Appendix H – Geotechnical Assessment

20 July 2022

TE RAPA RACECOURSE REDEVELOPMENT
KEN BROWNE DRIVE, HAMILTON

GEOTECHNICAL INVESTIGATION REPORT

Waikato Racing Club

HAM2022-0030AB Rev.1

HAM2022-0030AB		
Date	**Revision**	**Comments**
21 July 2017	0	First issue to client
7 July 2022	1B	Draft for internal review
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20 July 2022	1	Final issue to support land use consent change

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EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation, geohazards assessment, and geotechnical recommendations, to support a land use plan change application to Hamilton City Council for a proposed residential development on the eastern side of Te Rapa Racecourse grounds.

The site is relatively flat with existing ground levels ranging from RL 32.5m to RL 35m. Most of the site is currently grassed. It is underlain by sands and silts of the Hinuera Formation. Soft compressible soils were encountered within the top 1.0m to 1.5m at some locations. Groundwater was encountered at depths of 1.5m to 2.8m below the current ground level (RL 32m to 33.2m).

Geotechnical recommendations for the proposed redevelopment are summarised as follows:

- The geologically recent Hinuera Formation sands and silts are considered susceptible to liquefaction during the ultimate limit state ULS (1 in 500 year) earthquake event.
- To mitigate liquefaction induced settlement TC2 foundations will generally be required. TC2/TC3 hybrid foundations comprising a TC2 raft plus a geogrid reinforced gravel raft will be required at the location of CPT02. The lateral extent of this zone will require further investigation during subdivision design.
- The proposed development is located on flat to gently sloping (<5°) topography where the site was assessed to have a low risk of slope instability. Any temporary cut or fill batter stability should be assessed at resource consent stage.
- For the foundation dimension and working pressure combinations considered, load induced settlement across the site is expected to be relatively uniform and differential settlement expected to be below recommended building code limits, providing the soft soils encountered are undercut and replaced with engineered fill.
- The assessed expansive soils classification for the site with respect to AS2870 has been categorised as ‘A’ (non-expansive), for which no mitigating geotechnical actions are required.
- Soils of Hinuera Formation are expected be encountered at design subgrade level across the site. Cohesive Hinuera soils (silts and clays) are known to be susceptible to strength loss when remoulded, and particularly when they are allowed to get wet. These soils will require careful earthworking.
- Based on the geological units encountered beneath the site, the seismic site subsoil category is assessed as being Class D (deep soil site) in accordance with NZS1170.5.
- Conventional soakage trenches or soakholes are considered a practical solution for the disposal of stormwater within the proposed development area. Detailed assessment of stormwater design volumes, stormwater pond design, soakage trench locations and specific design will be required at the engineering plan approval stage and prior to any building development.

Further work will be required at Resource Consent / Engineering Plan approval stage and during detailed design, which includes further on-site investigation, and associated assessment and supplementary interpretive reporting.

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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Waikato Racing Club to carry out a geotechnical investigation and assessment for a site located at Ken Browne Drive, Hamilton, which is being considered for the construction of residential dwellings.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter / CTR / contract referenced 2016-0109AA, Rev.1 dated 2 May 2017.

This report is to support a land use plan change application to Hamilton City Council and provides the basis for the Statement of Professional Opinion provided in ***Appendix A***.

1.2 Scope of Work

The purpose of this report is to describe the investigation completed, the ground conditions encountered and to provide an assessment of the suitability of the land for development.

2 SITE DESCRIPTION

2.1 Site Location

The site is located at the Te Rapa Racecourse on Ken Browne Drive, Te Rapa, Hamilton, as shown in Figure 1 below.

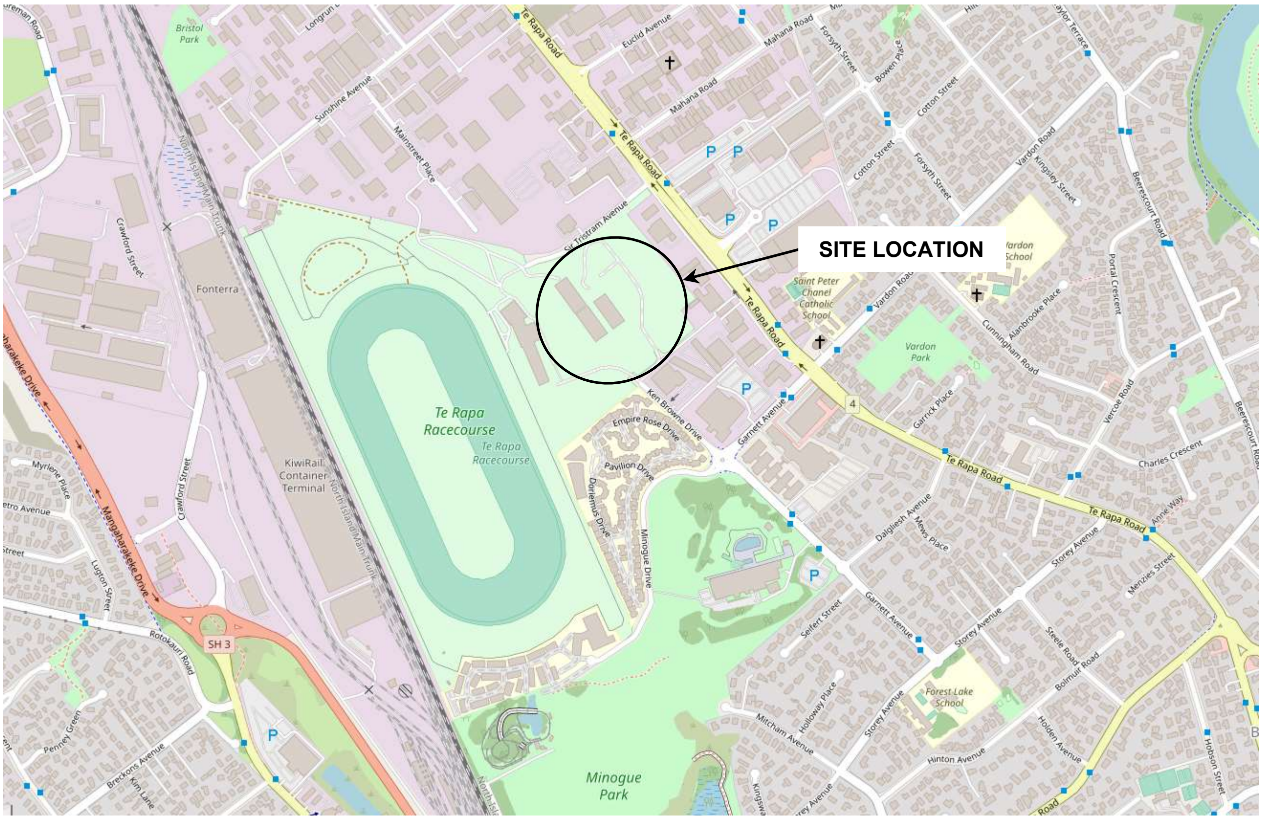

Figure 1: Site Location Plan (OpenStreetMap)

2.2 Landform

The site is relatively flat (RL 32.5m to RL 35m). A horse racing track is located along the western half of the site and to the east of the track is a grandstand and the Te Rapa Waikato Racing Club offices and events centre along with paved car parking. On the eastern portion of the site there are currently three horse stable buildings and large grassed paddocks used for horse grazing.

A soil stockpile, up to approximately 2m, high is located in the northern corner of the site and a bund of stockpiled soil is located adjacent to the racing track in the south-western corner of the site.

The Waikato River is the nearest large watercourse and is located approximately 1.2km to the east of the proposed development area. The site is accessed via Ken Browne Drive and Sir Tristram Ave.

3 PROPOSED DEVELOPMENT

The Chow Hill concept plan (***Appendix B***) provided by Bloxam Burnett and Olliver Ltd (BBO), shows the proposed residential development to be located to the east of the current racetrack and existing stables. We understand that a mix of housing types is being considered, including detached dwellings, two and three storey duplexes, terraced housing, and three storey apartment blocks. The plan also shows associated roads, laneways, and footpaths.

Based on the relatively level gradients across the site and adjacent land areas being of a similar elevation, it is envisaged that only minor cuts and fills will be carried out as part of the development.

Stormwater disposal is proposed via ground soakage plus a stormwater treatment/attenuation pond just to the east of the development area, in the location of the existing stables.

4 INVESTIGATION SCOPE

4.1 Field Investigation

Geotechnical field investigations were carried out from 23 May to 30 May 2017 under the direction of CMW. The scope of fieldwork completed was as follows:

- A walkover survey of the site by a CMW Engineering Geologist to assess the general landform and site conditions.
- Eight (8) hand auger boreholes, denoted HA01 to HA08, were drilled using 50mm diameter augers to depths of up to 2.2 metres below existing ground level (mbgl) to allow observation and sampling of the shallow soil profile. In-situ shear vane strength (VSS) measurements were recorded using a hand-held shear vane during the advancement of the hand auger boreholes. Additionally, dynamic cone (Scala) penetrometer (DCP) tests were carried out where coarse-grained soils were present.
- Two (2) falling head permeability tests at hand auger locations HA03 and HA05, were carried out to provide an indication of soil permeability for stormwater retention/drainage. Two additional falling head permeability tests were intended at hand auger locations HA07 and HA08, however due to the high groundwater table these were not able to be undertaken.
- Four (4) Cone Penetrometer Tests (CPT), denoted CPT01 to CPT04, were advanced to depths of up to 20 metres to provide an understanding of the deeper ground profile and for static settlement and liquefaction assessment purposes.

5 GROUND MODEL

5.1 Geological Setting

The geological map[1] of the area indicates that the site is underlain by fluvially reworked soil deposits of the Hinuera Formation. The Hinuera Formation (late Pleistocene age) infills the majority of the Waikato Basin and deposits generally comprise interbedded sands, silts and clays with interspersed peats.

