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14 August 2017

Our ref: 773-GENZTAUC12590AC-AD

Hugh Green Contractors Ltd
PO Box 12 443
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Dear Morgan,

**Geotechnical Completion Report for Lots 33 to 37, Bob Carter Place, Welcome Bay**

## 1. Introduction

This Geotechnical Completion Report (GCR) has been prepared by Coffey Geotechnics (NZ) Ltd (Coffey) for Hugh Green Contractors Ltd following completion of the earthworks for Lots 33 to 37 at Bob Carter Place, Welcome Bay.

This report contains the results of site investigations and relevant control test data, together with as-built plans derived from Harrison Grierson Consultants Limited topographical data. This report covers the construction period from April to August, 2017. It is intended to be used for certification purposes for 5 lots on the property legally described as “Lot 500 DP 445408”, 120 Ballintoy Park Drive, numbered lots 33 to 37.

The extent of earthworks supervised by Coffey is shown on the appended plans (Figures 01 to 05, Appendix A). A Geotechnical Suitability Statement and a Producer Statement (PS-4) for the works described herein are also appended.

## 2. Description of Subdivision

Lots 33 to 37 (referred to as the “subject site” in this report) form Stage 5B of Ballintoy Park Subdivision, located in Welcome Bay, Tauranga. Lots 33 to 35 are located within the northern portion of the subject site, and situated on the western side of Bob Carter Place. Further south, lots 36 and 37 are situated approximately 30m west of Bob Carter Place, behind Lots 66 and 67 in the Stage 5 subdivision. The subject site covers a plan area of approximately 3,200m$^2$.

Lots 33 to 35 are referred to as the “northern lots” in this report, and lots 36 and 37 are referred to as the “southern lots”. The lot boundaries are shown on figures in Appendix A.

Prior to the original earthworks undertaken in 2006, the subject site comprised topography which sloped to the west at approximately 1V:3H to 1V:8H. Up to approximately 2m of filling was placed across the subject site in 2006 to create a more uniform gradient. The filling placed in 2006 was documented in a previous GCR[1], and was generally left intact from the most-recent earthworks in 2017. The landform prior to the original earthworks in 2006 is shown on the Pre-2006 Contour Plan (Figure 02) in Appendix A.

The existing topography within the subject site prior to the most-recent (2017) earthworks was generally uniform and gently sloping to the west, at approximately 1V:5H to 1V:8H. To the west of the subject site however, the topography steepened to approximately 1V:2H towards a steep gully off the Waiorakei Stream. The development landform prior to the most-recent earthworks is depicted on the Pre-2017 Contour Plan (Figure 03) in Appendix A.

As depicted on the appended 2017 Cut/Fill Contour Plan (Figure 04) in Appendix A, the ground levels within the subject site have been modified during the 2017 earthworks season by incorporating cut and fill depths of approximately 2.0m and 2.6m respectively from the original ground levels. Four timber pole retaining walls have been constructed to create the near-level building platforms for the southern lots. An access way was also constructed to allow access to the southern lots from Bob Carter Place. With the exception of underground stormwater and wastewater utilities, no modifications were made to the ground surface within the northern lots as part of the 2017 earthworks season. The post-development landform is shown on the Finished Site Contour Plan (Figure 05) in Appendix A.

## 3. Related Reports

The following documents were prepared prior to or during the design and development of the subdivision:

1. *'Geotechnical Investigation Report on Proposed Residential Subdivision at 166 Waikite Road, Welcome Bay, Tauranga",* report by Foundation Engineering Ltd (FEL), reference 12590, dated 30 May, 2006.

2. *'Geotechnical Completion Report on Stage 1 Ballintoy Park Subdivision, 166 Waikite Road, Welcome Bay, Tauranga",* report by FEL, reference 12590, dated 8 June, 2007. This report is referred to as the 'Stage 1 GCR' in this document.

3. *'Ballintoy Park Stage 5, Geotechnical Assessment Report',* report by Coffey, reference GENZTAUC12590AB-AB, dated 6 March 2015. This report is referred to as the 'Stage 5 GAR' in this document.

4. *'Retaining Wall Design for Lots 36 and 37, Ballintoy Park Stage 5B',* report by Coffey, reference GENZTAUC12590AC-AB Revision 1, dated 11 January, 2017. This report is referred to as the 'Retaining Walls Design Report' in this document.

5. *'Amendment No.1 to Retaining Wall Design Report for Lots 36 and 37, Ballintoy Park Stage 5B',* report by Coffey, reference GENZTAUC12590AC-AC, dated 27 July 2017. This report is referred to as the 'Amendment Report' in this document. A copy of this report is included in Appendix F.

[1] *"Geotechnical Completion Report on Stage 1, Ballintoy Park Subdivision, 166 Waikite Road, Welcome Bay, Tauranga, for Hugh Green Contractors Limited",* Project Number 12590, dated 8 June 2007

For a full understanding of the site history and development it is recommended that these previous reports are read in conjunction with this report. The key conclusions from the above previous reports are summarised below.

### 3.1. Geotechnical Assessments

The following geotechnical issues relating to the subject site were identified in the above reports:

- The Stage 1 GCR stated that the filling placed across the site can generally be classed as engineer certified filling. However, significant depths of topsoil were respread across the site following the 2006 earthworks. The GCR stated that building developments will require the over-excavation of these respread topsoil materials followed by the placement of compacted subfloor filling. This depth of topsoil is addressed in Section 8.5 below.
- The Stage 5 GAR recommended that filling placed be monitored for settlement, to ensure that the majority of primary settlement be induced prior to construction. Settlement monitoring is addressed in Section 8.2 below.
- A Building Restriction Line (BRL) was placed across the subject site in the Stage 5 GAR, due to the relatively steep slope to the west of the site. The GAR stated that the BRL should be confirmed in the GCR. The BRL is addressed in Section 8.4 below.
- Coffey designed the four retaining walls that were proposed as part of the Stage 5B development. The designs and construction requirements were provided in the Retaining Walls Design Report. Our observations of the construction of the retaining walls are summarised in Section 7.2 below.

## 4. Investigations Completed

The geotechnical investigations used for this report are listed below. Logs of each investigations are included in Appendices B and C.

- 2 Test pits excavated to a depth of up to 5.4m, and 1 borehole drilled to a depth of 10.95m, to assess the subsurface conditions in 2015 (Coffey, TP510, TP511, and BH501 on Figure 03).
- 1 Hand auger borehole and 5 CPTs drilled to a depth of 4m, to assess the subsurface conditions in 2016 (Coffey, HA01 and CPT01 to CPT05, on Figure 03).
- 2 Hand auger boreholes drilled to a depth of 4m, and 5 CPTs drilled to a depth of 10m in 2016. The investigations were undertaken to assess the subsurface conditions for the design of the four retaining walls (Coffey, HA02 and HA03, CPT06 to CPT10, on Figure 03).
- 7 Hand auger boreholes drilled to a depth of up to 2m in 2017, to assess the recently-placed filling in the southern lots (Coffey, HA04 to HA10 on Figure 05).
- 2 Nuclear Densometer Tests in 2017, to assess the recently-placed filling in the southern lots (Coffey, NDM01 and NDM02 on Figure 05).

# 5. Overview of Geological Conditions

Published geological information[2, 3] of the area indicates that the site is underlain by Pliocene-aged Papamoa Ignimbrite.

Investigations across the site typically encountered topsoil filling, comprising black organic silt. This topsoil filling was observed to extend to a depth of up to 1.5m below ground level within testpit TP510 in the northern lots. As stated above, this relatively thick topsoil layer was placed during previous earthworks in 2006. Within the southern lots, topsoil filling was observed to extend to up to 0.3m depth.

The topsoil filling was generally underlain by filling comprising hard, low-plastic silt, with undrained shear strengths typically greater than 200kPa. This filling was classed as engineer-certified filling in the Stage 1 GCR. The filling was observed to extend to a depth of up to 2.5m below ground level at borehole BH501 in the northern lots.

Beneath the filling, the investigations encountered volcanic ashes which typically extended to beneath the termination depth of the investigations. Undrained shear strength testing within the ashes varied between 70kPa to greater than 200kPa (but generally between 100kPa to 160kPa), with an average of 130kPa. The ashes generally comprises silts and clays, with traces of fine grained sand.

The ashes were observed to extend to a depth of 10m in borehole BH501 in the northern lots, being underlain by weathered ignimbrite consisting of sandy silt. The SPT N-value within the weathered ignimbrite was 19. Within the southern lots, CPT08 and CPT09 refused on very hard material at depths of 7.9m and 6.9m below ground level respectively, likely to be weathered ignimbrite.

# 6. Earthworks Operations

## 6.1. Plant

The principal contractor for the 2006 earthworks was HEB Contractors Limited (HEB), who subcontracted the bulk earthworks portion to McPherson Contractors Limited (MCL). The main items of plant used by MCL comprised Terex and towed motor scrapers, hydraulic excavators, bulldozers and sheeps foot rollers.

The principal contractor for the 2017 earthworks was HEB. The main items of plant used during the earthworks comprised a 13 tonne excavator, 23 tonne excavator, 7 tonne padfoot roller, 12 tonne Hamm-padfoot roller, Ramex roller, and a Bobcat skidsteer loader.

## 6.2. Construction Programme

### 6.2.1. 2006 Earthworks

Within the subject area, the original earthworks commenced in November 2006 with the topsoil stripping and stockpiling operation. The exposed subgrade was then benched in preparation for the bulk filling.

Up to approximately 2m of filling was then placed across the subject site, and was sourced from the elevated ridge of the south of the site. The bulk filling across the subject site was completed in April

[2] *"Geology of the Tauranga Area",* Institute of Geological and Nuclear Sciences, 1:50,000 geological map
[3] *"Geology of the Rotorua Area",* Institute of Geological and Nuclear Sciences, 1:250,000 geological map

2007, following the respreading of the topsoil. As stated in Section 5 above, up to 1.5m of topsoil filling was respread across the subject site.

We understand that the council utilities which service properties on Bob Carter Place were installed during this phase of earthworks. However, no reference to these utilities have been made in the Stage 1 GCR.

#### 6.2.2. 2017 Earthworks

The 2017 earthworks commenced in April with the installation of underground stormwater utilities through the northern lots, and the construction of the accessway to the southern lots (lots 36 and 37). The location of the underground utilities are shown on Figure 05.

The bulk earthworks commenced in May with the cutting of up to approximately 1.8m and filling of up to 2.6m, and the construction of four retaining walls, within the southern lots. The location and extent of the cutting and filling process is shown on Figure 04. The 2017 earthworks was completed in August 2017.

## 7. Quality Control

### 7.1. Fill Control

#### 7.1.1. 2006 Earthworks

Fill testing within the 2006 earthworks filling was conducted by FEL in 2006, and presented in the Stage 1 GCR. Despite the Stage 1 GCR stating that the filling placed across the site could be considered as engineer-certified filling, it appears that the filling was not tested within the subject site area. We have therefore used the post-2006 subsurface investigations, shown on Figure 03 and 05 and in listed in Section 4 above, to assess the 2006 filling within the subject site.

The compaction control criteria for the assessment of the 2006 filling was based on compliance with NZS4431:1989 “Code of practice for earth fill for residential development”, and the Tauranga City Council Infrastructure Development Code. The compaction requirements for the fill are specified below:

- Within cohesive soils, undrained shear strength measured by hand held shear vane calibrated using the NZGS 2001 method. The target test values were an average value greater than 150kPa and a minimum single value of no less than 140kPa.

As stated in Section 5 above, the filling observed within the northern lots generally comprised hard, low-plastic silt filling, overlain by significant depths of topsoil filling. The shear vane was generally unable to penetrate the silt filling for testing, indicating that the material was well compacted. Undrained shear strengths of greater than 202kPa were recorded in HA01 in Lot 33.

Given the clean nature of the silt filling and the high undrained shear strength measurements, we consider that the silt filling placed within the subject site in 2006 can be considered to be engineer certified filling. However, the significant depth of topsoil filling overlying the silt filling does not meet the standards of certified filling.

#### 7.1.2. 2017 Earthworks

The compaction control criteria for the 2017 earthworks were based on compliance with NZS4431:1989 “Code of practice for earth fill for residential development”, and the Tauranga City Council Infrastructure Development Code. The compaction requirements for the fill are specified below:

- Within cohesive soils, undrained shear strength measured by hand held shear vane calibrated using the NZGS 2001 method. The target test values were an average value greater than 150kPa and a minimum single value of no less than 140kPa.

- Within cohesionless soils, DCP testing in accordance with NZS4402 Test 6.5.2. The target value was 5 blows per 100mm penetration, at a depth down to twice the footing width.

- The standard Proctor method as presented in NZS4402. This produces a water content vs dry density curve from which the optimum water content and maximum dry density are determined. The compaction specification then stipulates a minimum dry density and water content range, usually 95% of maximum dry density and about 2% each side of optimum water content.

The filling was tested within hand augers HA04 to HA10 and NDM01 and NDM02, as shown on Figure 05. The fill testing records are included in Appendix C.

Testing within hand auger boreholes HA06 and HA07, drilled within Lot 36, passed the compaction control criteria above. The recently-placed filling in Lot 36 can therefore be classed as engineer certified filling, and a geotechnical ultimate bearing capacity of 300kPa may be assumed for the design. Additionally, testing within hand auger HA08, drilled towards the centre of Lot 37 passed the compaction control criteria above.

However, testing within hand augers HA04 and HA05 drilled towards the western edge of Lot 37, failed to achieve the required compaction standards. The filling at these locations generally comprised pumice sand filling to a depth of approximately 1.0m, overlying silt filling. The silt filling beyond 1.0m depth generally achieve the compaction criteria, but the pumice sand filling above generally failed. The failed test results were relayed to the contractor, with instructions to rework the affected area of filling.

Following the rework of the affected area, the filling was retested with two hand auger boreholes (HA09 and HA10), and two Nuclear Densometer Tests (NDM) (NDM01 and NDM02). The NDM tests recorded appropriate moisture contents, resulting in an assessed adequate relative compaction of approximately 90%. Given the pumice nature of the sand filling, we assess that the optimum moisture content and maximum dry density of the pumice is likely to be lower than that shown on the compaction curve due to the crushing of the material during laboratory testing.

Based on these fill testing results, recommendations for foundation design are presented in Section 8.5 below.

No fill testing was undertaken within the northern lots as no bulk earthworks were carried out in these lots during the 2017 earthworks season.

## 7.2. Retaining Wall Observations

As stated in Section 3 above, Coffey designed the four retaining walls shown on Figure 05 to support the southern lots.

Coffey observed the construction of the retaining walls on four occasions between May to June 2017, to ensure that the design requirements and recommendations made in the Retaining Walls Design Report were satisfied. This included observations and testing of the ground conditions within the excavated post holes, and confirmation of post and hole dimensions and retained heights along the alignments of the walls.

The following alterations were made from the original design during the construction of the retaining walls:

- A surcharge slope of approximately 1V:2.5H was placed behind Wall 1, to allow the Lot 37 building platform to be raised by approximately 600mm. The wall had originally been

designed to support a level backslope. The wall was assessed by Coffey and it was confirmed that the wall would be capable for supporting the surcharge slope. This design alteration was summarised in the Addendum Report listed in Section 3 above.

- The rear drainage column of the walls incorporated an 'E Drain', rather than a Cirtex 'Secudrain'.
- Weepholes were installed towards the base of Wall 1, to allow seepage of water through the weepholes and onto the slope below. The original design for Wall 1 involved the drainage mat installed behind the wall to tuck under the lowest rail, allowing seepage under the wall.
- The safety fence was installed using 100mm x 100mm posts mounted onto the retaining wall posts. This differed from the design, which involved 125mm SED posts installed into the ground behind the retaining walls.
- The safety fence was installed with 125mm x 25mm fence palings, rather than 50mm x 50mm timber battens shown on the design. The palings were installed with a 15mm gap and attached with nails.

Coffey consider that the alterations above to the wall design will not compromise the originally consented design. Based on our testing and observations, it is considered that the retaining walls have been constructed in accordance with our design, the Addendum Report, and accepted engineering practice. Our Producer Statement PS4 is attached in Appendix D.

# 8. Evaluations and Recommendations

## 8.1. Fill Quality

### 8.1.1. Northern Lots (33 to 35)

As stated in Section 7.1.1 above, the silt filling placed within the northern lots in 2006 can generally be classed as engineer certified filling. However, the significant depth of topsoil filling overlying the silt filling do not meet the standards of engineer certified filling.

It should be noted that the backfilling and compaction of stormwater and sewer trenches within the northern lots were not inspected or tested by Coffey, and should be classified as uncertified filling. The location of underground stormwater and sewer lines are shown on Figure 05.

### 8.1.2. Southern Lots (36 and 37)

As stated in Section 7.1.2 above, the filling placed within Lot 36 passed the compaction control criteria. The filling placed within Lot 36 can therefore be classified as engineered filling.

Additionally, fill testing towards the centre of Lot 37 passed the compaction control criteria, and can therefore be classified as engineered filling. However, a strip of filling situated towards the western edge of Lot 37 was reworked. Based on the subsequent fill testing, we consider that the reworked filling has been adequately compacted. Foundation recommendations are presented in Section 8.5 below.

It should also be noted that the backfilling and compaction of stormwater and sewer trenches within the southern lots were not inspected or tested by Coffey, and should be classified as uncertified filling. The location of underground stormwater and sewer lines are shown on Figure 05.

## 8.2. Fill Induced Settlement

The Stage 5 GAR recommended that filling placed should be monitored for settlement, to ensure that the majority of primary settlement had been induced prior to construction of buildings, roading and services.

Fill induced settlement is not considered to be a concern in the northern lots, as these lots were not subject to bulk filling within the 2017 earthworks season.

An assessment of static and fill induced settlement was undertaken across the southern lots by using the proprietary GeoLogismiki software CPT-IT (2007 version 1.7.6.42), using the CPT data (CPT06 to CPT10). The assessment indicated that the induced differential settlements within the filling due to its imposed weight should comply with the minimum settlement criteria stated in Appendix B of Section B1/VM4 of the New Zealand Building Code.

Nonetheless, the proposed buildings should still be designed to tolerate differential settlements of up to 1 in 240 (approximately 25mm over a 6m length of building) as required by the New Zealand Building Code, Section B1/VM4, clause B1.0.2, under the serviceability limit state load combinations of NZS1170.

## 8.3. Retaining Walls

As stated in Section 7.2 above, Coffey consider that the four retaining walls have been constructed in accordance with our design, the Addendum Report, and accepted engineering practice. Our Producer Statement PS4 is attached in Appendix D.

It should be noted that the recommendations and requirements presented in the Retaining Walls Design Report should be observed during the development within the southern lots. These recommendations and requirements are summarised below:

- The retaining walls have not been designed to support a surcharge load behind the walls. Development within the southern lots are therefore subject to a Building Restriction Line (refer to Section 8.3 below); and

- Walls 1A, 1B and 3 have been designed to accommodate maximum toe-slopes of 10°, 22° and 10° respectively, and Walls 2 and 4 have not been designed for a toe-slope. Therefore, no excavation works should be undertaken within the passive zone beneath these walls which would cause a greater toe-slopes than those given above. It is noted that Wall 3 is situated above an existing wastewater line. If any maintenance is required to this utility, we recommend that the excavation is supported by trench shoring at the pole intervals. Alternatively, the excavation trenches may be excavated and backfilled in specifically designated lengths.

## 8.4. Slope Stability and BRLs

### 8.4.1. Northern Lots (33 to 35)

Stability analyses were undertaken within the northern lots of the subject site as part of the Stage 5 GAR, and a BRL was defined across the lots. Given that bulk earthworks weren't undertaken within the northern lots as part of the 2017 earthworks, we consider that the previously-defined BRL remains appropriate. The BRL is shown on Figure 05 in Appendix A.

It should be noted that the BRL does not preclude development across this line. Recommendations for lots affected by a BRL are discussed in Section 8.4.3 below.

### 8.4.2. Southern Lots (36 and 37)

As discussed in Section 7.2 above, the four retaining walls within the southern lots have been constructed in accordance with Coffey's designs and approved alterations. With these structures in place, it is considered that the stability of the southern lots is now adequate for residential development.

However, it is important that the future development on these lots is not allowed to comprise the retaining walls. The recommendations and requirements presented in the retaining walls design report (and summarised in Section 8.3 above) should therefore be observed during the development within the southern lots.

It should be noted that the BRL does not preclude development across this line. Recommendations for lots affected by a BRL are discussed in Section 8.4.3 below.

### 8.4.3. Development across a BRL

The following restrictions apply for development across a BRL:

- Any part of a dwelling or structure which extends beyond a BRL must be reviewed and approved by a Tauranga City Council Category 1 Geo-Professional prior to the building consent application. A geotechnical report must be provided including the specific design of any mitigation work proposed;
- Any filling placed between the BRL and slope within the northern lots must be reviewed and approved by a geotechnical engineer with a report to be provided to Council before work begins.
- Stormwater from any paved or impermeable surfaces including roofs and driveways must be collected and piped to the stormwater system. Stormwater must not be disposed of via ground soakage and any concentration of runoff over slopes must be avoided.

## 8.5. Foundation Design

### 8.5.1. Northern Lots (33 to 35)

As stated in Section 3.1 above, the northern lots are underlain by topsoil filling observed up to 1.5m deep in TP510.

The building development on these lots will require the over-excavation of the topsoil filling to expose the engineer certified filling beneath, followed by the placement and compaction of subfloor filling as required to achieve the desired grade. The exposed subgrade and subfloor filling will need to be observed, tested and certified by a geotechnical professional during the construction. Provided this is carried out, the lots would be appropriate for standard shallow foundations designed in accordance with NZS3604, and a geotechnical ultimate bearing capacity of 300kPa may be assumed for the design.

Alternatively, the building development on these lots may be supported on specifically designed piles or deepened foundations which extend into the certified filling beneath the topsoil. The excavations would need to be observed by a geotechnical engineer to ensure that the foundations extend into suitable material. Provided this is carried out, a geotechnical ultimate bearing capacity of 300kPa may be assumed for the design.

### 8.5.2. Southern Lots (36 and 37)

Provided that the proposed building platform on the southern lots are located outside the zone of influence of the buried services and behind the BRL, the ground conditions on these lots are considered to be adequate for standard shallow foundations designed in accordance with NZS3604.

The building platform should be stripped of topsoil prior to construction. A geotechnical ultimate bearing capacity of 300kPa may be assumed for the design.

As stated in Section 8.1.2 above, Lot 37 is partially underlain by reworked filling towards the western portion of the lot. Following the stripping of topsoil within Lot 37, we therefore recommend that the exposed subgrade be subjected to additional recompaction, to ensure that the building platform is underlain by relatively uniform material.

### 8.6. Liquefaction

Due to the elevation of the site, cohesive nature of the filling, and the depth of the groundwater, the risk of damage due to the effects of liquefaction is considered to be low.

### 8.7. Stormwater and Wastewater Management

All stormwater runoff generated from roofs, driveways, and other hard surfaces should be collected and piped to the stormwater reticulation provided. There is to be no in-ground disposal of stormwater by soakholes for any lots within the subject site.

Similarly, all wastewater from the proposed dwellings should be piped to the council sewer system.

