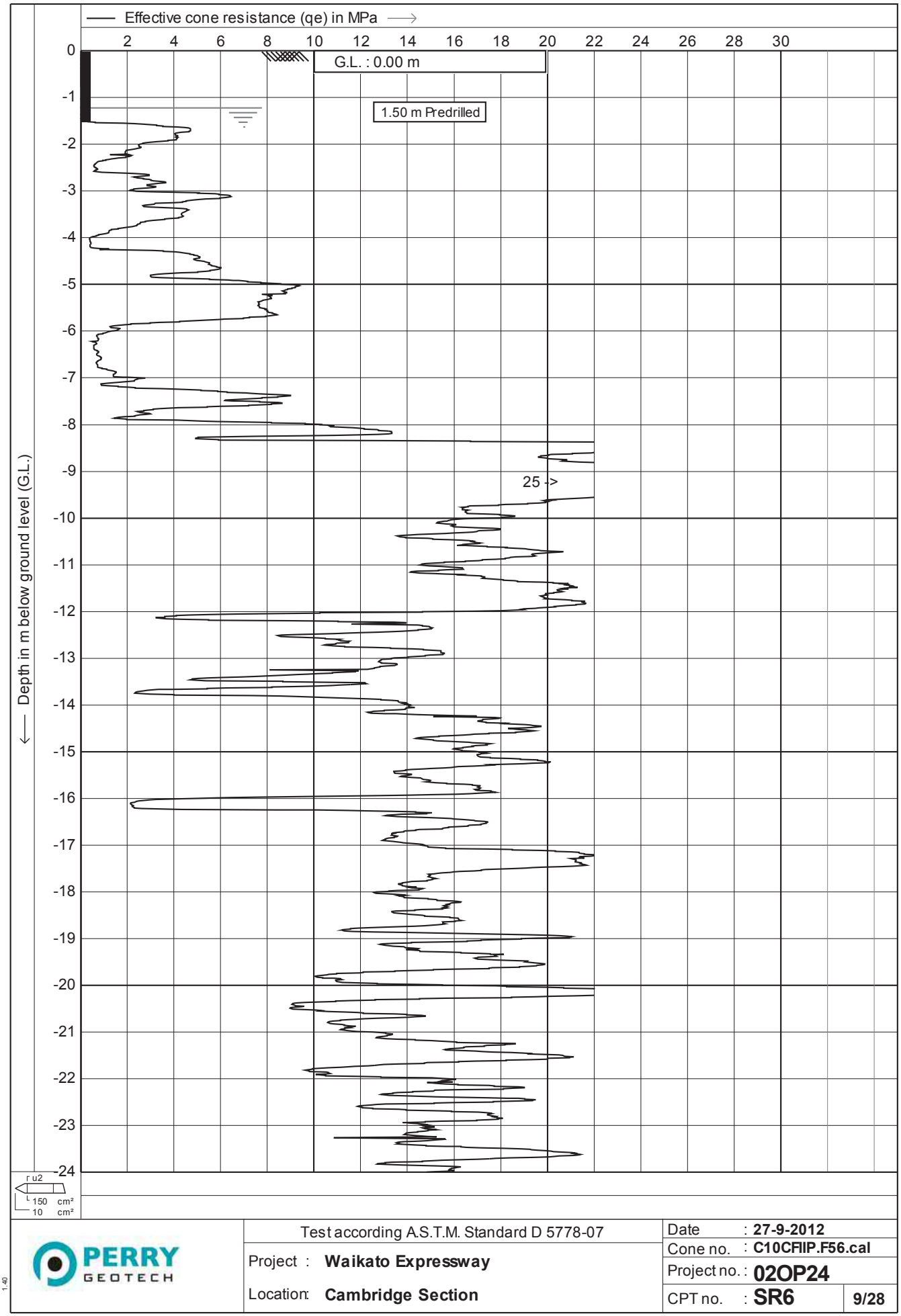
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **8/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

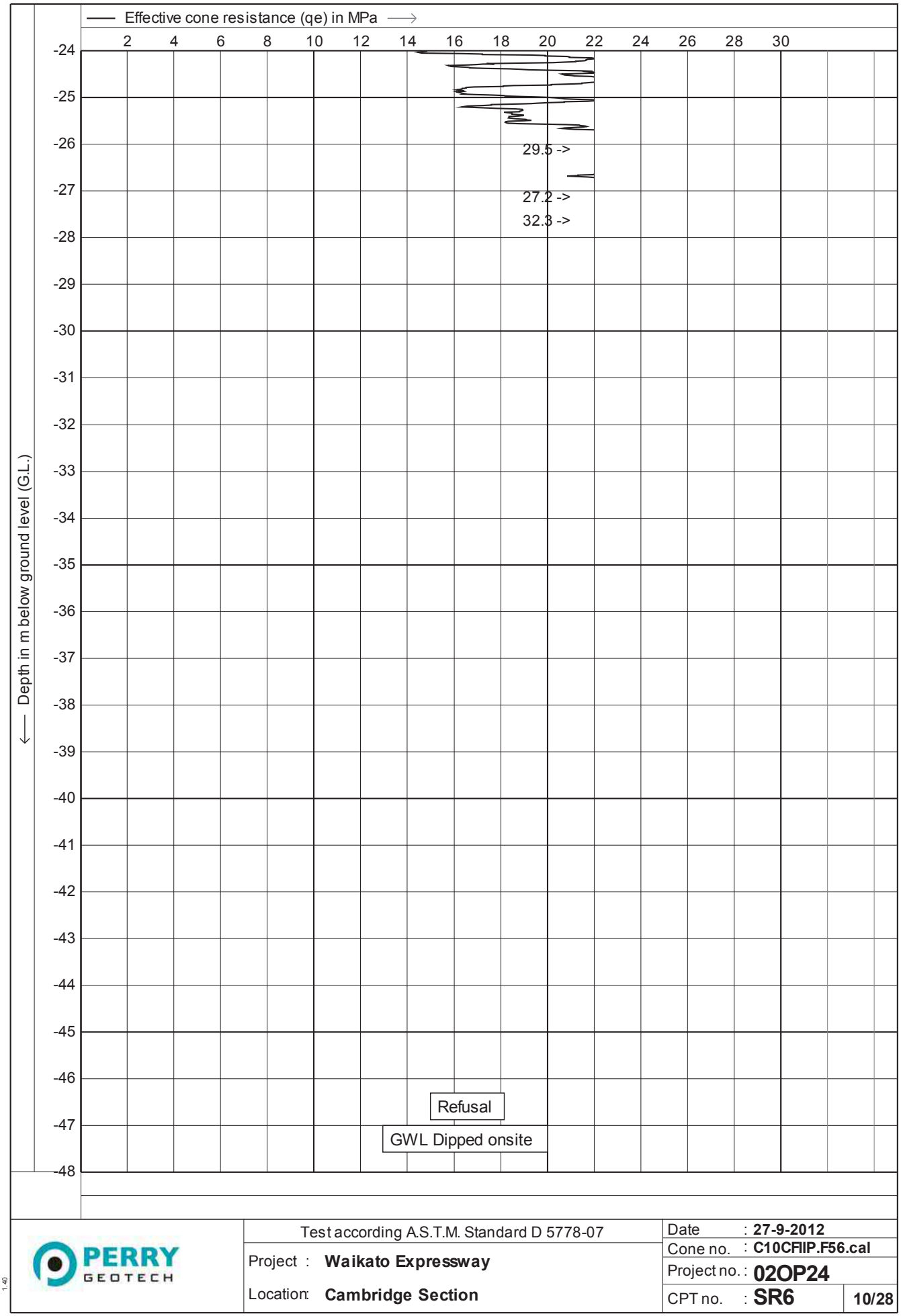
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **9/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

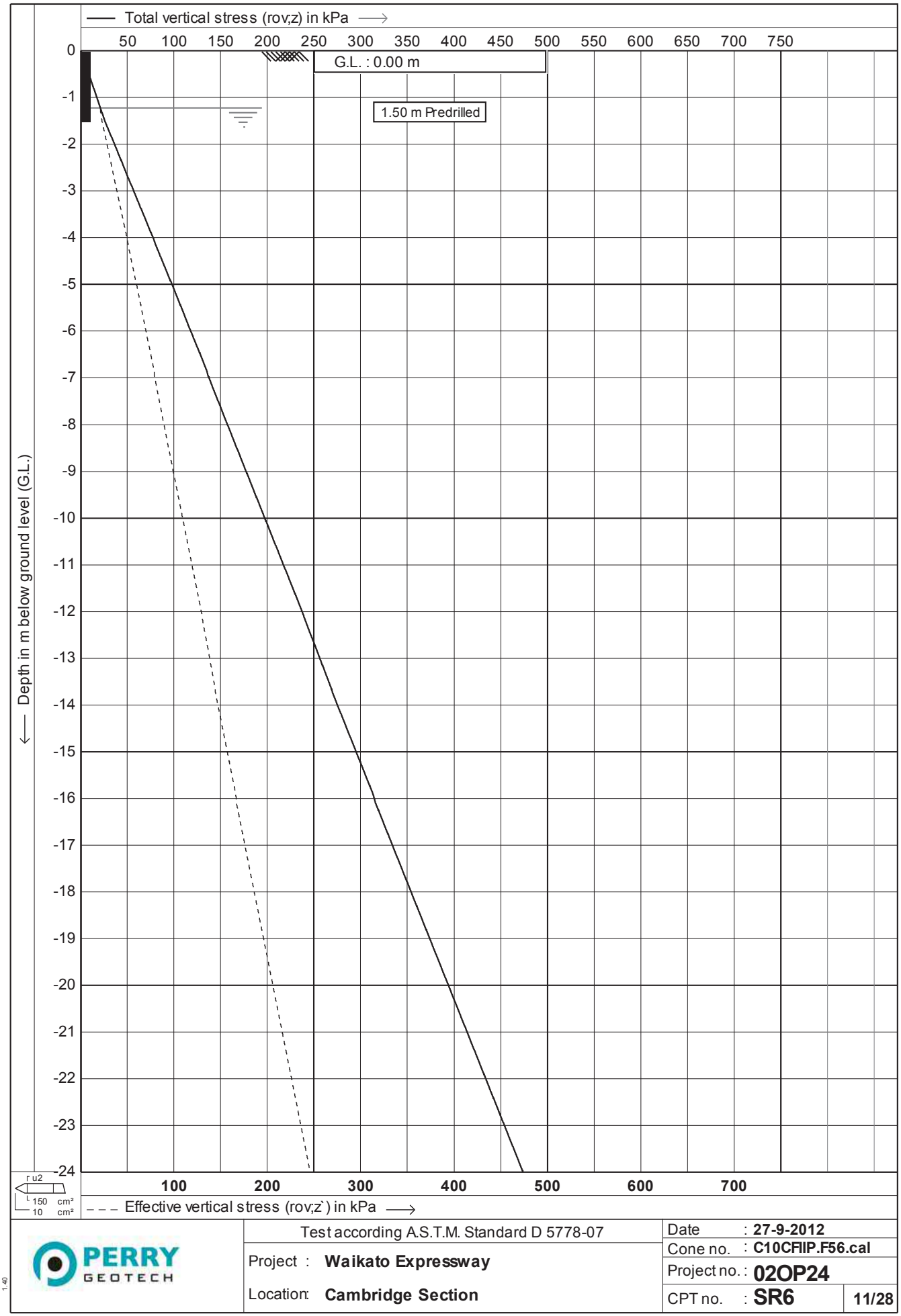
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **10/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

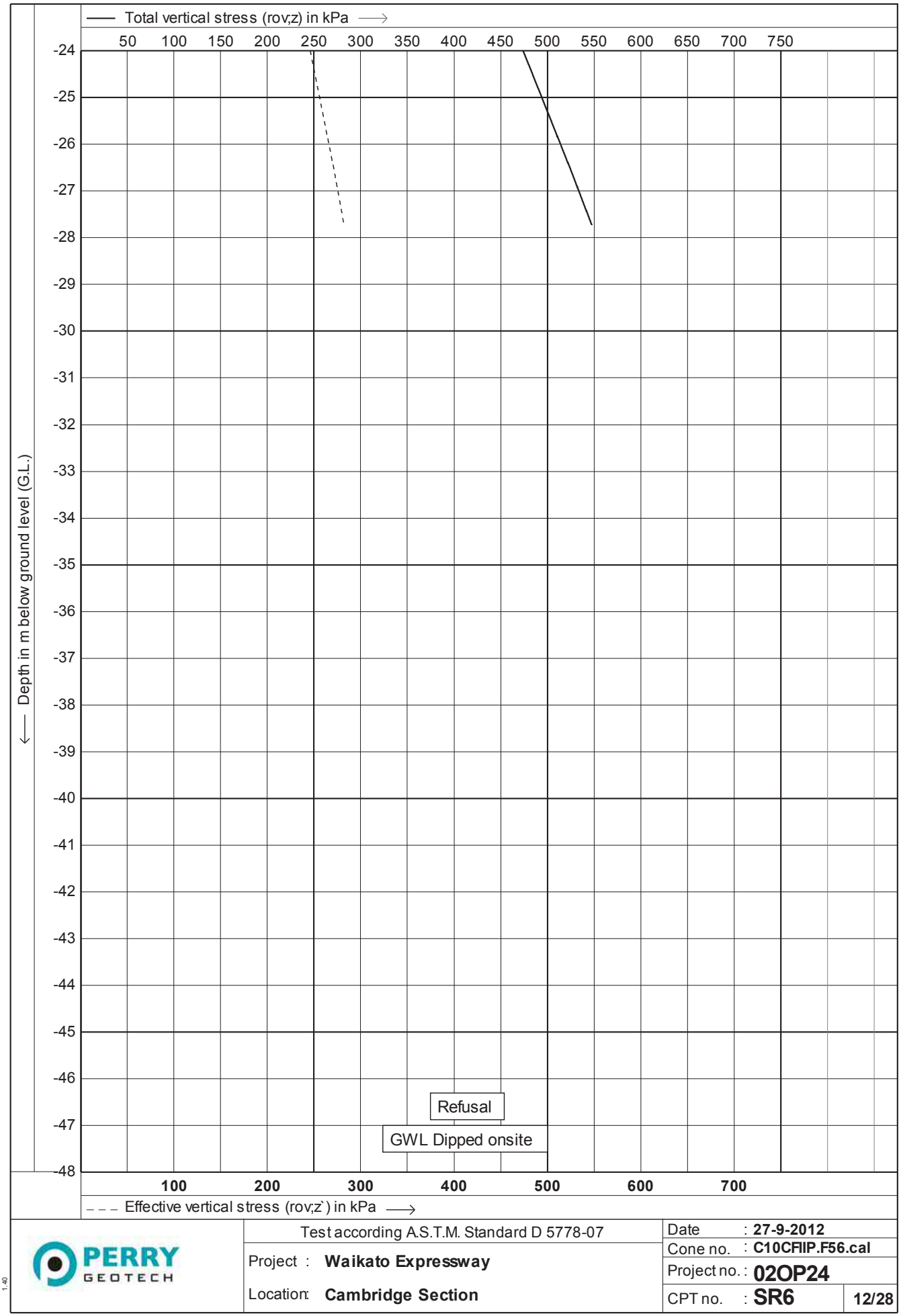
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **11/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

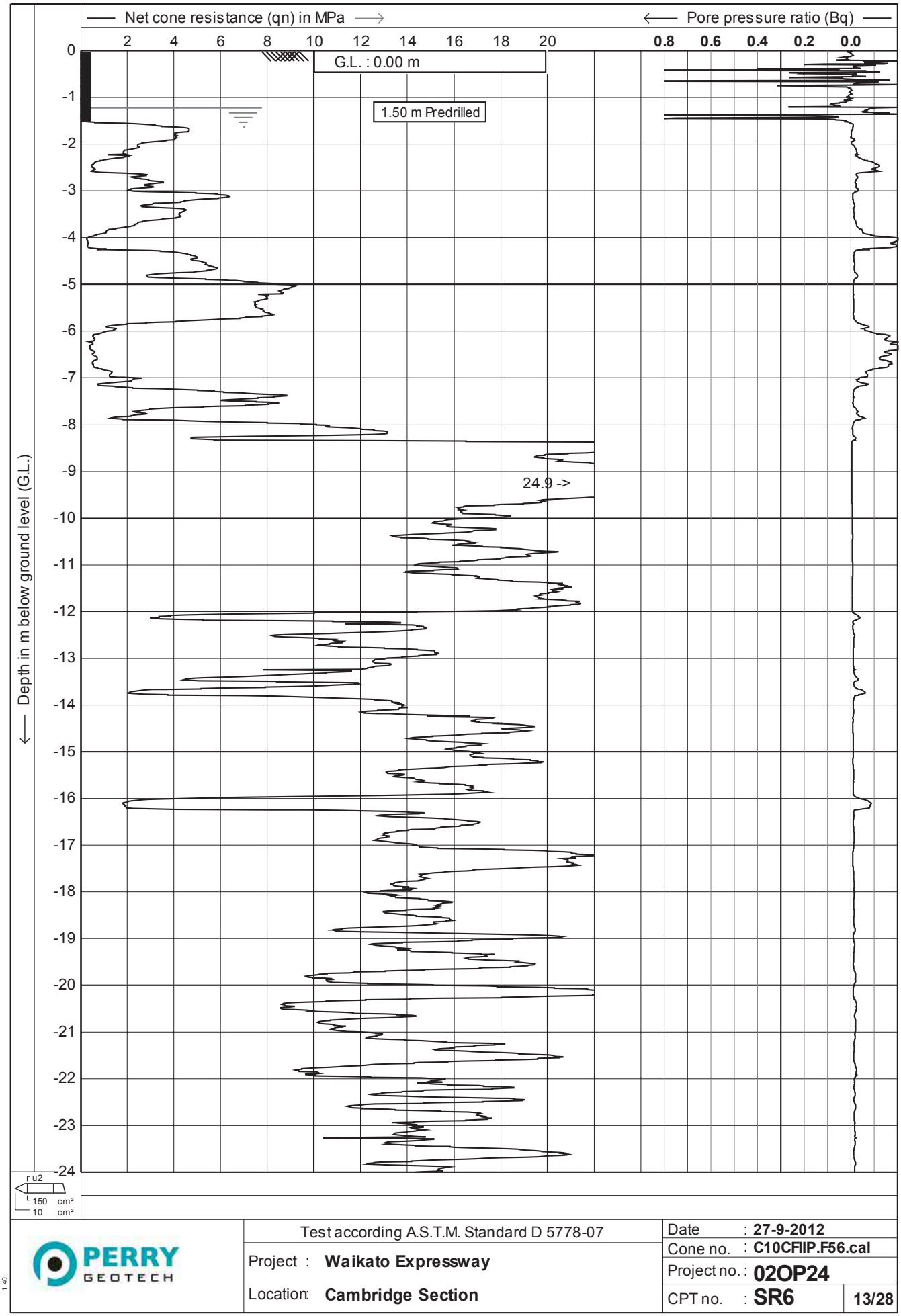
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **12/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