The relict Te Rapa Channel[2] extends through the eastern part of the site which is a paleo river channel when the Waikato River was a braided system.

5.2 Soil Stratigraphy

A ground model was developed for the site based on the published geology and the results of hand augers and CPT results. Generally, the hand augers and CPTs indicate geological conditions consistent with the published geology described above.

In summary, the Hinuera Formation materials at the site consist of the following:

- The upper 0.8m consists of firm to very stiff silt and sandy silt with peak vane shear strengths of between 56kPa to 152kPa.
- Underlying the surface silt, primarily medium dense to dense sand/silty sand with interbeds of stiff to very stiff silt/sandy silt to depths of around 7.0 to 13.0mbgl were encountered at all hand auger and CPT locations. DCP results in the sand layers typically ranged from 2 to >10 blows/ per 100mm penetration. CPT qc values typically ranged from 4MPa to 10MPa in the sand layers and 0.5MPa to 1MPa in the silt lenses.
- Firm to very stiff clay and silty clay deposits were inferred from the CPT traces from depths of 16 to 20mbgl.

Weak organic material was encountered within the upper 1.0m to 1.5m of CPT02 and CPT04, which may be attributed to the backfilling of the potential Te Rapa Channel running through the site.

The approximate extent of the fill stockpiles described in Section 2 are inferred from surface contours only, is shown in ***Figure 1*** of the attached drawings. In HA05 silty sand fill and buried topsoil was encountered down to 1m depth adjacent to the northern stockpile. Geological cross-sections are provided in ***Figure 2*** of the attached drawings.

5.3 Groundwater

During the investigation, which was completed in late autumn conditions May 2017, groundwater was encountered at the test locations at depths of 1.5m to 2.8m below the current ground level (RL 32m to 33.2m). In the weeks and months prior to the site investigation there were several significant rainfall events which are likely to have contributed to an elevated groundwater table. It is expected that there would be groundwater level variations between seasons and relatively high levels following significant rainfall events.

5.4 Permeability Testing

Two falling head percolation tests were undertaken to assess the permeability of the near surface soils underlying the eastern part of site. Testing was undertaken within 100mm diameter hand auger boreholes, drilled to depths of between 1.5m to 2.2m and pre-soaked (filled with water) and allowed to drain over

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[1] Edbrooke, S.W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250000 geological map 3. I sheet + 74 p. Lower Hutt. New Zealand. Institute of Geological & Nuclear Sciences Limited

[2] McCraw, J. 2011: The Wandering River, Landforms and geological history of the Hamilton Basin. Geoscience Society of New Zealand.

approximately 2.5 hours prior to testing. Permeability was calculated based on guidelines presented in CIRIA 113. Reported results are presented in ***Appendix D***.

Based on the falling head test results, seepage rates of between 1 x 10^{-5} m/sec to 5 x 10^{-6} m/sec were observed within the Hinuera sands and silty sands. Lower permeability values have been attributed to silt migration from the upper portion of the boreholes causing “caking” of the sides and base during testing. Seepage rates could be found to be an order of magnitude higher if more targeted testing is undertaken.

The falling head tests that were proposed to be undertaken within the centre of the racing track were abandoned due to the high groundwater level.

6 GEOHAZARDS ASSESSMENT

6.1 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[3] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.1 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (refer Section 6.1 for importance level)

f = site response factor subject to subsoil class (refer Section 7.1 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[4] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 1: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	Magnitude$_{eff}$
SLS	1/25	0.25	0.06	5.9
ULS	1/500	1.0	0.26	5.9

Note: SLS = serviceability limit state; ULS = ultimate limit state

6.2 Liquefaction

6.2.1 Assessment Methodology

Liquefaction occurs in loose saturated cohesionless soils that are subject to cyclic shear loading during an earthquake. This process leads to pore pressure build-up, soil grains moving into suspension and temporary loss of strength causing vertical and lateral ground deformation.

In accordance with MBIE/NZGS guidance[5] the liquefaction susceptibility of the soils at this site was assessed with respect to geological age and compositional (soil fabric and density) criteria, based on the following assumptions:

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[3] NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2021)

[4] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)

[5] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards”, (November 2021)

- Only saturated soils below an assessed seasonal average groundwater level of (1.5m to 2.8m depth) were modelled as being susceptible to liquefaction.
- In accordance with MBIE/NZGS guidance[1] and in the absence of site-specific shear wave velocity measurements, no aging / strength gain factor has been applied to the Pleistocene aged sands.
- Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. For this project, a cut-off threshold soil behaviour type index value (Ic) of 2.6 was used to distinguish between liquefiable (Ic>2.6) and non-liquefiable (Ic<2.6) soils.
- Specific liquefaction analyses were undertaken for an IL2 structure, using the software package CLiq and the Boulanger and Idriss (2014) method. The cyclic stress ratio (CSR), being a function of the earthquake magnitude for the design return period event, was compared to the cyclic resistance ratio (CRR), being a function of the CPT cone resistance (qc) and friction ratio (Fr).
- Free-field liquefaction induced settlements were determined in accordance with Zhang et al. (2002). With respect to liquefaction response, consideration was given to a 10m cut-off depth to estimate index settlements as per MBIE[6] guidance (foundation technical categories). These were compared to liquefaction settlement estimates over the full depth range of the CPT's with a depth weighting factor (e_v) applied ranging from 1 at the ground surface to 0 at 20m depth.

6.2.2 Results

Results are presented in ***Appendix E*** and can be summarised as in ***Table 2***:

Table 2: Liquefaction Analyses Results

CPT No.	SLS Settlement (mm)	Total ULS Settlement (mm)	Index ULS Settlement (mm)	Depth to Liquefied Layer (m)
CPT01	nil	50	55	3
CPT02	nil	85	105	3
CPT03	nil	50	65	2.5
CPT04	nil	70	70	4

Note: All settlements and depths based on existing ground profile.

Index settlements are for assessment of the site against the MBIE site Technical Category guidelines and are not comparable to the total ULS settlements.

Recommendations to mitigate effects of liquefaction settlements on the proposed development are provided below in Section 7.2.

6.3 Slope Stability

The proposed development is located on flat to gently sloping (<5°) topography and therefore on this basis the site was assessed qualitatively to have an overall low risk of slope instability for the proposed development. No quantitative stability analysis was completed for the site. Depending on the final design for the development this may need to be undertaken at building consent stage for any localised cut or fill batters.

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[6] Repairing and Rebuilding House affected by the Canterbury Easrthquakes", (December 2012)

6.4 Load Induced Settlement

6.4.1 General

Future building loads will induce settlements within the underlying subsoils.

Soil modulus parameters for load induced settlement analyses were derived from the CPT data.

The magnitude of the settlement will depend on:

- The stiffness of the soils within the zone of influence of the building foundations.
- The net additional loading applied to the ground taking account of the weight of soil that has been removed due to previous earthworks for the development, and for the proposed development.
- The type of soils (cohesive or granular). The local soils are predominantly sandy. Static settlements are therefore expected to be predominantly elastic (immediate) and are expected to be largely built out during construction with negligible long-term creep settlements predicted.

6.4.2 Settlement Predictions

Primary and secondary (creep) settlements were estimated based on the CPT data using the methodology outlined below. Calculations were undertaken using the commercially available software CPet-IT.

Primary Settlement

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

Where $\Delta\sigma_v$ = change in total vertical stress, Δz = layer thickness, M_{CPT} = constrained modulus estimated from the CPT data as follows:

$$M = \alpha_M (q_t - \sigma_{vo})$$

Where: α_M = factor, derived according to Robertson (2009)[7]; qt = cone resistance; σ_{vo} = total vertical stress

Secondary Creep Settlement

$$S = C_\alpha . \Delta z . \log\left(\frac{t}{t_p}\right)$$

Where: Cα = coefficient of secondary consolidation ≈ 0.1 (σ'_v/M), Δz = sublayer thickness, tp = duration of primary consolidation, t = time over which creep settlement is calculated.

Estimated static settlements, based on an assumed 10m x 20m raft foundation, founded at 0.5m below ground level, for selected bearing pressures and either a flexible or rigid raft, are presented in ***Table 3***.

Table 3: Estimated Static Settlements Beneath Centre of Raft Foundation

Footing Width (m)	Footing Length (m)	Footing Depth (m)	Net Applied Working Pressure (kPa)	Raft Settlement (mm)	
				Flexible	Rigid
10	20	0.5	10	<5 – 10	<5 - 10
10	20	0.5	20	10 – 15	5 – 15
10	20	0.5	30	10 – 25	10 – 20
Note: Settlements assume any soft soils in the top 1.5m are undercut and backfilled with engineered fill.					

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[7] Robertson, P.K., 2009a. Interpretation of cone penetration tests – a unified approach. Canadian Geotechnical Journal, 46:1337-1355.

New Zealand Building Code, Clause B.1.0.2 of B1/VM4 provides the following differential settlement criteria for design of shallow foundations:

> '*Foundation design should limit the probable maximum differential settlement over a horizontal distance of 6m to no more than 25mm under serviceability limit state load combinations of AS/NZS 1170 Part 0, unless the structure is specifically designed to prevent damage under a greater settlement.'*

For the foundation size and working pressure combinations considered in ***Table***:

- Settlement across the site is expected to be relatively uniform and differential settlement is expected to be below the limit set by the New Zealand building code.
- Total settlement should be within acceptable limits for the foundation cases presented in ***Table***, providing any soft soils, such as those encountered in the top 1.0m to 1.5m of CPT02 and CPT04, are undercut and replaced with engineered fill.

6.5 Expansive soils

Seasonal shrinking and swelling results in vertical surface ground movement, which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011[8] excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870[9] for foundation design advice. However, the November 2019 update of Acceptable Solution B1/AS1[10] provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence[11] indicating that the use of the B1/AS1 method of assessment of expansiveness may be inaccurate. Accordingly, our assessments herein have been made in line with our experience, BRANZ Report SR120A[12] and AS2870.