### 8.8. Clearance from Underground Pipes

Underground services have been placed across the subject site for water supply, stormwater and wastewater. As is normal on all subdivisions, building developments involving foundations within a 45° zone of influence from all service pipe inverts will require specific design by a Chartered Professional Engineer with a view to piling foundation loads to below that zone (as specified in the TCC Infrastructure Development Code). The location of underground pipes are shown on Figure 05 in Appendix A.

### 8.9. Road Subgrade

We understand that all road subgrade preparation, inspections, testing and certification was completed under the direction of Harrison Grierson Consultants Limited.

### 8.10. Contractor’s Work

This report has relied on the Contractor’s diligence and construction observations to ensure that the works have been carried out in accordance with:

(i) The approved Contract drawings and design details,

(ii) The approved Contract specifications,

(iii) Authorised Variations to (i) and (ii) during the execution of the works,

(iv) The conditions of Resource and Earthworks Consents where applicable,

(v) The relevant Geotechnical Investigation reports, recommendations and site instructions,

and that all as-built information and other details provided to the Client and/or Coffey are accurate and correct in all respects.

## 9. Summary of Recommendations

Based on the information contained in this report, it is considered that the geotechnical aspects of the works with Lots 33 to 37 have been completed in general accordance with accepted engineering

practice and standards. From a geotechnical perspective, development on the new lots may therefore proceed, subject to the following recommendations:

1. The recommendations and requirements presented in the retaining walls design report should be observed during the development within the southern lots. These recommendations and requirements are summarised in Section 8.3 above.

2. Development on all lots within the subject site will be subject to a BRL, shown on Figure 05. It should be noted that the BRL does not preclude development across this line. Recommendations for development across the BRL are discussed in Section 8.4 above.

3. Due to the significant depth of topsoil filling underlying the northern lots, the topsoil should be removed and replaced with compacted filling before proceeding with construction. Alternatively, the proposed building could be supported on piles or deepened foundations extending through the topsoil and into the certified filling beneath. Regardless of the option chosen, these works must be observed and certified by a suitably qualified geotechnical professional.

4. All stormwater and wastewater generated from the proposed development should be collected and piped to the council reticulation. There is to be no in-ground disposal of stormwater by soakholes.

5. Building developments involving foundations within a 45° zone of influence from all service pipe inverts will require specific design by a Chartered Professional Engineer with a view to piling foundation loads to below that zone (as specified in the TCC Infrastructure Development Code).

## 10. Limitations

This report has been prepared solely for the use of the client, Hugh Green Contractors Limited, their professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

The opinions, recommendations and comments given in this report result from the application of normal methods of site investigation. As the post construction factual evidence has been obtained solely subsurface investigations which by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report.

For and on behalf of Coffey

**Scott Higginson**
Geotechnical Engineer

**David Sullivan**
TCC Category 1 Geo-Professional
Principal Geotechnical Engineer
CPEng No. 1025183

**Appendices**

Appendix A – Figures
Appendix B – Pre-2017 Development Records
Appendix C – Fill Testing and Post-Construction Records
Appendix D – Retaining Walls Producer Statement (PS) 4
Appendix E – Geotechnical Suitability Statement and Summary Table
Appendix F – Amendment Report

# Important information about your Coffey Report

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

## Your report is based on project specific criteria

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

## Subsurface conditions can change

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

## Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time.

The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

## Your report will only give preliminary recommendations

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

## Your report is prepared for specific purposes and persons

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

# Important information about your Coffey Report

## Interpretation by other design professionals

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

## Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

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

## Geoenvironmental concerns are not at issue

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

## Rely on Coffey for additional assistance

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

## Responsibility

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

# Appendix A – Figures


**LEGEND**

LOT BOUNDARIES

EXTENT OF STAGE 5B

N

LOT 33

LOT 34

LOT 35

LOT 36/37 ACCESS WAY

LOT 36

LOT 37

BOB CARTER PLACE

NORTHERN LOTS

SOUTHERN LOTS

NOTES
1: Lot Layout provided by Harrison Grierson Consultants Limited, received July, 2017.

| revision | rev | description | drawn | approved | date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | 0 | Site Layout | SWH | DAS | 02/08/2017 |

0 10.0 20.0 30.0
Horizontal Scale (metres)
0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | SWH |
| approved | DAS |
| date | 02/08/17 |
| scale | 1:500 |
| original size | A3 |

coffey
A TETRA TECH COMPANY

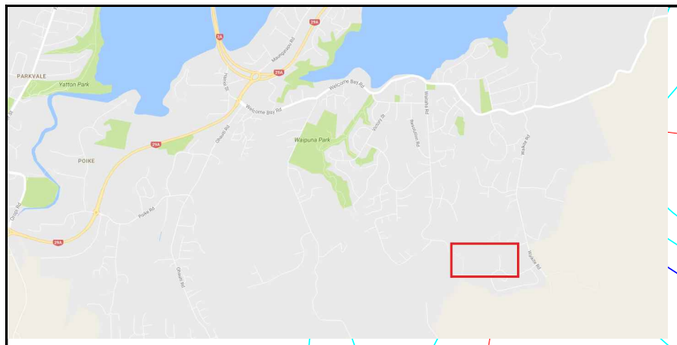
client: HUGH GREEN CONTRACTORS LTD

project: BALLINTOY PARK SUBDIVISION
STAGE 5B - LOTS 33 TO 37
GEOTECHNICAL COMPLETION REPORT

title: SITE LAYOUT

project no: GENZTAUC12590AC | figure no: 01 | rev: 0

4/07/2017F:\1.GENZ\1.GEOTECHNICS PROJECTS\12590AC BALLINTOY PARK, LOTS 33 TO 37\7. DRAWINGS\CGL DRAWINGS\WORKING\GCR DRAWINGS\GENZTAUC12590AC.DWG




**LEGEND**

LOT BOUNDARIES

EXTENT OF STAGE 5B

N

LOT 33

LOT 34

LOT 35

LOT 36/37 ACCESS WAY

LOT 36

LOT 37

BOB CARTER PLACE

NOTES
1: Contour data taken from Stage 1 GCR by Foundation Engineering Limited.
2: Contours shown at 1.0m intervals.
3: Lot Layout provided by Harrison Grierson Consultants Limited, received July, 2017.

| revision | rev | description | drawn | approved | date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | 0 | Pre-2006 Development Contour Plan | SWH | DAS | 02/08/2017 |

0 10.0 20.0 30.0
Horizontal Scale (metres)

0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | SWH |
| approved | DAS |
| date | 02/08/17 |
| scale | 1:500 |
| original size | A3 |

coffey
A TETRA TECH COMPANY

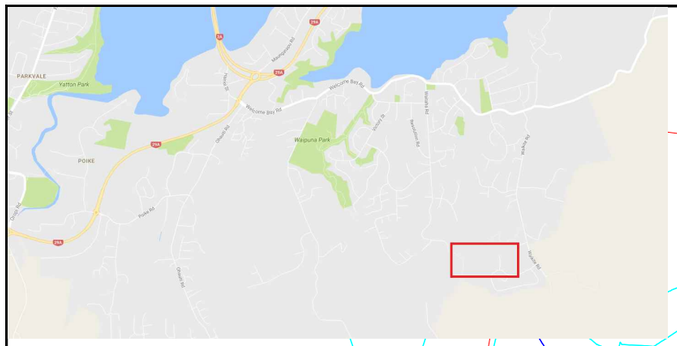
client: HUGH GREEN CONTRACTORS LTD

project: BALLINTOY PARK SUBDIVISION
STAGE 5B - LOTS 33 TO 37
GEOTECHNICAL COMPLETION REPORT

title: PRE-2006 DEVELOPMENT CONTOUR PLAN

project no: GENZTAUC12590AC | figure no: 02 | rev: 0

4/07/2017F:\1.GENZ\1.GEOTECHNICS PROJECTS\12590AC BALLINTOY PARK, LOTS 33 TO 37\7. DRAWINGS\CGL DRAWINGS\WORKING\GCR DRAWINGS\GENZTAUC12590AC.DWG



**LEGEND**

- LOT BOUNDARIES
- EXTENT OF STAGE 5B
- TEST PIT (2014)
- MACHINE BOREHOLE (2014)
- HAND AUGER BOREHOLE (2016)
- CONE PENETROMETER TEST (2016)

LOT 33
LOT 34
LOT 35
LOT 36
LOT 37
LOT 36/37 ACCESS WAY
BOB CARTER PLACE
HA01
TP511
BH501
TP510
CPT10
CPT07
HA02
HA03
CPT09
CPT08
CPT06
60
65
70
75
80
85
N

NOTES
1: Contour data provided by Harrison Grierson Consultants Limited, received July, 2017.
2: Contours shown at 1.0m intervals.
3: Lot Layout provided by Harrison Grierson Consultants Limited, received July, 2017.

| revision | rev | description | drawn | approved | date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | 0 | Pre-2017 Development Contour Plan | SWH | DAS | 02/08/2017 |

0 10.0 20.0 30.0
Horizontal Scale (metres)
0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | SWH |
| approved | DAS |
| date | 02/08/17 |
| scale | 1:500 |
| original size | A3 |

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A TETRA TECH COMPANY

client: HUGH GREEN CONTRACTORS LTD
project: BALLINTOY PARK SUBDIVISION
STAGE 5B - LOTS 33 TO 37
GEOTECHNICAL COMPLETION REPORT
title: PRE-2017 DEVELOPMENT CONTOUR PLAN
project no: GENZTAUC12590AC | figure no: 03 | rev: 0

4/07/2017F:\1.GENZ\1.GEOTECHNICS PROJECTS\12590AC BALLINTOY PARK, LOTS 33 TO 37\7. DRAWINGS\CGL DRAWINGS\WORKING\GCR DRAWINGS\GENZTAUC12590AC.DWG


**LEGEND**

- LOT BOUNDARIES
- EXTENT OF STAGE 5B
- FILL CONTOURS
- ZERO CUT FILL LINE
- CUT CONTOURS

N

LOT 33

LOT 34

LOT 35

LOT 36/37 ACCESS WAY

LOT 36

LOT 37

BOB CARTER PLACE

NOTES
1: Contour data provided by Harrison Grierson Consultants Limited, received July, 2017.
2: Contours shown at 0.2m intervals.
3: Lot Layout provided by Harrison Grierson Consultants Limited, received July, 2017.

| revision | rev | description | drawn | approved | date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | 0 | 2017 Cut/Fill Plan | SWH | DAS | 02/08/2017 |

0 10.0 20.0 30.0
Horizontal Scale (metres)
0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | SWH |
| approved | DAS |
| date | 02/08/17 |
| scale | 1:500 |
| original size | A3 |

coffey
A TETRA TECH COMPANY

client: HUGH GREEN CONTRACTORS LTD

project: BALLINTOY PARK SUBDIVISION
STAGE 5B - LOTS 33 TO 37
GEOTECHNICAL COMPLETION REPORT

title: 2017 CUT/FILL PLAN

project no: GENZTAUC12590AC | figure no: 04 | rev: 0

4/07/2017F:\1.GENZ\1.GEOTECHNICS PROJECTS\12590AC BALLINTOY PARK, LOTS 33 TO 37\7. DRAWINGS\CGL DRAWINGS\WORKING\GCR DRAWINGS\GENZTAUC12590AC.DWG


**LEGEND**

- LOT BOUNDARIES
- EXTENT OF STAGE 5B
- BUILDING RESTRICITON LINE
- RETAINING WALLS
- STORMWATER LINE
- WASTEWATER LINE
- HAND AUGER BOREHOLE
- CONE PENETROMETER TEST
- NUCLEAR DENSOMETER TEST

N

LOT 33
LOT 34
LOT 35
LOT 36
LOT 37
LOT 36/37 ACCESS WAY
BOB CARTER PLACE

CPT01
CPT02
CPT03
CPT04
CPT05

HA05
HA10
NDM02
HA08
NDM01
HA09
HA04
HA07
HA06

Wall 1A
Wall 1B
Wall 2
Wall 3
Wall 4

NOTES
1: Contour data provided by Harrison Grierson Consultants Limited, received July, 2017.
2: Contours shown at 1.0m intervals.
3: Lot Layout provided by Harrison Grierson Consultants Limited, received July, 2017.

| revision | rev | description | drawn | approved | date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | 0 | Finished Site Contours | SWH | DAS | 02/08/2017 |

0 10.0 20.0 30.0
Horizontal Scale (metres)
0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | SWH |
| approved | DAS |
| date | 02/08/17 |
| scale | 1:500 |
| original size | A3 |

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client: HUGH GREEN CONTRACTORS LTD
project: BALLINTOY PARK SUBDIVISION
STAGE 5B - LOTS 33 TO 37
GEOTECHNICAL COMPLETION REPORT
title: FINISHED SITE CONTOURS
project no: GENZTAUC12590AC | figure no: 05 | rev: 0

4/07/2017F:\1.GENZ\1.GEOTECHNICS PROJECTS\12590AC BALLINTOY PARK, LOTS 33 TO 37\7. DRAWINGS\CGL DRAWINGS\WORKING\GCR DRAWINGS\GENZTAUC12590AC.DWG

# Appendix B – Pre-2017 Development Records

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# Engineering Log - Excavation

| | |
|---|---|
| Excavation ID. | ***TP510*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AB*** |
| client: | ***Hugh Green Ltd*** |
| date excavated: | ***28 Aug 2014*** |
| principal: | |
| date completed: | ***28 Aug 2014*** |
| project: | ***Stage 5 Ballintoy Park, Tauranga*** |
| logged by: | ***SLC*** |
| location: | ***Between Lot 67 and 68*** |
| checked by: | ***EPD*** |

position: E: 376,465; N: 802,119 (BOPC2000 ) surface elevation: 74.0 m (MOTURIKI) pit orientation:

equipment type: 12t Excavator Track excavation method: excavation dimensions: vane id.: DR4523

**excavation information** | **material substance**

| method | support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕ remoulded ⊙ peak (kPa) 50 100 150 200 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | N | | Not Encountered | | 74.0 | | | | **ORGANIC SILT**: non plastic, black, some brown silt inclusions, dry to moist. | D to M | | | **TOPSOIL FILL** |
| | | | | | 73.5 | 0.5 | | | | | | | |
| | | | | | 73.0 | 1.0 | | | | | | | |
| | | | | | | | | | **Sandy SILT**: non plastic, brown mottled pale brown, dry to moist, hard. | | H | VS UTP | **FILL** |
| | | | | | 72.5 | 1.5 | | | | | | VS UTP | |
| | | | | | 72.0 | 2.0 | | | | | | VS UTP | |
| | | | | | 71.5 | 2.5 | | | | | | VS UTP | |
| | | | | | 71.0 | 3.0 | | | | | | VS UTP | |
| | | | | | | | | | **SILT**: non plastic, orange brown, some fine grained sand, dry to moist, stiff to very stiff. | | St to VSt | ⊕ ⊙ | **YOUNGER ASHES** |
| | | | | | 70.5 | 3.5 | | | | | | | |
| | | | | | 70.0 | 4.0 | | | | | | ⊕ ⊙ | |
| | | | | | 69.5 | 4.5 | | | | | | ⊕ ⊙ | |
| | | | | | | | | | Test pit TP510 terminated at 4.6 m Target depth | | | | |
| | | | | | 69.0 | 5.0 | | | | | | | |
| | | | | | 68.5 | 5.5 | | | | | | | |

CDF_0_9_05_LIBRARY.GLB rev:AO Log COF EXCAVATION GENZTAUC12590AB AUGERS AND TEST PITS SLC 270814.GPJ <<DrawingFile>> 09/09/2014 13:35

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

**support**
- N none
- S shoring

**penetration**
1 2 3 — no resistance ranging to refusal

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

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

**classification symbol & soil description**
based on Unified Classification System

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

**consistency / relative density**

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

coffey

# Engineering Log - Excavation

| | |
|---|---|
| Excavation ID. | ***TP511*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AB*** |
| client: | ***Hugh Green Ltd*** |
| date excavated: | ***28 Aug 2014*** |
| principal: | |
| date completed: | ***28 Aug 2014*** |
| project: | ***Stage 5 Ballintoy Park, Tauranga*** |
| logged by: | ***SLC*** |
| location: | ***Between Lot 67 and 68*** |
| checked by: | ***EPD*** |

position: E: 376,454; N: 802,158 (BOPC2000 ) surface elevation: 74.0 m (MOTURIKI) pit orientation:

equipment type: 12t Excavator Track excavation method: excavation dimensions: vane id.: DR4523

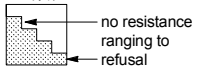
**excavation information** | **material substance**

| method | support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕ remoulded ⊙ peak (kPa) 50 100 150 200 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | N | | Not Encountered | | 74.0 | | | | | | | | |
| | | | | | 73.5 | 0.5 | | | **ORGANIC SILT**: non plastic, black, moist. | M | | | **TOPSOIL FILL** |
| | | | | | | | | | **Sandy SILT**: non plastic, brown mottled pale brown, some fine to medium grained sand, moist, hard. | | H | VS UTP | **FILL** |
| | | | | | 73.0 | 1.0 | | | **SILT**: non plastic, orange brown, some fine grained sand, moist, very stiff. | | VSt | | **YOUNGER ASHES** |
| | | | | | 72.5 | 1.5 | | | | | | | |
| | | | | | 72.0 | 2.0 | | | | | | | |
| | | | | | 71.5 | 2.5 | | | | | | | |
| | | | | | 71.0 | 3.0 | | | **SAND**: fine to coarse grained, well graded, orange brown, moist, loose. | | L | | **HAUPARU TEPHRA** |
| | | | | | 70.5 | 3.5 | | | **SILT**: low plasticity, brown, moist, stiff to very stiff. | | St to VSt | | |
| | | | | | 70.0 | 4.0 | | | 3.7 m: becoming pale brown | | | | |
| | | | | | 69.5 | 4.5 | | | **INTERBEDDED SANDS AND SILT**: sands are fine to medium grained, pale brown grey. Silts are low plasticity, pale brown with minor fine grained sand, moist, stiff. | | St | | **ROTOEHU ASH** |
| | | | | | 69.0 | 5.0 | | | 5.0 m: becoming dark red brown | | | | |
| | | | | | 68.5 | 5.5 | | | Test pit TP511 terminated at 5.4 m Target depth | | | | |

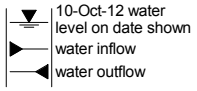
**method**
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

**support**
- N none
- S shoring

**penetration**




**water**




**samples & field tests**

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

**classification symbol & soil description** based on Unified Classification System

**moisture**

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

**consistency / relative density**

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | **HA01** |
| sheet: | 1 of 1 |
| project no. | **GENZTAUC12590AC** |
| client: **Hugh Green Contractors Ltd** | date started: **02 Dec 2016** |
| principal: | date completed: **02 Dec 2016** |
| project: **Ballintoy Park, Lots 33 to 37** | logged by: **ODS** |
| location: **Lot 33** | checked by: **RBT** |

position: E: 429,407; N: 5,822,575 (Datum Not Specified) surface elevation: 70 m (Datum Not Specified) angle from horizontal: 90°

drill model: drilling fluid: hole diameter : 50 mm vane id.: SL588

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕remoulded ⊕peak (kPa) 50 100 150 200 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | VS >202 kPa | 70 | 0.0 | | | **SILT**: non plastic, Dark brown with mottled brown, with trace to minor fine to medium grained sand. | D | H | | **TOPSOIL / FILL** |
| | | | VS >202 kPa | | 0.5 | | | **SILT**: non plastic to low plasticity, yellow brown with mottled dark brown, with trace to minor fine grained sand. | | | | **FILL** |
| | | | VS >202 kPa | 69 | 1.0 | | | **SILT**: non plastic to low plasticity, orange brown, with trace fine to medium grained sand. | D to M | St to H | | **VOLCANIC ASHES** |
| | | | VS 190/ 46 kPa | | | | | 1.2 m: with trace clay | | | | |
| | | | VS 165/ 35 kPa | | 1.5 | | | 1.6 m: with minor clay. Low plasticity | M | | | |
| | | | VS >202 kPa | | | | | | | | | |
| | | | VS 98/ 26 kPa | 68 | 2.0 | | | 2.0 m: with trace fine to coarse grained sand. Becomes orange. Is greasy in hand sample | | | | |
| | | | VS 120/ 52 kPa | | 2.5 | | | 2.6 m: with minor fine to coarse grained sand | | | | |
| | | | VS 125/ 71 kPa | | | | | 2.8 m: with some fine to coarse grained sand | | | | |
| | | | VS 77/ 29 kPa | 67 | 3.0 | | | **SILT**: non plastic to low plasticity, pale brown with mottled orange brown, with some clay and with trace fine to coarse grained sand. | | St to VSt | | |
| | | | VS 75/ 55 kPa | | | | | | | | | |
| | | | VS 125/ 54 kPa | | 3.5 | | | 3.6 m: with minor fine to coarse grained sand | | | | |
| | | | VS 128/ 42 kPa | 66 | 4.0 | | | Hand Auger HA01 terminated at 4.0 m Target depth | | | | |



**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud N nil
C casing

**penetration**
1 2 3 no resistance ranging to refusal

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

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | **HA02** |
| sheet: | 1 of 1 |
| project no. | **GENZTAUC12590AC** |
| client: **Hugh Green Contractors Ltd** | date started: **02 Dec 2016** |
| principal: | date completed: **02 Dec 2016** |
| project: **Ballintoy Park, Lots 33 to 37** | logged by: **ODS** |
| location: **Lot 36** | checked by: **RBT** |

position: E: 429,398; N: 5,822,527 (Datum Not Specified) surface elevation: 72 m (Datum Not Specified) angle from horizontal: 90°

drill model: drilling fluid: hole diameter : 50 mm vane id.: SL588

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕remoulded ⊕peak (kPa) 50 100 150 200 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | VS >202 kPa | 72 | 0.0 | | | **SILT**: non plastic, Dark brown with mottled brown, with trace to minor fine to medium grained sand. | D | VSt to H | | **TOPSOIL / FILL** |
| | | | VS 149/ 35 kPa | | 0.5 | | | **SILT**: non plastic, Orange brown with mottled brown and grey, with trace fine to minor grained sand. | D to M | | | **FILL** |
| | | | VS >202 kPa | 71 | 1.0 | | | | | | | |
| | | | VS >202 kPa | | | | | | | | | |
| | | | VS >202 kPa | | 1.5 | | | | | | | |
| | | | VS >202 kPa | | | | | **SILT**: non plastic, orange brown, with trace fine grained sand. | | St to H | | **VOLCANIC ASHES** |
| | | | VS >202 kPa | 70 | 2.0 | | | 2.0 m: with minor to some clay, low plasticity | M | | | |
| | | | VS 177/ 44 kPa | | | | | | | | | |
| | | | VS 139/ 58 kPa | | 2.5 | | | 2.5 m: becomes yellow brown | | | | |
| | | | VS 112/ 51 kPa | 69 | 3.0 | | | | | | | |
| | | | VS 134/ 46 kPa | | | | | 3.3 m: becomes sticky in hand sample when reworked | | | | |
| | | | VS 98/ 54 kPa | | 3.5 | | | | | | | |
| | | | VS 96/ 44 kPa | | | | | | | | | |
| | | | | 68 | 4.0 | | | Hand Auger HA02 terminated at 4.0 m Target depth | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AS Log COF BOREHOLE: NON CORED HA01-03 - 5.12.16 - ODS - COPY.GPJ <<DrawingFile>> 22/12/2016 15:26