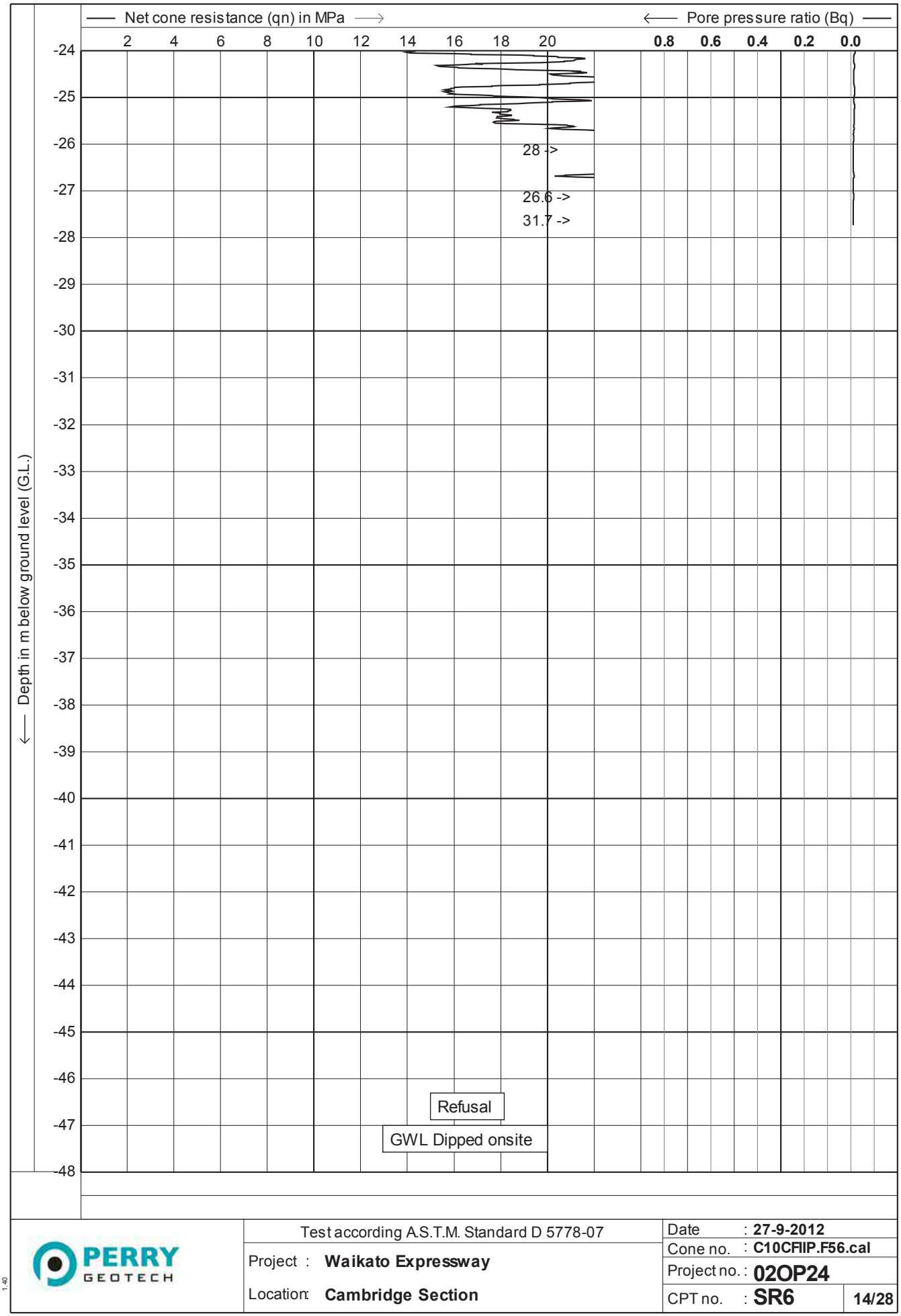
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **13/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

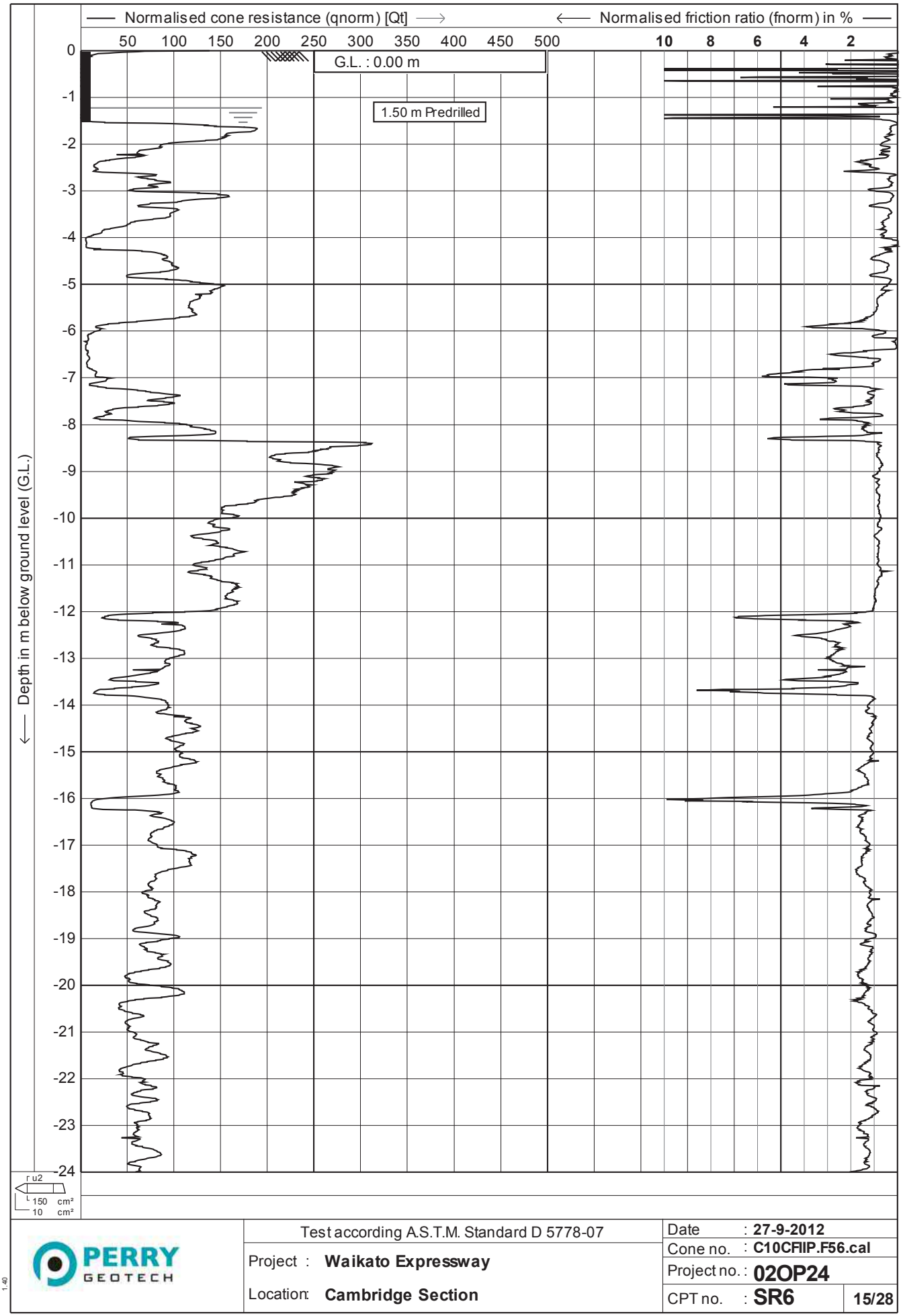
Date : **27-9-2012**

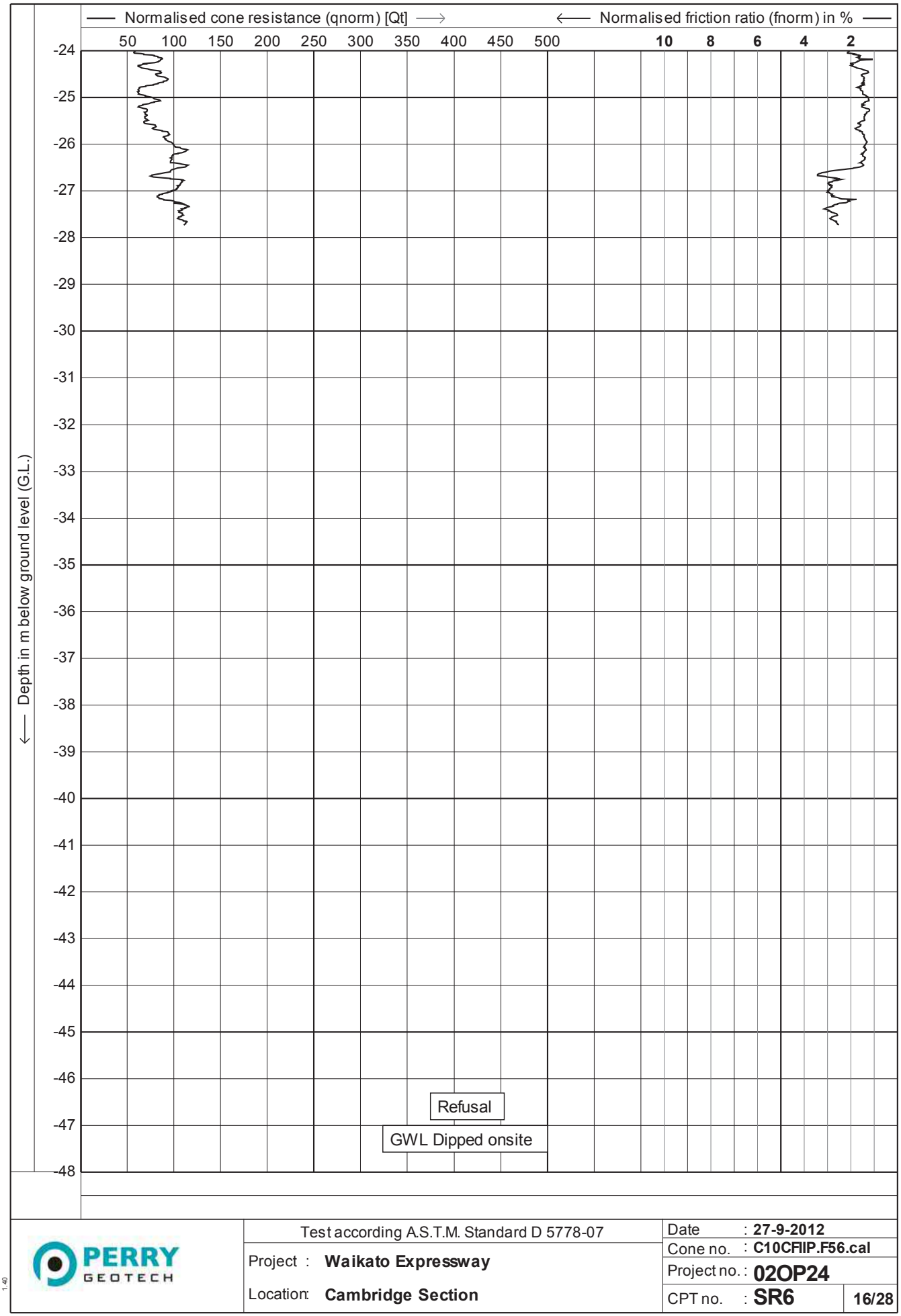
Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **14/28**

1.40





PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

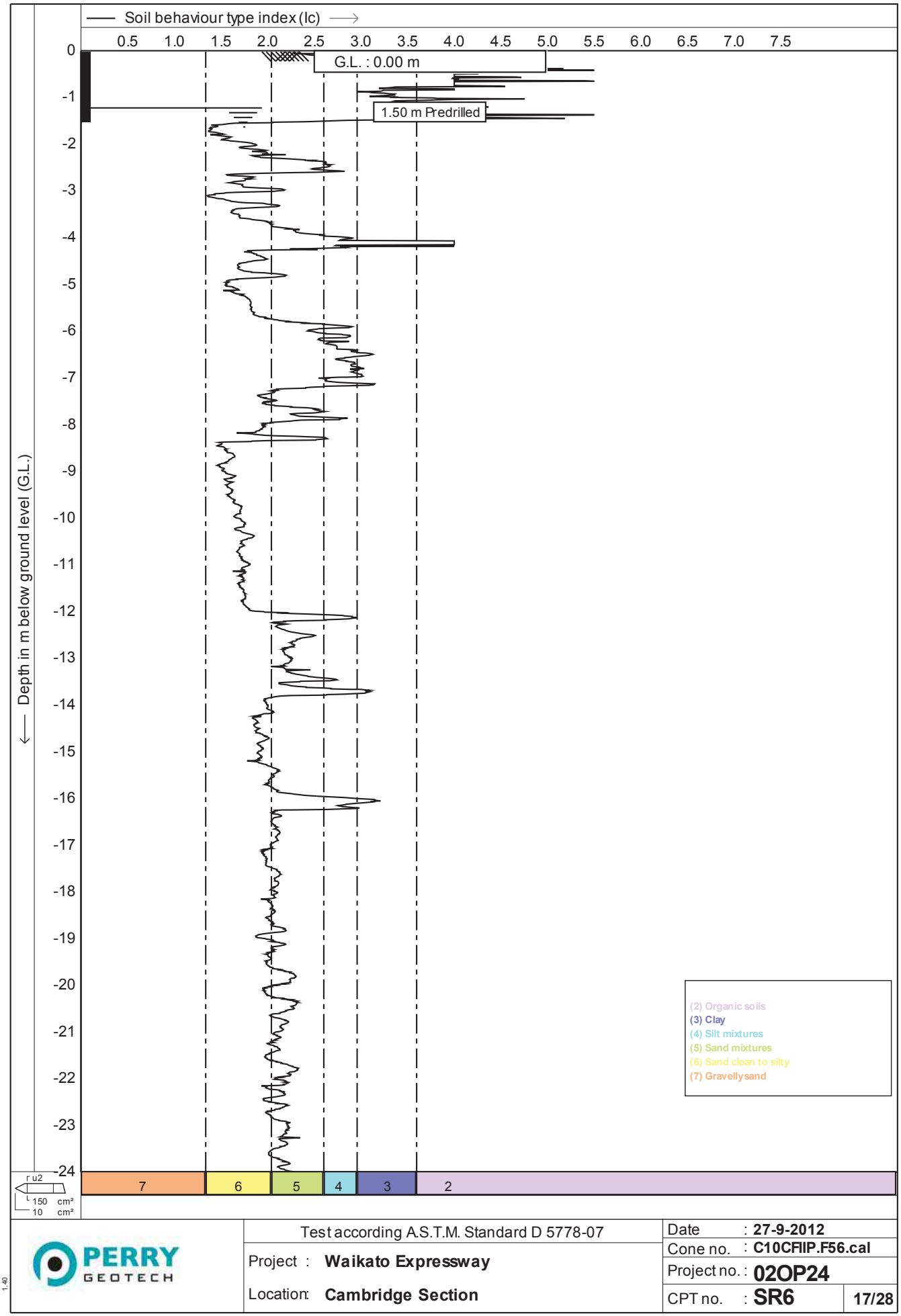
Date : **27-9-2012**

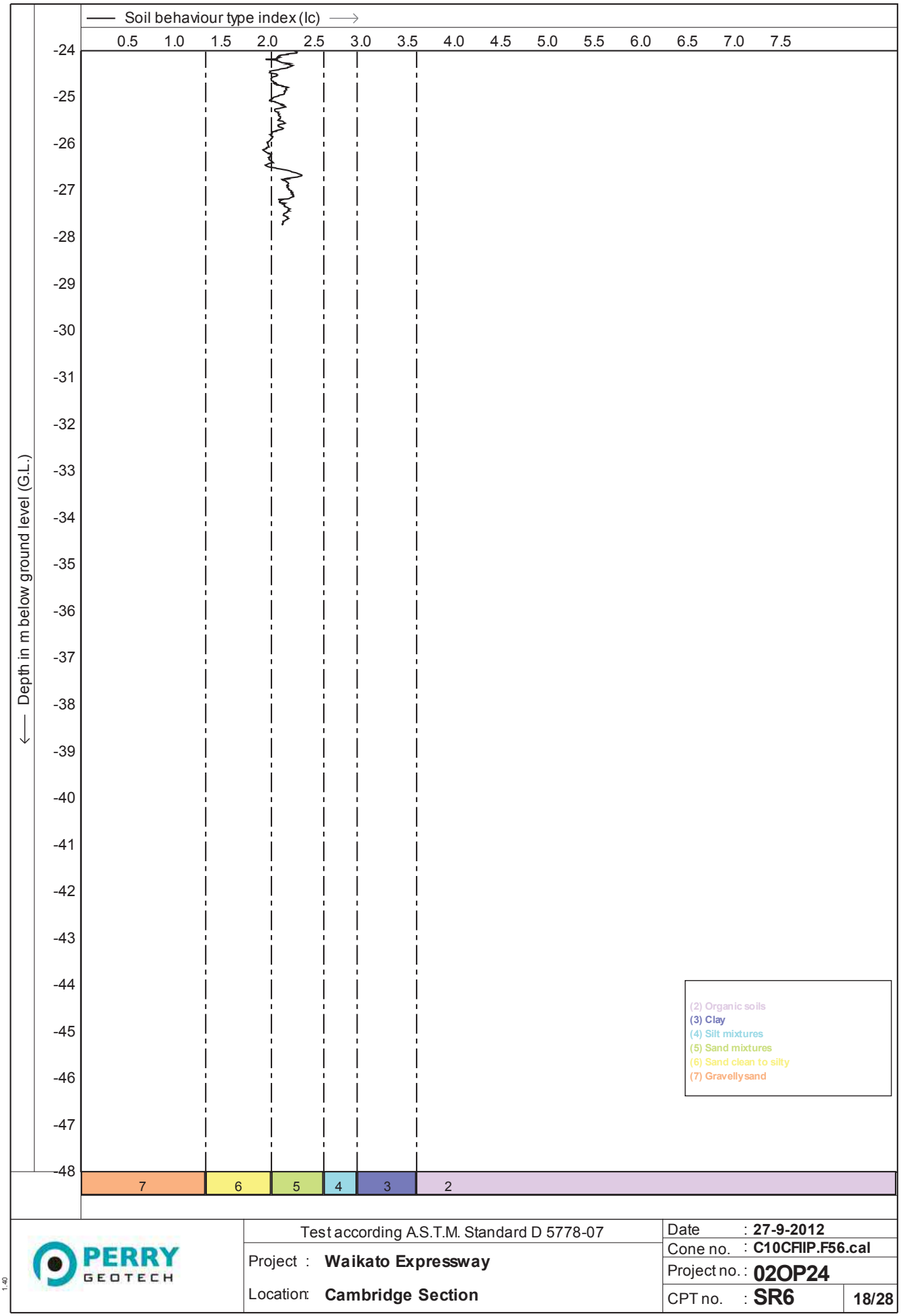
Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **16/28**