Given the implications of the information presented above, the assessed soil classification for the site with respect to AS2870 has been categorised as 'A' (non-expansive), for which no mitigating geotechnical actions are required.

6.6 Sensitive soils

Soils of Hinuera Formation are expected be encountered at design subgrade level across the site. Cohesive Hinuera soils (silts and clays) are known to be susceptible to strength loss when remoulded, and particularly when they are allowed to get wet. This can make them particularly challenging to earthwork and requires specific consideration to plant, vehicle movements, and surface protection where exposed. Further recommendations are provided in ***Section 8*** below.

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[8] Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard

[9] Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW

[10] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/AS1, Amendment 19

[11] Rogers, N., McDougall, N., Twose, G., Teal, J. & Smith, T. (2020) The Shrink Swell Test: A Critical Analysis, *NZ Geomechanics News,* Issue 99, pages 66-80.

[12] Fraser Thomas Limited (2008) - Addendum Study Report (BRANZ SR120A), Soil Expansivity in the Auckland Region – Final Report

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

Based on the geological units encountered beneath the site, the seismic site subsoil category is assessed as being Class D (deep soil site) in accordance with NZS1170.5.

7.2 Liquefaction Mitigation

To mitigate liquefaction induced settlement TC2 type raft foundations will be required across most of the site based on three of four CPT tests.

At the location of (CPT02), approximately halfway along the southeast boundary, TC2/TC3 hybrid foundations comprising a TC2 raft plus an underlying geogrid reinforced gravel raft will be required. The extent of this zone will require further CPT investigation to be carried out as part of the projects detailed design.

It is also recommended that that a number of seismic CPT's be carried out as part of the detailed design process to evaluate if any soil ageing factors can be applied, which may eliminate the requirement for any TC2 / TC3 hybrid foundations.

7.3 Earthworks

Based on the relatively gentle relief across the site it is expected that minor bulk cut and fill depths up to nominally 1m will be required during site development. It is anticipated that there will be cuts from the elevated areas and filling of the low-lying areas.

All earthworks should be carried out in accordance with the requirements of NZS4404:2010 (Land Development and Subdivision Infrastructure) and NZS4431:1989 (Code of Practice for Earth Fill for Residential Development), Hamilton City Council Development Manual and under the guidance of a Chartered Professional Geotechnical Engineer.

From initial investigation results the near surface materials likely to be earthworked consist of loose to medium dense sand, silty sand and firm to very stiff sandy silt. These materials may be used for cut to fill earthworks across the site with appropriate moisture conditioning.

In HA05 silty sand fill and buried topsoil was encountered to 1m depth. It is not recommended to use the material around this area for fill due to the organics located within the topsoil. This test was undertaken next to the soil stockpile in the north of the site. Further investigation on the suitability of the stockpiled material located at the north and south of the site will need to be undertaken however it may be used as landscape fill in reserve areas or removed from site. Other areas of non-engineered fill due to the sites previous history may be present on site and were not identified during this investigation.

7.4 Stormwater Disposal

Stormwater from the proposed development is shown to discharge into a stormwater attenuation and treatment pond in on the just to the east of the development area in the location of the existing stables (refer to concept plan in ***Appendix B***).

Conventional soakage trenches or soakholes are considered a practical solution for the disposal of stormwater, where located within the proposed building development areas due to the sands encountered. Groundwater was encountered between 1.5m to 2.8m below the current ground level throughout the building development area. A coefficient of permeability (k) of 1×10^{-5} m/sec to 5×10^{-6}m/sec should be used for modelling unless further site-specific testing is undertaken.

Detailed assessment of stormwater design volumes, stormwater pond design, soakage trench locations and specific design will be required at the engineering plan approval stage and prior to any building development.

7.5 Foundation Bearing Capacity

Liquefaction and static load induced settlement analyses results suggest that raft foundations should be appropriate to support the proposed 1-storey to 3-storey high buildings.

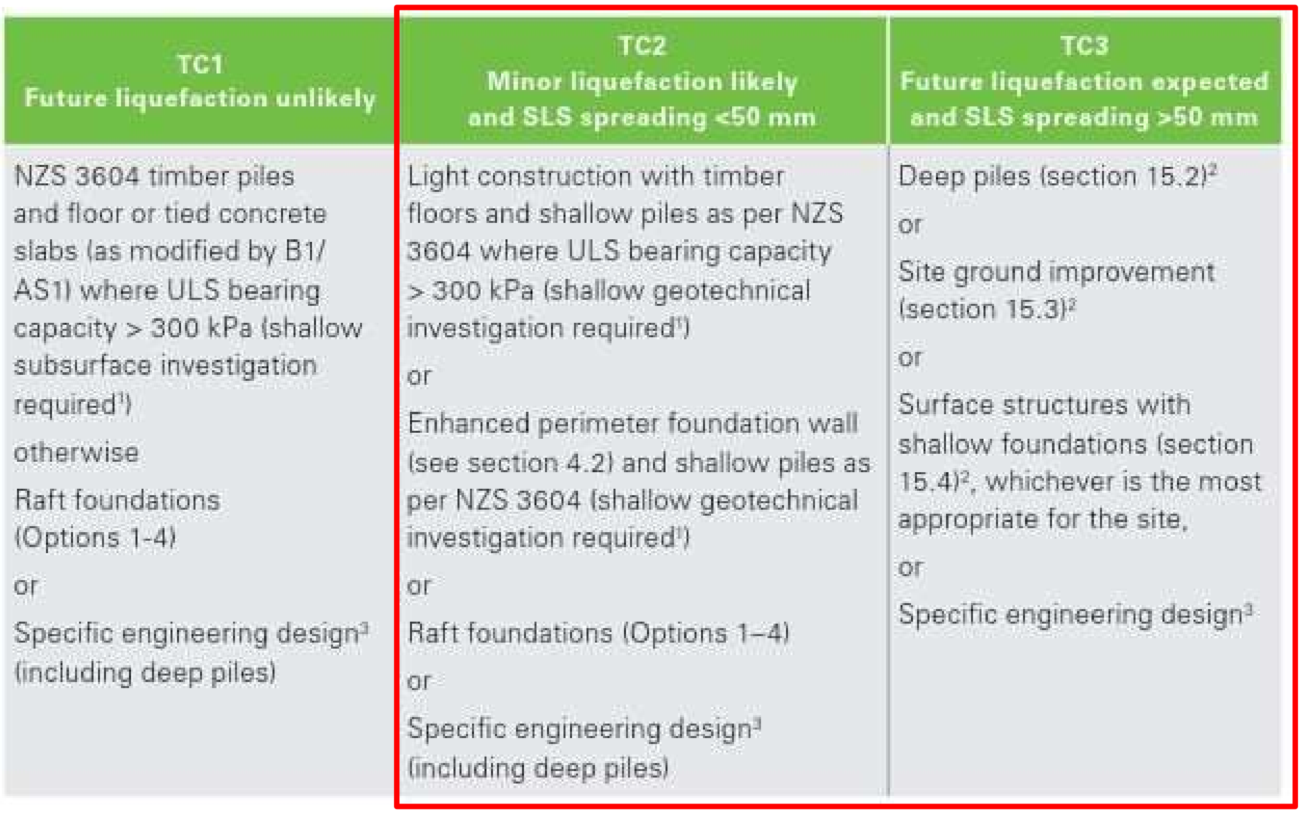
The subgrade at design foundation level is expected to predominantly comprise Hinuera formation silts, silty sands, and sands. Weak silty / organic soils were encountered in the upper 1.0m to 1.5m of CPT02 and CPT04. These soils should be undercut and replaced with engineered fill to provide adequate bearing capacity avoid excessive load induced settlements. The undercut material should be removed from site or used as landscape fill onsite. The extent of the soft soils should be confirmed by further investigation.

Subject to the silt material being managed appropriately during construction, as discussed in Section 7.3, a geotechnical ultimate bearing capacity of 300kPa may be assumed for the raft foundation beams, provided perimeter and internal beams do not exceed 500mm in the short axis.

Liquefaction settlements of 55mm to 105mm could be expected under the ULS seismic event for the site. Differential settlements should be taken across the width of the relevant structure. Limited surface expression is anticipated due to a non-liquefied crust thickness of at least 2.5m.

With respect to the Ministry of Business, Innovation and Employment (MBIE) guidance, raft foundations should be designed based on a TC2 solution adopting the total and differential settlements stated above, as defined in Figure 3 below. For areas of the site where liquefaction induced settlement is predicted to be greater than 100mm, TC2/TC3 hybrid foundations will be required, as discussed in Section 7.2.

The results of our investigation suggest there is the potential for isolated pockets of weak soil to exist that will require local over-excavation and compaction to densify the in-situ materials. This should be verified during routine foundation observations.



TC1 Future liquefaction unlikely	TC2 Minor liquefaction likely and SLS spreading <50 mm	TC3 Future liquefaction expected and SLS spreading >50 mm
NZS 3604 timber piles and floor or tied concrete slabs (as modified by B1/AS1) where ULS bearing capacity > 300 kPa (shallow subsurface investigation required[1]) otherwise Raft foundations (Options 1-4) or Specific engineering design[3] (including deep piles)	Light construction with timber floors and shallow piles as per NZS 3604 where ULS bearing capacity > 300 kPa (shallow geotechnical investigation required[1]) or Enhanced perimeter foundation wall (see section 4.2) and shallow piles as per NZS 3604 (shallow geotechnical investigation required[1]) or Raft foundations (Options 1–4) or Specific engineering design[3] (including deep piles)	Deep piles (section 15.2)[2] or Site ground improvement (section 15.3)[2] or Surface structures with shallow foundations (section 15.4)[2], whichever is the most appropriate for the site, or Specific engineering design[3]

Figure 3: Canterbury Rebuild Guidance Part A, Table 5.1: Summary of proposed foundation solutions for rebuilt foundations or new foundations on the flat

7.6 Strength Reduction Factors

As required by section B1/VM4[13] of the New Zealand Building Code Handbook, the following strength reduction factors must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases:

- 0.8 for load combinations involving earthquake overstrength.
- 0.5 for all other load combinations.