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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

coffey
A TETRA TECH COMPANY

# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | **HA03** |
| sheet: | 1 of 1 |
| project no. | **GENZTAUC12590AC** |
| client: **Hugh Green Contractors Ltd** | date started: **02 Dec 2016** |
| principal: | date completed: **02 Dec 2016** |
| project: **Ballintoy Park, Lots 33 to 37** | logged by: **ODS** |
| location: **Lot 37** | checked by: **RBT** |

position: E: 429,377; N: 5,822,502 (Datum Not Specified) | surface elevation: 68 m (Datum Not Specified) | angle from horizontal: 90°

drill model: | drilling fluid: | hole diameter : 50 mm | vane id.: SL588

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕remoulded ⊕peak (kPa) 50 100 150 200 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | | 68 | 0.0 | | | **SILT**: non plastic, Dark brown with mottled brown, with trace to minor fine to medium grained sand. | D | H | | **TOPSOIL / FILL** |
| | | | VS 202 kPa | | | | | **SILT**: low plasticity, pale brown with mottled brown, with trace fine to coarse grained sand and trace to minor clay. | D to M | | | **FILL** |
| | | | VS 118/ 32 kPa | | 0.5 | | | **SILT**: non plastic to low plasticity, orange brown, with trace fine grained sand. | | VSt | | **VOLCANIC ASHES** |
| | | | VS 190/ 39 kPa | 67 | 1.0 | | | 0.7 m: with trace to minor clay, low plasticity | | | | |
| | | | VS 156/ 29 kPa | | | | | | | | | |
| | | | VS 120/ 52 kPa | | 1.5 | | | | | | | |
| | | | VS 112/ 29 kPa | | | | | 1.8 m: becomes greasy in hand sample | | | | |
| | | | VS 142/ 44 kPa | 66 | 2.0 | | | 2.0 m: with some clay | | | | |
| | | | VS 146/ 31 kPa | | | | | | | | | |
| | | | | | 2.5 | | | **Clayey SILT**: non plastic to low plasticity, pale brown with mottled orange and grey, With trace fine to coarse grained sand. Is sticky in hand sample. With trace manganese oxide grains.. | M | St to VSt | | |
| | | | VS 139/ 62 kPa | | | | | | | | | |
| | | | VS 85/ 36 kPa | 65 | 3.0 | | | | | | | |
| | | | VS 105/ 31 kPa | | | | | | | | | |
| | | | | | 3.5 | | | 3.5 m: with mottled dark brown | | | | |
| | | | VS 190/ 54 kPa | | | | | | | | | |
| | | | VS 139/ 52 kPa | | | | | | | | | |
| | | | | 64 | 4.0 | | | Hand Auger HA03 terminated at 4.0 m Target depth | | | | |

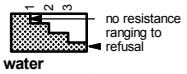
CDF_0_9_06_LIBRARY.GLB rev:AS Log COF BOREHOLE: NON CORED HA01-03 - 5.12.16 - ODS - COPY.GPJ <<DrawingFile>> 22/12/2016 15:26

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

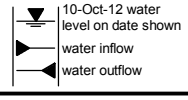
**support**
- M mud
- C casing
- N nil

**penetration**



no resistance ranging to refusal

**water**


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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH501** |
| sheet: | 1 of 2 |
| project no. | **GENZTAUC12590AB** |
| client: | **Hugh Green Ltd** |
| date started: | **27 Aug 2014** |
| principal: | |
| date completed: | **27 Aug 2014** |
| project: | **Stage 5 Ballintoy Park, Tauranga** |
| logged by: | **SLC** |
| location: | **Between Lot 67 and 68** |
| checked by: | **EPD** |

position: E: 376,459; N: 802,136 (BOPC2000 ) | surface elevation: 73.5 m (MOTURIKI) | angle from horizontal: 90°

drill model: Morooka, Track mounted | drilling fluid: None | hole diameter : 75 mm | vane id.:

**drilling information** | **material substance**

| method & support | core run details | samples, field tests & Is(50) (MPa) a = axial; d = diametral | RL (m) | depth (m) | graphic log | classification symbol | material description | moisture condition | consistency / relative density | weathering & alteration | estimated strength | defect spacing (mm) | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AD | TCR= 100% | | 73 | | | | **ORGANIC SILT**: non plastic, black mottled pale grey, moist, firm. | M | F | | | | **TOPSOIL FILL** |
| | | | | 1.0 | | | **SILT**: low plasticity, pale grey brown, minor fine grained sand, some topsoil inclusions, moist, hard. | | H | | | | **FILL** |
| SPT | TCR= 89% | SPT 2, 3, 3, 3, 3, 3 N*=12 | 72 | | | | | | | | | | |
| | | | | 2.0 | | | | | | | | | |
| AD | TCR= 100% | | 71 | | | | **SILT**: low plasticity, orange brown, moist, very stiff. | | VSt | | | | **YOUNGER ASHES** |
| N | | | | 3.0 | | | | | | | | | |
| SPT | TCR= 78% | SPT 1, 1, 1, 2, 2, 2 N*=7 | | | | | | | | | | | |
| | | | 70 | | | | | | | | | | |
| AD | TCR= 100% | | | 4.0 | | | | | | | | | |
| SPT | TCR= 89% | SPT HW/50mm, 1, 0, 0, 1, 0, 0 N*=1 | 69 | | | | **Sandy SILT**: low to medium plasticity, orange brown, moist, soft. | | S | | | | **HAUPARU TEPHRA** |
| | | | | 5.0 | | | 5.00 m: becoming pale grey brown | | | | | | |
| AD | TCR= 100% | | 68 | | | | 5.50 m: becoming pale grey | | | | | | |
| | | | | | | | **SAND**: fine grained, uniform, grey, moist, loose. | | L | | | | **ROTOEHU ASH** |

CDF_0_9_05_LIBRARY.GLB rev:AO Log COF BOREHOLE: CORED + MOIST & CONS GENZTAUC12590AB AUGERS AND TEST PITS SLC 270814.GPJ <<DrawingFile>> 10/09/2014 10:31

**method & support**
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test

**core details**
TCR = Total Core Recovery (%)
SCR = Solid Core Recovery (%)
RQD = Rock Quality Designation (%)

**water**
10 Oct., 73 Water Level on Date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss

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

**classification symbols**
Based on Unified Classification System

**moisture**
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

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

**weathering & alteration***
RS residual soil
CW completely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
UW unweathered
*W replaced with A for alteration

**strength**
VW very weak
W weak
MS moderately strong
S strong
VS very strong
ES extremely strong

**defect type**
BS bedding shear
PT parting
JT joint
SZ shear zone
SS shear surface
CO contact
CS crushed seam
SM seam

**planarity**
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

**roughness**
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

**coating**
CN clean
SN stain
VN veneer
CO coating

coffey

# Engineering Log - Cored Borehole

| | |
|---|---|
| Borehole ID. | **BH501** |
| sheet: | 2 of 2 |
| project no. | **GENZTAUC12590AB** |
| client: | **Hugh Green Ltd** |
| date started: | **27 Aug 2014** |
| principal: | |
| date completed: | **27 Aug 2014** |
| project: | **Stage 5 Ballintoy Park, Tauranga** |
| logged by: | **SLC** |
| location: | **Between Lot 67 and 68** |
| checked by: | **EPD** |

position: E: 376,459; N: 802,136 (BOPC2000 ) surface elevation: 73.5 m (MOTURIKI) angle from horizontal: 90°

drill model: Morooka, Track mounted drilling fluid: None hole diameter : 75 mm vane id.:

**drilling information** | **material substance**

| method & support | core run details | samples, field tests & ls(50) (MPa) a = axial; d = diametral | RL (m) | depth (m) | graphic log | classification symbol | material description | moisture condition | consistency / relative density | weathering & alteration | estimated strength VW W MS S VS ES | defect spacing (mm) 20 60 200 600 2000 | additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular | general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPT | TCR= 122% | SPT 1, 0, 0, 0, 1, 2 N*=3 | 67 | | | | **Silty CLAY**: medium plasticity, orange brown, moist, stiff to very stiff. | M | St to VSt | | | | | **HAMILTON ASH** |
| AD | TCR= 100% | | | 7.0 | | | 7.10 m: becoming pale brown | | | | | | | |
| SPT | TCR= 122% | SPT 1, 1, 1, 2, 2, 2 N*=7 | 66 | | | | | | | | | | | |
| AD | TCR= 100% | | 65 | 8.0 | | | | | | | | | | |
| SPT | TCR= 0% | SPT 2, 2, 3, 3, 3, 3 N=12 | | 9.0 | | | | | | | | | | |
| AD | TCR= 100% | | 64 | | | | | | | | | | | |
| SPT | TCR= 100% | SPT 3, 4, 4, 4, 5, 6 N*=19 | 63 | 10.0 | | | **Sandy SILT**: medium plasticity, pale grey, some clay, moist, hard. | | H | | | | | **WEATHERED IGNIMBRITE** |
| | | | 62 | 11.0 | | | Borehole BH501 terminated at 10.95 m Target depth | | | | | | | |

N

**method & support**
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

**core details**

TCR = Total Core Recovery (%)
SCR = Solid Core Recovery (%)
RQD = Rock Quality Designation (%)

**water**
- 10 Oct., 73 Water Level on Date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss

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

**classification symbols**
Based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

**weathering & alteration***
- RS residual soil
- CW completely weathered
- HW highly weathered
- MW moderately weathered
- SW slightly weathered
- UW unweathered

*W replaced with A for alteration

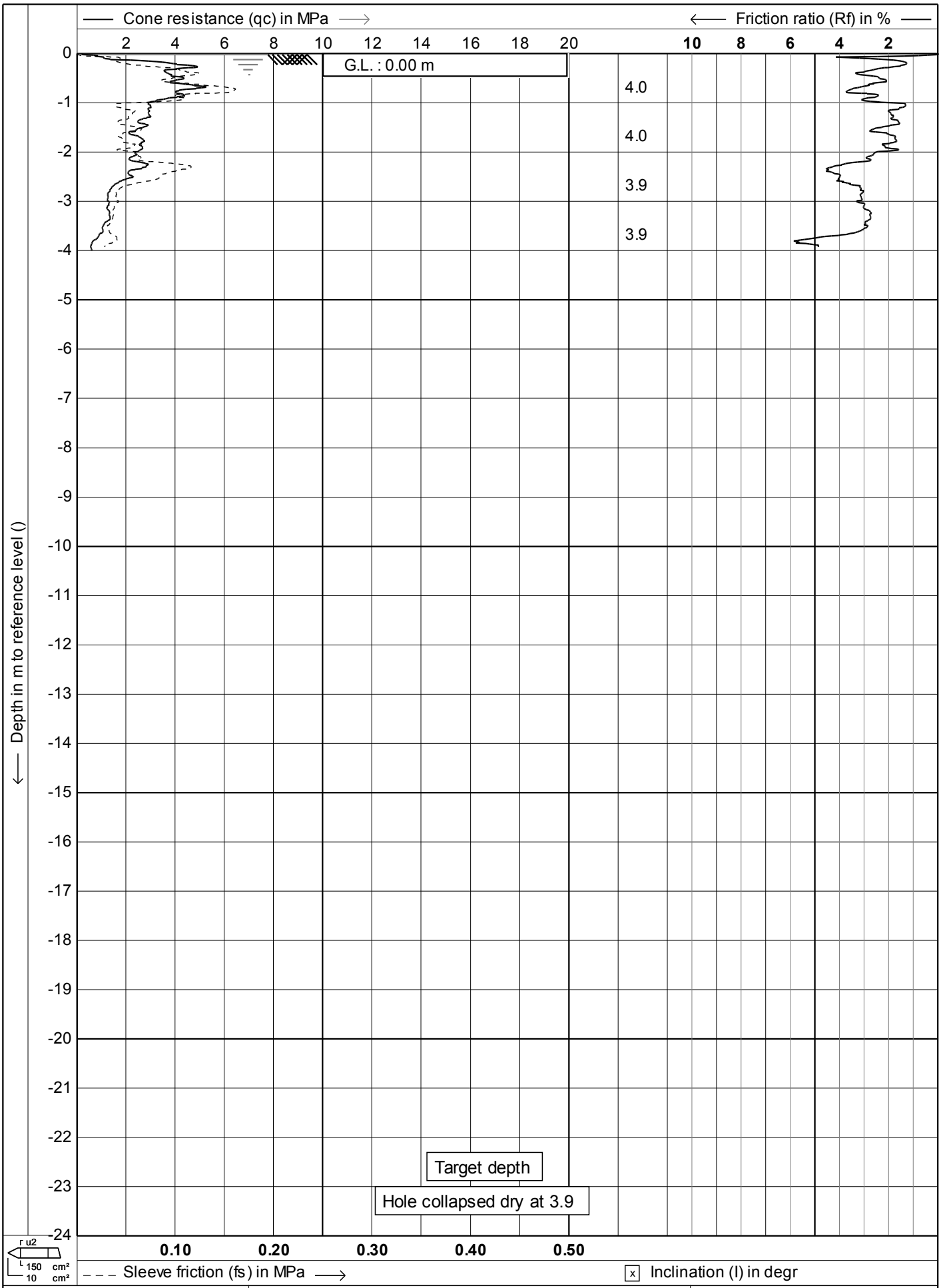
**strength**
- VW very weak
- W weak
- MS moderately strong
- S strong
- VS very strong
- ES extremely strong

**defect type**
- BS bedding shear
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

**planarity**
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

**roughness**
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

**coating**
- CN clean
- SN stain
- VN veneer
- CO coating




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

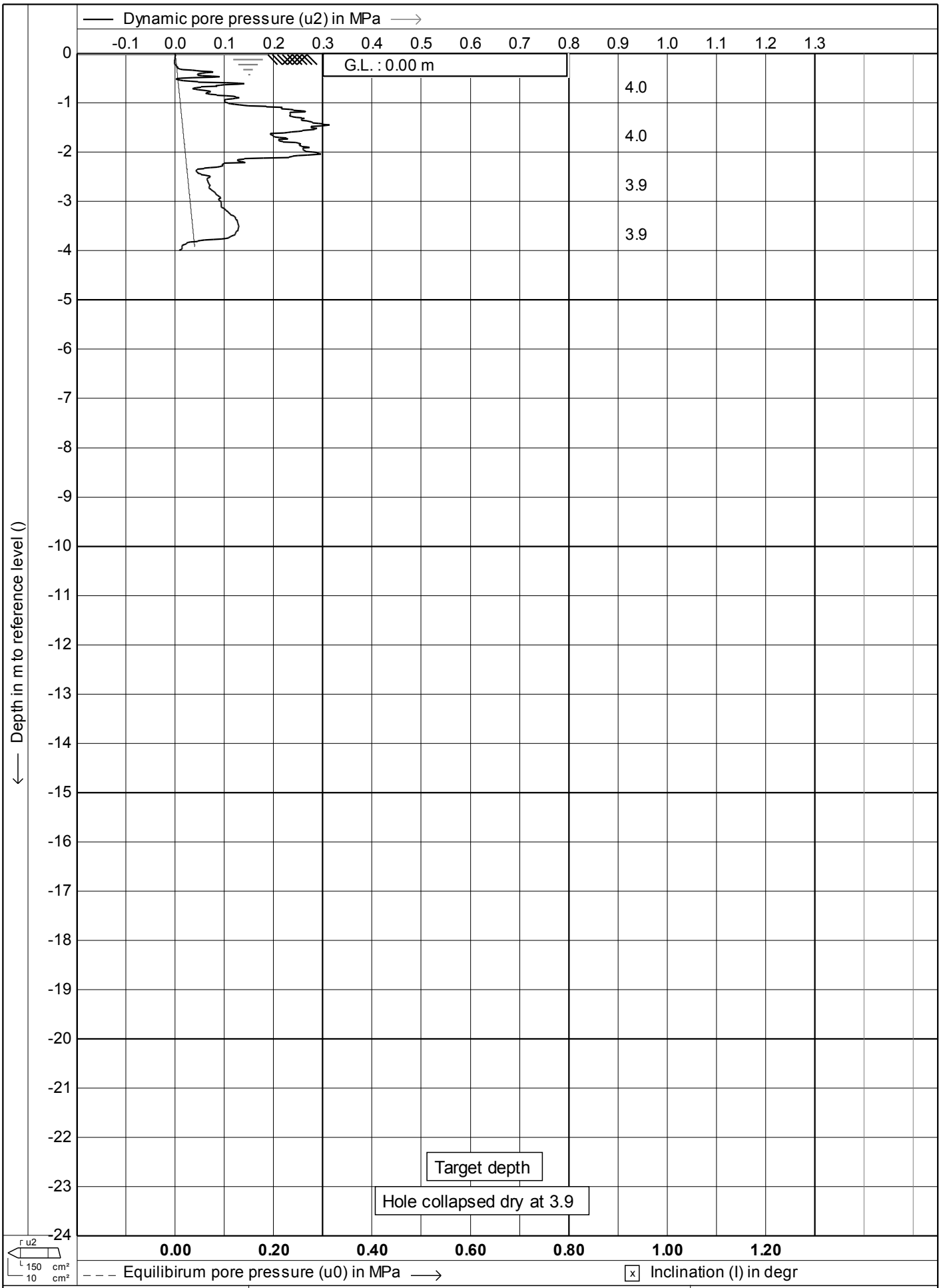
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **01**



CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

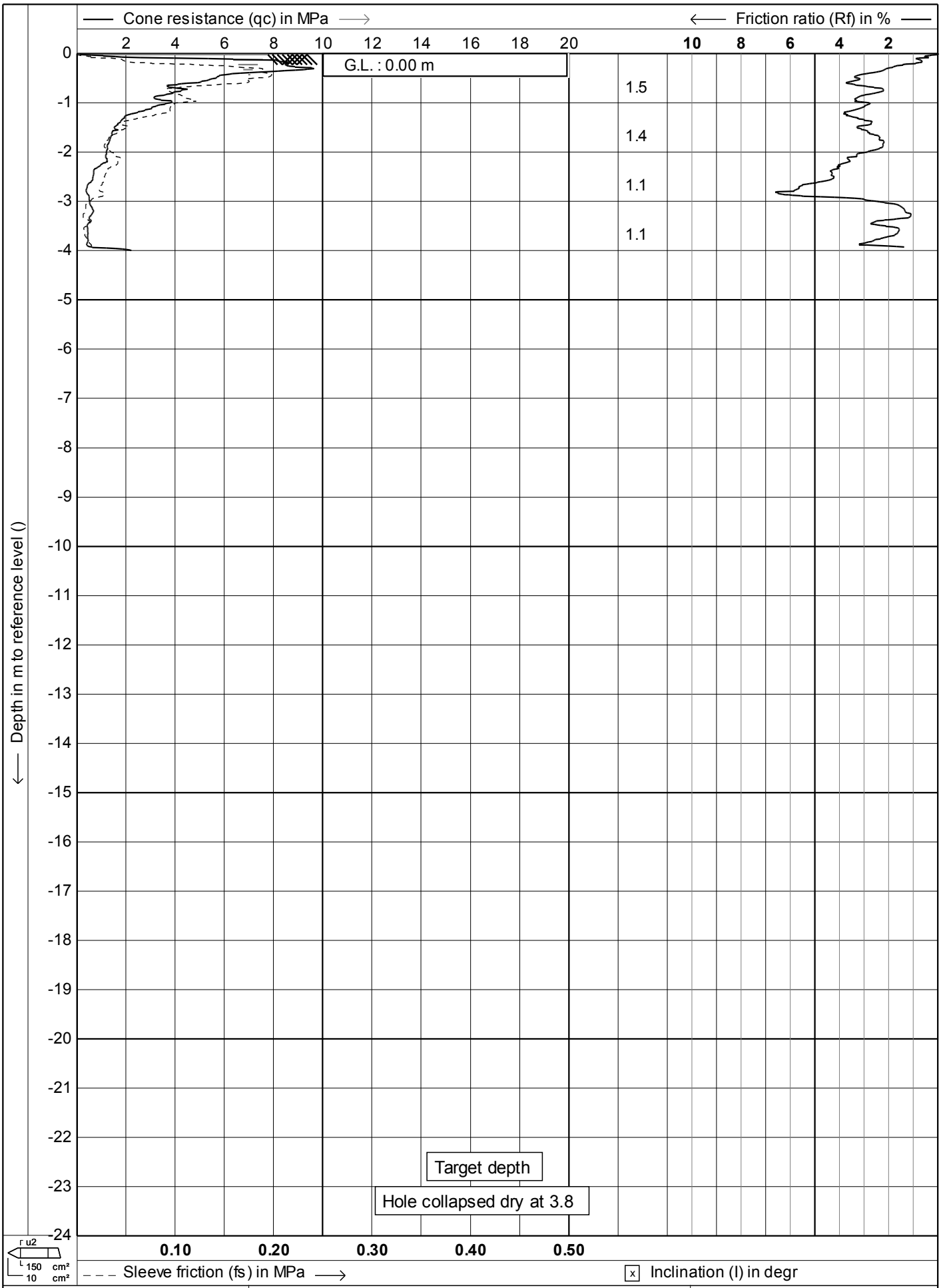
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **01**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

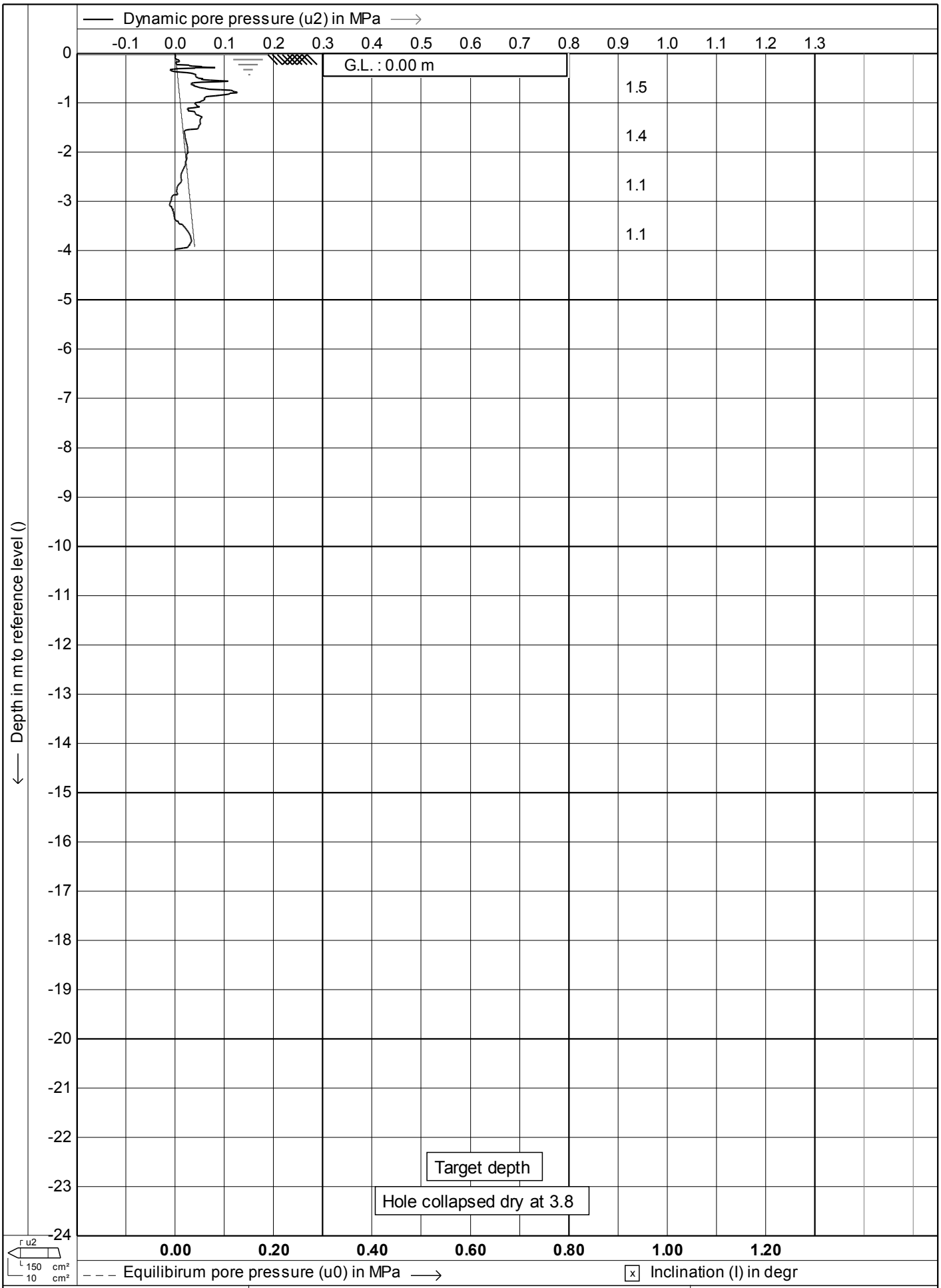
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **02**



CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

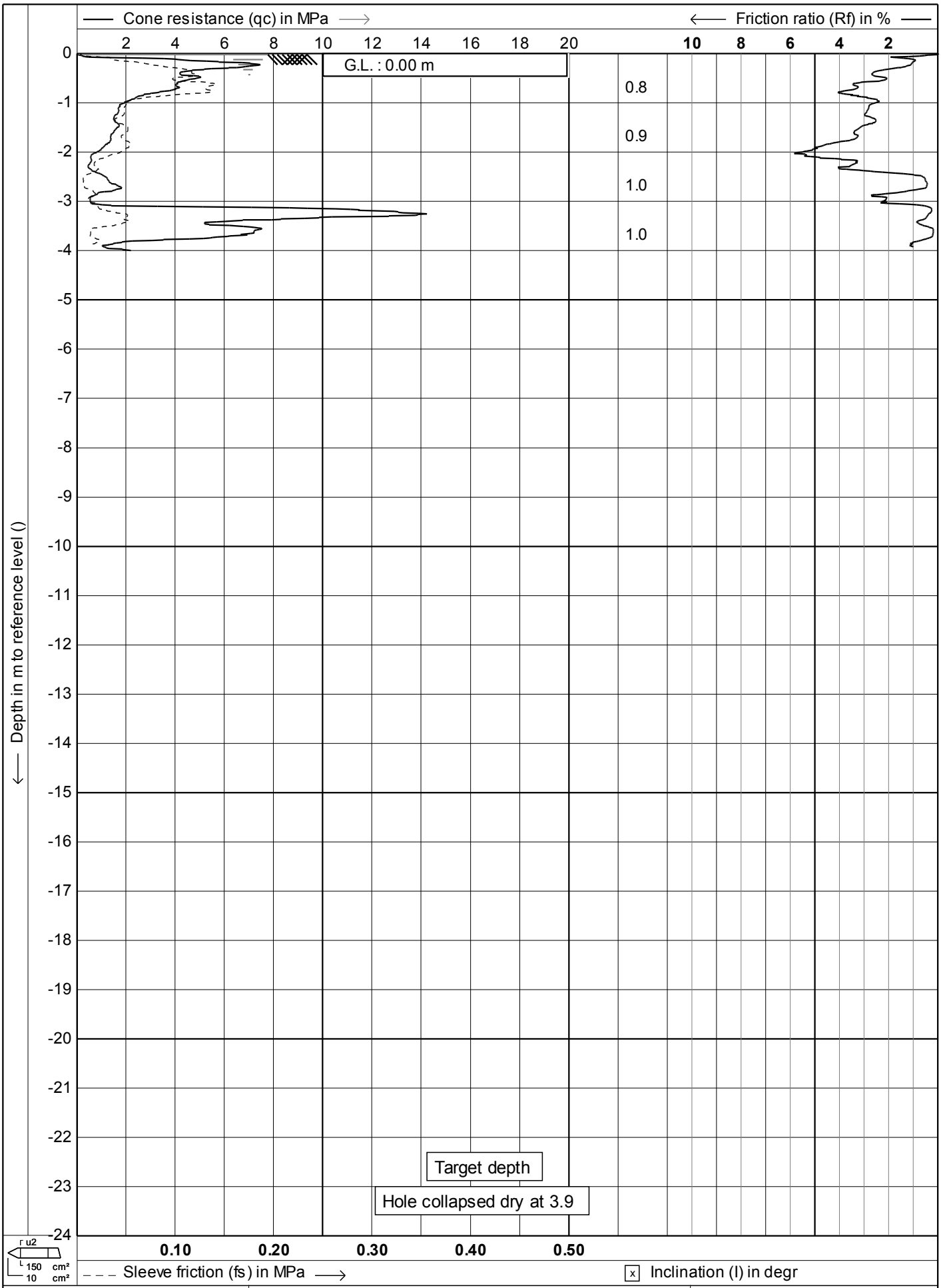
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **02**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

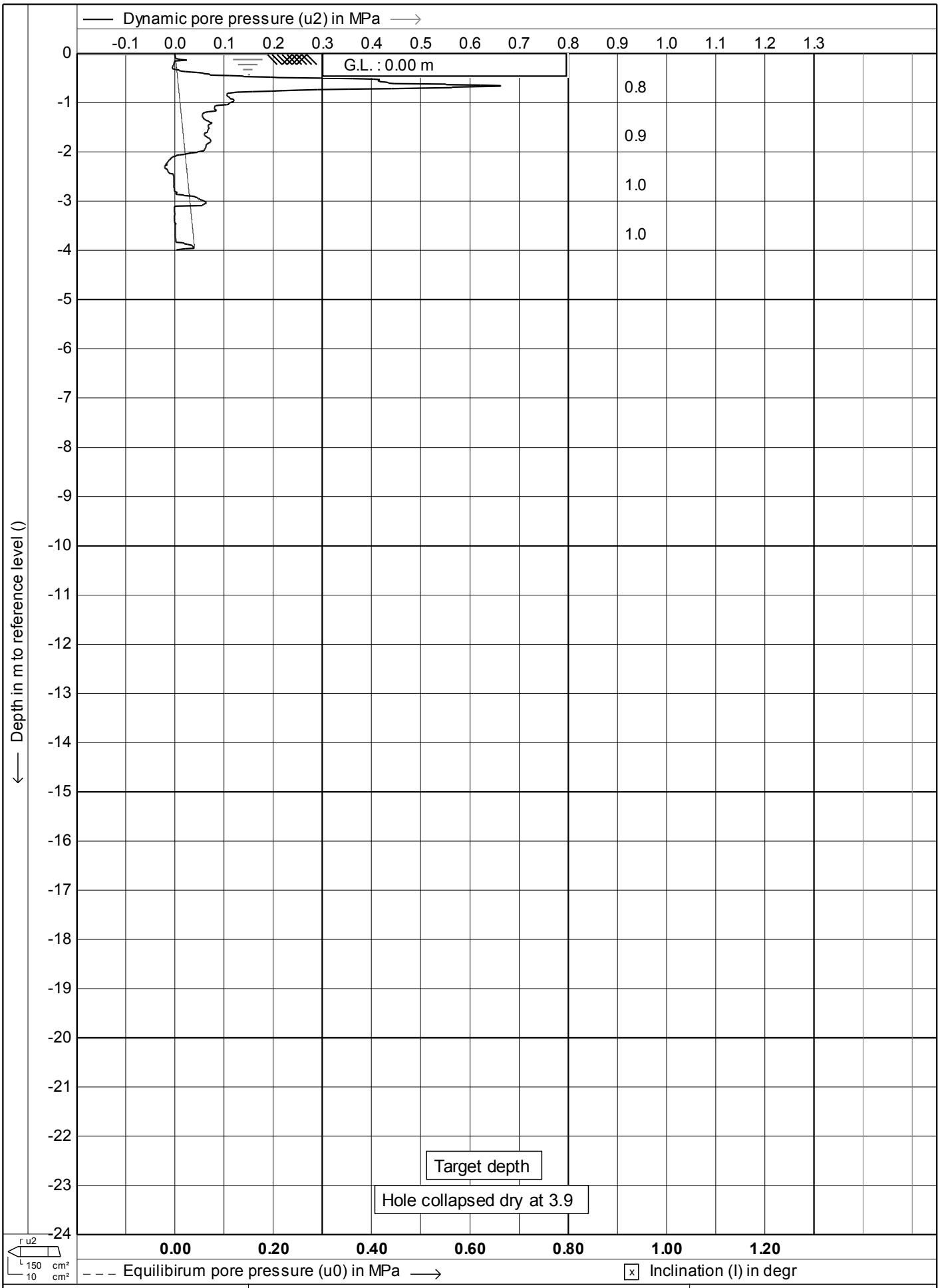
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **03**



CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

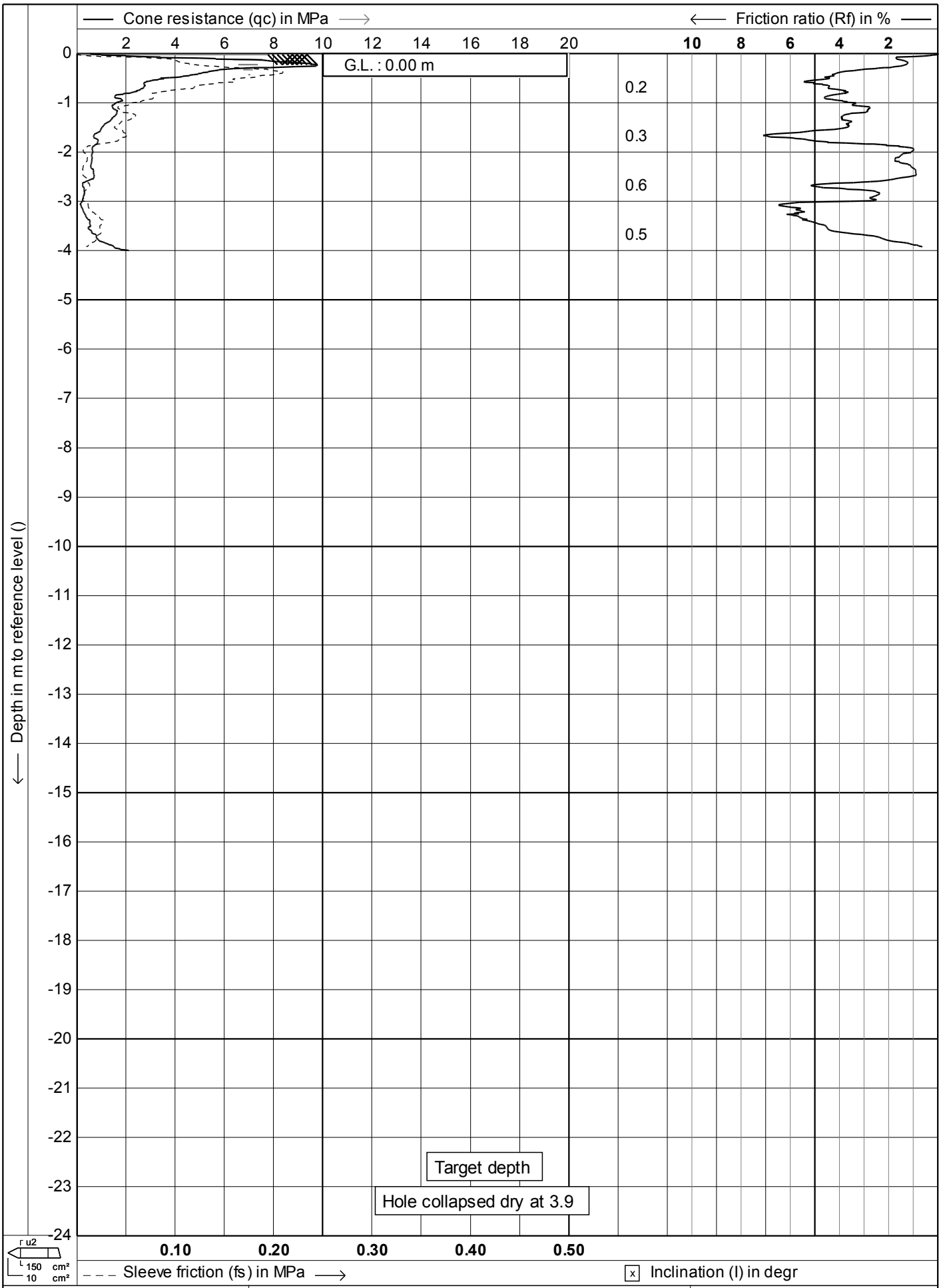
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **03**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

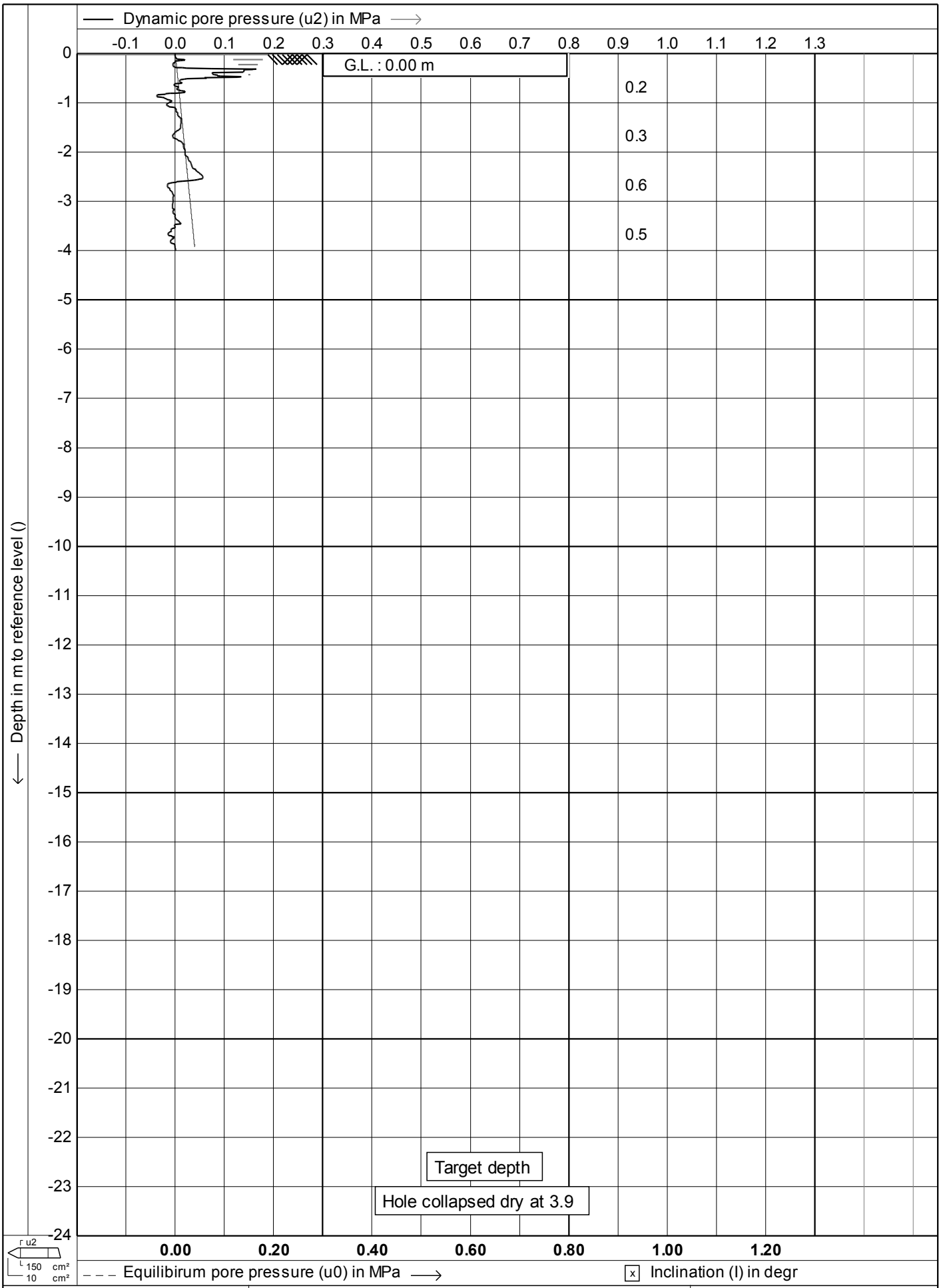
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **04**

**1/14**

CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

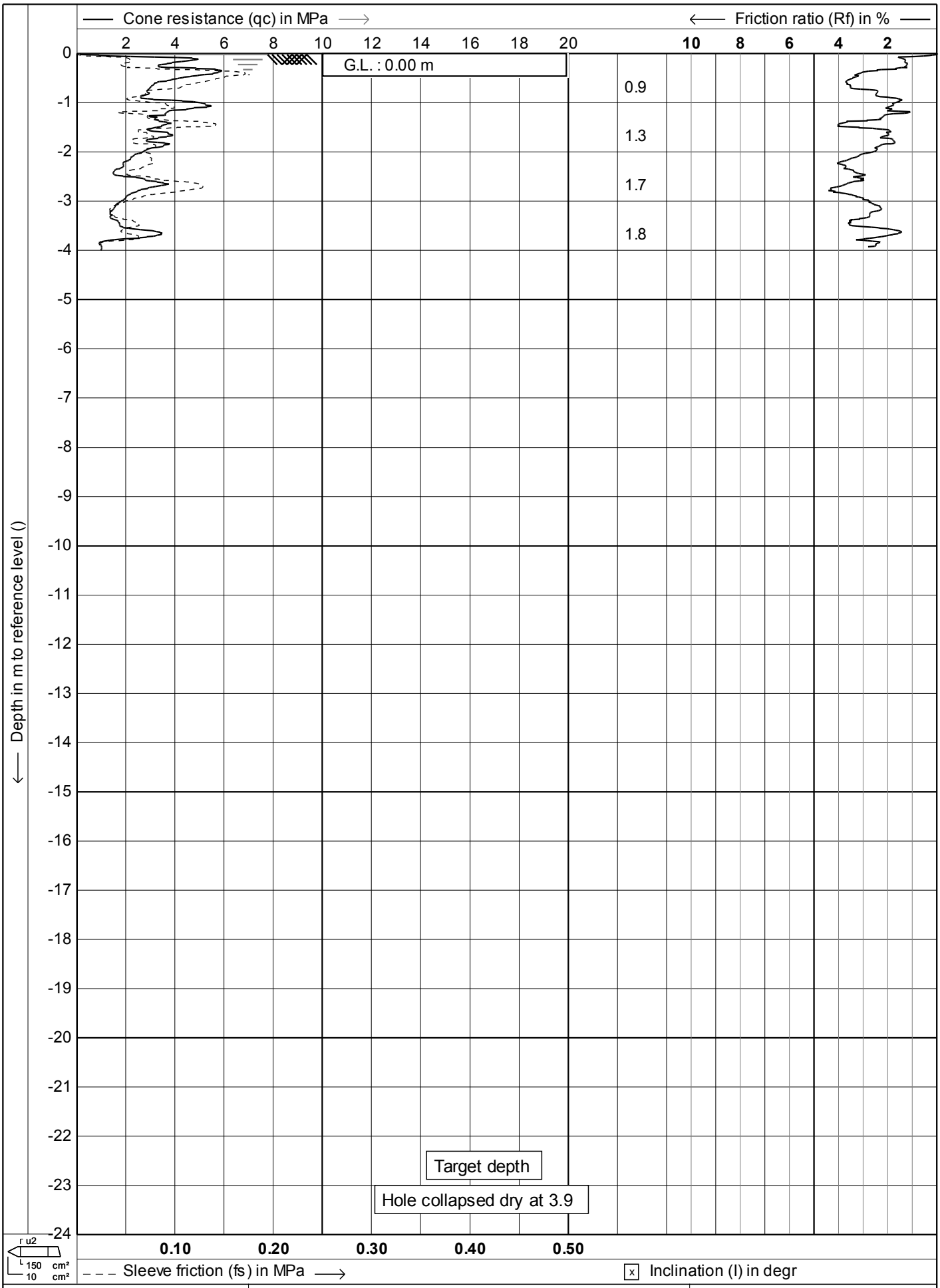
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **04**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

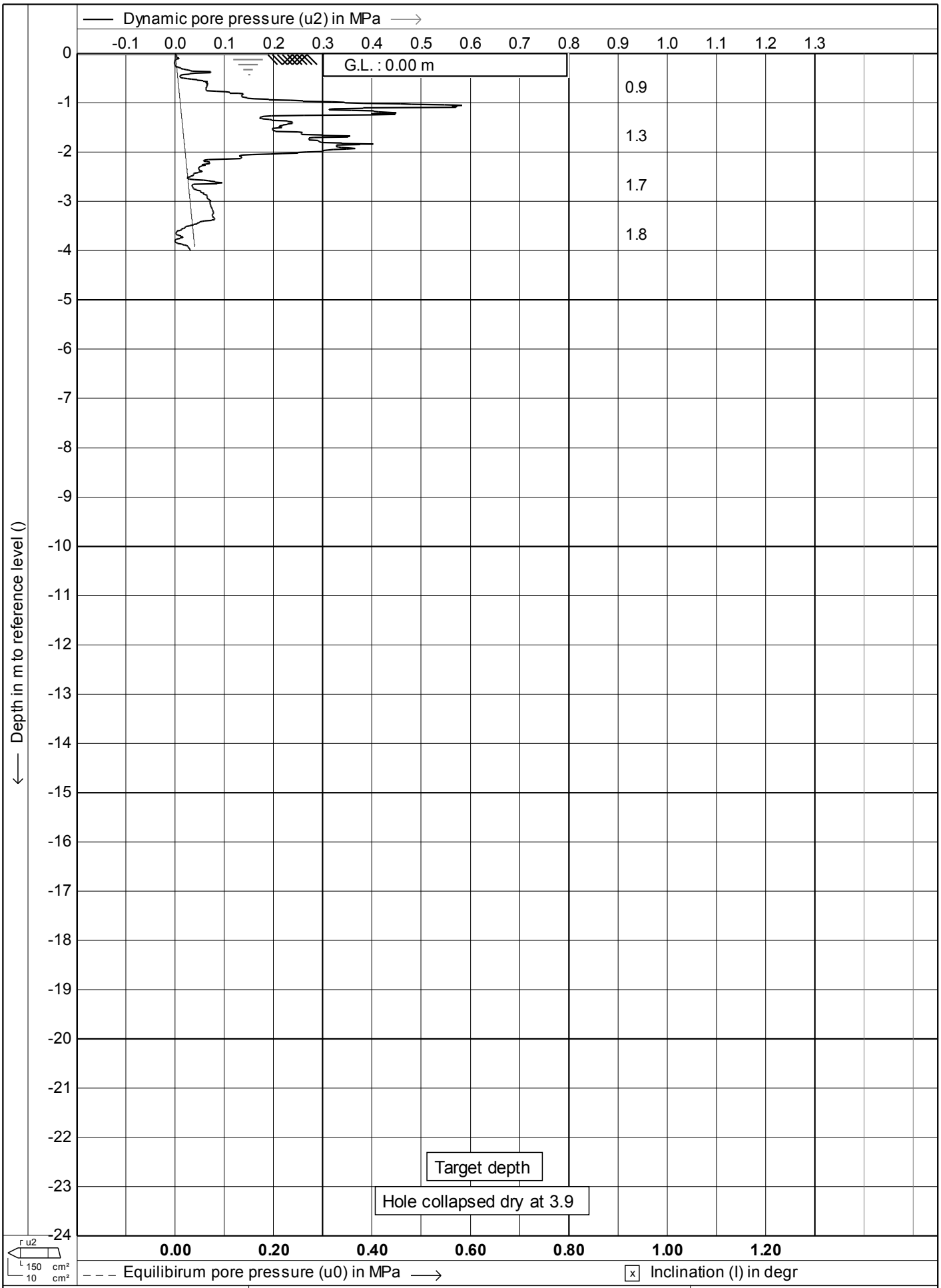
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **05**