1.40





PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

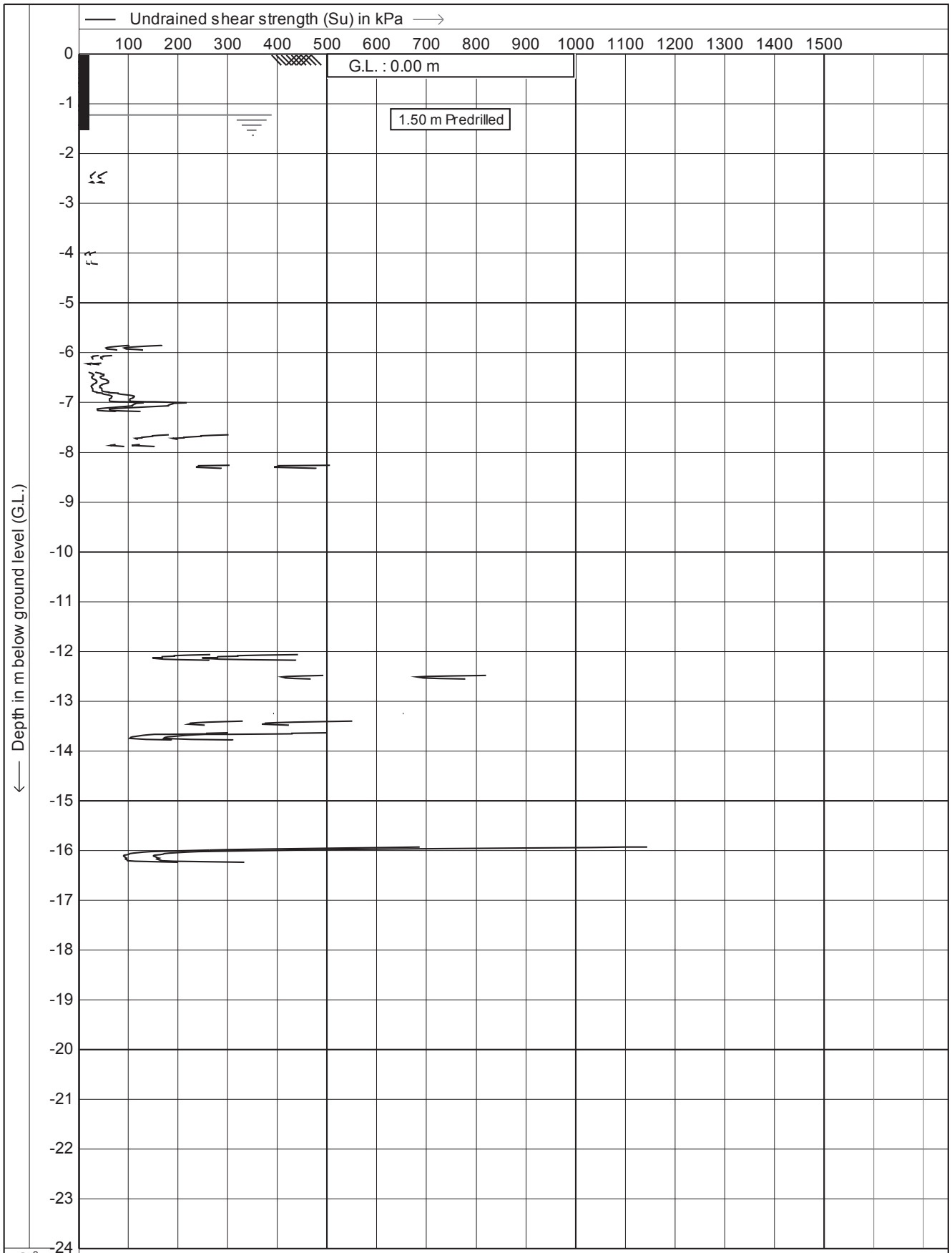
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **18/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

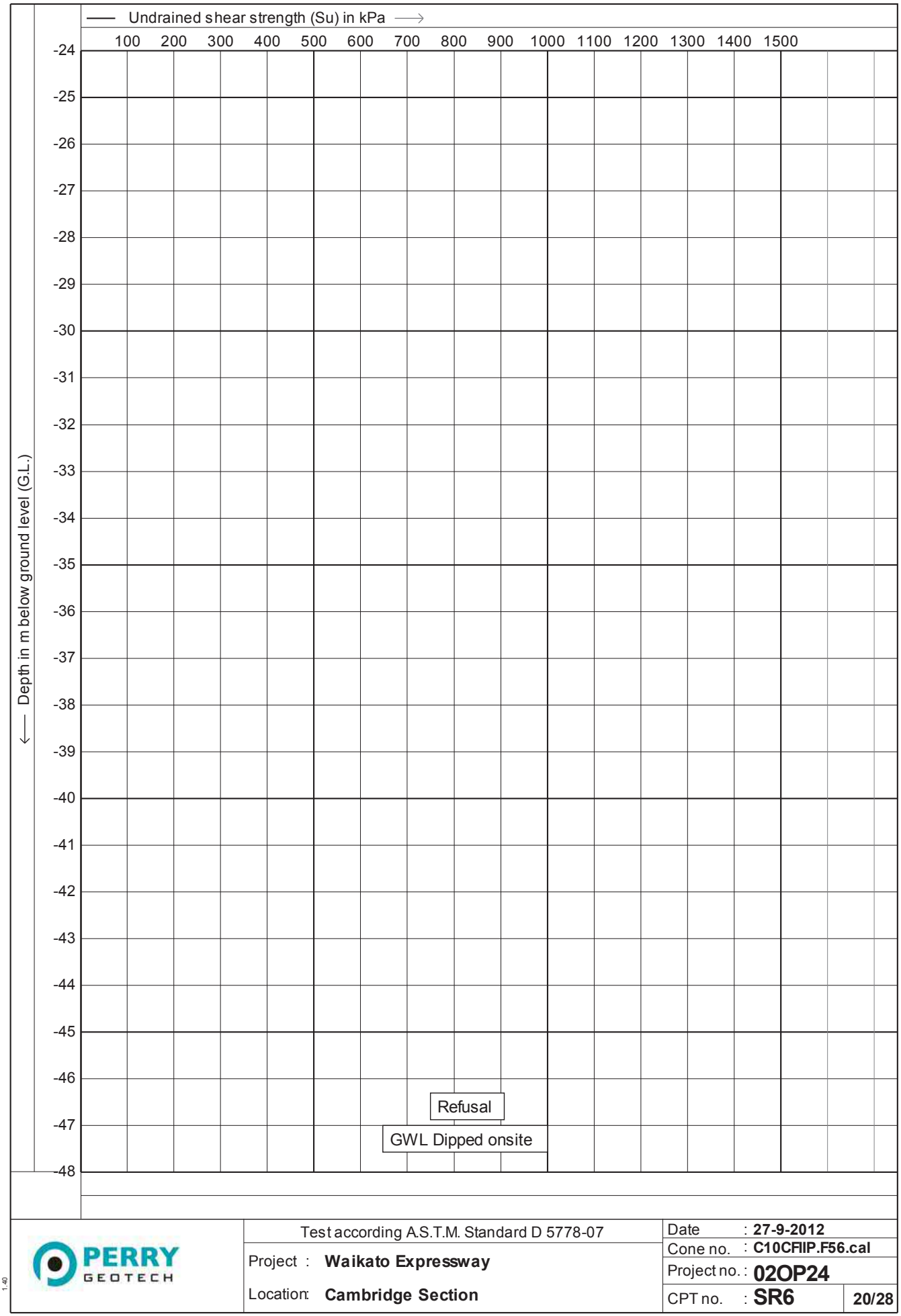
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **19/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

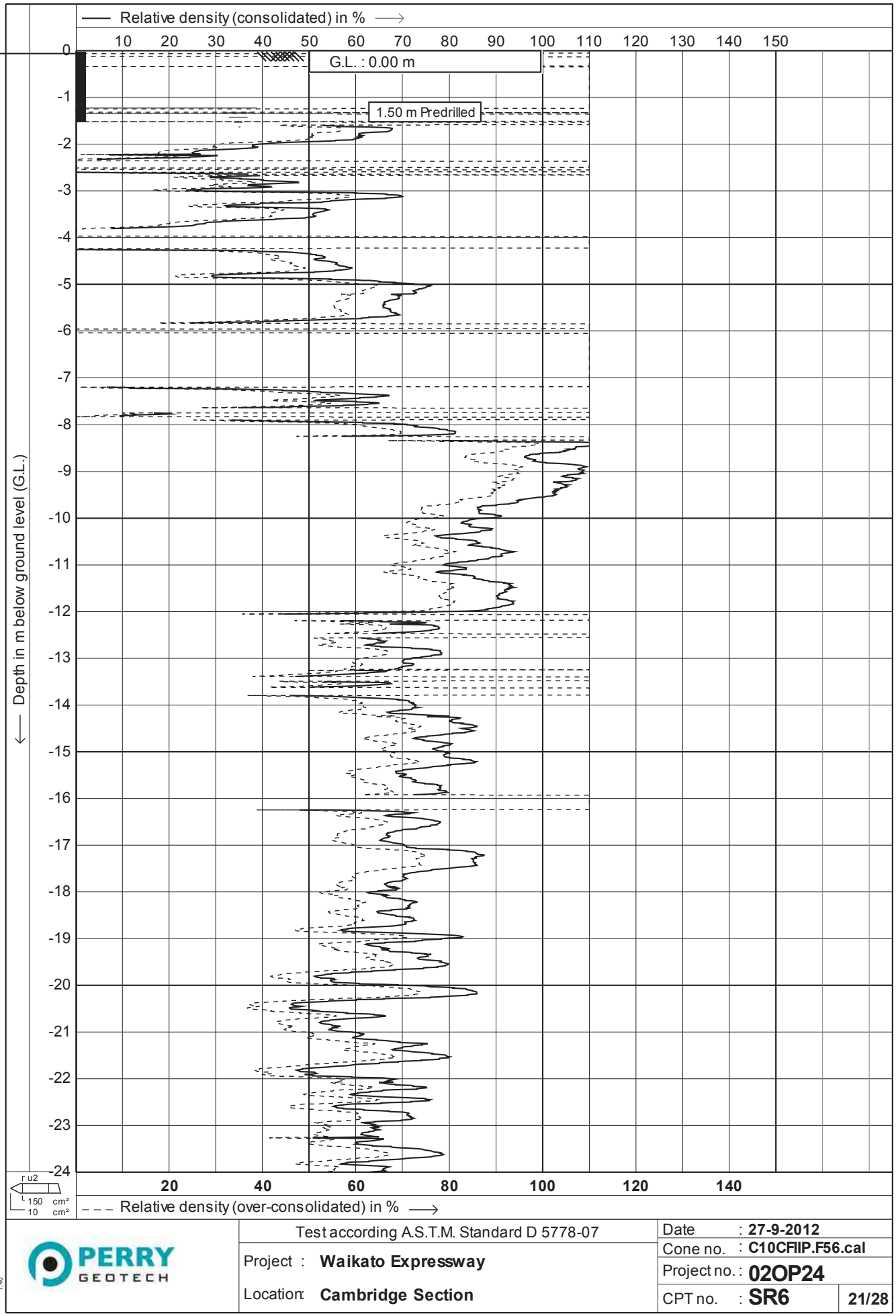
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **20/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

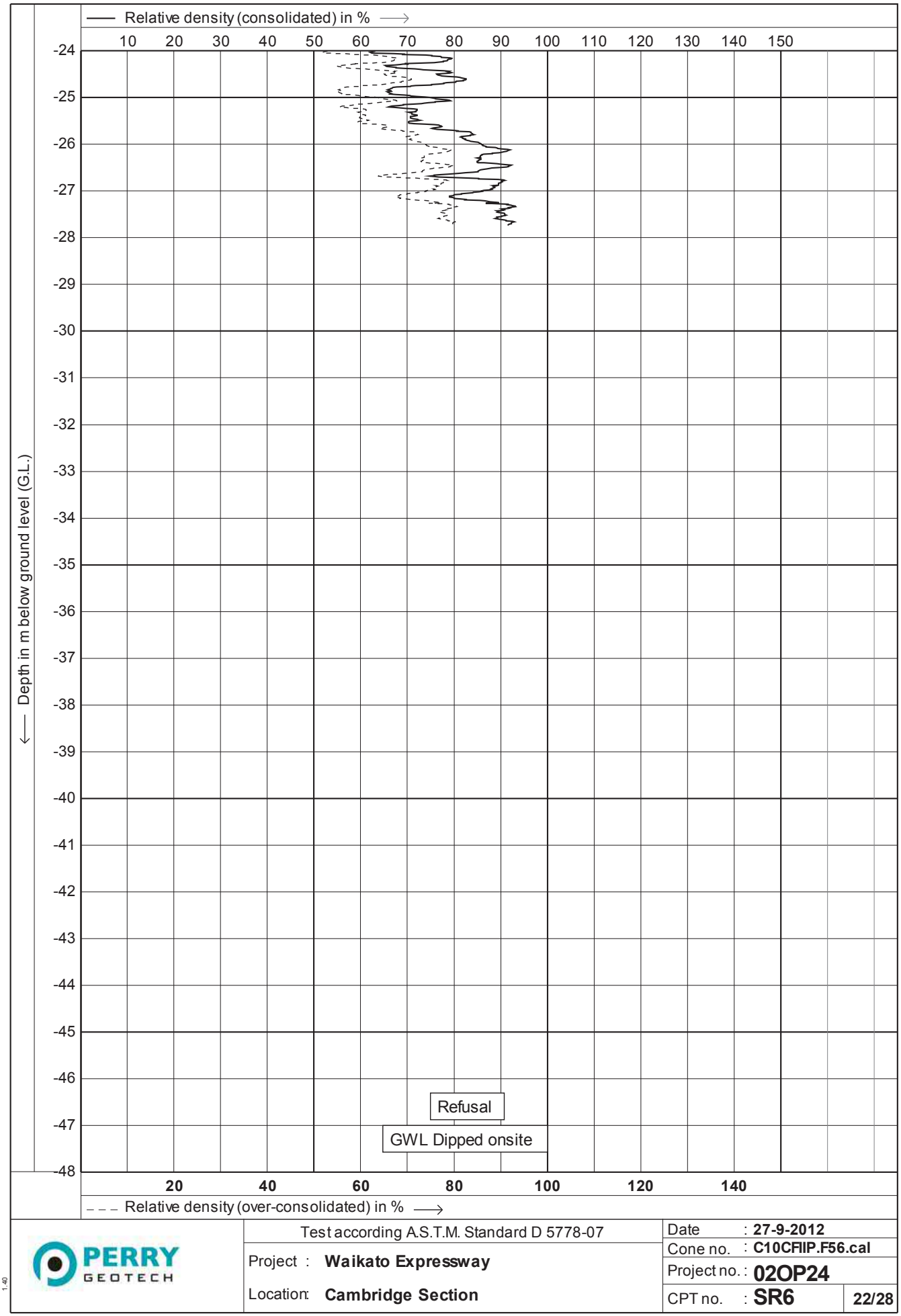
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

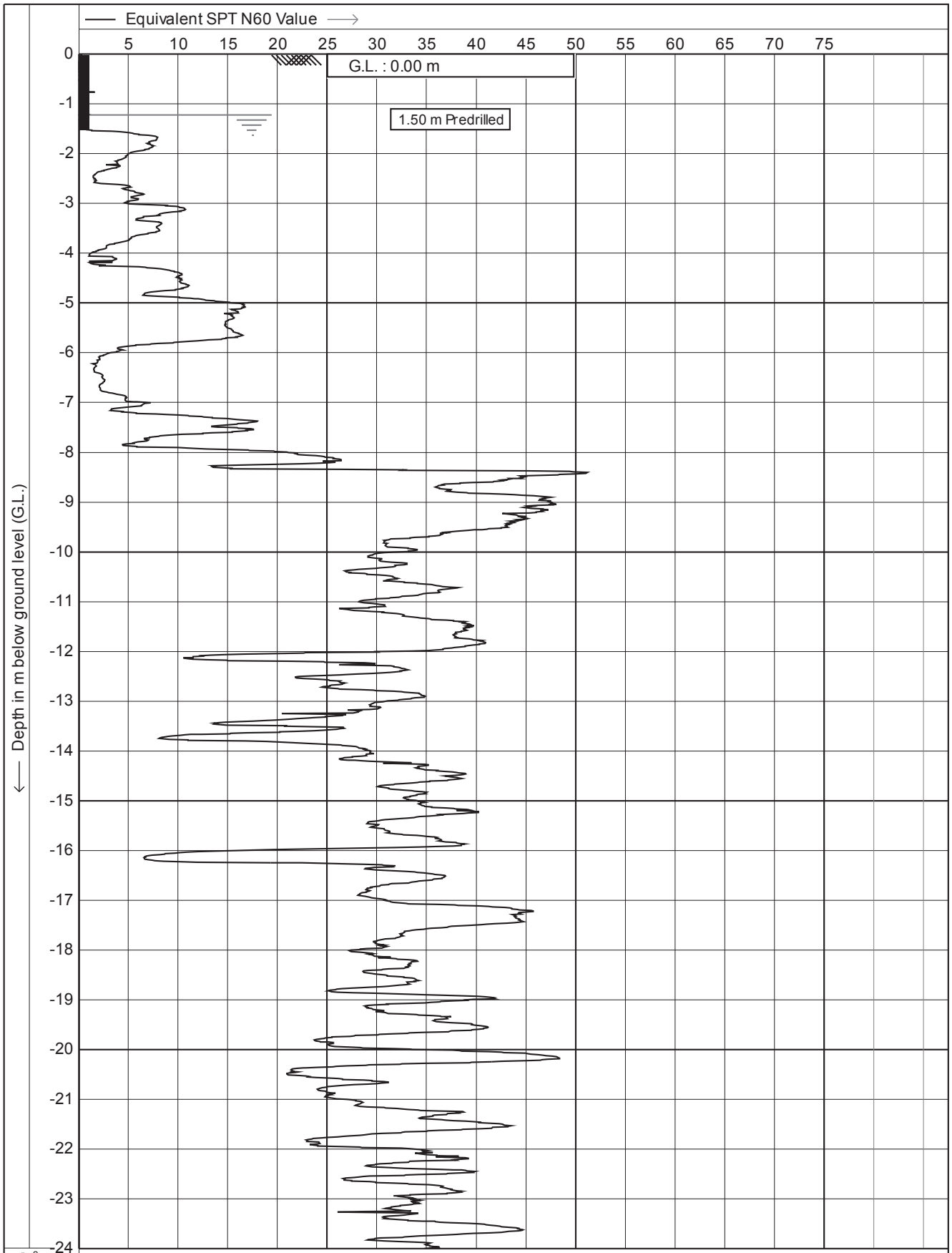
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **22/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