8 SAFETY IN DESIGN

The design landform has not been finalised but is expected to require site excavations that may include geotechnical works such as undercuts, temporary excavations, subsoil drains. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

Our SiD risk assessment is presented in ***Appendix F***. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

9 FURTHER WORK

As design proposals are still at concept design stage, we should be given the opportunity to undertake further site investigation prior to earthworks and engineering plan approval stages. Only a preliminary geotechnical site investigation and assessment has been undertaken to support the land use plan change.

Further work will be required at the Resource Consent / Engineering Plan approval stage and during Detailed design, this includes and is not limited to the following:

- Additional hand auger boreholes or test pits, to assess the extent of non-engineered fill and weak/organic soils and allow installation of standpipe piezometers to measure groundwater level variability over the summer and winter season.
- At detailed design stage additional CPTs should be undertaken to assist in defining the extent where hybrid TC2/3 foundations are required based on predicted liquefaction induced settlement.
- Further liquefaction assessment based on seismic CPTs to evaluate potential for beneficial ageing effects to be included in the analyses.
- Further investigation and nested piezometer installation within proposed stormwater pond footprint to evaluate perched groundwater table and effect on pond design.
- Review detailed design proposals and if necessary, update settlement and bearing capacity assessments.
- Update to geotechnical recommendations for the development based on findings of the above.

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[13] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19

10 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Waikato Racing Club in relation to the Te Rapa Racecourse Redevelopment, Ken Browne Drive, Hamilton project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Waikato Racing Club seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project’s requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site-specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. 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. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Drawings

LEGEND:

⊕ HA01	HAND AUGER (HA) LOCATION
⊙ CPT01	CONE PENETROMETER TEST (CPT) LOCATION
Ⓢ	FALLING HEAD PERMEABILITY (SOAKAGE) TEST LOCATION
▨	POTENTIAL NON-ENGINEERED FILL LOCATIONS

NOTES:

1. IMAGE FROM NEARMAP 21.12.16
2. CONTOUR PLAN SUPPLIED BY BLOXAM BURNETT & OLLIVER

0 25 50 75 100 125 m

1:2500

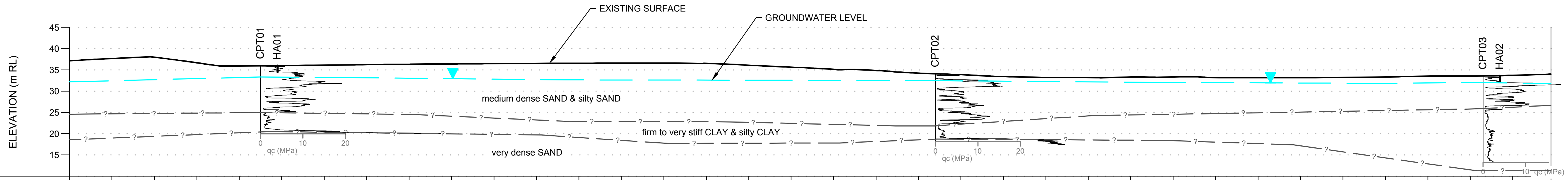
CMW Geosciences

CLIENT:
TE RAPA WAIKATO RACING CLUB

PROJECT:
TE RAPA RACECOURSE REDEVELOPMENT
HAMILTON, NZ

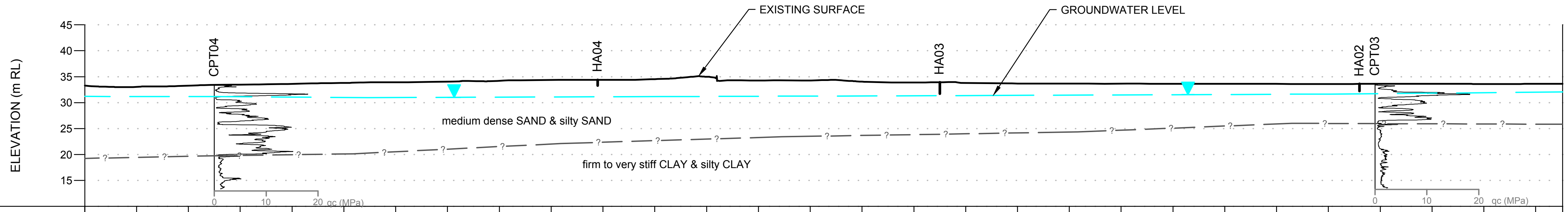
TITLE:
SITE INVESTIGATION PLAN

DRAWN:	DE	PROJECT:	HAM2016-0109
CHECKED:	JC	FIGURE:	01
REVISION:	0	SCALE:	1:2500
DATE:	14.06.17	SHEET:	A3 L



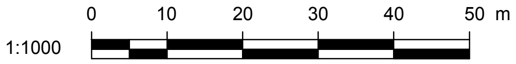
EXISTING GROUND (m RL)	37.67	37.99	36.67	35.93	35.99	36.12	36.24	36.32	36.40	36.47	36.54	36.56	36.59	36.60	36.53	36.10	35.65	35.15	34.84	34.23	33.89	33.43	33.20	33.19	33.32	33.34	33.17	33.18	33.17	33.24	33.34	33.53	33.55	33.73	34.02
CHAINAGE (m)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	349

SECTION A
SCALE: H 1:2500,V 1:2500.



EXISTING GROUND (m RL)	33.05	33.27	33.46	33.62	33.78	33.94	34.06	34.22	34.38	34.40	34.52	34.99	34.28	34.25	34.04	33.90	33.79	33.69	33.65	33.65	33.63	33.63	33.62	33.59	33.63	33.62	33.59	33.62	33.63
CHAINAGE (m)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	285

SECTION B
SCALE: H 1:2500,V 1:2500.



CMW Geosciences

CLIENT: **TE RAPA WAIKATO RACING CLUB**

PROJECT: **TE RAPA RACECOURSE REDEVELOPMENT HAMILTON, NZ**

TITLE: **SECTIONS**

DRAWN: DE
CHECKED: JC
REVISION: 0
DATE: 14.06.17

PROJECT: HAM2016-0109
FIGURE: 02
SCALE: 1:1000
SHEET: A3 L

Appendix A: Statement of Professional Opinion

STATEMENT OF PROFESSIONAL OPINION AS TO THE GEOTECHNICAL SUITABILITY OF LAND FOR DEVELOPMENT

ISSUED BY: CMW Geosciences (NZ) Limited
(Construction Review Firm)

TO: Waikato Racing Club
(Owner / Developer)

TO BE SUPPLIED TO: Hamilton City Council
(Local Authority)

IN RESPECT OF: Proposed Te Rapa Racecourse Redevelopment
(Description of Relevant Development)

AT: Te Rapa Racecourse, Hamilton
(Location)

COUNCIL FILE NUMBER BC/RC No: To Be Confirmed

I Dave Morton,	Principal Geotechnical Engineer (CMEngNZ, CPEng)	of	CMW Geosciences (NZ) Limited, 116 Cameron Road, Tauranga 3110
(Full Name)	(Qualifications)		(Name & Address of Firm)

Hereby confirm that;

1. I am a professional person appropriately qualified in geomechanics to ascertain the suitability of the land for building development and was retained as the geotechnical consultant for the above development.

2. An appropriate level of site investigation has been carried out under my direction & is described in the report titled, "*Geotechnical Investigation Report – Te Rapa Racecourse Redevelopment, Ken Browne Drive, Te Rapa, reference HAM2022-0030AB Rev.1, dated 20 July 2022*".

3. I am aware of the details of the proposed plan of development & of the general nature of the proposed engineering works as shown on the following drawings:

- Figure 01, Site Investigation Plan, HAM2016-0109, dated 14/06/2017;
- ChowHill Concept Design, ref:16704, sheet L80.09, Rev.2, dated 18/07/2022.

4. In my professional opinion, not to be construed as a guarantee, I consider that the proposed works give due regard to land slope & foundation stability considerations & that the land is suitable for the proposed development providing that;