CPTask V1.33




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

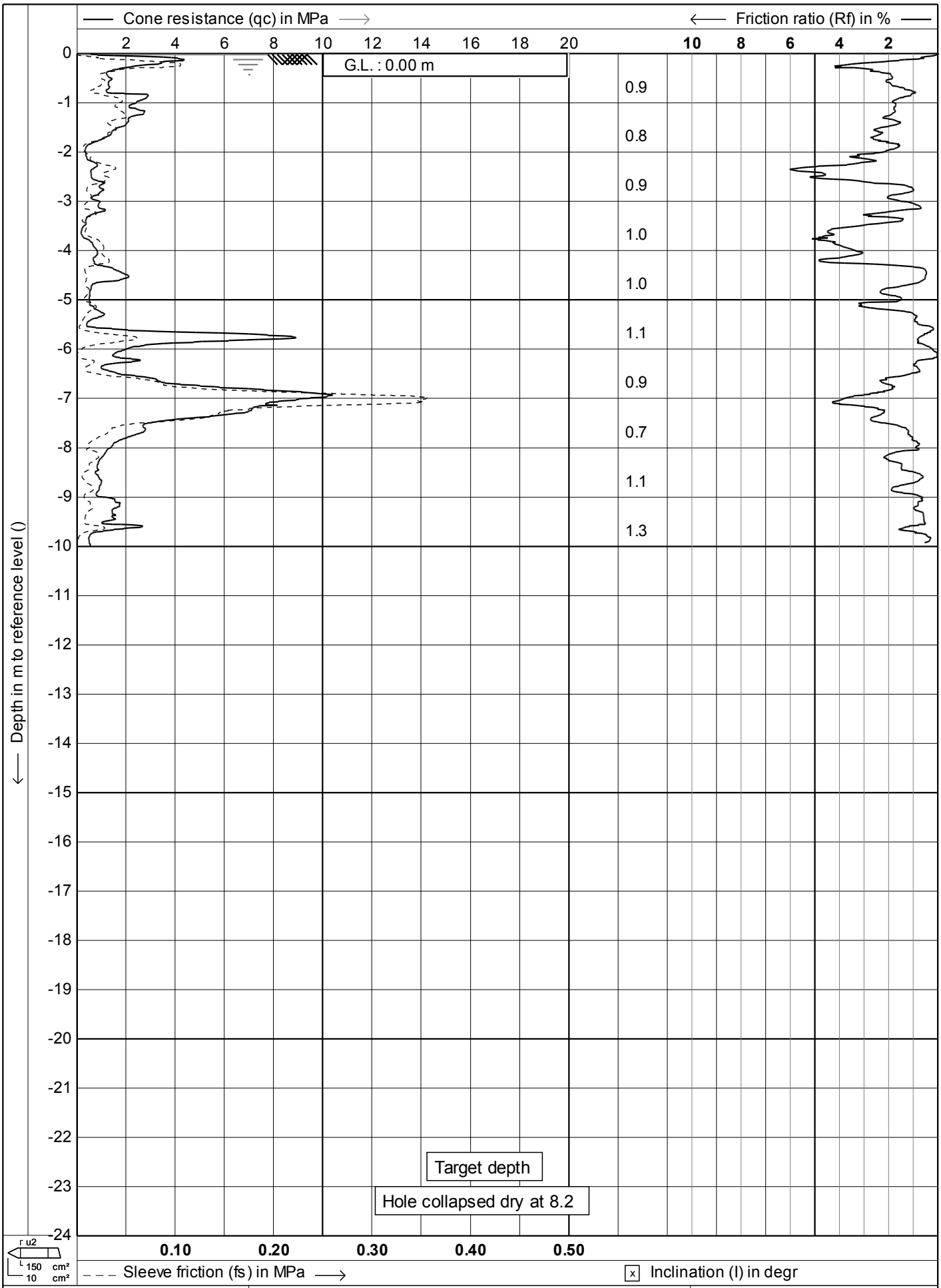
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **05**



CPTask V1.33




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

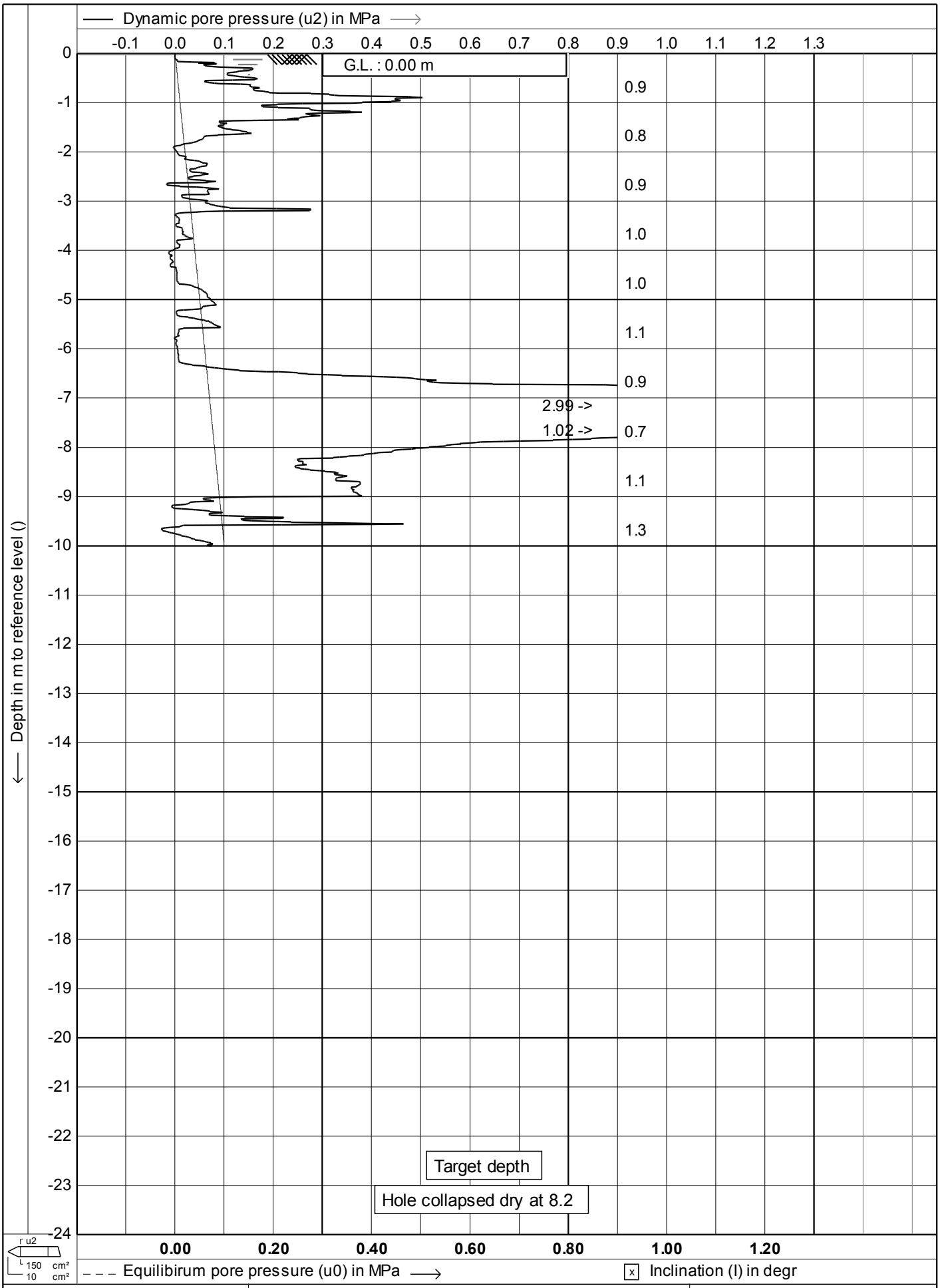
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **06**



CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

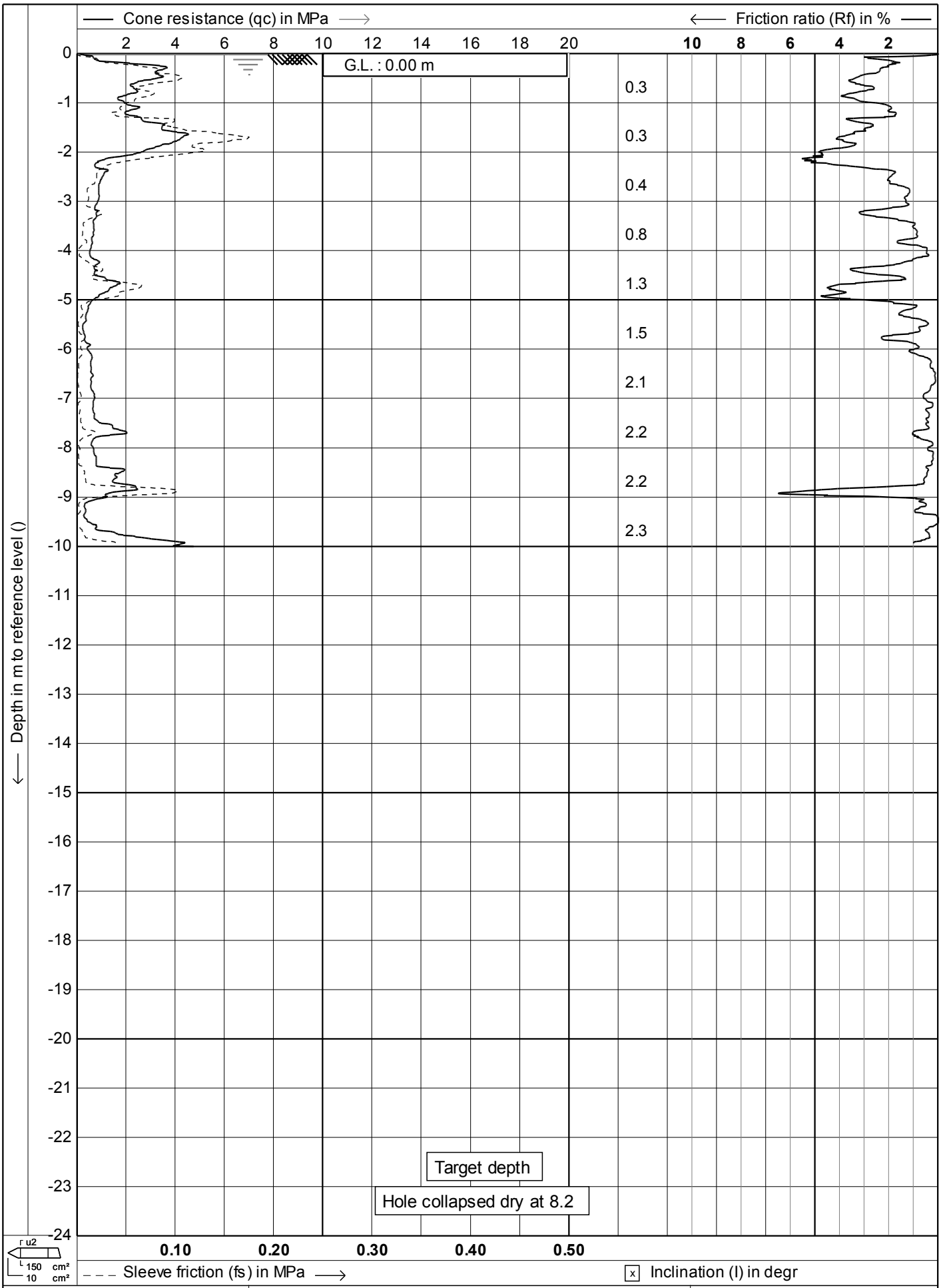
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

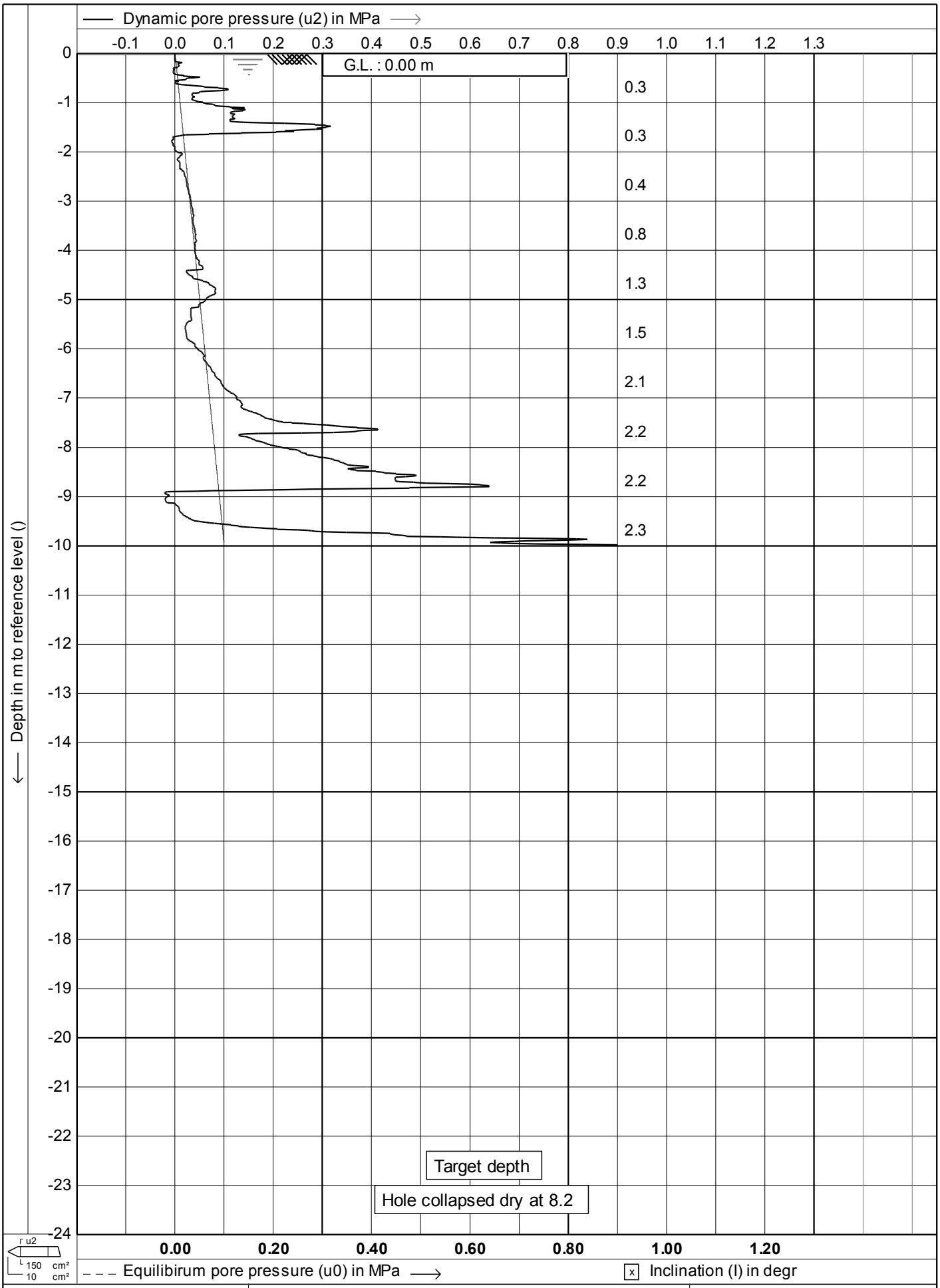
Project no. : **02COF4**

CPT no. : **06**




| | | | |
|---|---|---|---|
| PERRY GEOTECH | Test according A.S.T.M. Standard D 5778-12 | Date | : **2-12-2016** |
| | Project : **Site Investigation** | Cone no. | : **C10CFIIP.C15213** |
| | | Project no. | : **02COF4** |
| | Location: **Bob Carter Place - Welcome bay** | CPT no. | : **07** 1/14 |

CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

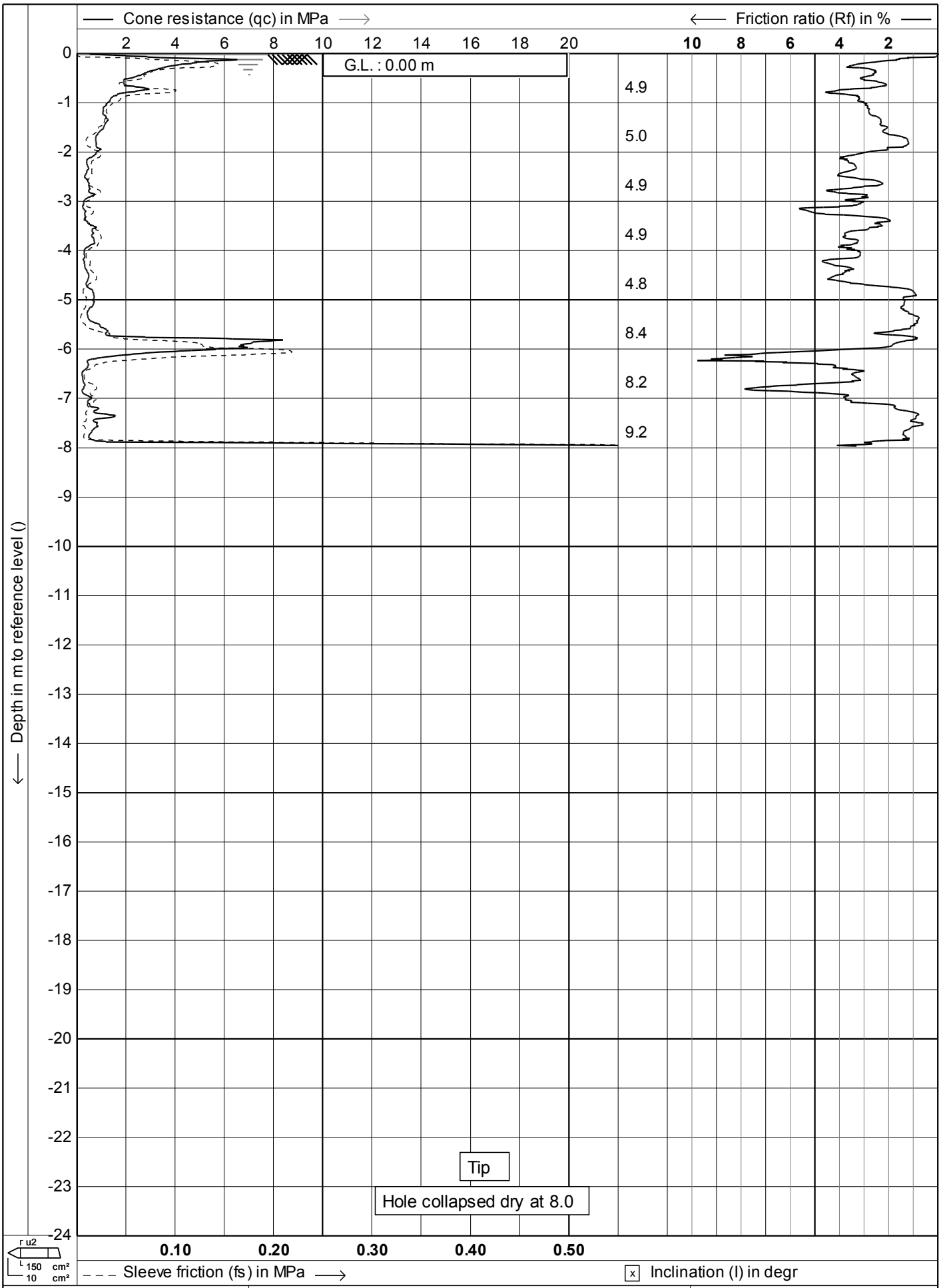
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **07**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

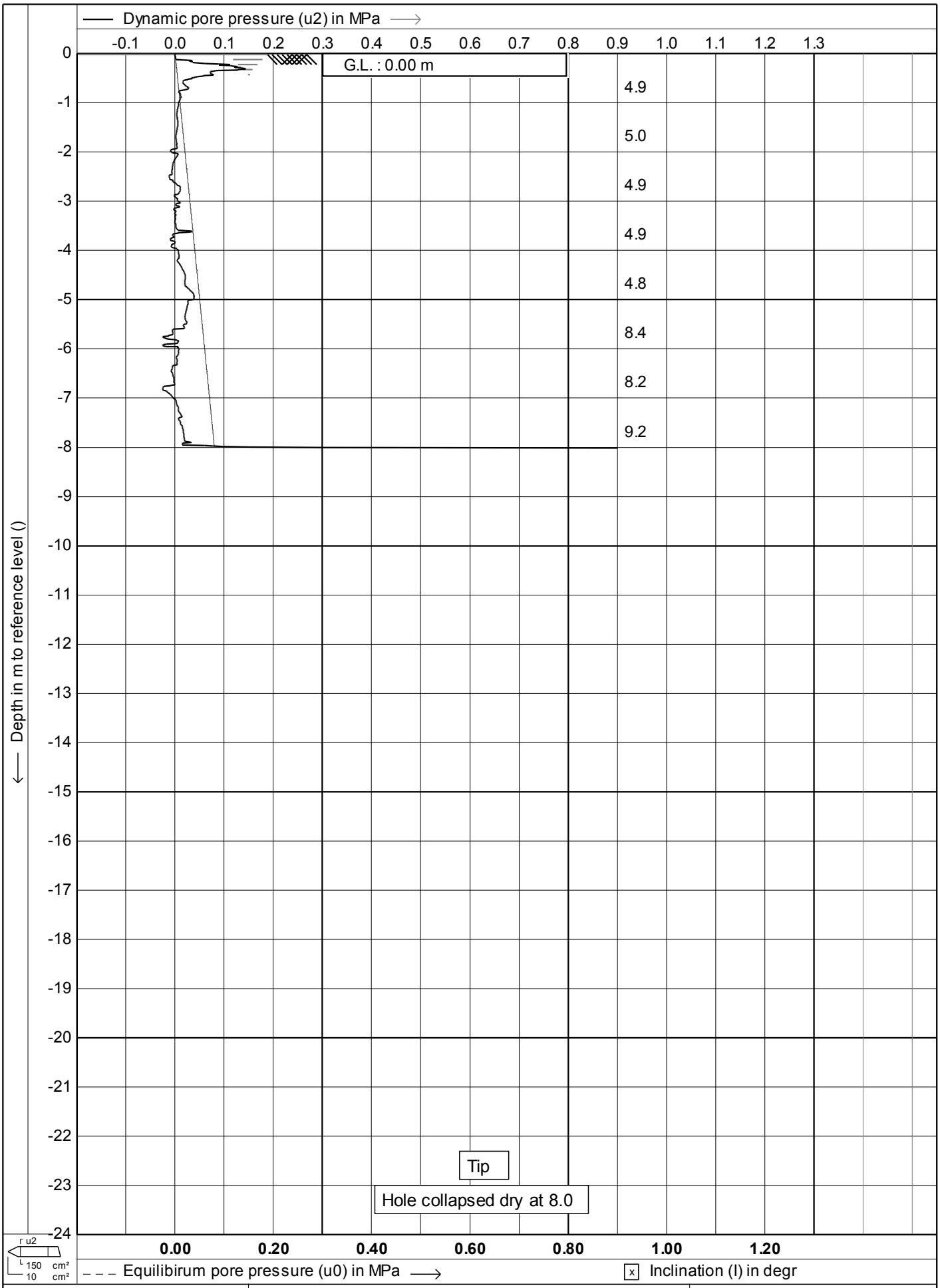
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **08**