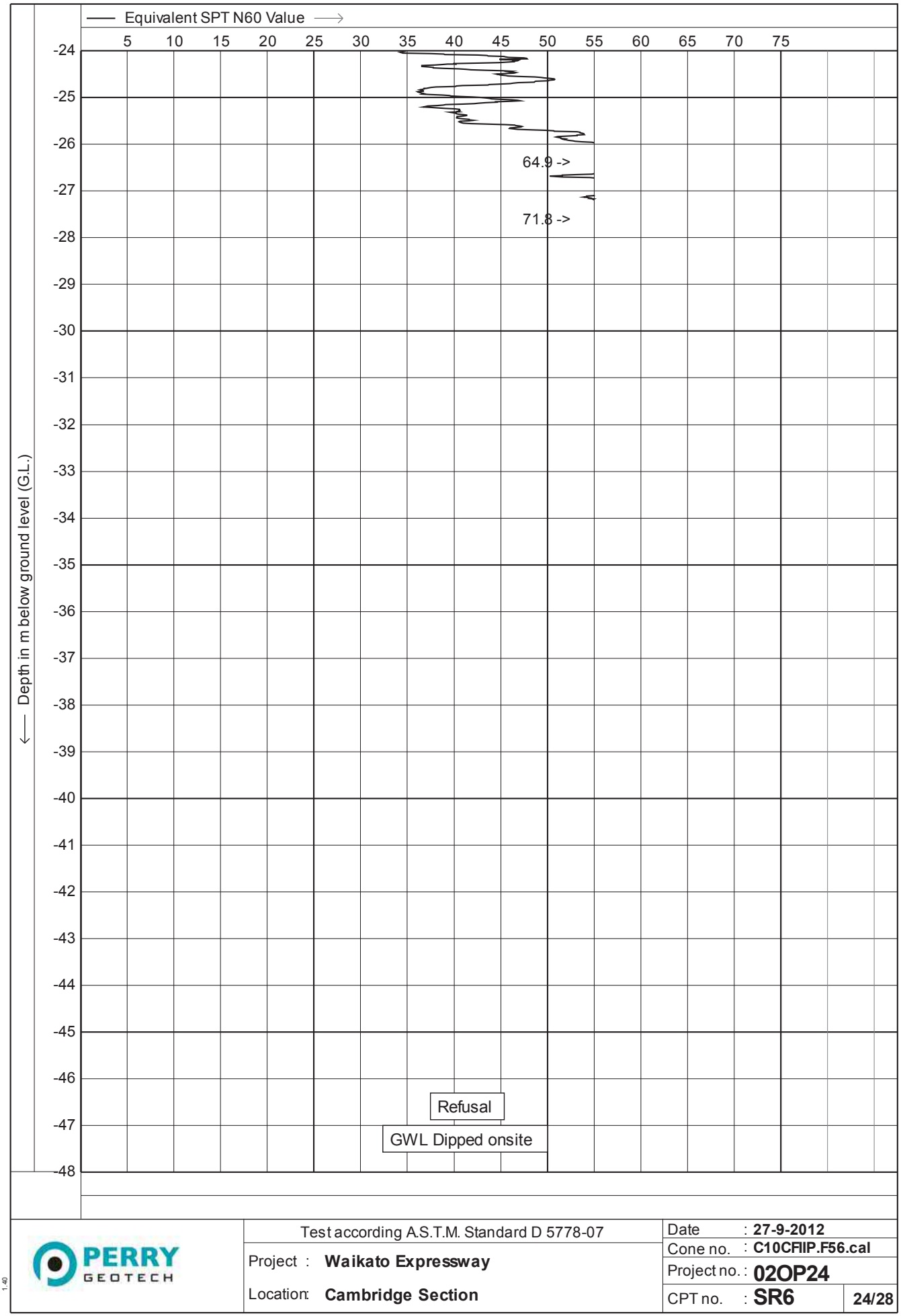
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **23/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

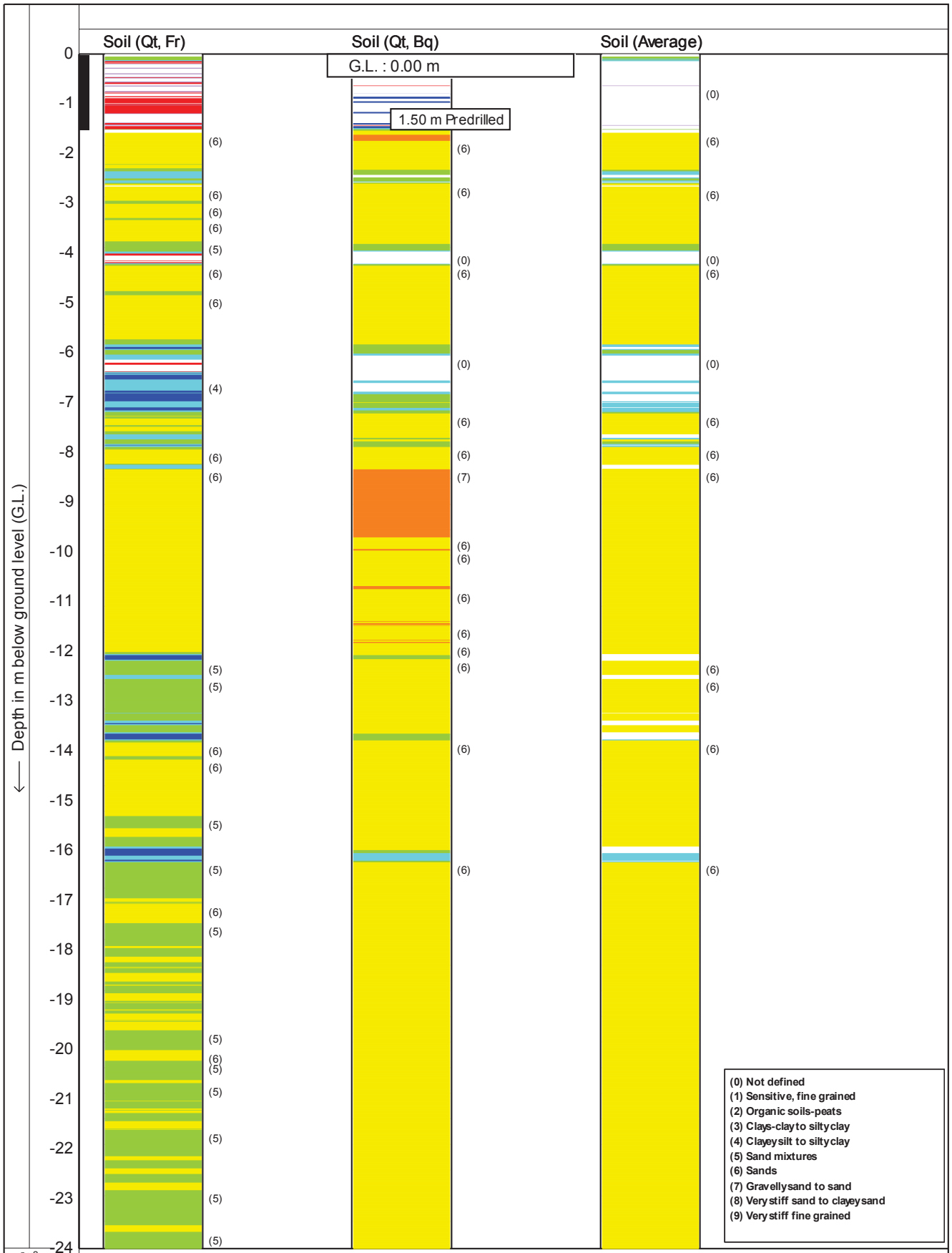
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **24/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

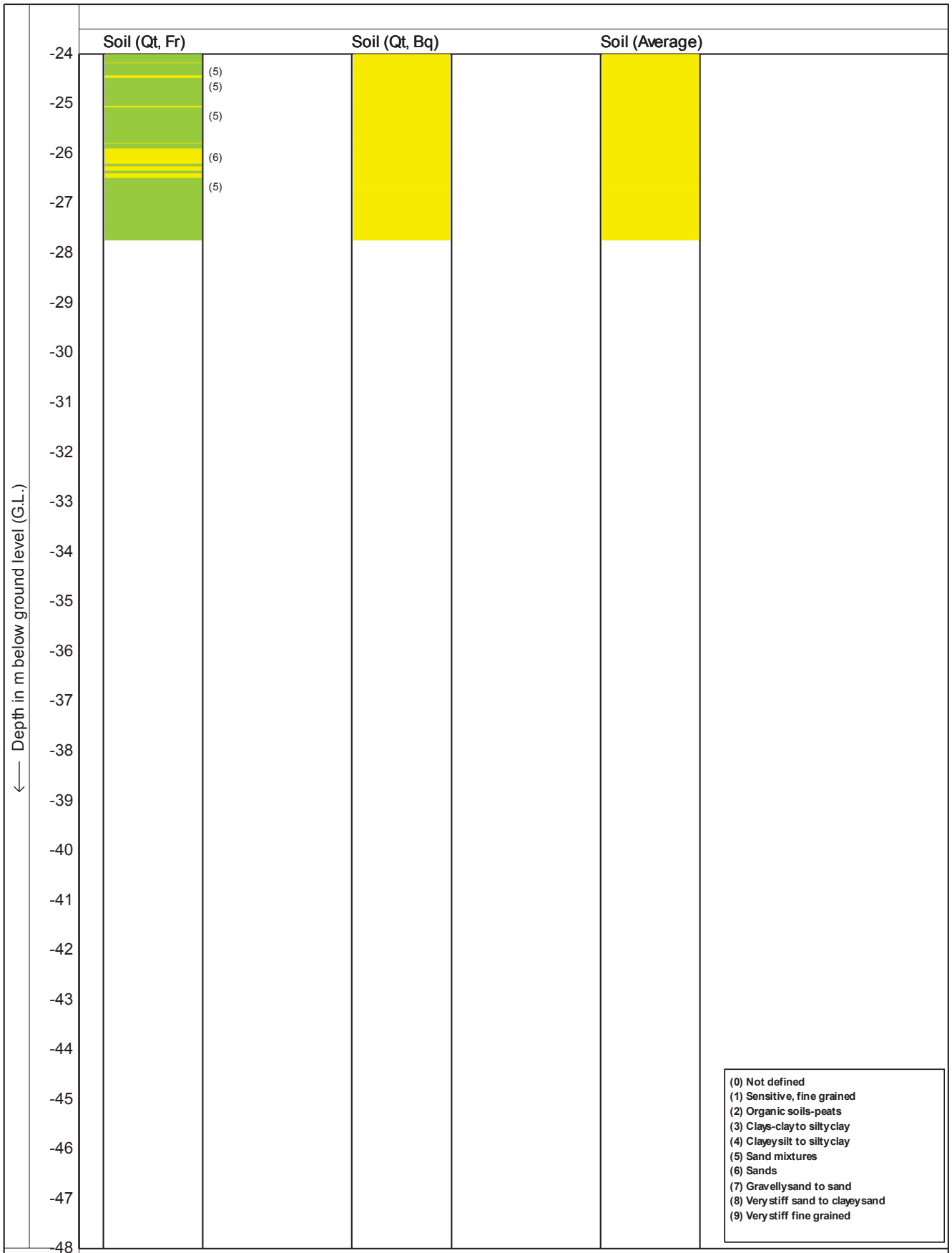
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **25/28**

1.40



Soil behaviour type classification after Robertson 1990

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

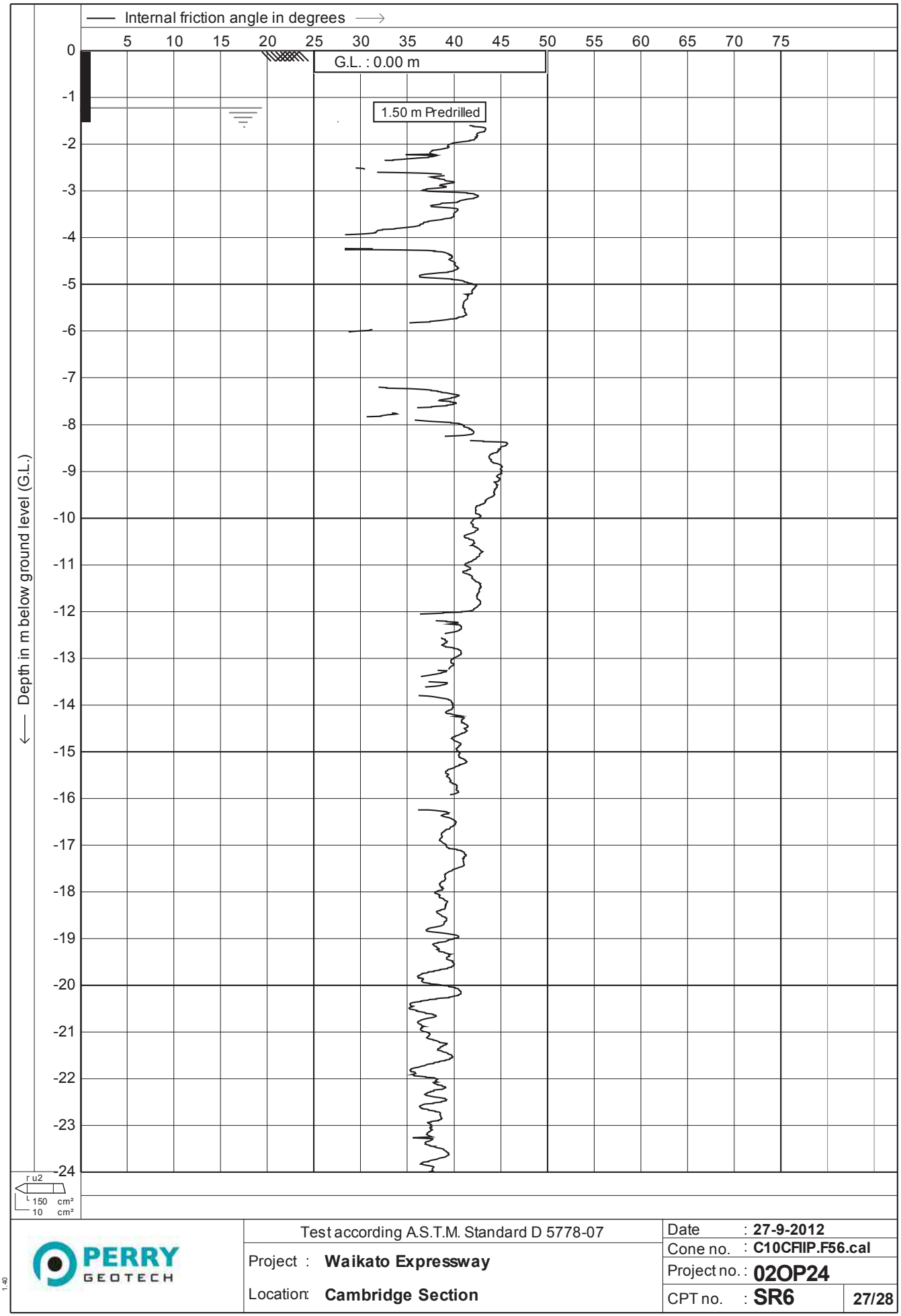
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **26/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