a) *the recommendations of the above referenced report are adhered to.*

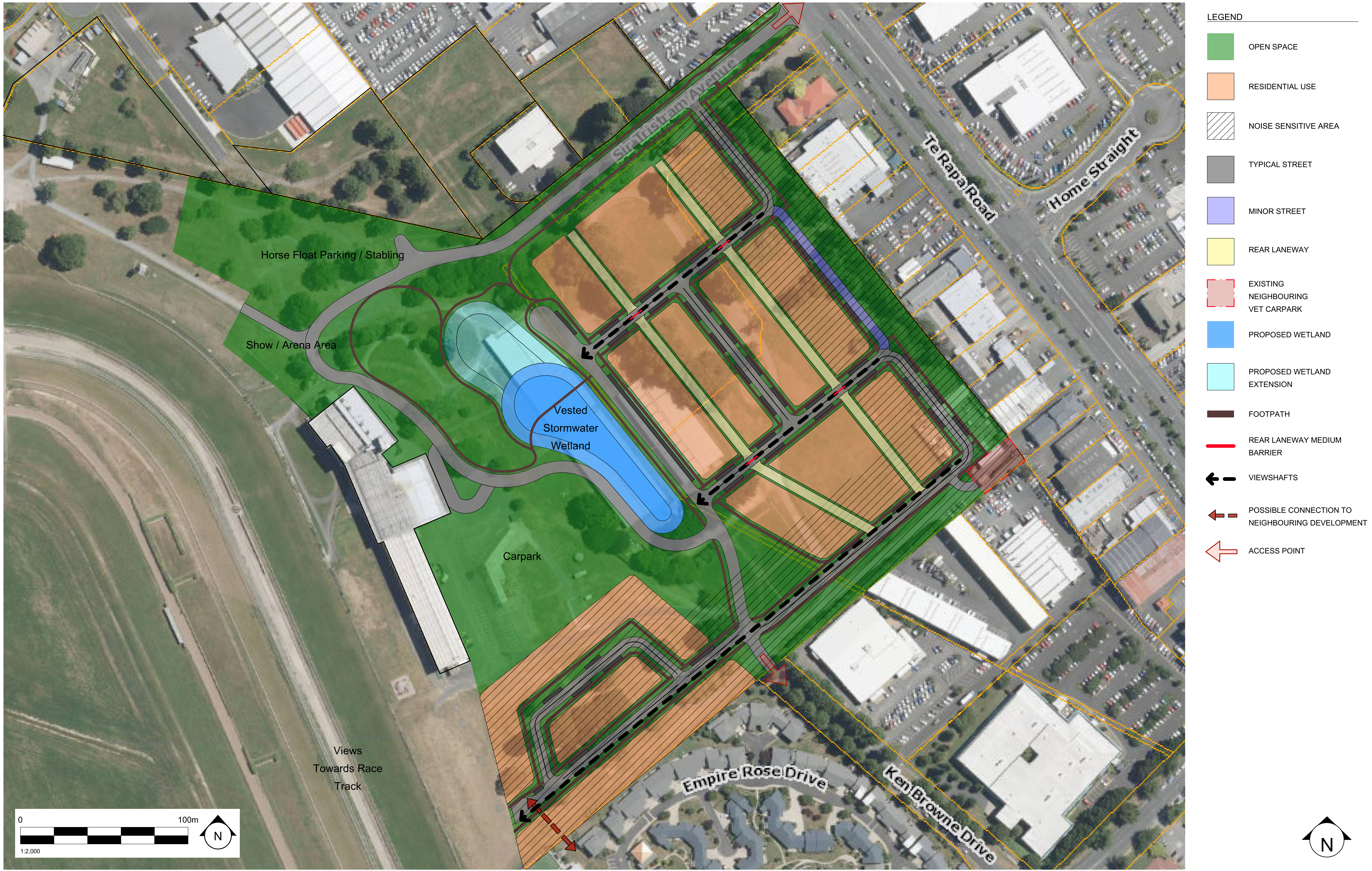
5. This professional opinion is furnished to the Council & the owner for their purpose alone on the express condition that it will not be relied upon by any other person.

Signed

Date: 20 July 2022

For and on behalf of CMW Geosciences (NZ) Ltd

Appendix B: Chow Hill Concept Development Plan



notes:
do not scale from drawings. all data to be verified on site prior to commencement of work.

copyright:
chow:hill architects limited ©

original scale
0 10 20 30mm

rev	issue	date
B	Landscape Layout Update	18/07/2022

project consultant list:

structural	mechanical
#Structural Engineer	#Mechanical Engineer

chowhill

135 Broadway, P.O. Box 109169, Newmarket,
Auckland, New Zealand

t: +64 9 522 6460 f: +64 9 522 6461
i: www.chowhill.co.nz

Te Rapa
Waikato Racing Club

WAIKATO RACING CLUB

PROPOSED SITE CONCEPT PLAN
MARCH 2022

design ChowHill scale 1:2000@A3
drawn ChowHill
check approved
C:\Users\joshua.chia\Desktop\16704 Te Rapa Racecourse Plan v22 220713.pln

CONCEPT DESIGN

project no.	sheet	revision
16704	L80.09	2

date printed 18/07/2022

Appendix C: Site Investigation Records

CMW Geosciences - SOIL (Field Logging Guide)

SEQUENCE OF TERMS

Fine: Soil type - Colour - Structure - Strength - Moisture - Bedding - Plasticity - Sensitivity - Origin/Geological Unit - Comments

Coarse: Soil Type - Colour - Structure - Grading - Strength/Relative Density - Moisture - Origin/Geological Unit - Comments

GRAIN SIZE CRITERIA

TYPE	COARSE								FINE		ORGANIC
	Boulders	Cobbles	Gravel			Sand			Silt	CLAY	Organic Soil
			coarse	medium	fine	coarse	medium	fine			
Size Range (mm)	200	60	20	6	2	0.6	0.2	0.06	0.002		
Graphic Symbol	●	● ●	○○○○			∴∴∴			×××	☰	ѱ ѱ ѱ

SHADE and COLOUR TERMS

Term	Abbreviation
Light	lt
Dark	dk
pink	pk
red	rd
orange	or
yellow	yl
brown	br
green	grn
blue	blu
white	wh
grey	gr
black	bl

PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

Fraction	Term	% of Soil Mass	Example
Major	(….) [UPPER CASE]	≥50 [major constituents]	GRAVEL
Subordinate	(….)y [lower case]	20 - 50	Sandy
Minor	with some…	1 2 - 20	with some sand
	with minor…	5 - 1 2	with minor sand
	with trace of (or slightly)	< 5	with trace of sand (slightly sandy)

Major divisions			Soil symbol	Soil name
Coarse grained soils more than 65% >0.06mm	gravel >50% of coarse fraction > 2mm	clean gravel <5% smaller 0.075mm	GW	well graded gravel, fine to coarse gravel
			GP	poorly graded gravel
		gravel with >1 2% fines	GM	silty gravel
			GC	clayey gravel
	sand ≥50% of coarse fraction <2mm	clean sand	SW	well-graded sand, fine to coarse sand
			SP	poorly graded sand
		sand with >1 2% fines	SM	silty sand
			SC	clayey sand
Fine grained soils 35% or more <0.06mm	silt and clay liquid limit <50	inorganic	ML	silt
			CL	clay of low plasticity
		organic	OL	organic silt
	silt and clay liquid limit ≥50	inorganic	MH	silt of high plasticity
			CH	clay of high plasticity
		organic	OH	organic clay
Highly Organic Soils			Pt	peat

ORGANIC SOILS / DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However topsoil may occour at greater depth, having been buried by geological processes or man-made fill, and should be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Desribe as for inorganic soils
Peat	Consists predominantly of plant remains. ***Firm:*** Fibres already compressed together ***Spongy:*** Very compressible and open structure ***Plastic:*** Can be moulded in hand and smears in fingers ***Fibrous:*** Plant remains recognisable and retain some strenght ***Amorphous:*** No recognisable plant remains
Rootlets	Fine, partly decomposed roots, normally found in the uper part of a soil profile or in a redeposited soil (e.g. colluvium of fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

DENSITY INDEX (RELATIVE DENSITY) TERMS

DESCRIPTIVE TERM	Density Index (RD)	SPT "N" value (blows / 300mm)	Dynamic Cone (blows / 100mm)	Abbreviation
Very Dense	> 85	> 50	> 1 7	VD
Dense	65- 85	30 - 50	7 - 1 7	D
Medium dense	35 - 65	1 0 - 30	3 - 7	MD
Loose	1 5 - 35	4 - 1 0	1 - 3	L
Very loose	< 1 5	< 4	0 - 2	VL

Note: No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values. SPT "N" values are uncorrected. Dynamic Cone Penetrometer (Scala)

CONSISTENCY TERMS FOR COHESIVE SOILS

Descriptive Term	Undrained Shear Strength (kPa)	Diagnostic Features	Abbreviation
Very soft	< 1 2	Easily exudes between fingers when squeezed	VS
Soft	1 2 - 25	Easily indented by fingers	S
Firm	25 - 50	Indented by strong finger pressure and can be indented by thumb pressure	F
Stiff	50 - 1 00	Cannot be indented by thumb pressure	St
Very Stiff	1 00 - 200	Can be indented by thumb nail	Vst
Hard	200 - 500	Difficult to indent by thumb nail	H

Revision 0 – April 2016 – TL

CMW Geosciences - SOIL (Field Logging Guide)

SEQUENCE OF TERMS

Fine: Soil type - Colour - Structure - Strength - Moisture - Bedding - Plasticity - Sensitivity - Origin/Geological Unit - Comments

Coarse: Soil Type - Colour - Structure - Grading - Strength/Relative Density - Moisture - Origin/Geological Unit - Comments

Moisture Condition

Condition	Look and Feel	Granular Soils	Cohesive Soils	Abbreviation
Dry	Looks and feels dry	Run freely through hands	Hard, powdery or friable	D
Moist	Feels cool, darkened in colour	Tend to cohere	Weakened by moisture, but no free water on hands when remoulding	M
Wet			Weakened by moisture, free water forms on hands when handling	W
Saturated	Feels cool, darkened in colour and free water is present on the sample			S

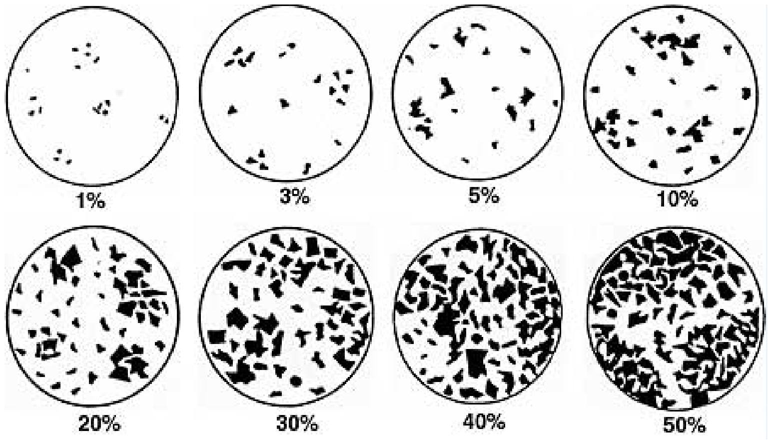
PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be mouled or deformed over a wide range of moisture contents without cracking or showing any tendancy to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

GRADING (GRAVELS & SANDS)