**1/14**

CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

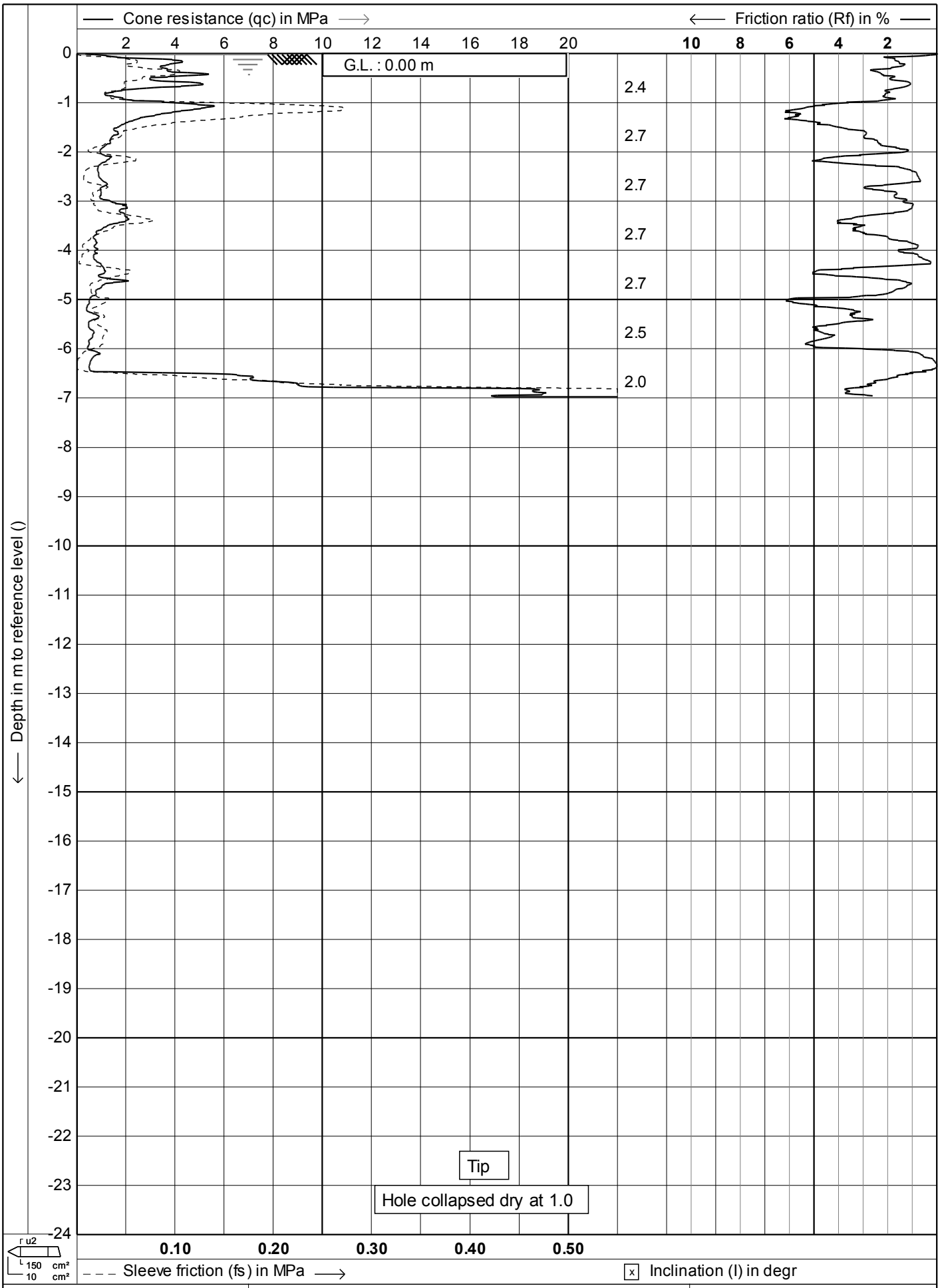
Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **08**




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

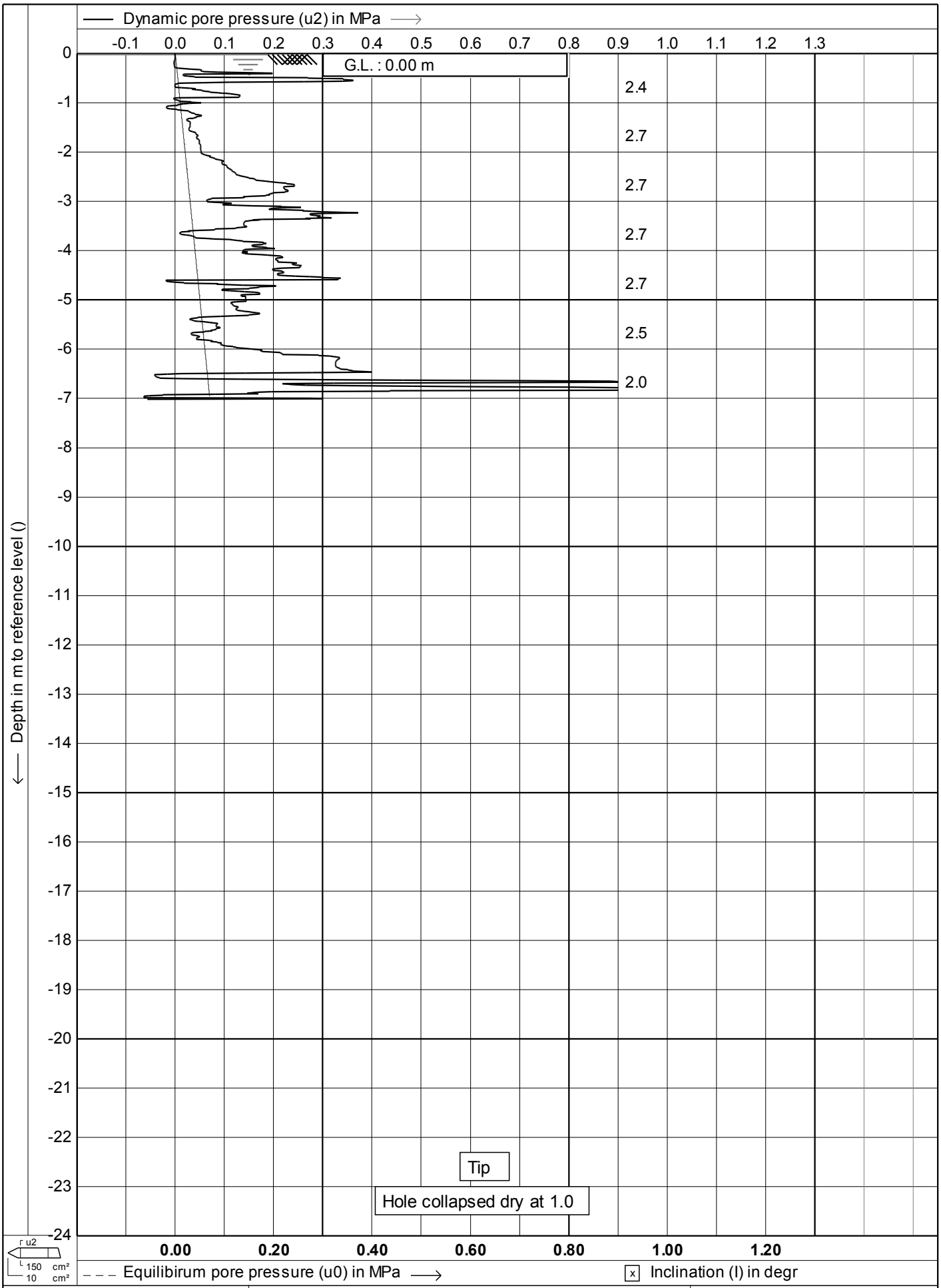
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **09**



CPTask V1.33




CPTask V1.33

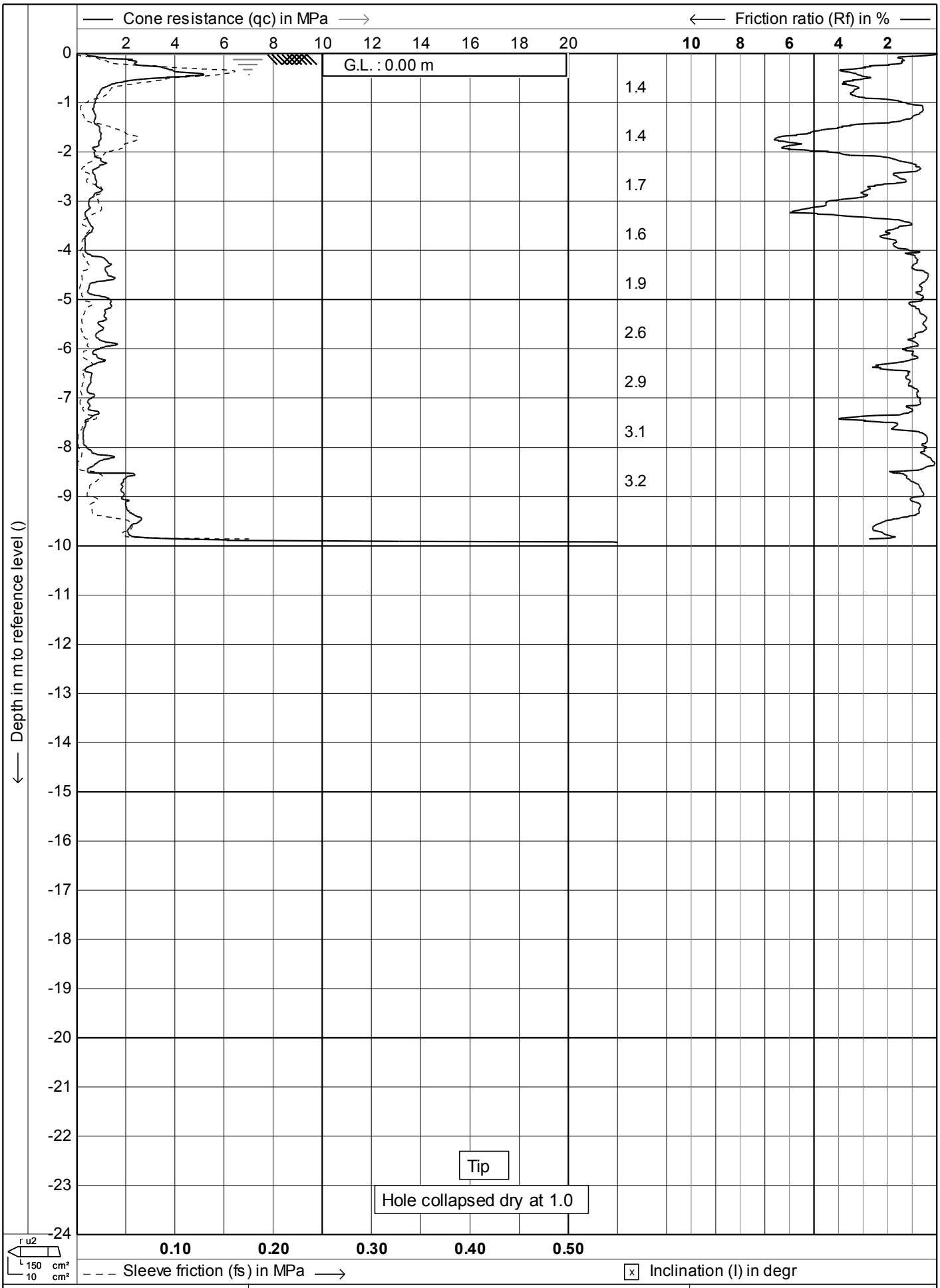
PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

| | |
|---|---|
| Date | : **2-12-2016** |
| Cone no. | : **C10CFIIP.C15213** |
| Project no. | : **02COF4** |
| CPT no. | : **09** |




PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

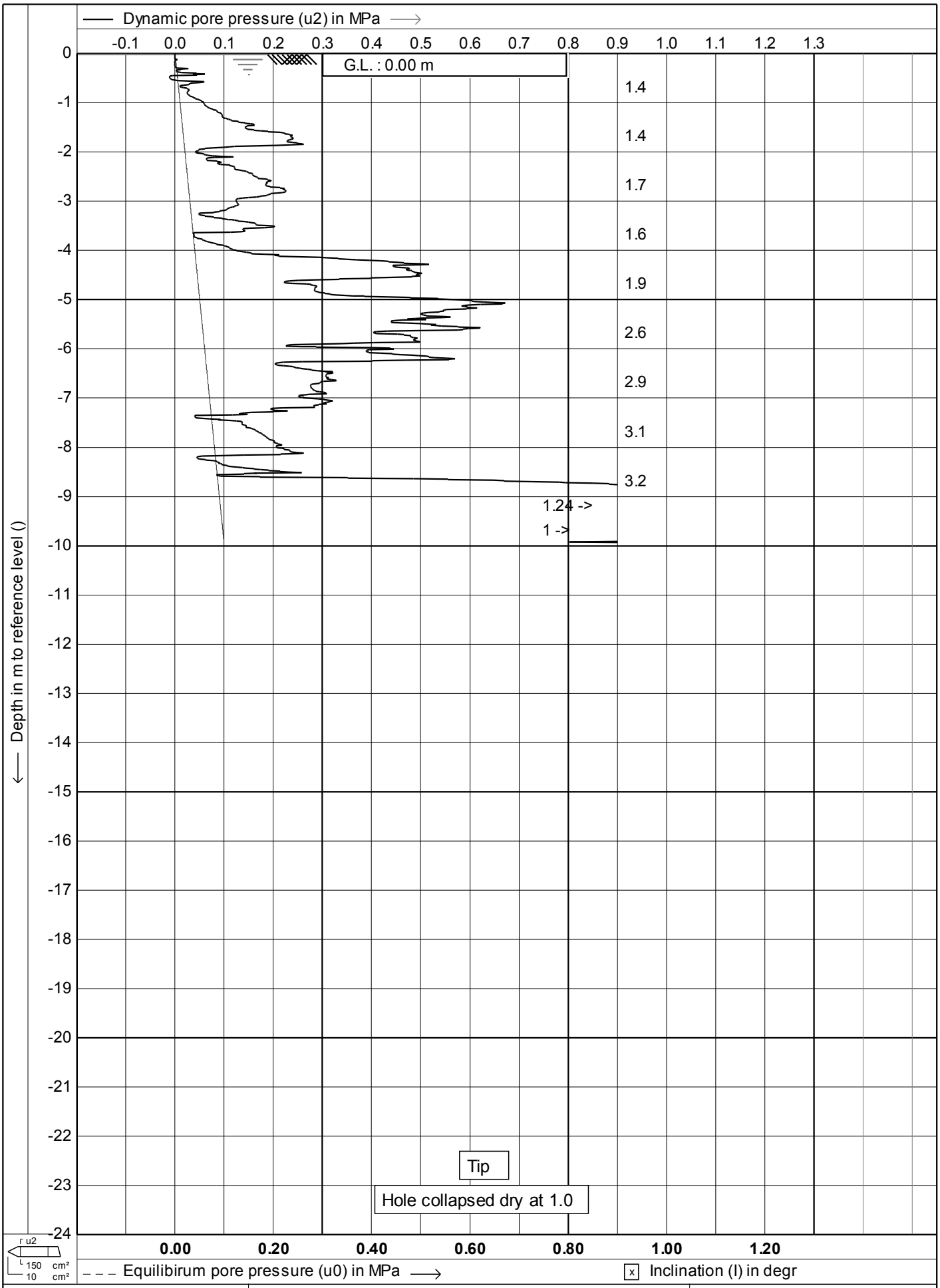
Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **10**

1/14

CPTask V1.33




CPTask V1.33

PERRY GEOTECH

Test according A.S.T.M. Standard D 5778-12

Project : **Site Investigation**

Location: **Bob Carter Place - Welcome bay**

Date : **2-12-2016**

Cone no. : **C10CFIIP.C15213**

Project no. : **02COF4**

CPT no. : **10**

# Appendix C – Fill Testing and Post-Construction Records

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA04*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: ***Hugh Green Contractors Ltd*** | date started: ***29 Jun 2017*** |
| principal: | date completed: ***29 Jun 2017*** |
| project: ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** | logged by: ***SWH*** |
| location: ***Lot 37*** | checked by: ***DBC*** |

position: E: 802,077; N: 376,422 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:
drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear (remoulded ⊕ / peak ⊙) (kPa) 50 100 150 200 | DCP (blows/ 100 mm) 2 4 6 8 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA<br>N | | Not Encountered | | | 0.0 | | OL | **ORGANIC SILT**: non plastic, black. | M | | | | **TOPSOIL FILL** |
| | | | | | | | SW | **SAND**: fine to coarse grained, pale grey. | | L to MD | | | **RECENT FILLING** |
| | | | VS 133/ 48 kPa | | 0.5 | | ML | **SILT**: low plasticity, orange-brown. | | VSt to H | ⊕ ⊙ | | |
| | | | VS 135/ 45 kPa | | 1.0 | | | | | | ⊕ ⊙ | | |
| | | | VS 205/ 60 kPa | | | | | | | | ⊕ ⊙ | | |
| | | | VS 194/ 63 kPa | | 1.5 | | | | | | ⊕ ⊙ | | |
| | | | VS >212 kPa | | | | ML | **SILT**: low plasticity, brown-orange. | | H | ⊙ | | **EXISTING FILLING** |
| | | | | | 2.0 | | | Hand Auger HA04 terminated at 2.0 m<br>Target stratum | | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF BOREHOLE: NON CORED + DCP 12590AC.GPJ <<DrawingFile>> 15/08/2017 13:13

**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud
C casing
N nil

**penetration**
1 2 3 no resistance ranging to refusal

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

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

**consistency / relative density**

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA05*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: ***Hugh Green Contractors Ltd*** | date started: ***29 Jun 2017*** |
| principal: | date completed: ***29 Jun 2017*** |
| project: ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** | logged by: ***SWH*** |
| location: ***Lot 37*** | checked by: ***DBC*** |

position: E: 802,091; N: 376,422 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:
drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear (kPa) remoulded ⊕ peak ⊙ 50 100 150 200 | DCP (blows/ 100 mm) 2 4 6 8 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA<br>N | | Not Encountered | | | 0.0 | | OL | **ORGANIC SILT**: non plastic, black. | M | | | | **TOPSOIL FILL** |
| | | | | | | | SW | **SAND**: fine to coarse grained, pale grey. | | L to MD | | | **RECENT FILLING** |
| | | | VS 165/ 55 kPa | | 1.0 | | SM | **SILTY SAND**: fine to coarse grained, pale grey. | W | L to MD | ⊕ ⊙ | | |
| | | | VS 179/ 60 kPa | | 1.5 | | ML | **SILT**: low plasticity, orange-brown. | M | VSt to H | ⊕ ⊙ | | |
| | | | VS >212 kPa | | | | | | | | ⊙ | | |
| | | | VS >212 kPa | | | | ML | **SILT**: low plasticity, brown-orange. | | H | ⊙ | | **EXISTING FILLING** |
| | | | | | 2.0 | | | Hand Auger HA05 terminated at 2.0 m<br>Target stratum | | | | | |

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**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud
C casing
N nil

**penetration**
1 2 3 no resistance ranging to refusal

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

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA06*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: ***Hugh Green Contractors Ltd*** | date started: ***29 Jun 2017*** |
| principal: | date completed: ***29 Jun 2017*** |
| project: ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** | logged by: ***SWH*** |
| location: ***Lot 36*** | checked by: ***DBC*** |

position: E: 802,078; N: 376,437 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:
drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕ remoulded ⊙ peak (kPa) 50 100 150 200 | DCP (blows/ 100 mm) 2 4 6 8 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | VS 205/ 63 kPa | | 0.0 | | OL | **ORGANIC SILT**: non plastic, black. | M | | | | **TOPSOIL FILL** |
| | | | VS >212 kPa | | 0.5 | | ML | **SILT**: low plasticity, orange-brown. | | H | ⊕ ⊙ | | **RECENT FILLING** |
| | | | VS >212 kPa | | | | ML | **SILT**: low plasticity, brown-grey. | | H | ⊙ | | **EXISTING FILLING** |
| | | | | | 1.0 | | | Hand Auger HA06 terminated at 1.0 m<br>Target stratum | | | | | |
| | | | | | 1.5 | | | | | | | | |
| | | | | | 2.0 | | | | | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF BOREHOLE: NON CORED + DCP 12590AC.GPJ <<DrawingFile>> 15/08/2017 13:13

**method**
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

**support**
M mud
C casing
N nil

**penetration**
1 2 3 no resistance ranging to refusal

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

**samples & field tests**
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
D dry
M moist
W wet
S saturated
Wp plastic limit
Wl liquid limit