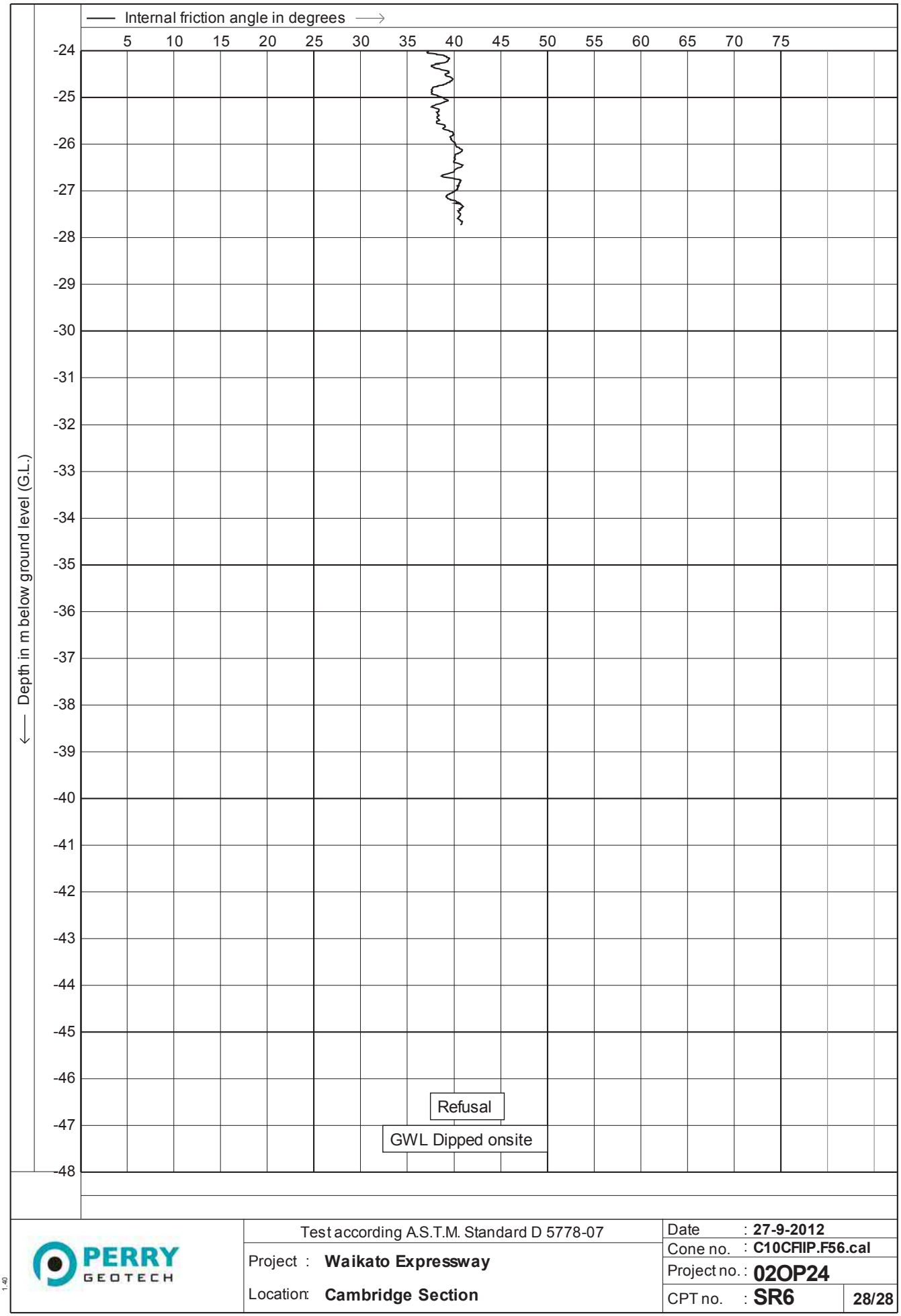
Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **27/28**

1.40



PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-07

Project : **Waikato Expressway**

Location: **Cambridge Section**

Date : **27-9-2012**

Cone no. : **C10CFIIP.F56.cal**

Project no. : **02OP24**

CPT no. : **SR6** **28/28**

1.40

Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G7

Project Name: Cambridge Bypass Investigations
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: E464386.91 N687811.16
Grid: Mt Eden Circuit 2000
Elevation: 27.27 Datum: Moturiki Datam
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
			Ground Surface							
0	HQ Size - Triple Tube - Wireline Rotary Coring		**SILT** Brown SILT, saturated, soft, slightly plastic. Some medium Sand and trace fine Gravel.		0.00					
			CLAY Grey orange mottled CLAY, moist, soft, slightly plastic-moderately plastic.		0.16					
			SAND Greyish brown fine-coarse SAND, some fine-medium pumice and lithic Gravel, saturated, "loose", non plastic.		0.33					
1			**SAND** Brownish grey fine SAND, wet, "loose", non plastic.		0.50					
					0.70	HQ	65			
					0.85					
			SAND Brownish grey medium-coarse SAND, trace subrounded-subangular fine-medium lithic Gravel, saturated, "loose", non plastic.		1.50					
2			**SAND** Grey orange bedded fine SAND, minor Silt, saturated "loose", non plastic.		1.60				Shearbox	
			Gravelly SAND Grey fine Gravelly coarse SAND, saturated, "loose", non plastic.		2.20	HQ	53			
			SAND Grey fine SAND, saturated, "loose", non plastic.							
3			**SAND** Grey black flecked medium-coarse SAND, some fine subrounded lithic Gravel, saturated, "loose-medium dense", non plastic.		3.00	SPT	100	12	Sieve 1//2/2/4/4	
			SAND Grey fine-coarse SAND, some fine-coarse pumice Gravel, saturated, "medium dense", non plastic, 40% pumice.		3.55					
4			**Gravelly SAND** Grey coarse subangular Gravelly fine to coarse SAND, saturated, "medium dense", non plastic.			HQ	72			
						HQ	0			
5										
			Sandy SILT Greyish brown very fine Sandy SILT, wet, firm, slightly plastic-non plastic, dilatent.		5.40	HQ	69			
6			**SAND** Grey fine-coarse SAND, minor Silt, saturated, " very loose", non plastic, 40% pumice.		5.90	SPT	0	0	Hydrometer 0//0/0/0/0	
			SAND Grey very fine SAND, minor Silt and fine-medium pumice Gravel, saturated, "very loose", non plastic.		6.30				Shearbox	
7			**Gravelly SAND** Grey fine-coarse Gravelly fine SAND, saturated, "loose", non plastic, 100% pumice.		7.00	HQ	88			
						HQ	97			
8										
						HQ	93			
9			**Gravelly SAND** Grey fine Gravelly fine-medium SAND, saturated, "loose", non plastic, 100% pumice.		8.70	SPT	0	5	2//1/0/1/3	
						HQ	0			
10										

Remarks:

Logged: S Amoore/J Garvey Date: 7-9/08/07
Checked: S Amoore

Drill Rig: Boart Longyear - Helicopter Rig
Start Date: 7/08/07 Finish Date: 9/08/07

Scale: 1:50

OPUS
Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G7

Project Name: Cambridge Bypass Investigations
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: E464386.91 N687811.16
Grid: Mt Eden Circuit 2000
Elevation: 27.27 Datum: Moturiki Datam
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test (Δ kPa Δ 0 20 60 100) / SPT (■ N ■ 0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
						HQ	0			
			SILT Grey brown SILT, moist, soft, slightly plastic.		10.40					
11			**Sandy SILT** Grey fine Sandy SILT, saturated, soft, slightly plastic.		10.93	HQ	100			
						HQ	100			
12						PT	80		Hydrometer, Oedometer	
						SPT	67	0	0//0/0/0/0	
13			**SAND** Grey fine-coarse SAND, minor Silt, wet, "medium dense", non plastic.		13.10	HQ	100			
			SAND Grey some dark green bedding fine SAND, moist, "medium dense", non plastic.		13.30					
			SAND Grey green interbedded fine SAND, wet, "medium dense", non plastic.		13.50	HQ	93			
14			**SAND** Grey medium SAND, some Silt, wet-saturated, "loose", non plastic.		14.00					
			SAND Greyish green medium SAND, some fine Gravel, saturated, "medium dense", non plastic.		14.10	HQ	91			
			SAND Grey fine-medium SAND, trace fine-coarse pumice Gravel, wet, "medium dense", non plastic.		14.70	SPT	100	22	3//4/5/7/6	
15			**SAND** Dark grey fine SAND, some fine subrounded lithic Gravel, saturated, "medium dense", non plastic.		15.50	HQ	38			
16			**SAND** Grey medium-coarse SAND, some fine-medium subangular lithic Gravel, saturated, "loose", non plastic.		16.50	HQ	67			
			SAND Dark grey medium-coarse SAND, saturated, "loose", non plastic.		17.25	HQ	83			
17			Some fine-medium subangular-subrounded lithic Gravel.		17.90	SPT	78	5	1//2/2/3/2	
			SAND Grey fine-medium SAND, saturated, "medium dense", non plastic.		18.50					
18			**SAND** Brown fine-medium SAND, saturated, "loose", non plastic.		18.60	HQ	5			
			SAND Grey brown mottled fine-medium SAND, some fine-medium subangular-subrounded Gravel, saturated, "loose", non plastic.		19.50	HQ	7			
19										
20	HQ Size - Triple Tube - Wireline Rotary Coring									

Remarks:

Logged: S Amoore/J Garvey Date: 7-9/08/07
Checked: S Amoore

Drill Rig: Boart Longyear - Helicopter Rig
Start Date: 7/08/07 Finish Date: 9/08/07

Scale: 1:50

Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G7

Project Name: Cambridge Bypass Investigations
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: E464386.91 N687811.16
Grid: Mt Eden Circuit 2000
Elevation: 27.27 Datum: Moturiki Datam
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test / SPT	Additional Lab Tests/Notes	Piezometer Installation
			SAND Grey medium-coarse SAND, some fine-medium subangular to subrounded Gravel, saturated, "loose", non plastic.							
			GRAVEL/COBBBLE Grey GRAVEL/COBBLE, "dense".		20.25	HQ	100			
21						HQ	18			
			GRAVEL Brownish grey medium-coarse subangular-subrounded GRAVEL, minor coarse SAND, "dense".		21.00	HQ	53			
22						HQ	0			
						SPT	0	36	29//12/9/7/8	
23						HQ	0			
24						SPT	0	50	43//17/14/13/6 for 25mm	
			GRAVEL Greyish brown fine-coarse subangular-subrounded Gravel, "dense-very dense".		24.50				Sieve	
25						HQ	19			
						SPT	0	46	29//10/12/12/12	
26	HQ Size - Triple Tube - Wireline Rotary Coring					HQ	0			
27						SPT	0	50	48//19/17/14 for 75mm	
			GRAVEL Greyish brown fine-medium subrounded-subangular GRAVEL, "dense".		27.45	HQ	35			
28			**GRAVEL** Light greyish white fine-coarse subrounded-subangular GRAVEL, some pumice, "dense".		28.00	HQ	25			
						SPT	0	46	23//13/9/11/13	
29			**GRAVEL** Greyish brown fine-medium subrounded-subangular GRAVEL, "very dense".		28.95	HQ	29			
30										

Sand

Slot Screen

Remarks:

Logged: S Amoore/J Garvey Date: 7-9/08/07
Checked: S Amoore

Drill Rig: Boart Longyear - Helicopter Rig
Start Date: 7/08/07 Finish Date: 9/08/07

Scale: 1:50

OPUS
Hamilton Office
Private Bag 3057
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New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G7

Project Name: Cambridge Bypass Investigations
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: E464386.91 N687811.16
Grid: Mt Eden Circuit 2000
Elevation: 27.27 Datum: Moturiki Datam
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Ground Profile: Description	Graphic Log	Depth/Elev	Samples: Type	Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
						SPT	0	50	14//10/14/12/14 for 65mm	
			End of Log		30.44					

31
32
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34
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36
37
38
39
40

Remarks:

Logged: S Amoore/J Garvey Date: 7-9/08/07
Checked: S Amoore

Drill Rig: Boart Longyear - Helicopter Rig
Start Date: 7/08/07 Finish Date: 9/08/07

Scale: 1:50

OPUS
Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G8

Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803611.00 E1819522.93
Grid: NZTM
Elevation: 25.85 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
			Ground Surface							
0	HQ Size - Triple Tube - Wireline Rotary Coring		**SAND** Grey brown fine-medium SAND, moist-wet, "loose", non plastic.		0.00	HQ	57			Bentonite
1			**Silty CLAY** Grey brown orange Silty CLAY, some wood, moist, soft, moderately plastic.		1.00					
2			**Sandy SILT** Grey fine Sandy SILT, saturated, very soft, slightly plastic.		1.45	SPT	67	0	0//0/0/0/0	
						HQ	38			
3			**SAND** Grey fine SAND, wet, "loose", non plastic.		2.70	SPT	89	6	3//2/2/1/1	Sand
4			Some wood. Some coarse lithic Sand.		4.10	HQ	5			
						SPT	33	14	3//3/4/3/4	
5			**Silty SAND** Grey brown Silty very fine SAND, saturated, "loose", non plastic, dilatent. No Silt.		5.00 5.40	HQ	76		Sieve, shearbox	
6			**Gravelly SAND** Grey brown fine-medium pumiceous Gravelly fine SAND, saturated, "loose", non plastic.		5.60	SPT	0	6	3//1/2/1/2	Bentonite
			GRAVEL Grey fine-coarse subrounded-subangular lithic GRAVEL, moist, "medium dense", non plastic.		6.45 6.70					
7			**SAND** Grey fine-coarse Gravelly fine SAND, pumiceous, saturated, "medium dense", non plastic. Wood fragment 2cm.		7.00	HQ	95		Sieve	
						SPT	44	5	1//1/1/1/2	
8						HQ	100			Sand
9			Trace lithic Gravel.		9.00	SPT	4	5	2//1/1/2/1	Slotted Screen
						HQ	67			20mm PVC
10										

Remarks:

Logged: S Amoore Date: 21-23/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 21/5/08 Finish Date: 23/5/08

Scale: 1:50

Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G8

Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803611.00 E1819522.93
Grid: NZTM
Elevation: 25.85 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ 0 20 60 100 / SPT N 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
			SILT Grey brown SILT, saturated, soft, slightly plastic, sensitive.		10.20					
						SPT	0	0	1//0/0/0/0	Bentonite
11			Some small Gravel possibly washed in.		11.00					
						HQ	14			
12						SPT	4	4	0//2/0/1/1	
						HQ	100		Plasticity Index, Hydrometer	
13						PT	0			
14			**GRAVEL** Grey brown wood and fine-coarse subangular GRAVEL, well graded, saturated, "medium dense", non plastic.		14.00					
			Sandy GRAVEL Grey coarse Sandy fine-coarse GRAVEL, well graded. 10cm wood, saturated, "medium dense", non plastic.		14.50	HQ	67			
15						SPT	7	14	Sieve 5//2/3/4/5	
			SAND Grey brown medium-coarse SAND, trace coarse subangular Gravel, saturated, "medium dense", non plastic.		15.45					
16						HQ	62			
						SPT	0	27	SOLID NOSE 2//5/5/8/9	Bentonite
17			**Sandy SILT** Grey fine-medium Sandy SILT, wet, soft-stiff, slightly plastic.		16.95					
			SILT Light grey SILT, some sand beds, wet, firm, slightly plastic.		17.30	HQ	100			
			SILT Dark grey green mottled SILT, wet, stiff, slightly plastic.		17.70					
18						SPT	0	29	SOLID NOSE 10//7/7/7/8	Sand
			SAND Grey brown fine SAND, some fine-coarse subangular Gravel, saturated, "loose", non plastic.		18.70					
19			Red brown		18.90	HQ	100			
			GRAVEL Orange brown fine pumiceous GRAVEL, wet-saturated, "medium dense-dense", non plastic.		19.35					
						SPT	0	50+	SOLID NOSE 12//9/7 for 25mm bouncing	Slotted Screen
20			**SAND** Brown fine SAND, some coarse Sand/fine Gravel, saturated, "medium dense"		19.80 / 19.90 / 20.00					

HQ Size - Triple Tube - Wireline Rotary Coring

Remarks:

Logged: S Amoore Date: 21-23/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 21/5/08 Finish Date: 23/5/08

Scale: 1:50

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Co-ordinates: N5803611.00 E1819522.93
Grid: NZTM
Elevation: 25.85 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ 0 20 60 100 / SPT ■ N ■ 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
21	HQ Size - Triple Tube - Wireline Rotary Coring		**SILTSTONE** Grey rock (boulder) black mottled SILTSTONE							
			SAND Grey brown green coarse SAND, some fine Gravel and Silt, saturated, "dense", non plastic.		20.40	HQ	84			
			GRAVEL Dark green grey subangular-subrounded fine-coarse GRAVEL, 30% pumice, some fine-coarse Sand, saturated, "dense", non plastic.		20.85					
			SILTSTONE Grey SILTSTONE, "very dense", non plastic.		21.00	SPT	0	50+	SOLID NOSE 12//7/9/5 for 20mm bouncing	
22			**SILT** Grey SILT, some fine Sand, wet, stiff, slightly plastic. No Sand.		21.87	HQ	85			
			SAND Grey some green bedding, fine-coarse SAND, saturated, "medium dense", non plastic.		21.97					
			GRAVEL/BOULDER Grey brown red GRAVEL/BOULDER.		22.50			50+	SOLID NOSE 3 for 0mm bouncing	
23			**GRAVEL** Green fine-coarse subrounded GRAVEL, saturated, "dense", non plastic.			HQ	40			
			SAND Green fine-medium SAND, saturated, "dense", non plastic.		23.50					
24			Some fine subrounded lithic Gravel.		24.00	SPT	0	50+	SOLID NOSE 10 for 100mm bouncing	
			Becoming orange.		24.40					
			SAND Light brown fine SAND, trace Silt, saturated, "dense", non plastic.		24.55	HQ	65			
25			No Silt.							
					25.50		0	50+	SOLID NOSE 10 for 70mm bouncing	
26						HQ	14			
							0	50+	SOLID NOSE 8 for 65mm bouncing	
27						HQ	77		Sieve	
28										
							0	50+	SOLID NOSE 8 for 70mm bouncing	
29						HQ	56			
			Gravelly SAND Orange fine subrounded Gravelly medium-coarse SAND, saturated, "dense", non plastic.		29.40					
30					30.00					

Remarks:

Logged: S Amoore Date: 21-23/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 21/5/08 Finish Date: 23/5/08

Scale: 1:50

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Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803611.00 E1819522.93
Grid: NZTM
Elevation: 25.85 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Samples: Type	Samples: Recovery	Vane Test kPa / SPT N	Additional Lab Tests/Notes	Piezometer Installation
31	HQ Size - Triple Tube - Wireline Rotary Coring		**SILT** Light brown SILT, wet, hard, slightly plastic-moderately plastic.			SPT	0	50+	SOLID NOSE 10 for 80mm bouncing	
			SAND Light brown fine SAND, wet-moist, "very dense", non plastic.		30.60	HQ	100			
32			**SAND** Green brown fine-coarse SAND, some pumice, some fine-coarse subrounded Gravel, saturated, "very dense", non plastic.		31.49	SPT	0	50+	SOLID NOSE 10 for 80mm bouncing	
33						HQ	42			
						SPT	0	50+	SOLID NOSE 10 for 90mm bouncing	
34			End of Log		33.09					
35										
36										
37										
38										
39										
40										

Remarks:

Logged: S Amoore Date: 21-23/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 21/5/08 Finish Date: 23/5/08