Term	Description	
Well Graded	Good representation of all particle size ranges from largest to smallest	
Poorly Graded	Limited representation of grain sizes - further divided into:	
	Uniformly graded	Most particles about the same size
	Gap graded	Absence of one or more intermediate sizes

VISUAL PROPORTION PERCENTAGE



Revision 0 – April 2016 – TL

HAND AUGER BOREHOLE - HA01

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

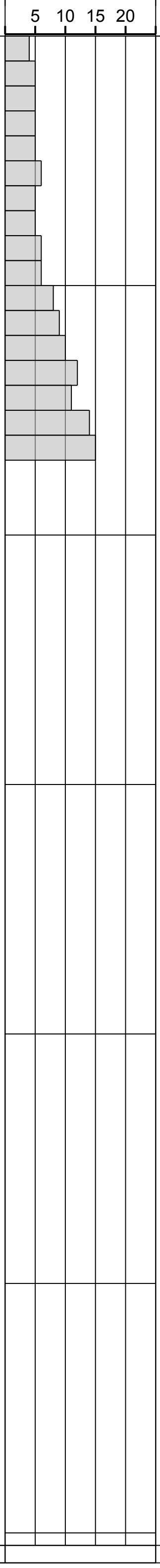
Sheet 1 of 1

Logged by: JC
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments
TS					OL: TOPSOIL - ORGANIC SILT: dark brown, low plasticity	M					
Hinuera Formation			1		SP: SAND: brown, fine to coarse, poorly graded, with minor fine subrounded gravel.	M to W	MD D				
			2 3 4 5 6		Borehole terminated at 1.500 m						



Termination reason: Refusal on gravel

Remarks: Groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA02

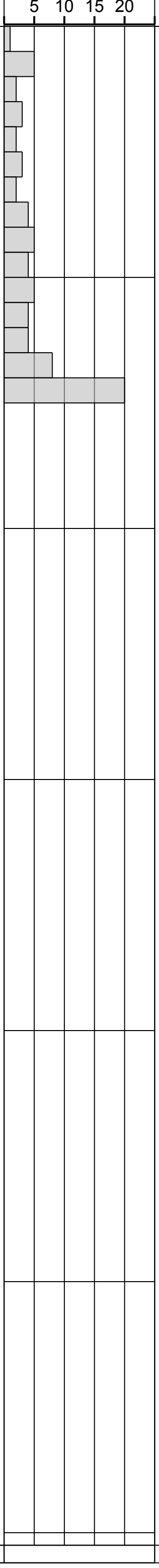
Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

CMW Geosciences

Scale: 1:30
Sheet 1 of 1

Logged by: AMH
Checked by: KAL
Position:
Survey Source:
Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm) 5 10 15 20	Comments
Top soil					OL: TOPSOIL - ORGANIC SILT: dark brown, low plasticity, with minor fine to medium sand and trace clay	M	S to F				
Hinuera Formation					SM: Sandy SILT: brown to grey, no to low plasticity, fine to coarse sand, with minor fine to medium sub-angular to sub-rounded gravel						
					SP: SAND: pale brown, fine to coarse, poorly graded (predominantly fine), with some fine to coarse sub-angular to sub-rounded gravel *0.5m: sand becomes fine to medium, with minor silt, no gravel*	M to W	L MD				
			1		SW: SAND: brownish grey, fine to coarse, well graded, with trace fine sub-rounded gravel	W	D to VD				
					Borehole terminated at 1.400 m						
			2								
			3								
			4								
			5								
			6								



Termination reason: Refusal on gravel

Remarks: Groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA03

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

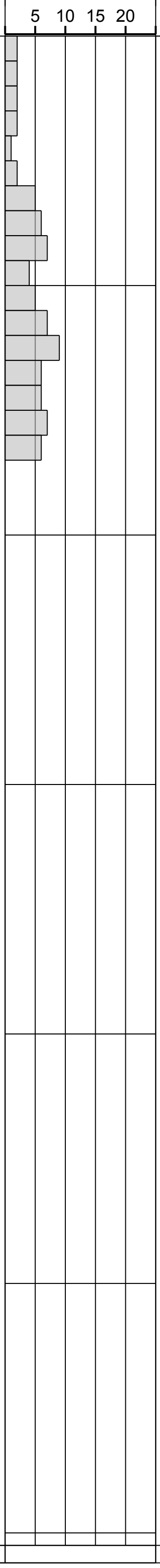
Sheet 1 of 1

Logged by: JC
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments
Topsoil					OL: TOPSOIL - ORGANIC SILT: dark brown, low plasticity	M					
Hinuera Formation					SM: Sandy SILT: light brown, mottled orange, low plasticity	M to W	Vst to H		204+		
					SP: SAND: light grey, fine, poorly graded, with minor silt	W	MD to D				
					SW: SAND: greyish brown, fine to coarse, well graded						
					Borehole terminated at 2.200 m						



Termination reason: Refusal on gravel

Remarks: Groundwater not encountered, but likely to be near bottom of hole as becoming more wet

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA04

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

Sheet 1 of 1

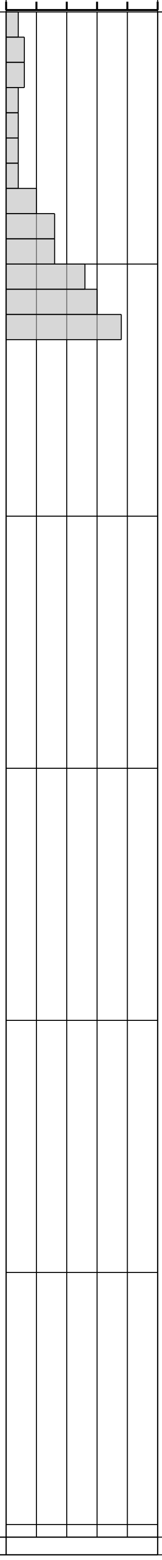
Logged by: JC
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Topsoil				OL: TOPSOIL - ORGANIC SILT: dark brown, low plasticity	M				
Hinuera Formation				SM: Silty SAND: light brown, mottled orange, fine grained, poorly graded	M to W	L			
			1	SW: Gravelly SAND: light brown to grey, fine to coarse sand, fine to medium sub-rounded gravel, well graded	W	D			
				Borehole terminated at 1.100 m					

Dynamic Cone Penetrometer (Blow/100 mm)



Depth (m): 1, 2, 3, 4, 5, 6

Termination reason: Refusal on gravel

Remarks: Groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA05

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

Sheet 1 of 1

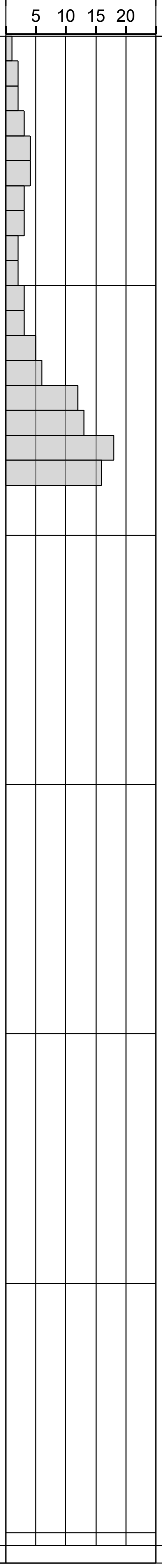
Logged by: AMH
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments
Topsoil					OL: TOPSOIL - ORGANIC SILT: brown, low plasticity, with minor fine to coarse sand and minor fine to coarse sub-angular to sub-rounded gravel, and some rootlets	M					
Fill					SW: Silty SAND: pale brown, fine to coarse, well graded, with minor fine to coarse angular to sub-rounded gravel		L				
Topsoil					OL: ORGANIC SILT - BURIED TOPSOIL: dark brown, low plasticity, with trace fine to coarse sand, with some rootlets *0.8m: becomes dark brown to black*				UTP - SV influenced by sand		
Hinuera Formation			1		SP: Silty SAND: pale brown streaked/mottled orange, fine, poorly graded, slightly dilatant	M to W	MD				
					SW: Gravelly SAND: brown, fine to coarse sand, fine to coarse sub-angular to sub-rounded gravel (some pumice), well graded, with minor silt Borehole terminated at 1.500 m	W	D				

Depth (m): 1, 2, 3, 4, 5, 6



Termination reason: Refusal on gravel

Remarks: Groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA06

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

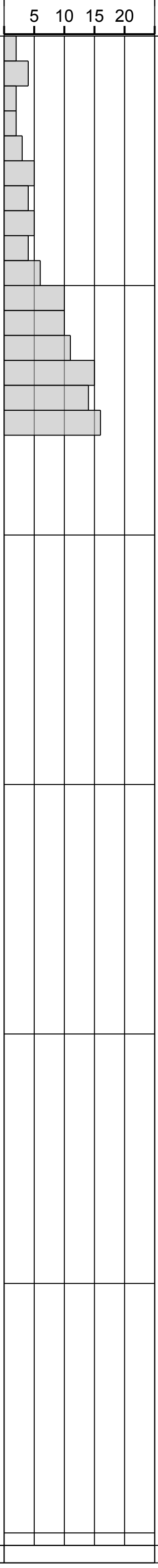
Sheet 1 of 1

Logged by: AMH
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments
Topsoil					OL: TOPSOIL - ORGANIC SILT: dark brown, low plasticity	M					
Hinuera Formation					SP: Silty SAND: light brown with orange mottling, fine, poorly graded		L				
					SW: SAND: light grey, fine to coarse, well graded, with trace silt		MD				
			1		*1.0m: with some fine to medium sub-rounded gravel*	W	D				
					Borehole terminated at 1.200 m						
			2								
			3								
			4								
			5								
			6								