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA07*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: | ***Hugh Green Contractors Ltd*** |
| date started: | ***29 Jun 2017*** |
| principal: | |
| date completed: | ***29 Jun 2017*** |
| project: | ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** |
| logged by: | ***SWH*** |
| location: | ***Lot 36*** |
| checked by: | ***DBC*** |

position: E: 802,092; N: 376,440 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:

drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration (1 2 3) | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear (kPa) ⊕ remoulded ⊙ peak (50 100 150 200) | DCP (blows/ 100 mm) (2 4 6 8) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA<br>N | | Not Encountered | VS 133/ 43 kPa<br>VS 150/ 48 kPa<br>VS 161/ 57 kPa | | 0.5 | | OL | **ORGANIC SILT**: non plastic, black. | M | | | | **TOPSOIL FILL** |
| | | | VS 165/ 55 kPa<br>VS 205/ 76 kPa | | 1.0 | | ML | **SILT**: low plasticity, orange-brown. | | VSt<br>VSt to H | | | **RECENT FILLING** |
| | | | VS >212 kPa | | 1.5 | | ML | **SILT**: low plasticity, brown-orange. | | H | | | **EXISTING FILLING** |
| | | | | | 2.0 | | | Hand Auger HA07 terminated at 1.7 m<br>Target stratum | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA08*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: | ***Hugh Green Contractors Ltd*** |
| date started: | ***29 Jun 2017*** |
| principal: | |
| date completed: | ***29 Jun 2017*** |
| project: | ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** |
| logged by: | ***SWH*** |
| location: | ***Lot 37*** |
| checked by: | ***DBC*** |

position: E: 802,080; N: 376,430 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:

drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕ remoulded ⊙ peak (kPa) 50 100 150 200 | DCP (blows/ 100 mm) 2 4 6 8 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | VS >212 kPa | | 0.5 | | ML | **ORGANIC SILT**: non plastic, black. | M | | | | **TOPSOIL FILL** |
| | | | | | | | SW | **SAND**: fine to coarse grained, grey. | | MD | | | **RECENT FILLING** |
| | | | | | 1.0 | | ML | **SILT**: low plasticity, pale brown. | | H | | | **EXISTING FILLING** |
| | | | | | | | | Hand Auger HA08 terminated at 1.0 m<br>Target stratum | | | | | |
| | | | | | 1.5 | | | | | | | | |
| | | | | | 2.0 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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

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# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA09*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: | ***Hugh Green Contractors Ltd*** |
| date started: | ***01 Aug 2017*** |
| principal: | |
| date completed: | ***01 Aug 2017*** |
| project: | ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** |
| logged by: | ***SWH*** |
| location: | ***Lot 37*** |
| checked by: | ***DBC*** |

position: E: 802,076; N: 376,421 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:

drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear ⊕ remoulded ⊙ peak (kPa) 50 100 150 200 | DCP (blows/ 100 mm) 2 4 6 8 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA N | | Not Encountered | | | 0.0 | | SW | **SAND**: fine to coarse grained, grey. | M | L to MD | | | **RECENT FILLING** |
| | | | VS 150/ 48 kPa<br>VS 179/ 60 kPa | | 0.5 | | ML | **SILT**: low plasticity, pale brown. | | VSt | ⊕ ⊙ ⊕ ⊙ | | |
| | | | | | 1.0 | | | Hand Auger HA09 terminated at 1.0 m<br>Target stratum | | | | | |
| | | | | | 1.5 | | | | | | | | |
| | | | | | 2.0 | | | | | | | | |

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**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description** based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**

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

coffey
A TETRA TECH COMPANY

# Engineering Log - Hand Auger

| | |
|---|---|
| Borehole ID. | ***HA10*** |
| sheet: | 1 of 1 |
| project no. | ***GENZTAUC12590AC*** |
| client: ***Hugh Green Contractors Ltd*** | date started: ***01 Aug 2017*** |
| principal: | date completed: ***01 Aug 2017*** |
| project: ***Ballintoy Park, Lots 33 to 37, Welcome Bay, Tauranga*** | logged by: ***SWH*** |
| location: ***Lot 37*** | checked by: ***DBC*** |

position: E: 802,090; N: 376,422 (Datum Not Specified) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.:

drill model: Hand Auger | drilling fluid: | hole diameter : 50 mm | vane id.: 4523-19

**drilling information** | **material substance**

| method & support | penetration 1 2 3 | water | samples & field tests | RL (m) | depth (m) | graphic log | classification symbol | material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components) | moisture condition | consistency / relative density | vane shear (kPa) ⊕ remoulded ⊙ peak (50 100 150 200) | DCP (blows/ 100 mm) (2 4 6 8) | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HA, N | | Not Encountered | | | 0.0 | | SW | **SAND**: fine to coarse grained, grey. | M | L to MD | | | **RECENT FILLING** |
| | | | VS 161/ 57 kPa<br>VS 183/ 60 kPa | | 0.5 | | ML | **SILT**: low plasticity, pale brown. | | VSt | ⊕ ⊙ ⊕ ⊙ | | |
| | | | | | 1.0 | | | Hand Auger HA10 terminated at 1.0 m<br>Target stratum | | | | | |
| | | | | | 1.5 | | | | | | | | |
| | | | | | 2.0 | | | | | | | | |

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF BOREHOLE: NON CORED + DCP 12590AC.GPJ <<DrawingFile>> 15/08/2017 13:13

**method**
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

**support**
- M mud
- C casing
- N nil

**penetration**
1 2 3 — no resistance ranging to refusal

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

**samples & field tests**
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

**classification symbol & soil description**
based on Unified Classification System

**moisture**
- D dry
- M moist
- W wet
- S saturated
- Wp plastic limit
- Wl liquid limit

**consistency / relative density**
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

| Test | Wet Density (t/m3) | Water Content (%) | Dry Density (t/m3) | Optimum Water Content (%) | Maximum Dry Density (t/m3) | Relative Compaction (%) |
|---|---|---|---|---|---|---|
| NDM01 | 1.513 | 26.7 | 1.11 | 30 | 1.31 | 85% |
| NDM02 | 1.501 | 24.3 | 1.14 | 30 | 1.31 | 87% |

# DRY DENSITY / WATER CONTENT RELATIONSHIP
# STANDARD COMPACTION

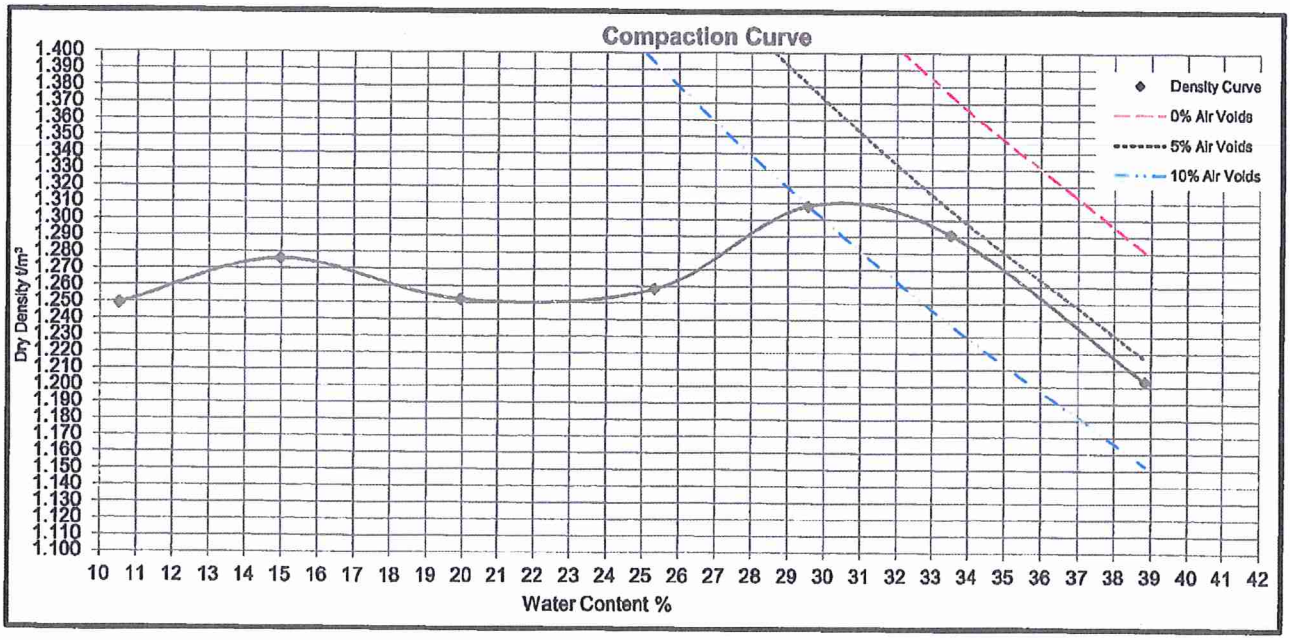
| | |
|---|---|
| Project : | **Pumice Fill Pit SAND (Green Bag)** |
| Location : | **Matamata** |
| Client : | **McPherson Contractors Ltd, P O Box 456, Matamata 3440** |
| Contractor : | **McPherson Contractors Ltd.** |
| Sampled by : | **McPherson s** |
| Date sampled : | **Not Known** |
| Sampling method : | **Not Known** |
| Sample description : | **Pumice Sand** |
| Sample condition : | **Moist** |
| Solid density : | **2.55 t/m3** |
| Source : | **Matamata** |

| | |
|---|---|
| **Project No :** | **21040G1M.616** |
| **Lab Ref No :** | **16//084/3** |
| **Client Ref No :** | **Stephen McPherson** |

**Test Results**

| | | | | |
|---|---|---|---|---|
| Maximum dry density | 1.31 t/m³ | Natural water content | 34.0 % |
| Optimum water content | 30 % | Fraction tested | Passing 19 mm |

| Sample ID | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|
| Bulk density | t/m³ | 1.381 | 1.467 | 1.502 | 1.577 | 1.695 | 1.724 | 1.671 |
| Water content | % | 10.5 | 15.0 | 19.9 | 25.3 | 29.6 | 33.5 | 38.8 |
| Dry density | t/m³ | 1.249 | 1.276 | 1.252 | 1.258 | 1.308 | 1.291 | 1.203 |
| Sample condition | | Hard Dry | Hard Moist | Hard Moist | Hard Moist | Hard Moist | Hard Moist | Firm Saturated |




| Test Methods | | Notes |
|---|---|---|
| Compaction | NZS 4402 : 1986 Test 4.1.1 (Standard) | |

Date tested : 07/06/16
Date reported : 08/06/16



**Approved**

Designation : *Laboratory Manager*
Date : 08/06/16



Opus International Consultants Ltd
Gisborne Laboratory
Quality Management Systems Certified to ISO 9001

59 Awapuni Road
PO Box 49, Gisborne 4040, New Zealand

Telephone +64 6 868 1529
Facsimile +64 6 868 1528
Website www.opus.co.nz

# Appendix D – Retaining Walls Producer Statement (PS) 4

Building Code Clause(s) B1/B2

# PRODUCER STATEMENT – PS4 – CONSTRUCTION REVIEW

(Guidance on use of Producer Statements (formerly page 2) is available at www.ipenz.nz)

**ISSUED BY:** COFFEY GEOTECHNICS (NZ) LIMITED
(Construction Review Firm)

**TO:** HUGH GREEN CONSULTANTS LIMITED
(Owner/Developer)

**TO BE SUPPLIED TO:** TAURANGA CITY COUNCIL
(Building Consent Authority)

**IN RESPECT OF:** FOUR RETAINING WALLS
(Description of Building Work)

**AT:** LOTS 36 AND 37 BALLINTOY PARK SUBDIVISION, BOB CARTER PLACE, WELCOME BAY
(Address)

Town/City: TAURANGA CITY COUNCIL **LOT** 500 **DP** 445408 **SO**
(Address)

We COFFEY GEOTECHNICS (NZ) LIMITED have been engaged by HUGH GREEN CONSULTANTS LIMITED
(Construction Review Firm)

To provide ☐ CM1 ☐ CM2 ☐ CM3 ☐ CM4 ☐ CM5 (Engineering Categories) or ☒ observation as per agreement with owner/developer HUGH GREEN CONSULTANTS LIMITED

or ☐ other .....services
(Extent of Engagement)

in respect of clause(s) B1/B2 of the Building Code for the building work described in documents relating to Building Consent No. 58081 and those relating to Building Consent Amendment(s) Nos. AMENDMENT LETTER REF: 773-GENZTAUC12590AC-AC issued during the course of the works. We have sighted these Building Consents and the conditions of attached to them.

Authorised instructions/variations(s) No. REFER TO REPORT SECTION 7.2 (copies attached) or by the attached Schedule ☐ have been issued during the course of the works.

On the basis of ☒ this review ☐ these review(s) and information supplied by the contractor during the course of the works and **on behalf of the firm** undertaking this Construction Review, **I believe on reasonable grounds** that ☐ All or ☒ Part only of the building works have been completed in accordance with the relevant requirements of the Building Consent and Building Consent Amendments identified above, with respect to Clause(s) B1/B2 of the Building Code. I also believe on reasonable grounds that the persons who have undertaken this construction review have the necessary competency to do so.

I, DAVID SULLIVAN am: ☐ CPEng 1025183 # ☐ Reg Arch ..... #
(Name of Construction Review Professional)

I am a Member of: ☒ IPENZ ☐ NZIA and hold the following qualifications: BSc (Hon)
The Construction Review Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Construction Review Firm is a member of ACENZ: ☐

**SIGNED BY** DAVID SULLIVAN (Signature)
(Name of Construction Review Professional)

**ON BEHALF OF** COFFEY GEOTECHNICS (NZ) LIMITED Date 14/08/2017
(Construction Review Firm)

*Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000*.*

This form is to accompany **Forms 6 or 8 of the Building (Form) Regulations 2004** for the issue of a Code Compliance Certificate.

# Appendix E – Geotechnical Suitability Statement and Summary Table

**CERTIFICATION** **G2**

## STATEMENT OF PROFESSIONAL OPINION AS TO THE GEOTECHNICAL SUITABILITY OF LAND FOR BUILDING

| | |
|---|---|
| NAME OF SUBDIVISION | Ballintoy Park - Stage 5B |
| COUNCIL FILE NUMBER RC No: | RC 24492 |
| ENGINEER RESPONSIBLE FOR DEVELOPMENT: | David Sullivan |
| QUALIFICATIONS: | BSc (Hons), CPEng, TCC Cat-1 |

I David Sullivan (Full Name) of Coffey Geotechnics (NZ) Limited. (Name & Address of Firm)

Hereby confirm that;

1. I am a professional person, appropriately qualified with experience in geotechnical engineering to ascertain the suitability of the land for building development and was retained as the Soils Engineer to the above development.
2. An appropriate level of site investigation and construction supervision has been carried out under my direction and is described in my development evaluation report dated: 14/8/17
3. In my professional opinion, not to be construed as a guarantee, I consider that;

a) ~~Every part /~~ the area shown in my report dated 14/8/17 of each new allotment is suitable for the erection thereon of the building types appropriate to the zoning of the land, provided that: Refer to GCR ref: 773-GEN2TAUC12590AC-AD, Section 8

b) The earth fills shown on the attached Plan No. Fig 04 have been placed in accordance with the requirements of the Infrastructure Development Code.

c) The completed works give due regard to all land slope and foundation stability considerations.

d) The filled ground is suitable for the erection thereon of residential buildings not requiring specific design in terms of NZS 3604: 2011 and related documents provided that: Refer to GCR ref: 773-GEN2TAUC12590AC-AD, Section 8

e) The original ground not affected by filling is suitable for the erection thereon of residential buildings not requiring specific design in terms of NZS 3604: 2011 and related documents provided that: Refer to GCR ref: 773-GEN2TAUC12590AC-AD, Section 8

4. This professional opinion is furnished to the Council and the owner for their purpose alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection for any dwelling.

Signed [signature] Date 14/8/17

| DP No: | 445408 | Property Address | 120 Ballintoy Park Drive, Welcome Bay | RC No: | RC24492 |
|---|---|---|---|---|---|

| Lot No: | Area ($m^2$) | Subsurface data | | | | | | Foundations | | Building Restriction Line | S/W Specific Design | S/W Soakage | S/W Reticulate | Designated Building Platform | Minimum Building Platform | Compressible Soils | On-Site Effluent Disposal | Consent Notice | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Shear Strength (kPa) at 0.5m depth | Subdivision Filling Y/N | Subdivision Filling Depth (m) | Natural Topography Unworked Y/N | Natural Topography Earthworked Y/N | Natural Topography Earthworked Depth (m) | Conventional Shallow Foundation to NZS 3604:2011 Y/N/NA | Specific Design Y/N/NA | | | | | | | | | | |
| 33 | 740 | > 150 | Y | 2.0 | N | Y | - | N | Y | Y | N | N | Y | N | N | Y | N | Y | Development on these lots is subject to a BRL shown on Figure 05. The building developments on these lots will require the over-excavation of topsoil filling (approximately 1.0m to 1.5m), followed by placement and compaction of subfloor filling; or development to be supported on specifically designed piles extending below the topsoil filling. |
| 34 | 624 | > 150 | Y | 1.0 | N | Y | - | N | Y | Y | N | N | Y | N | N | Y | N | Y | |
| 35 | 650 | > 150 | Y | 3.0 | N | Y | - | N | Y | Y | N | N | Y | N | N | Y | N | Y | |
| 36 | 883 | > 150 | Y | 2.0 | N | Y | - | Y | N | Y | N | N | Y | N | N | N | N | Y | The retaining wall recommendations stated in Section 8.3 of the report should be observed during the development of the lots. Development on these lots is subject to a BRL shown on Figure 05. Ground conditions on these lots are adequate for shallow foundations designed in accordance with NZS3604. The topsoil filling should be stripped and subgrade recompacted prior to construction. |
| 37 | 1146 | DCP | Y | 3.5 | N | Y | - | Y | N | Y | N | N | Y | N | N | N | N | Y | |

DCP = Dynamic Cone Penetration Test

# Appendix F – Amendment Report

96 Cameron Road, Tauranga
Tauranga Central
3110 New Zealand

t: +64 7 571 1842
f: +64 571 6085

coffey.com

27 July 2017

Our ref: GENZTAUC12590AC-AC

Hugh Green Contractors Ltd
PO Box 12443
Penrose
Auckland

Dear Morgan,

**RE: Amendment No.1 to Retaining Walls Design Report for Lots 36 and 37, Ballintoy Park Stage 5B**

## 1. Introduction

As requested, Coffey Services (NZ) Ltd (Coffey) has completed a geotechnical assessment of an already-constructed retaining wall on Lot 37 of the Ballintoy Park Subdivision – Stage 5B, Bob Carter Place, Welcome Bay.

This report should be read in conjunction with the design report[1] for the retaining walls, as well as the Geotechnical Completion Report (GCR) for the stage (yet to be issued).

## 2. Site Description and Background

Stage 5B of the Ballintoy Park Subdivision comprises lots 33 to 37 and is situated in Welcome Bay, Tauranga.

As part of the development of the lots, four retaining walls were constructed to provide near-level building platforms for lots 36 and 37. Coffey undertook the design of the retaining walls, with the wall designs, specifications and Producer Statement (PS) 1 provided in a design report[1].

Following the construction of the western-most retaining wall ("Wall 1"), it was decided by the contractor to raise the Lot 37 building platform by approximately 600mm. It was proposed to support this raised level by placing a surcharge slope of 1V:2.5H behind Wall 1 to achieve the required floor level. Two wall designs were provided for Wall 1 in the design report ("Wall 1A and Wall 1B"), due to

[1] *"Retaining Wall Design for Lots 36 and 37 – Ballintoy Park Stage 5B",* Revision 1, ref: GENZTAUC12590AC-AB, dated 11 January 2017

the variability of the toe-slope conditions beneath the wall. However, neither design for Wall 1 allowed for a surcharge slope behind the wall.

During the construction of Wall 1, Coffey observed the construction, tested the ground conditions and took measurements of the wall. These measurements are included in Appendix C and were compared with the updated wall design, as stated in Section 3 below.

## 3. Updated Design for Wall 1

The wall designs for Wall 1A and 1B presented in the design report have been updated to include a surcharge slope of 1V:2.5H behind the wall. The other wall parameters have not been altered from the design report.

The updated designs for Wall 1A and 1B are presented in Appendix A, and a comparison of the updated design wall dimensions with the original design is presented in Appendix B. A comparison of the updated design wall dimensions with the wall measurements of the already-constructed wall is then included in Appendix C.

The results indicate that the measurements of the already-constructed Wall 1 are generally greater than the minimum dimensions required in the updated design. Several dimensions are slightly lower than required by the updated design, however this is generally due to the wall heights in the design being presented in increments of 0.2m to 0.4m. These low results were then recalculated with their specific measured wall heights, with adequate results.

We therefore consider that the alteration to the wall design will not compromise the originally consented design for Wall 1.

It should be noted that the Specific Design Zone defined in the design report is now considered to be superseded for Wall 1, due to the altered ground level behind the wall. The Specific Design Zone will be updated in the GCR.

## 4. Limitations

This report has been prepared solely for the use of our client, Hugh Green Contractors Limited, their professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

This document should always be read in its entirety and in conjunction with the previous reports provided for this project. It is not to be split for further distribution.

Further discussion on the uses and limitations of this report are presented in the attached document entitled “Important Information about your Coffey Report”.