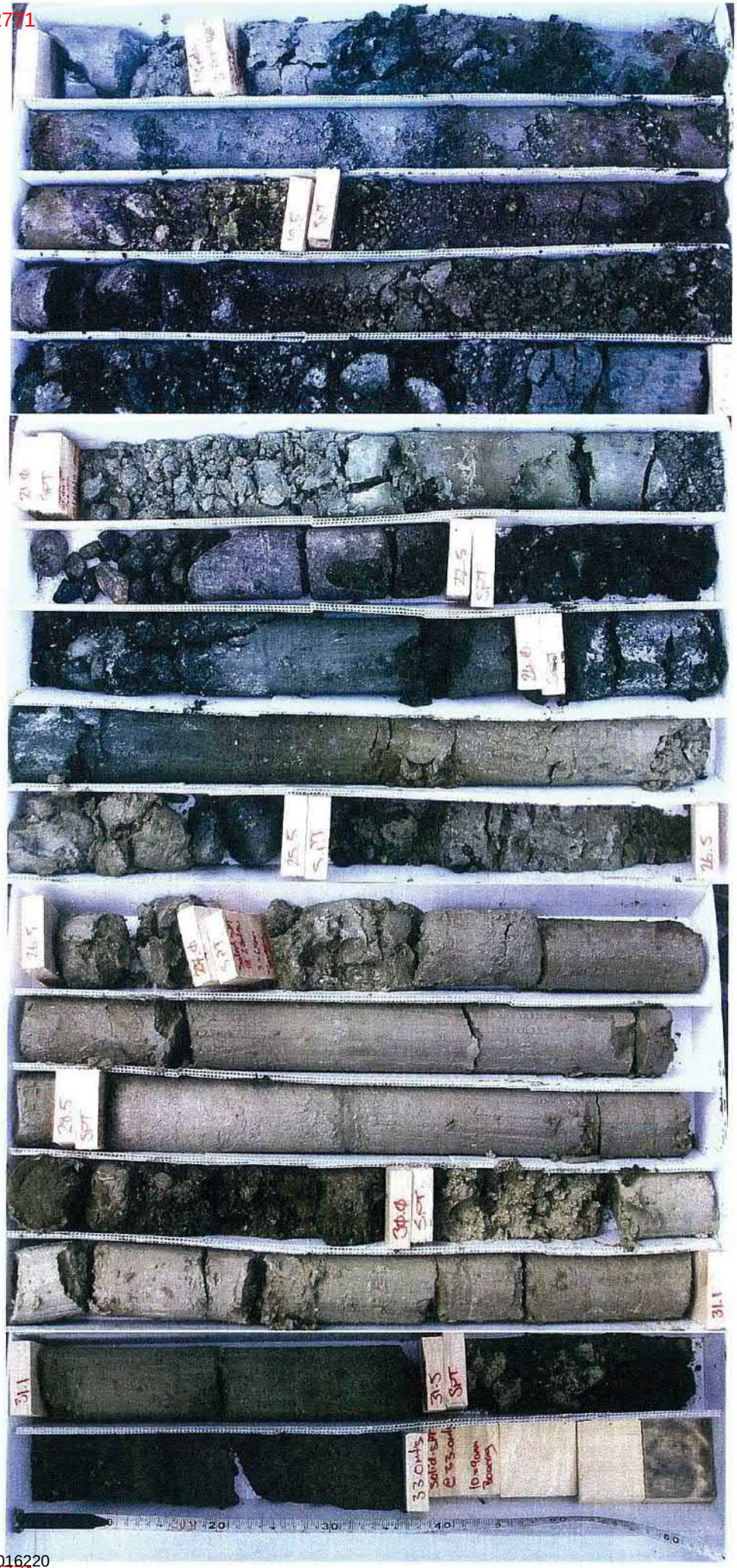
Scale: 1:50

SH1 CAMBRIDGE BYPASS

261647.00

DATE: 21/5/08

BOREHOLE: G8



SH1 CAMBRIDGE BYPASS

261647.00

DATE: 21/5/08

BOREHOLE: G8

Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G9

Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803643.86 E1819485.00
Grid: NZTM
Elevation: 32.65 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ 0 20 60 100 / SPT ■ N ■ 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
			Ground Surface							
0	HQ Size - Triple Tube - Wireline Rotary Coring		**SILT** Brown SILT, wet, very soft, slightly plastic.		0.00					Bentonite Seal
			SAND Grey brown medium-coarse SAND, saturated, "loose", non plastic.		0.30					
1			**SAND** Grey fine SAND, some tree roots, saturated, "very loose", non plastic.		0.50	HQ	40			
						SPT	0	0	0//0/0/0/0	
2			**SAND** Grey fine-coarse SAND, some fine pumice Gravel, saturated, "loose", non plastic.		2.10	HQ	86			
3						SPT	100	2	Sieve, Shearbox 1//1/0/1/0	
4						HQ	48			
			SAND Grey fine SAND, minor Silt, saturated, "very loose", non plastic.		4.50	SPT	45	5	0//0/1/2/2	
5			**Sandy SILT** Grey fine Sandy SILT, saturated, soft, slightly plastic-non plastic.		5.00	HQ	57			
			SAND Grey fine SAND, some medium-coarse pumice Gravels, saturated, "very loose", non plastic.		5.50					
6						SPT	89	2	0//0/1/0/1	
						HQ	100			
7			**SAND** Grey medium SAND, some Silt, wet, "medium dense", non plastic. Becoming Sandy SILT.		7.10					
					7.40	PT	100		Hydrometer, Oedometer	
8						HQ	100			
			SAND Dark grey green orange medium-coarse SAND, some Silt bedding, minor fine subangular-subrounded Gravel, moist-wet, "medium dense", non plastic.		8.60					
9						SPT	100	3	Sieve 4//2/4/3/4	
						HQ	100			
10										Backfill

Remarks:

Logged: S Amoore/J Ormond Date: 27-30/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 27/5/08 Finish Date: 30/5/08

Scale: 1:50

OPUS
Hamilton Office
Private Bag 3057
Hamilton
New Zealand
Tel. 64 7 838 9344
Fax 64 7 838 9324

Borehole No: G9

Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803643.86 E1819485.00
Grid: NZTM
Elevation: 32.65 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
			Becoming orange.		10.30					
			Clayey SILT White Clayey SILT, minor fine Sand, moist, soft-firm, slightly plastic.		10.50	SPT	56	1	Plasticity Index, Hydrometer 2//0/0/1/0	
11			Some orange mottles.		11.20					
			SAND Brown medium SAND, slightly weathered, moist, "medium dense", non plastic.		11.30	HQ	100			
12						SPT	71	10	Sieve 4//2/3/2/3	
13						HQ	100			
			Medium-coarse, some orange mottles.		13.30	SPT	67	19	6//4/6/5/4	
14			2cm Black Silt bed.		14.20					
			SAND Grey brown black fine-coarse SAND, some Silt and coarse Gravel, saturated, "loose", non plastic.		14.30	HQ	100			
15			**Sandy SILT** Brown white coarse Sandy SILT, some subrounded fine-medium Gravel, moist, firm, slightly plastic.		15.20	SPT	0	14	SOLID SPT 3//2/2/4/6	
16	HQ Size - Triple Tube - Wireline Rotary Coring					HQ	57			
			SAND Grey medium-coarse SAND, trace fine subrounded-subangular Gravel, saturated, "medium dense", non plastic.		16.50	SPT	0	20	SOLID SPT 6//4/6/5/5	
17						HQ	86			
18						SPT	0	28	SOLID SPT 8//6/7/7/8	
			Silty SAND Light brown Silty fine-coarse SAND, saturated, "medium dense", non plastic.		18.60	HQ	86			
19										
			SAND Light brown fine-coarse SAND, minor Silt, saturated, "medium dense", non plastic.		19.60	SPT	0	40	SOLID SPT 12//10/9/10/11	
20					20.00					

Slotted Screen
Bentonite Seal
Sand

Remarks:

Logged: S Amoore/J Ormond Date: 27-30/5/08
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Drill Rig: Perry Drilling - Tractor
Start Date: 27/5/08 Finish Date: 30/5/08

Scale: 1:50

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Private Bag 3057
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Borehole No: G9

Project Name: Cambridge Bypass Investigation
Client: Transit New Zealand
Location: Karapiro Gully
Project No. 2-61647.00 Lab Ref.

Co-ordinates: N5803643.86 E1819485.00
Grid: NZTM
Elevation: 32.65 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
21	HQ Size - Triple Tube - Wireline Rotary Coring		**SAND** Light brown medium-coarse SAND, some fine-medium subrounded-subangular Gravel, saturated, "loose", non plastic.			HQ	67			
						SPT	0	34	SOLID SPT 12//8/8/9/9	
22						HQ	0			
23			**SAND** Green fine-coarse lithic SAND, some fine-coarse Gravel, minor Silt, saturated, "medium dense", non plastic.		22.70	SPT	0	50+	SOLID SPT 11//11/14/13/12 for 70mm	
						HQ	92			
24						SPT	0	50+	SOLID SPT 16//11/7 for 30mm bouncing	
25						HQ	16			
						SPT	0	34	SOLID SPT 13//10/7/9/8	
26						HQ	100			
27			**SAND** Grey, some yellow mottles/beds fine-medium pumiceous SAND, some subangular to subrounded fine-coarse pumice Gravel, wet-saturated, "medium dense", non plastic.		26.80	SPT	0	32	SOLID SPT 8//8/8/8/8	
28						HQ	100			
			SAND Light brown fine-medium SAND, minor Silt, saturated, "dense", non plastic.		28.40	SPT	0	50+	Sieve SOLID SPT 30 for 120mm bouncing	
29						HQ	43			
			Some fine-coarse subangular lithic Gravel.		29.80				SOLID SPT 3 for 0mm bouncing	
30										

Remarks:

Logged: S Amoore/J Ormond Date: 27-30/5/08
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Co-ordinates: N5803643.86 E1819485.00
Grid: NZTM
Elevation: 32.65 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ▲ kPa ▲ 0 20 60 100 / SPT ■ N ■ 0 10 30 50+	Additional Lab Tests/Notes	Piezometer Installation
31	HQ Size - Triple Tube - Wireline Rotary Coring		**SAND** Light brown, some green mottles, fine-coarse SAND, some fine pumiceous Gravel, saturated, "dense", non plastic.		30.20	HQ	40		Shearbox	
32						SPT	0	50+	SOLID SPT 11 for 80mm bouncing	
						HQ	21			
33			**Sandy SILT** Brown very fine Sandy SILT, moist, hard, slightly plastic.		33.00	SPT	0	50+	SOLID SPT 13 for 130mm bouncing	
34			**Gravelly SAND** Dark orange subangular-subrounded Gravelly coarse SAND, saturated, "very dense", non plastic.		33.70	HQ	100			
35								50+	SOLID SPT 10 for 60mm bouncing	
						HQ	100			
36								50+	SOLID SPT 10 for 60mm bouncing	
37			**Sandy SILT** Brown grey very fine Sandy SILT, moist, hard, slightly plastic.		36.70	HQ	100			
			Gravelly SAND Dark orange subangular-subrounded fine-coarse Gravelly coarse SAND, saturated, "very dense", non plastic.		37.40			50+	SOLID SPT 6 for 30mm bouncing	
38			**GRAVEL** Brown grey subangular-subrounded fine-coarse GRAVEL, saturated, "very dense", non plastic, well graded.		38.00	HQ	78		Sieve	
39								50+	SOLID SPT 7 for 30mm bouncing	
						HQ	20			
40										

Remarks:

Logged: S Amoore/J Ormond Date: 27-30/5/08
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Grid: NZTM
Elevation: 32.65 Datum: Moturiki
Inclination: Vertical Azimuth:

Depth	Drilling Method	Casing	Description	Graphic Log	Depth/Elev	Samples: Type	Samples: Recovery	Vane Test ▲ kPa ▲ (0 20 60 100) / SPT N (0 10 30 50)	Additional Lab Tests/Notes	Piezometer Installation
								50+	SOLID SPT 6 for 30mm bouncing	
			End of Log		40.53					
41										
42										
43										
44										
45										
46										
47										
48										
49										
50	HQ Size - Triple Tube - Wireline Rotary Coring									

Remarks:

Logged: S Amoore/J Ormond Date: 27-30/5/08
Checked: G Tait

Drill Rig: Perry Drilling - Tractor
Start Date: 27/5/08 Finish Date: 30/5/08

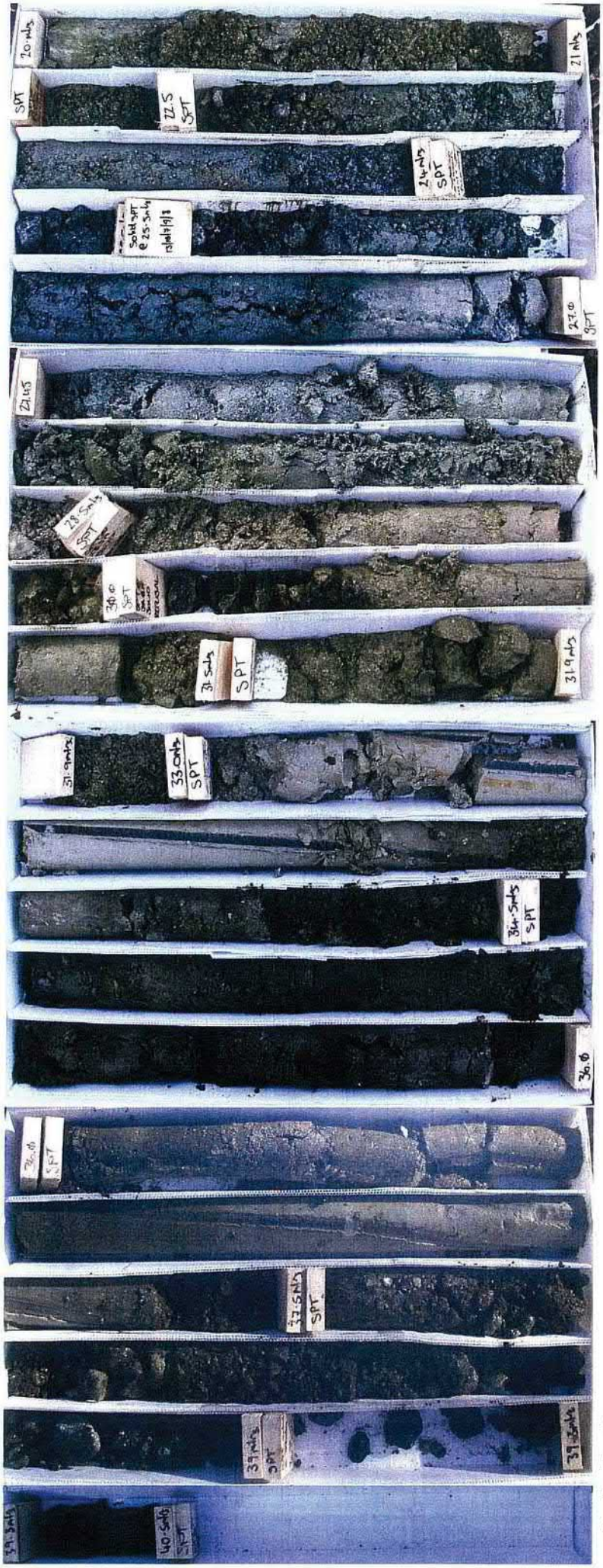
Scale: 1:50

SH1 CAMBRIDGE BYPASS

261647.00

DATE:27/5/08

BOREHOLE: G9



SH1 CAMBRIDGE BYPASS

261647.00

DATE: 27/05/08

BOREHOLE: G9

APPENDIX C – HISTORICAL IMAGES

Retrolens

Figure 1. Historical Imagery from 1943. Approximate site location marked by red square. (Imagery from http://retrolens.nz/)

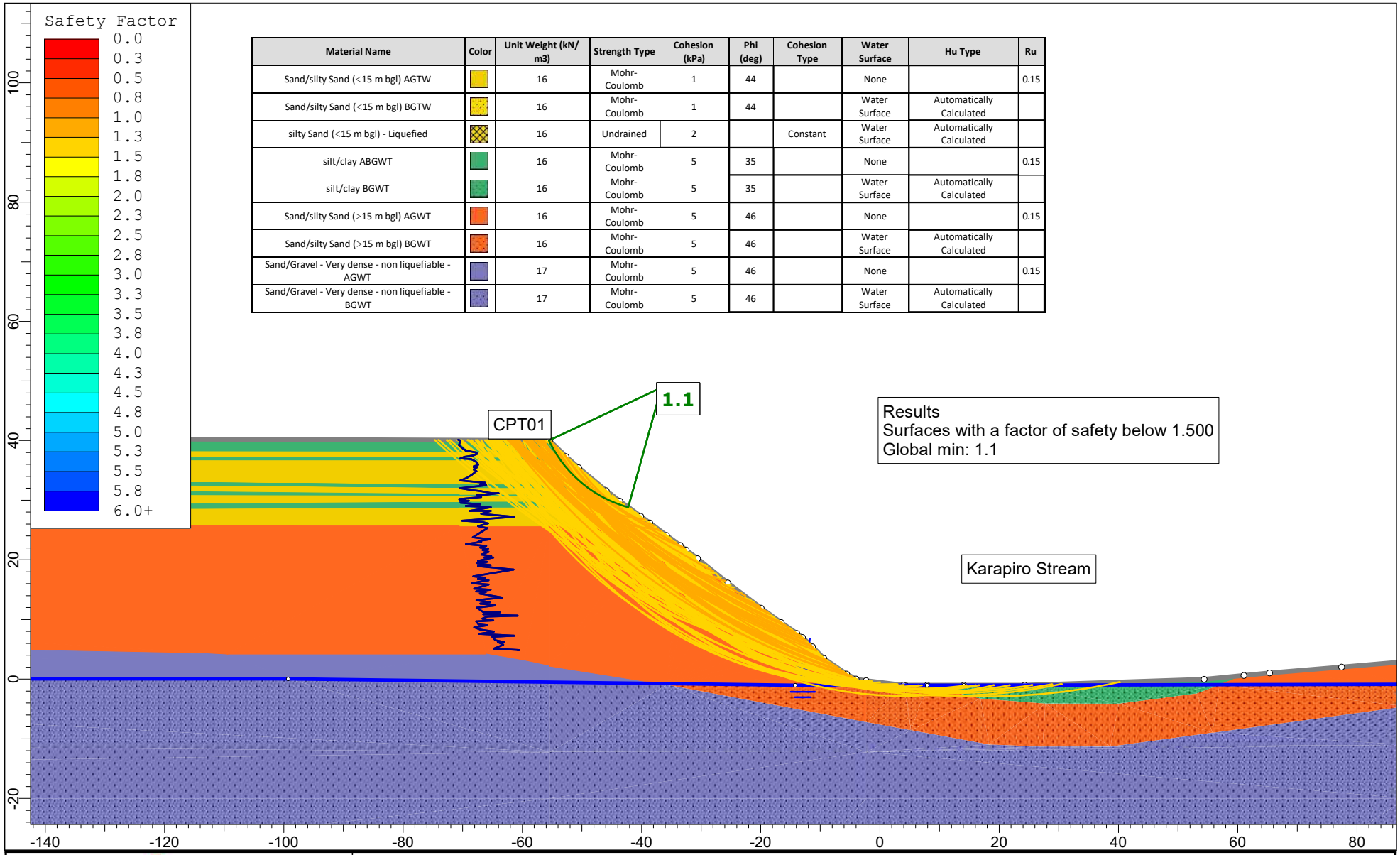
Figure 2. Historical Imagery from 1966. Approximate site location marked by red square. (Imagery from http://retrolens.nz/)

Figure 3. Recent Imagery from 2020. Approximate site location marked by red square. (Imagery from Google Earth pro).