Termination reason: Refusal on gravel

Remarks: Groundwater not encountered

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA07

CMW Geosciences

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

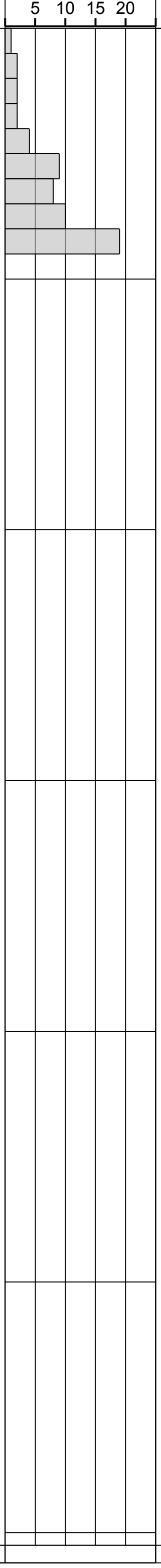
Sheet 1 of 1

Logged by: AMH
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Dynamic Cone Penetrometer (Blow/100 mm)	Comments
TS	▼				ML: TOPSOIL - Clayey SILT: dark brown, low plasticity, with some rootlets	W					
Hinuera Formation					ML: SILT: grey with orange streaks/mottling, low plasticity, with minor rootlets	M to W	F to St	Q	V-56		
					SW: SAND: grey to pale brown, fine to coarse, well graded, with trace fine sub-rounded gravel (pumice), and trace silt	W	D				
			1		*0.8m: becomes mainly coarse grained*	S					
					Borehole terminated at 1.200 m						



Termination reason: No recovery due to saturated sands.

Remarks: Groundwater at surface, however may be influenced by ponding surface water in the area.
Unit TS = Topsoil.

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

HAND AUGER BOREHOLE - HA08

Client: Te Rapa Waikato Racing Club
Project: Te Rapa Racecourse Redevelopment
Site Address: Ken Browne Drive, Hamilton
Project No: HAM2016_0109
Date: 30/05/2017
Borehole Location: Refer to site plan

Scale: 1:30

Sheet 1 of 1

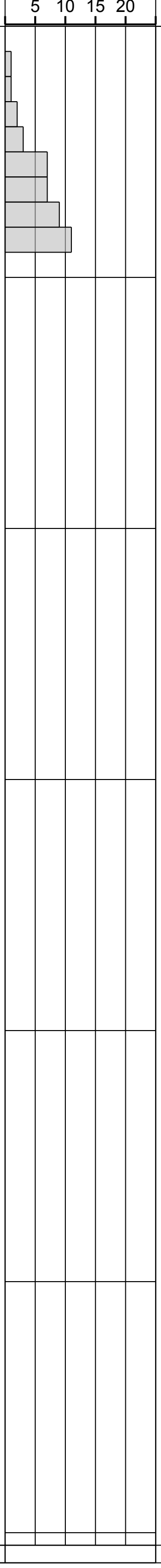
Logged by: AMH
Checked by: KAL

Position:
Survey Source:

Elevation:
Datum:

Unit	Groundwater	RL (m)	Depth (m)	Graphic Log	Material Description Soil: USC; Soil type; colour; structure; strength; moisture; bedding; plasticity; sensitivity; additional comments Rock: Weathering; colour; fabric; rock name; strength; additional comments	Moisture Condition	Consistency/ Relative Density	Sensitivity	Shear Strengths (kPa) Peak (Residual)	Comments
Top soil	▼				OL: TOPSOIL - Clayey SILT: dark brown, low plasticity, with some rootlets	W to S				
Hinuera Formation					ML: SILT: grey with orange streaks/mottling, low plasticity, with trace rootlets *0.5m: with some fine to coarse sand*	M to W	St to VSt	Q	V-152(9) SV influenced by sand	
					SW: SAND: pale grey to pale brown, fine to coarse, well graded, with minor fine to medium sub-rounded gravel (pumice), and trace silt	S	MD to D			
			1		Borehole terminated at 0.900 m					
			2							
			3							
			4							
			5							
			6							

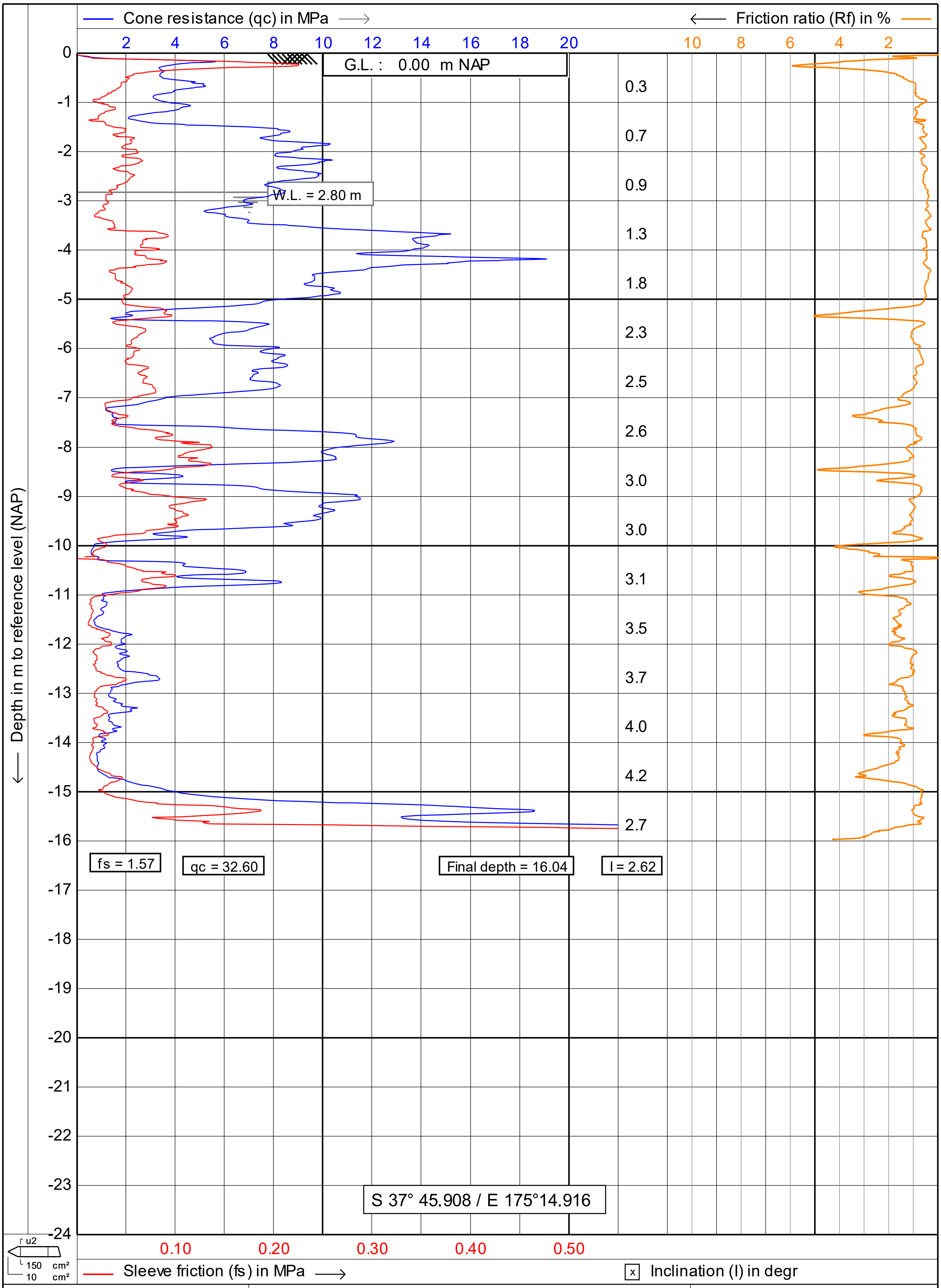
Dynamic Cone Penetrometer (Blow/100 mm)



Termination reason: No recovery due to saturated sands.

Remarks: Groundwater at surface, however may be influenced by ponding surface water in the area.

This report is based on the attached field description for soil and rock, New Zealand, Geotechnical Society Inc 2005.