For and on behalf of Coffey

Prepared by:

**Scott Higginson**
Geotechnical Engineer

Reviewed by:

**David Sullivan, BSc, MBA, CE (Calif.), MIPENZ, CPEng**
Principal Geotechnical Engineer
TCC Category I Geotechnical Engineer
CPEng No. 1025183

**Attachments:**

Important Information about your Coffey Report

Appendix A: Updated Wall 1 Designs

Appendix B: Comparison of Original Design with Updated Design

Appendix C: Comparison of Updated Design with Measured Dimensions

# Important information about your **Coffey** Report

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

## Your report is based on project specific criteria

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

## Subsurface conditions can change

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

## Interpretation of factual data

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

## Your report will only give preliminary recommendations

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

## Your report is prepared for specific purposes and persons

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

## Interpretation by other design professionals

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

## Data should not be separated from the report

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

## Geoenvironmental concerns are not at issue

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

## Rely on Coffey for additional assistance

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

## Responsibility

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

# Appendix A – Updated Wall 1 Designs

# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC
**LOCATION:** Wall 1A **DATE:** 26.07.17
Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 1 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 2.0

**MAX RETAINED WALL HT = 2.0 m** **TRAFFIC LOAD = NIL kPa**

## DEFINITIONS

| | | | | | |
|---|---|---|---|---|---|
| H = | Retained wall height (m) | | M* = | Ultimate design bending moment (KNm) M |
| x = | Upright spacing (m) | | F* = | Ultimate lateral wall load (KN) |
| L = | Depth of embedment (m) | | Q = | Traffic load (kPa) |
| Hdia = | Drilled hole diameter (m) | | Ka, Ko = | Active or At rest earth pressure coeff |
| Δtotal = | Upright defln under load (mm) | | ¥s = | Bulk density of backfill (kN/m^3) |
| E = | Young's modulus (GPa) | | ƒb = | Characteristic bending stress (MPa) |
| Cu = | Undrained soil shear strength (kPa) | | Øp = | Strength reduction factor 0.80 |
| k = | Product of perm mod factors | 0.459 | k1 = | Strength load factor 0.60 |
| k4 = | Parallel support factor | 1.00 | k20 = | Peeling / shaving factor 0.90 |
| k5 = | Grid system factor | 1.00 | k21 = | Steaming factor 0.85 |
| k8 = | Stability factor | 1.00 | k22 = | Dry use factor 1.00 |

## SOIL TYPE SELECTIONS (all soil types must occupy 45° wedge behind wall)

| | | | | | |
|---|---|---|---|---|---|
| Type (1) | Loose gravels and scoria | | | | |
| | Ø = | 35 ° | ¥s = | 16.0 | kN/m^3 |
| Type (2) | Dense gravelly sands | | | | |
| | Ø = | 38 ° | ¥s = | 19.0 | kN/m^3 |
| Type (3) | Soft to firm silty clays and clayey silts | | | | |
| | Ø = | 28 ° | ¥s = | 17.0 | kN/m^3 |
| Type (4) | Firm to stiff silty clays and clayey silts | | | | |
| | Ø = | 30 ° | ¥s = | 18.0 | kN/m^3 |

## INPUT DATA

| | | | | | |
|---|---|---|---|---|---|
| Max retained wall height = | 2.0 | m | Soil Type = | 4 | |
| Max design wall height = | 2.2 | m | toe slope = | -10.0 | degrees |
| Wall slope = | 86 | degrees | Ø = | 30.0 | degrees |
| Max traffic load = | | kPa | ∂wall = | 20.0 | degrees |
| Max slope surcharge = | 22 | degrees | ¥s = | 18.0 | kN/m^3 |
| Undrained soil shear strength Cu = | 130 | kPa | Ka = | 0.393 | |
| Soil strength reduction factor Øs = | 0.60 | | Design increment = | 0.2 | m |
| Characteristic bending stress ƒb = | 38 | MPa | E = | 8.7 | GPa |
| minal bending stress (perm) Øpkƒb = | 14.0 | MPa | Øp = | 0.80 | |
| ominal bending stress (med) Øpkƒb = | 18.6 | MPa | | | |

Toe restraint = no (yes or no)

Installed by DRILLING (drilling or driving)

**FULLY DRAINED BACKFILL CONDITIONS ARE ASSUMED IN THIS DESIGN**

coffey geotechnics

Coffey Services
Level 11, 7 City Road
Grafton, Auckland 1010
Ph + 64 9 379 9463

# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC

**LOCATION:** Wall 1A **DATE:** 26.07.17

Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 2 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 2.0

**DESIGN CALCULATIONS**

| H design | H actual | x | Pdia | Hdia B | Perm load stress | Medium load stress | Total stress | L calc | L revised | F* total | M* total | Δ total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2.2** | 2.0 | **1.00** | **.280** | **.600** | 13.33 | | 13.33 | 2.0 | **1.7** | 24.6 | 28.7 | 40 |
| **2.0** | 1.8 | **1.00** | **.275** | **.600** | 10.67 | | 10.67 | 1.8 | **1.6** | 20.2 | 21.8 | 38 |
| **1.8** | 1.6 | **1.00** | **.230** | **.450** | 13.31 | | 13.31 | 1.3 | **1.4** | 16.3 | 15.9 | 39 |
| **1.6** | 1.4 | **1.00** | **.205** | **.450** | 13.57 | | 13.57 | 1.2 | **1.2** | 12.8 | 11.5 | 40 |
| **1.4** | 1.3 | **1.00** | **.180** | **.450** | 13.90 | | 13.90 | 1.0 | **1.1** | 9.7 | 8.0 | 38 |
| **1.2** | 1.1 | **1.00** | **.158** | **.350** | 13.26 | | 13.26 | 0.8 | **0.9** | 7.0 | 5.1 | 38 |
| **1.0** | 0.9 | **1.00** | **.140** | **.350** | 11.64 | | 11.64 | 0.7 | **0.7** | 4.8 | 3.1 | 39 |
| **0.8** | 0.7 | **1.00** | **.120** | **.350** | 10.19 | | 10.19 | 0.6 | **0.7** | 3.0 | 1.7 | 33 |

**CHECK RAIL SUITABILITY**

**TESTS** all ht above ground = 2.0 m

Upright spacing = 1.0 m

C-C rail spacing dh = 150 mm

| Type No. | RAIL TYPE | dia Ø (mm) | b width (mm) | d thickness (mm) | Max Stress (MPa) | Allow Stress (MPa) | Max Defln (mm) | Allow Defln (mm) | OK or NO |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Full Round | 110 | | | 2.03 | 10.40 | 0.4 | 3.3 | √ **OK** √ |
| 2 | 1/2 Round-flat facing | 125 | | | 4.21 | 5.00 | 1.5 | 3.3 | √ **OK** √ |
| 3 | 1/2 Round-curved facing | 150 | | | 3.30 | 5.00 | 0.7 | 3.3 | √ **OK** √ |
| 4 | Rect. rough sawn planks | | 150 | 100 | 1.06 | 5.00 | 0.2 | 3.3 | √ **OK** √ |
| 5 | Rect. rough sawn planks | | 150 | 75 | 1.89 | 5.00 | 0.5 | 3.3 | √ **OK** √ |
| 6 | Rect. rough sawn planks | | 150 | 50 | 4.25 | 5.00 | 1.7 | 3.3 | √ **OK** √ |

Selected rail type = **6**

**WHEN TYPES 4, 5 or 6 RAILS ARE TO BE USED**

| | | | | | |
|---|---|---|---|---|---|
| for upright spacing = | 1.0 m | max retained ht for 150 x 100 rails = | N/A m |
| for upright spacing = | 1.0 m | max retained ht for 150 x 75 rails = | N/A m |
| for upright spacing = | 1.0 m | max retained ht for 150 x 50 rails = | 2.0 m |

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# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC

**LOCATION:** Wall 1A **DATE:** 26.07.17

Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 3 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 2.0

## SUMMARY

**MAX WALL HEIGHT = 2.0 m** **TRAFFIC LOAD = NIL kPa**

**MAX SLOPE SURCHARGE = 22 deg** **MAX TOE SLOPE = -10 deg**

**UPRIGHTS ARE DRILLED NORMAL DENSITY ROUND H5B TIMBER POLES**

**rail type = 6** RAILS ARE **150 BY 50 Rect. rough sawn planks H4**

**CONCRETE SPECIFICATION 20 MPa Grout mix**

| DESIGN HEIGHT (m) | UPRIGHT CONSTRUCTED HEIGHT | SPACING (m) | SMALL END DIA (mm) | HOLE DIA (mm) | DESIGN EMBEDDED LENGTH (m) | ACTUAL EMBEDDED LENGTH | TOTAL SECTION LENGTH (m) |
|---|---|---|---|---|---|---|---|
| 2.2 | **2.0** | **1.00** | **280** | **600** | 1.7 | **1.8** | **3.9** |
| 2.0 | **1.8** | **1.00** | **275** | **600** | 1.6 | **1.7** | **3.6** |
| 1.8 | **1.6** | **1.00** | **230** | **450** | 1.4 | **1.5** | **3.2** |
| 1.6 | **1.4** | **1.00** | **205** | **450** | 1.2 | **1.3** | **2.8** |
| 1.4 | **1.3** | **1.00** | **180** | **450** | 1.1 | **1.2** | **2.5** |
| 1.2 | **1.1** | **1.00** | **158** | **350** | 0.9 | **1.0** | **2.1** |
| 1.0 | **0.9** | **1.00** | **140** | **350** | 0.7 | **0.8** | **1.7** |
| 0.8 | **0.7** | **1.00** | **120** | **350** | 0.7 | **0.7** | **1.5** |

**NOTES**

**(i) ENGINEER MUST INSPECT GROUND AND CONFIRM ASSUMED SOIL PARAMETERS**

**(ii) FULLY DRAINED BACKFILL CONDITIONS ARE ASSUMED IN THIS DESIGN**

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# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC
**LOCATION:** Wall 1B **DATE:** 26.07.17
Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 1 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 3.0

**MAX RETAINED WALL HT = 3.0 m** **TRAFFIC LOAD = NIL kPa**

## DEFINITIONS

| | | | | | |
|---|---|---|---|---|---|
| H = | Retained wall height (m) | | M* = | Ultimate design bending moment (KNm) M |
| x = | Upright spacing (m) | | F* = | Ultimate lateral wall load (KN) |
| L = | Depth of embedment (m) | | Q = | Traffic load (kPa) |
| Hdia = | Drilled hole diameter (m) | | Ka, Ko = | Active or At rest earth pressure coeff |
| Δtotal = | Upright defln under load (mm) | | ¥s = | Bulk density of backfill (kN/m^3) |
| E = | Young's modulus (GPa) | | ƒb = | Characteristic bending stress (MPa) |
| Cu = | Undrained soil shear strength (kPa) | | Øp = | Strength reduction factor 0.80 |
| k = | Product of perm mod factors | 0.459 | k1 = | Strength load factor 0.60 |
| k4 = | Parallel support factor | 1.00 | k20 = | Peeling / shaving factor 0.90 |
| k5 = | Grid system factor | 1.00 | k21 = | Steaming factor 0.85 |
| k8 = | Stability factor | 1.00 | k22 = | Dry use factor 1.00 |

## SOIL TYPE SELECTIONS (all soil types must occupy 45° wedge behind wall)

| | | | | | |
|---|---|---|---|---|---|
| Type (1) | Loose gravels and scoria | | | | |
| | Ø = | 35 ° | ¥s = | 16.0 | kN/m^3 |
| Type (2) | Dense gravelly sands | | | | |
| | Ø = | 38 ° | ¥s = | 19.0 | kN/m^3 |
| Type (3) | Soft to firm silty clays and clayey silts | | | | |
| | Ø = | 28 ° | ¥s = | 17.0 | kN/m^3 |
| Type (4) | Firm to stiff silty clays and clayey silts | | | | |
| | Ø = | 30 ° | ¥s = | 18.0 | kN/m^3 |

## INPUT DATA

| | | | | | |
|---|---|---|---|---|---|
| Max retained wall height = | 3.0 | m | Soil Type = | 4 | |
| Max design wall height = | 3.6 | m | toe slope = | -22.0 | degrees |
| Wall slope = | 86 | degrees | Ø = | 30.0 | degrees |
| Max traffic load = | | kPa | ∂wall = | 20.0 | degrees |
| Max slope surcharge = | 22 | degrees | ¥s = | 18.0 | kN/m^3 |
| Undrained soil shear strength Cu = | 130 | kPa | Ka = | 0.393 | |
| Soil strength reduction factor Øs = | 0.60 | | Design increment = | 0.2 | m |
| Characteristic bending stress ƒb = | 38 | MPa | E = | 8.7 | GPa |
| minal bending stress (perm) Øpkƒb = | 14.0 | MPa | Øp = | 0.80 | |
| ominal bending stress (med) Øpkƒb = | 18.6 | MPa | | | |

Toe restraint = no (yes or no)

Installed by DRILLING (drilling or driving)

**FULLY DRAINED BACKFILL CONDITIONS ARE ASSUMED IN THIS DESIGN**

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# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC

**LOCATION:** Wall 1B **DATE:** 26.07.17

Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 2 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 3.0

**DESIGN CALCULATIONS**

| H design | H actual | x | Pdia | Hdia B | Perm load stress | Medium load stress | Total stress | L calc | L revised | F* total | M* total | Δ total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3.6** | 3.0 | **1.00** | **.445** | **.600** | 13.73 | | 13.73 | 4.2 | **3.1** | 67.8 | 118.8 | 42 |
| **3.4** | 2.8 | **1.00** | **.420** | **.600** | 13.88 | | 13.88 | 3.8 | **2.8** | 60.4 | 101.0 | 43 |
| **3.2** | 2.7 | **1.00** | **.400** | **.600** | 13.50 | | 13.50 | 3.5 | **2.7** | 53.5 | 84.8 | 41 |
| **3.0** | 2.5 | **1.00** | **.375** | **.600** | 13.65 | | 13.65 | 3.2 | **2.5** | 47.0 | 70.7 | 41 |
| **2.8** | 2.3 | **1.00** | **.350** | **.600** | 13.82 | | 13.82 | 2.9 | **2.3** | 40.8 | 58.2 | 41 |
| **2.6** | 2.2 | **1.00** | **.330** | **.600** | 13.36 | | 13.36 | 2.6 | **2.1** | 35.2 | 47.1 | 41 |
| **2.4** | 2.0 | **1.00** | **.310** | **.600** | 12.85 | | 12.85 | 2.3 | **1.8** | 29.9 | 37.6 | 41 |
| **2.2** | 1.8 | **1.00** | **.280** | **.600** | 13.71 | | 13.71 | 2.1 | **1.6** | 25.1 | 29.5 | 43 |
| **2.0** | 1.7 | **1.00** | **.255** | **.600** | 13.93 | | 13.93 | 1.8 | **1.4** | 20.7 | 22.7 | 43 |
| **1.8** | 1.5 | **1.00** | **.230** | **.450** | 13.76 | | 13.76 | 1.4 | **1.2** | 16.7 | 16.4 | 43 |
| **1.6** | 1.4 | **1.00** | **.210** | **.450** | 13.08 | | 13.08 | 1.2 | **1.1** | 13.1 | 11.9 | 42 |
| **1.4** | 1.2 | **1.00** | **.185** | **.350** | 13.08 | | 13.08 | 0.9 | **1.0** | 10.0 | 8.1 | 40 |
| **1.2** | 1.0 | **1.00** | **.160** | **.350** | 13.39 | | 13.39 | 0.8 | **0.8** | 7.3 | 5.4 | 40 |
| **1.0** | 0.8 | **1.00** | **.140** | **.350** | 12.33 | | 12.33 | 0.7 | **0.7** | 5.0 | 3.3 | 41 |
| **0.8** | 0.7 | **1.00** | **.115** | **.350** | 12.44 | | 12.44 | 0.6 | **0.6** | 3.2 | 1.9 | 37 |

**CHECK RAIL SUITABILITY**

**TESTS** all ht above ground = 2.9 m

Upright spacing = 1.0 m

C-C rail spacing dh = 150 mm

| Type No. | RAIL TYPE | dia Ø (mm) | b width (mm) | d thickness (mm) | Max Stress (MPa) | Allow Stress (MPa) | Max Defln (mm) | Allow Defln (mm) | OK or NO |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Full Round | 110 | | | 2.95 | 10.40 | 0.5 | 3.3 | √ **OK** √ |
| 2 | 1/2 Round-flat facing | 125 | | | 6.10 | 5.00 | 2.2 | 3.3 | **X NO X** |
| 3 | 1/2 Round-curved facing | 150 | | | 4.79 | 5.00 | 1.1 | 3.3 | √ **OK** √ |
| 4 | Rect. rough sawn planks | | 150 | 100 | 1.54 | 5.00 | 0.3 | 3.3 | √ **OK** √ |
| 5 | Rect. rough sawn planks | | 150 | 75 | 2.74 | 5.00 | 0.7 | 3.3 | √ **OK** √ |
| 6 | Rect. rough sawn planks | | 150 | 50 | 6.16 | 5.00 | 2.4 | 3.3 | **X NO X** |

Selected rail type = **5**

**WHEN TYPES 4, 5 or 6 RAILS ARE TO BE USED**

| | | | | | |
|---|---|---|---|---|---|
| for upright spacing = | 1.0 m | max retained ht for 150 x 100 rails = | N/A m | | |
| for upright spacing = | 1.0 m | max retained ht for 150 x 75 rails = | 3.0 m | | |
| for upright spacing = | 1.0 m | max retained ht for 150 x 50 rails = | 2.4 m | | |

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# DESIGN OF CANTILEVER POLE RETAINING WALL

**ULTIMATE LIMIT STATE DESIGN** APX

**CLIENT:** Hugh Green Contractors Ltd **JOB NUMBER:** 12590AC
**LOCATION:** Wall 1B **DATE:** 26.07.17
Ballintoy Park Subdivision, Bob Carter Place, Tauranga **SHEET:** 3 of 3

traff NIL **BROMS METHOD FOR COHESIVE SOILS** ht 3.0

## SUMMARY

**MAX WALL HEIGHT = 3.0 m** **TRAFFIC LOAD = NIL kPa**

**MAX SLOPE SURCHARGE = 22 deg** **MAX TOE SLOPE = -22 deg**

**UPRIGHTS ARE DRILLED NORMAL DENSITY ROUND H5B TIMBER POLES**

**rail type = 5** RAILS ARE **150 BY 75 Rect. rough sawn planks H4**

**See above table for wall heights and upright spacings where thinner planks are OK**

**CONCRETE SPECIFICATION 20 MPa Grout mix**

| DESIGN HEIGHT (m) | CONSTRUCTED HEIGHT | UPRIGHT SPACING (m) | SMALL END DIA (mm) | HOLE DIA (mm) | DESIGN EMBEDDED LENGTH (m) | ACTUAL EMBEDDED LENGTH | TOTAL SECTION LENGTH (m) |
|---|---|---|---|---|---|---|---|
| 3.6 | **3.0** | **1.00** | **445** | **600** | 3.1 | **3.6** | **6.6** |
| 3.4 | **2.8** | **1.00** | **420** | **600** | 2.8 | **3.4** | **6.2** |
| 3.2 | **2.7** | **1.00** | **400** | **600** | 2.7 | **3.2** | **5.9** |
| 3.0 | **2.5** | **1.00** | **375** | **600** | 2.5 | **3.0** | **5.5** |
| 2.8 | **2.3** | **1.00** | **350** | **600** | 2.3 | **2.7** | **5.0** |
| 2.6 | **2.2** | **1.00** | **330** | **600** | 2.1 | **2.5** | **4.7** |
| 2.4 | **2.0** | **1.00** | **310** | **600** | 1.8 | **2.2** | **4.2** |
| 2.2 | **1.8** | **1.00** | **280** | **600** | 1.6 | **1.9** | **3.7** |
| 2.0 | **1.7** | **1.00** | **255** | **600** | 1.4 | **1.7** | **3.4** |
| 1.8 | **1.5** | **1.00** | **230** | **450** | 1.2 | **1.5** | **3.0** |
| 1.6 | **1.4** | **1.00** | **210** | **450** | 1.1 | **1.3** | **2.7** |
| 1.4 | **1.2** | **1.00** | **185** | **350** | 1.0 | **1.2** | **2.4** |
| 1.2 | **1.0** | **1.00** | **160** | **350** | 0.8 | **1.0** | **2.0** |
| 1.0 | **0.8** | **1.00** | **140** | **350** | 0.7 | **0.8** | **1.6** |
| 0.8 | **0.7** | **1.00** | **115** | **350** | 0.6 | **0.7** | **1.4** |

**NOTES**

**(i) ENGINEER MUST INSPECT GROUND AND CONFIRM ASSUMED SOIL PARAMETERS**
**(ii) FULLY DRAINED BACKFILL CONDITIONS ARE ASSUMED IN THIS DESIGN**

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# Appendix B – Comparison of Original Design with Updated Design

**Wall 1A: Original and Updated Wall Dimensions**

| Chainage (m) | Out of Ground Wall Height (m) | Minimum Design Embeddment (m) | Minimum Pole SED (mm) | | Minimum Hole Diameter (mm) | | Rail Type | Upright Spacing (m) |
|---|---|---|---|---|---|---|---|---|
| | | | Original Design | Updated Design | Original Design | Updated Design | | |
| 0 to 30 | 2.0 | 1.7 | 225 | 280 | 450 | 600 | 150 x 50 | 1.0 |
| | 1.6 | 1.4 | 200 | 230 | 350 | 450 | | |
| | 1.4 | 1.2 | 175 | 205 | | | | |
| | 1.1 | 0.9 | 150 | 160 | | 350 | | |
| | 0.9 | 0.7 | 125 | 140 | | | | |

**Wall 1B: Original and Updated Wall Dimensions**

| Chainage (m) | Out of Ground Wall Height (m) | Minimum Design Embeddment (m) | Minimum Pole SED (mm) | | Minimum Hole Diameter (mm) | | Rail Type | Upright Spacing (m) |
|---|---|---|---|---|---|---|---|---|
| | | | Original Design | Updated Design | Original Design | Updated Design | | |
| 30 to 54 | 3.0 | 3.6 | 375 | 445 | 600 | 600 | 150 x 50 above 2.4m height<br>150 x 75 below 2.4m height | 1.0 |
| | 2.8 | 3.4 | 350 | 420 | | | | |
| | 2.5 | 3.0 | 325 | 375 | | | | |
| | 2.3 | 2.7 | 300 | 350 | | | | |
| | 2.0 | 2.2 | 250 | 310 | 450 | | 150 x 50 | |
| | 1.7 | 1.7 | 225 | 255 | | | | |
| | 1.5 | 1.5 | 200 | 230 | 350 | 450 | | |
| | 1.4 | 1.3 | 175 | 210 | | | | |
| | 1.0 | 1.0 | 150 | 160 | | 350 | | |
| | 0.8 | 0.8 | 125 | 140 | | | | |

Legend

Original Design Dimension
Updated Design Dimension
Unchanged Design Dimension

# Appendix C – Comparison of Updated Design with Measured Dimensions

**Comparison of Updated Design with Constructed Measurements**

| Wall Number | Post Number | Wall Height (m) | Pole SED (mm) | | Hole Diameter (mm) | |
|---|---|---|---|---|---|---|
| | | | Updated Design | Constructed | Updated Design | Constructed |
| Wall 1A | 1 | 0.25 | 155 | 170 | 350 | 450 |
| | 2 | 0.51 | | 175 | | |
| | 3 | 0.62 | | 170 | | |
| | 4 | 0.68 | | 170 | | |
| | 5 | 0.77 | | 145* | | |
| | 6 | 0.87 | | 170 | | |
| | 7 | 1.00 | 170 | 185 | | |
| | 8 | 1.10 | | 190 | | |
| | 9 | 1.21 | 200 | 215 | 450 | |
| | 10 | 1.31 | | 190* | | |
| | 11 | 1.37 | | 240 | | |
| | 12 | 1.43 | 215 | 240 | | |
| | 13 | 1.51 | | 255 | | |
| | 14 | 1.55 | | 245 | | |
| | 15 | 1.55 | | 240 | | |
| | 16 | 1.51 | | 230 | | |
| | 17 | 1.43 | | 240 | | |
| | 18 | 1.40 | | 240 | | |
| | 19 | 1.39 | 200 | 240 | | |
| | 20 | 1.37 | | 250 | | |
| | 21 | 1.37 | | 220 | | |
| | 22 | 1.31 | | 230 | | |
| | 23 | 1.31 | | 250 | | |
| | 24 | 1.31 | | 290 | | |
| Wall 1B | 25 | 1.40 | 210 | 270 | 450 | 450 |
| | 26 | 1.49 | 220 | 270 | | |
| | 27 | 1.51 | 235 | 270 | | |
| | 28 | 1.57 | | 300 | | |
| | 29 | 1.63 | | 310 | | |
| | 30 | 1.74 | 270 | 380 | 600 | 450* |
| | 31 | 1.81 | | 370 | | 600 |
| | 32 | 1.94 | | 340 | | |
| | 33 | 1.99 | | 400 | | |
| | 34 | 2.12 | 310 | 375 | | |
| | 35 | 2.23 | | 370 | | |
| | 36 | 2.29 | | 375 | | |
| | 37 | 2.36 | 325 | 420 | | |
| | 38 | 2.36 | | 385 | | |
| | 39 | 2.32 | | 355 | | |
| | 40 | 2.29 | 310 | 410 | | |
| | 41 | 2.29 | | 380 | | |
| | 42 | 2.23 | | 350 | | |
| | 43 | 2.00 | 270 | 390 | | |
| | 44 | 1.87 | | 365 | | |
| | 45 | 1.71 | | 325 | | 450* |
| | 46 | 1.64 | 235 | 315 | 450 | 450 |
| | 47 | 1.39 | 210 | 245 | | |
| | 48 | 1.24 | 210 | 255 | | |
| | 49 | 1.23 | | 220 | | |
| | 50 | 1.00 | 170 | 175 | | |
| | 51 | 0.90 | | 160* | 350 | |
| | 52 | 0.65 | 155 | 175 | | |
| | 53 | 0.46 | | 160 | | |

NOTE

* Calculations conducted with the specific wall heights, showing adequate results. We therefore consider these dimensions to be appropriate. Refer to the report section 3