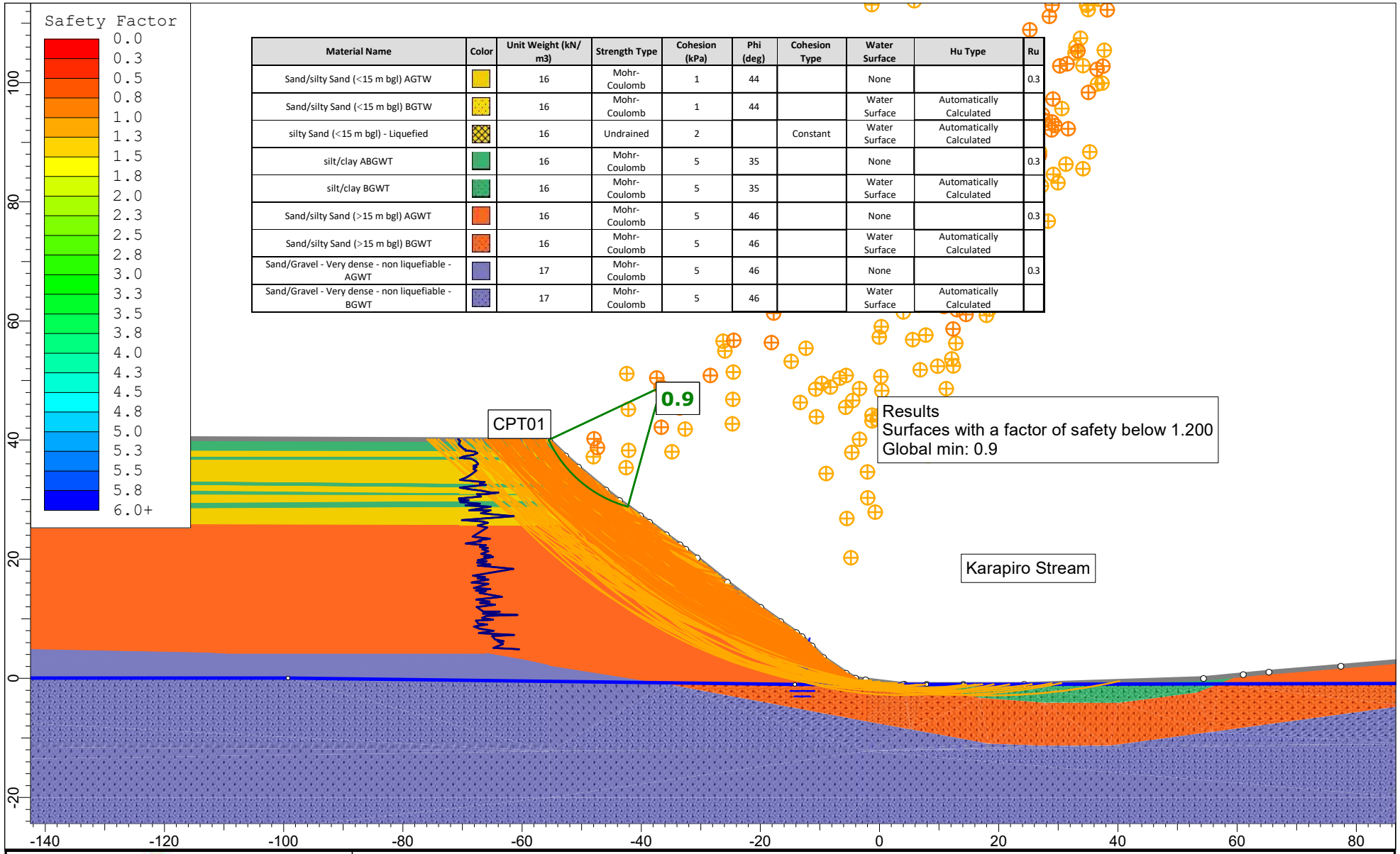
APPENDIX D – SLOPE STABILITY ASSESSMENT

SLIDE

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44		None		0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44		Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant	Water Surface	Automatically Calculated	
silt/clay ABGWT		16	Mohr-Coulomb	5	35		None		0.15
silt/clay BGWT		16	Mohr-Coulomb	5	35		Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46		None		0.15
Sand/silty Sand (>15 m bgl) BGWT		16	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46		None		0.15
Sand/Gravel - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	

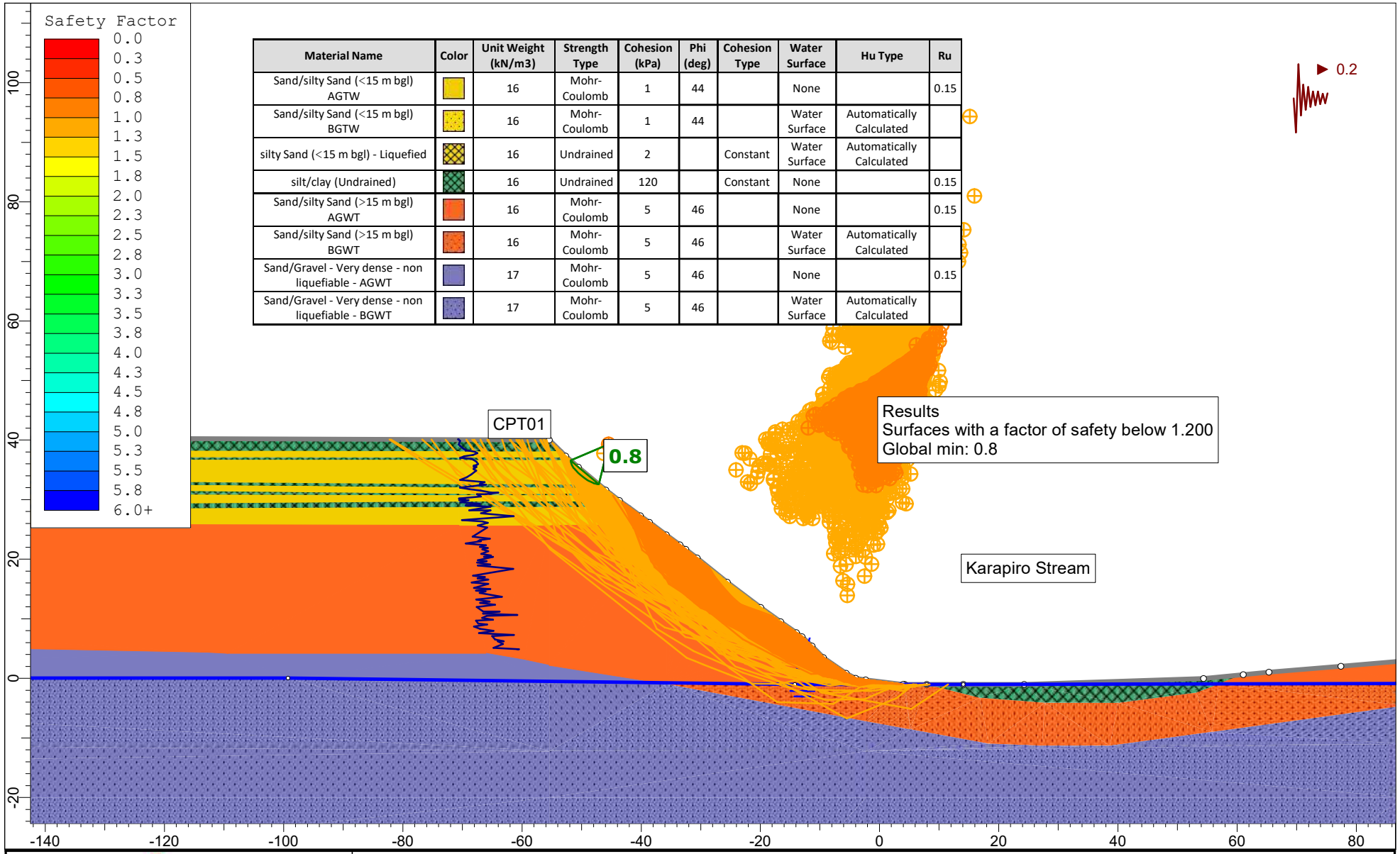


SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	Back assessment - Long term, static	*Scenario* RU 0.15
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1684 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44		None		0.3
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44		Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant	Water Surface	Automatically Calculated	
silt/clay ABGWT		16	Mohr-Coulomb	5	35		None		0.3
silt/clay BGWT		16	Mohr-Coulomb	5	35		Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46		None		0.3
Sand/silty Sand (>15 m bgl) BGWT		16	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46		None		0.3
Sand/Gravel - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	

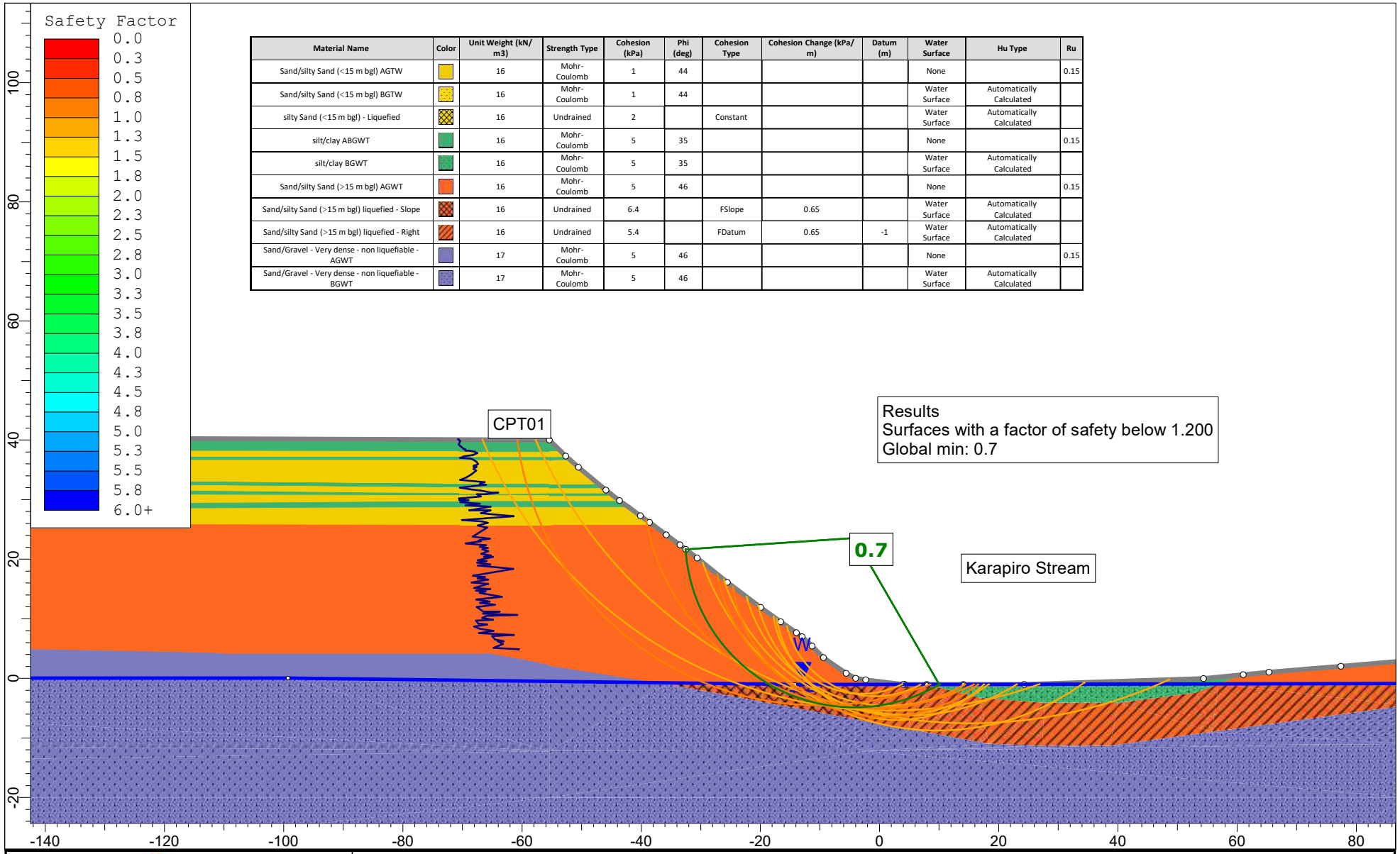
SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	Back assessment - Long term, static	*Scenario* RU 0.3
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1684 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44		None		0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44		Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant	Water Surface	Automatically Calculated	
silt/clay (Undrained)		16	Undrained	120		Constant	None		0.15
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46		None		0.15
Sand/silty Sand (>15 m bgl) BGWT		16	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46		None		0.15
Sand/Gravel - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	

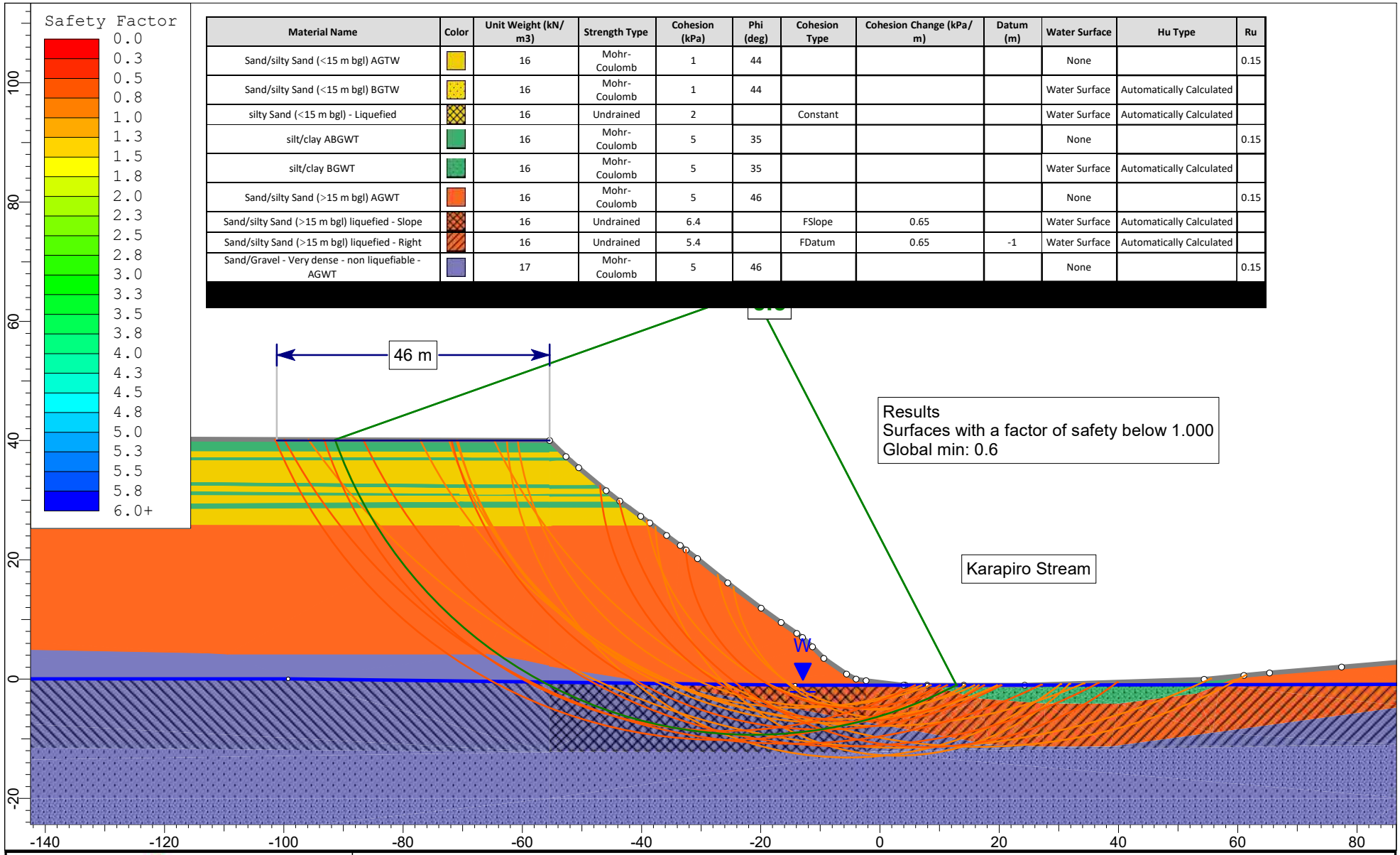
SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	Back assessment - Long term, static	*Scenario* Seismic undrained
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1984 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Datum (m)	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44				None		0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44				Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant			Water Surface	Automatically Calculated	
silt/clay ABGWT		16	Mohr-Coulomb	5	35				None		0.15
silt/clay BGWT		16	Mohr-Coulomb	5	35				Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46				None		0.15
Sand/silty Sand (>15 m bgl) liquefied - Slope		16	Undrained	6.4		FSlope	0.65		Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) liquefied - Right		16	Undrained	5.4		FDatum	0.65	-1	Water Surface	Automatically Calculated	
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46				None		0.15
Sand/Gravel - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46				Water Surface	Automatically Calculated	



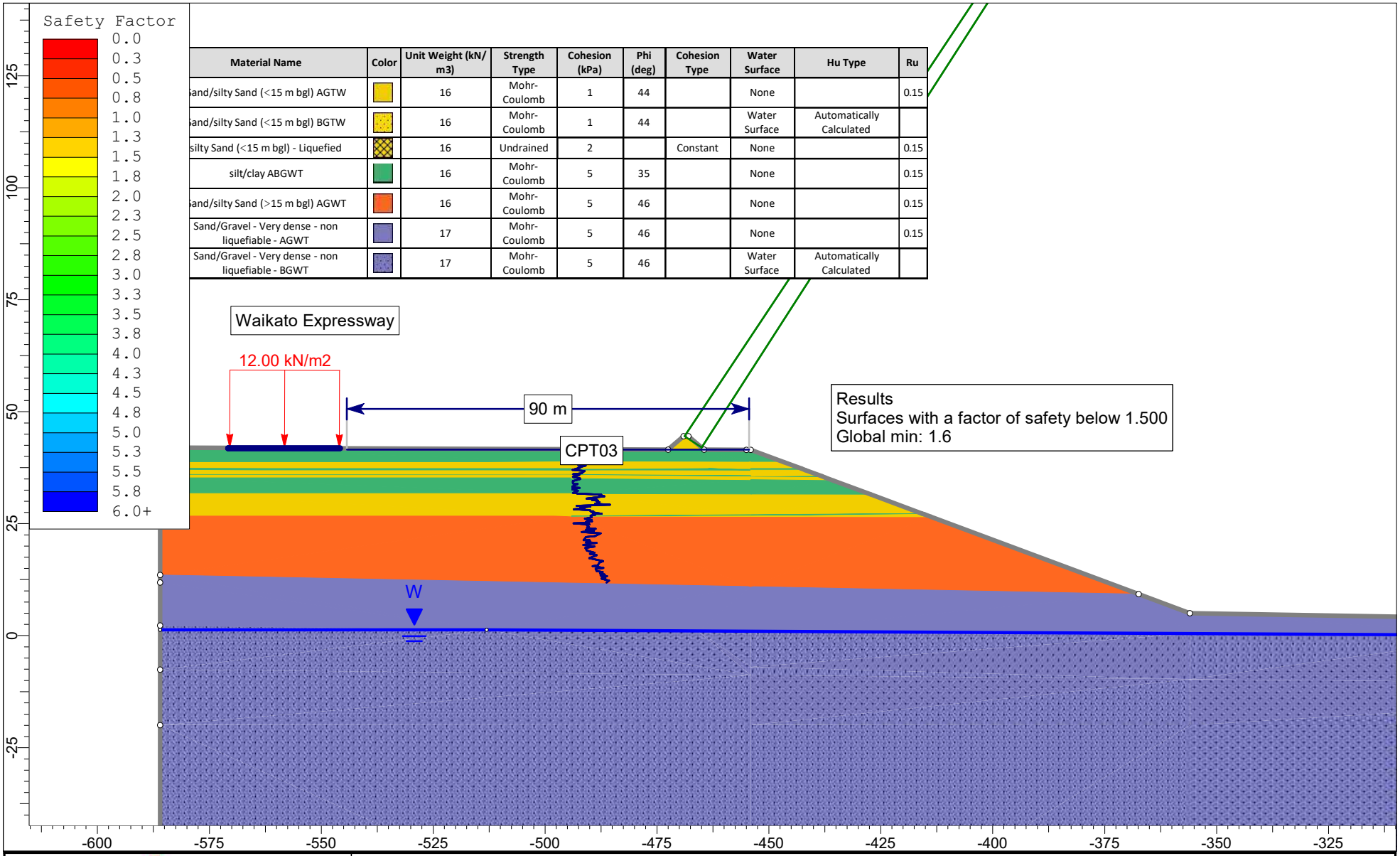
	Project	RS Sand - 77 Newcombe Road, Cambridge	
	Group	Back assessment - Long term, static	*Scenario* Liquified
	Drawn By	HJ	*Company* HD Geo Ltd
SLIDEINTERPRET 9.018	*Date*	16.12.2020	*File Name* HD1984 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Datum (m)	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44				None		0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44				Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant			Water Surface	Automatically Calculated	
silt/clay ABGWT		16	Mohr-Coulomb	5	35				None		0.15
silt/clay BGWT		16	Mohr-Coulomb	5	35				Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46				None		0.15
Sand/silty Sand (>15 m bgl) liquefied - Slope		16	Undrained	6.4		FSlope	0.65		Water Surface	Automatically Calculated	
Sand/silty Sand (>15 m bgl) liquefied - Right		16	Undrained	5.4		FDatum	0.65	-1	Water Surface	Automatically Calculated	
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46				None		0.15



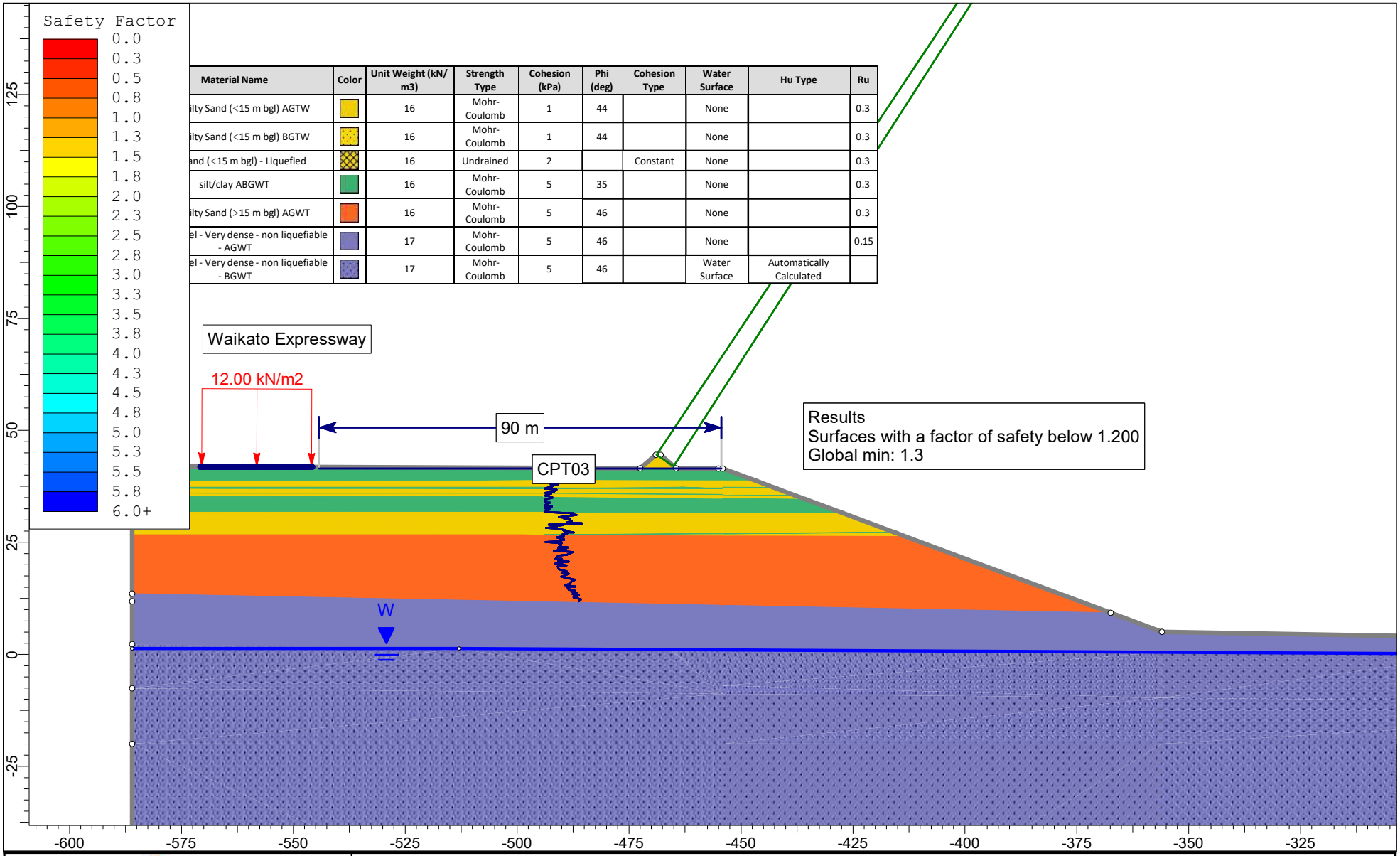
	Project	RS Sand - 77 Newcombe Road, Cambridge	
	Group	Back assessment - Long term, static	Scenario: Liquefied - worst case
	Drawn By	HJ	Company: HD Geo Ltd
SLIDEINTERPRET 9.018	Date	16.12.2020	File Name: HD1884 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd

Proposed



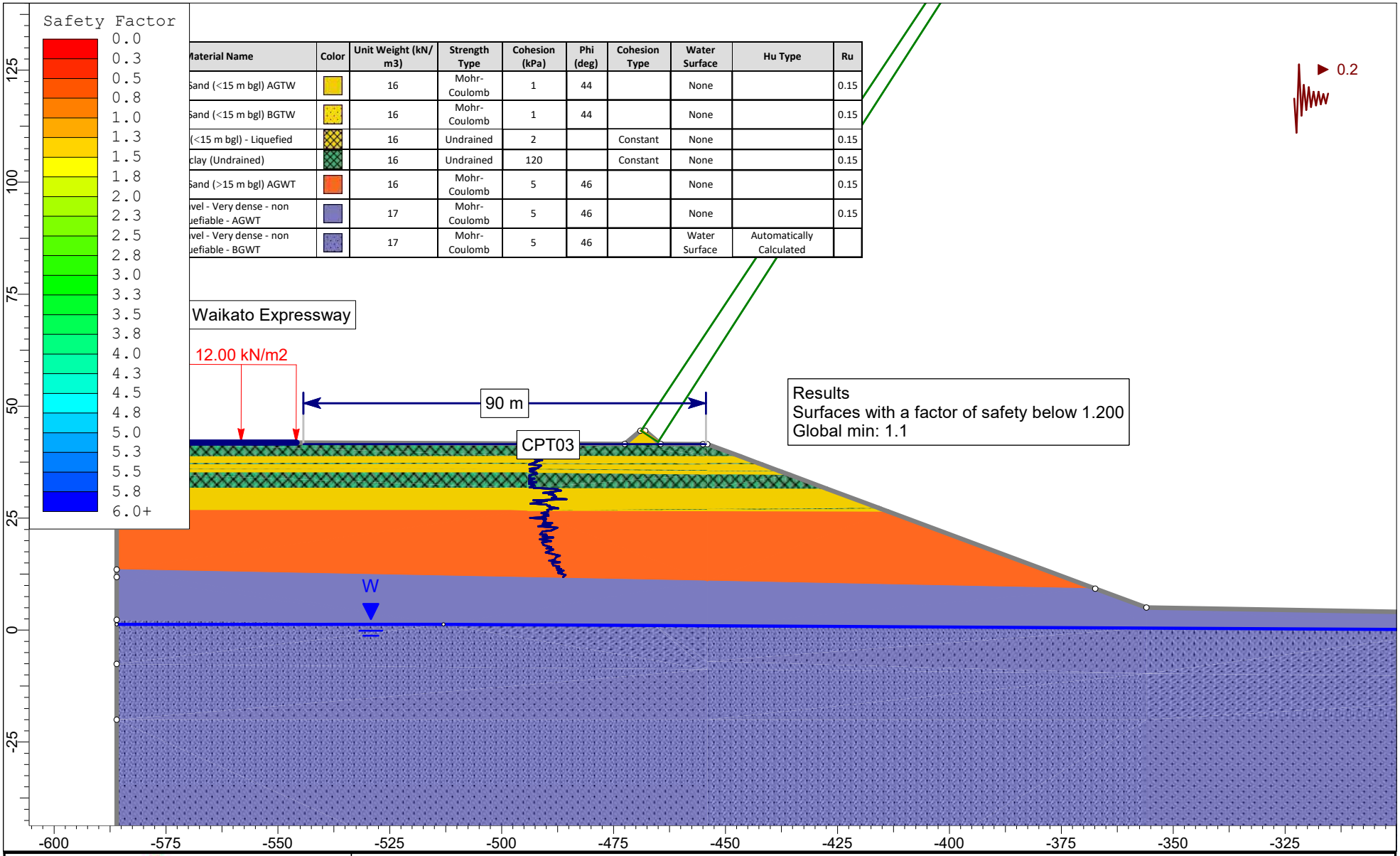
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44		None		0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44		Water Surface	Automatically Calculated	
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant	None		0.15
silt/clay ABGWT		16	Mohr-Coulomb	5	35		None		0.15
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46		None		0.15
Sand/Gravel - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46		None		0.15
Sand/Gravel - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	

	Project	RS Sand - 77 Newcombe Road, Cambridge	
	Group	3:1 batter	Scenario: RU 0.15
	Drawn By	HJ	Company: HD Geo Ltd
SLIDEINTERPRET 9.018	Date	16.12.2020	File Name: HD1684 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd

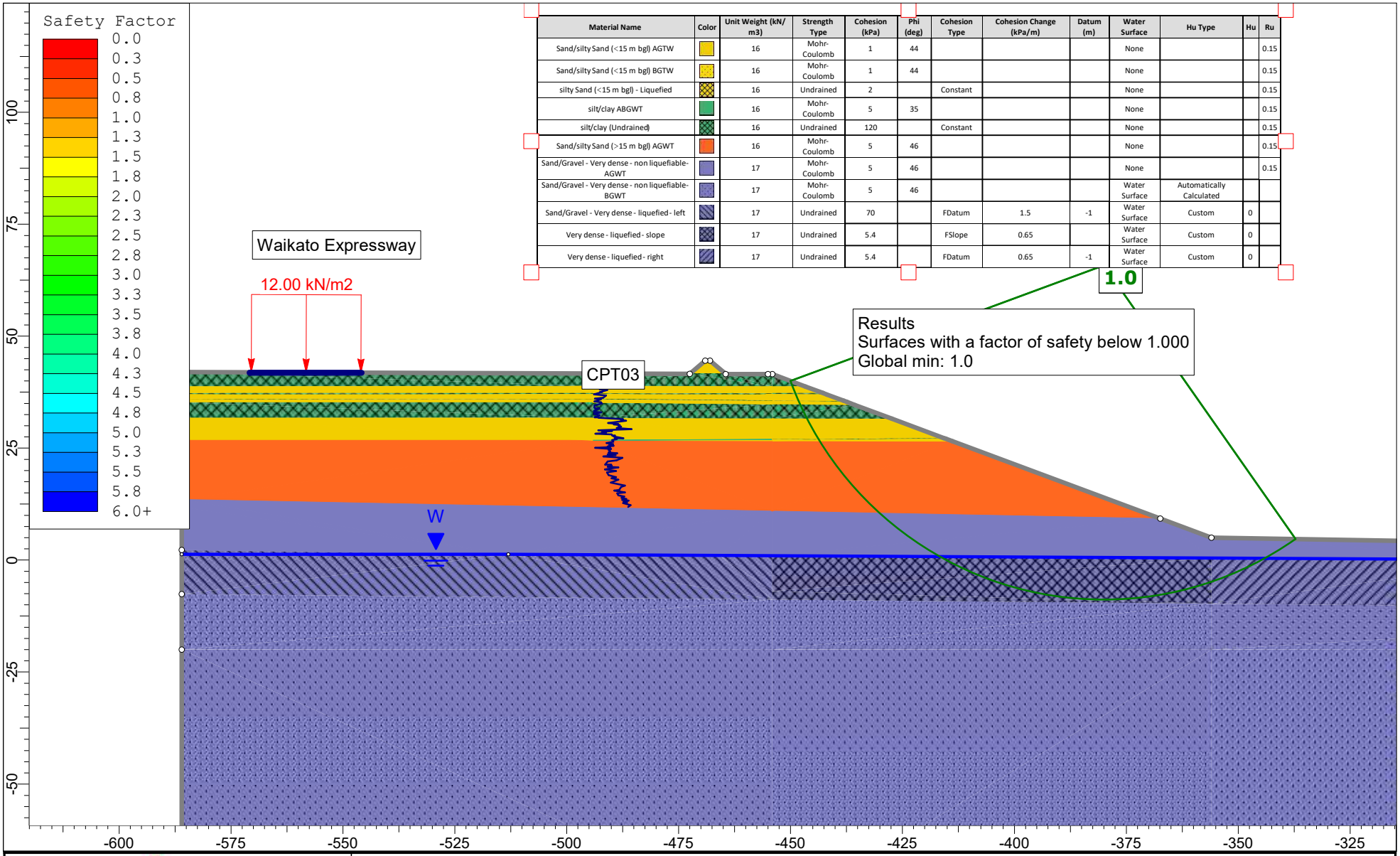


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
ilty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44		None		0.3
ilty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44		None		0.3
and (<15 m bgl) - Liquefied		16	Undrained	2		Constant	None		0.3
silt/clay ABGWT		16	Mohr-Coulomb	5	35		None		0.3
ilty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46		None		0.3
el - Very dense - non liquefiable - AGWT		17	Mohr-Coulomb	5	46		None		0.15
el - Very dense - non liquefiable - BGWT		17	Mohr-Coulomb	5	46		Water Surface	Automatically Calculated	

SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	3:1 batter	*Scenario* RU 0.3
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1884 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd



SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	3:1 batter	*Scenario* Seismic undrained
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1684 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Cohesion Change (kPa/m)	Datum (m)	Water Surface	Hu Type	Hu	Ru
Sand/silty Sand (<15 m bgl) AGTW		16	Mohr-Coulomb	1	44				None			0.15
Sand/silty Sand (<15 m bgl) BGTW		16	Mohr-Coulomb	1	44				None			0.15
silty Sand (<15 m bgl) - Liquefied		16	Undrained	2		Constant			None			0.15
silt/clay ABGWT		16	Mohr-Coulomb	5	35				None			0.15
silt/clay (Undrained)		16	Undrained	120		Constant			None			0.15
Sand/silty Sand (>15 m bgl) AGWT		16	Mohr-Coulomb	5	46				None			0.15
Sand/Gravel - Very dense - non liquefiable-AGWT		17	Mohr-Coulomb	5	46				None			0.15
Sand/Gravel - Very dense - non liquefiable-BGWT		17	Mohr-Coulomb	5	46				Water Surface	Automatically Calculated		
Sand/Gravel - Very dense - liquefied - left		17	Undrained	70		FDatum	1.5	-1	Water Surface	Custom	0	
Very dense - liquefied - slope		17	Undrained	5.4		FSlope	0.65		Water Surface	Custom	0	
Very dense - liquefied - right		17	Undrained	5.4		FDatum	0.65	-1	Water Surface	Custom	0	

SLIDEINTERPRET 9.018	*Project*	RS Sand - 77 Newcombe Road, Cambridge	
	Group	3:1 batter	*Scenario* Liquified - worst case
	Drawn By	HJ	*Company* HD Geo Ltd
	Date	16.12.2020	*File Name* HD1684 - Newcombe Road, Cambridge - RS Sand Rev 4 - updated GWT.slmd