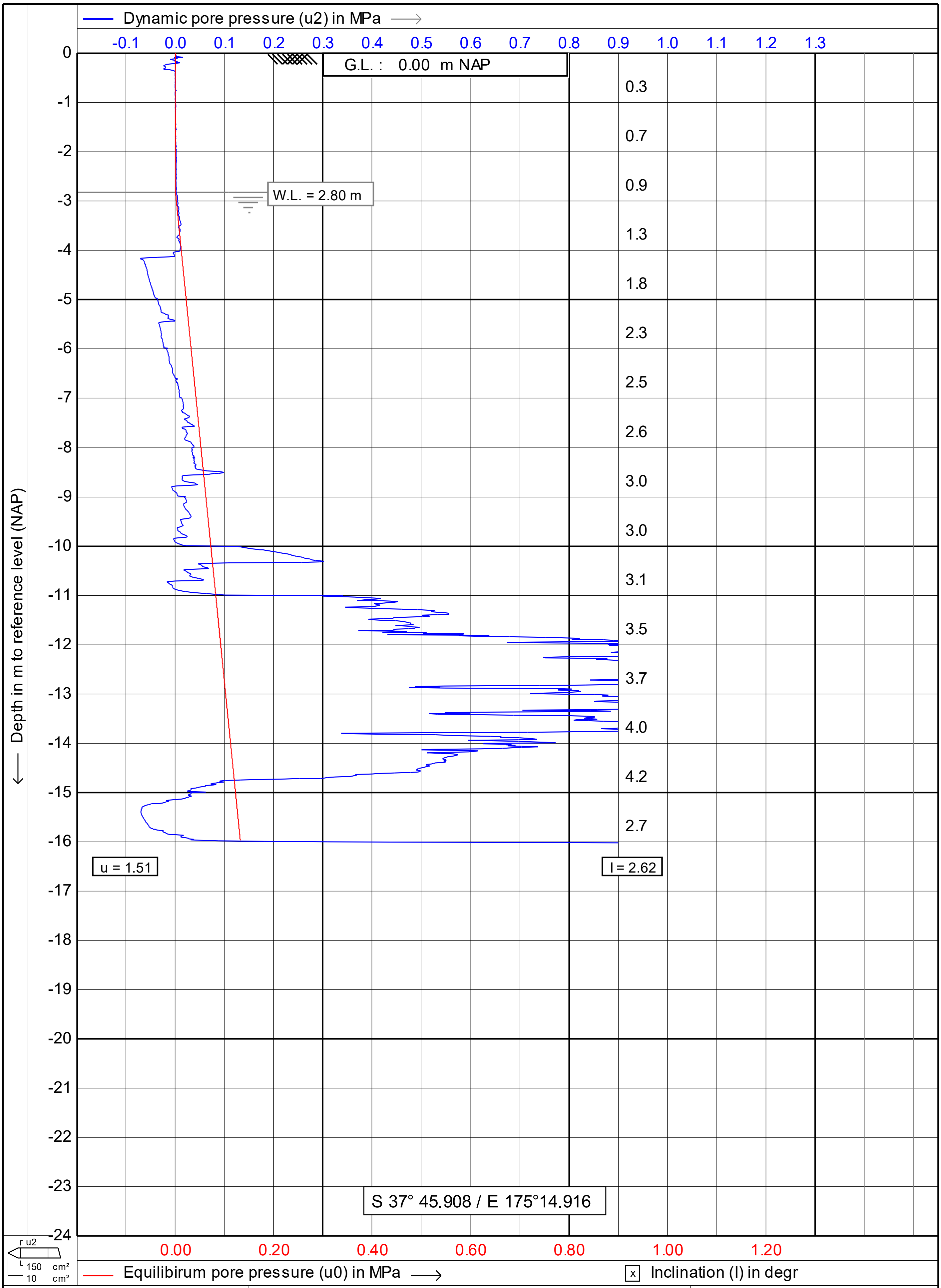


ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT01** **1/15**

1.47



CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01** **2/15**

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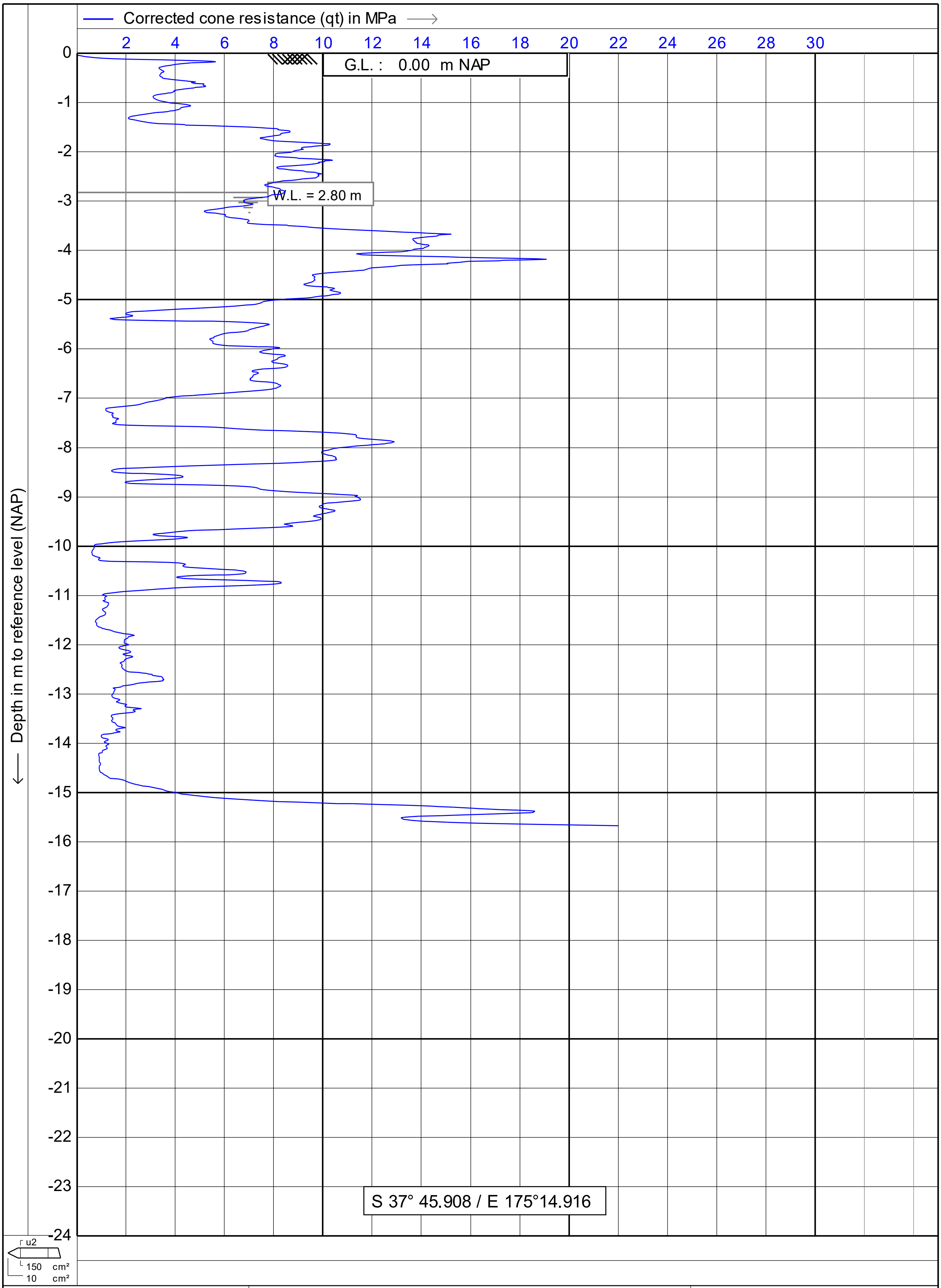

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

3/15

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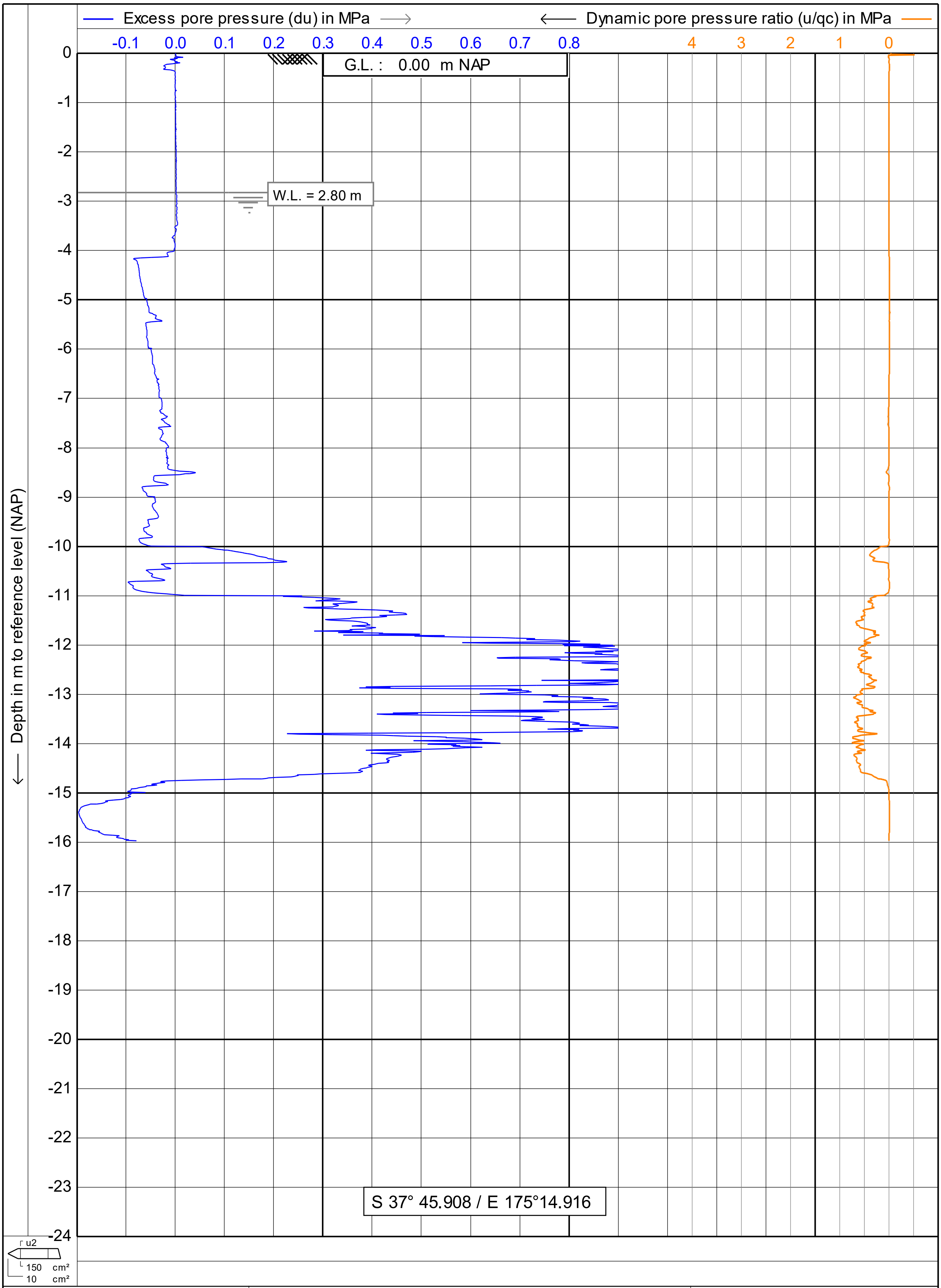

CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01** **4/15**

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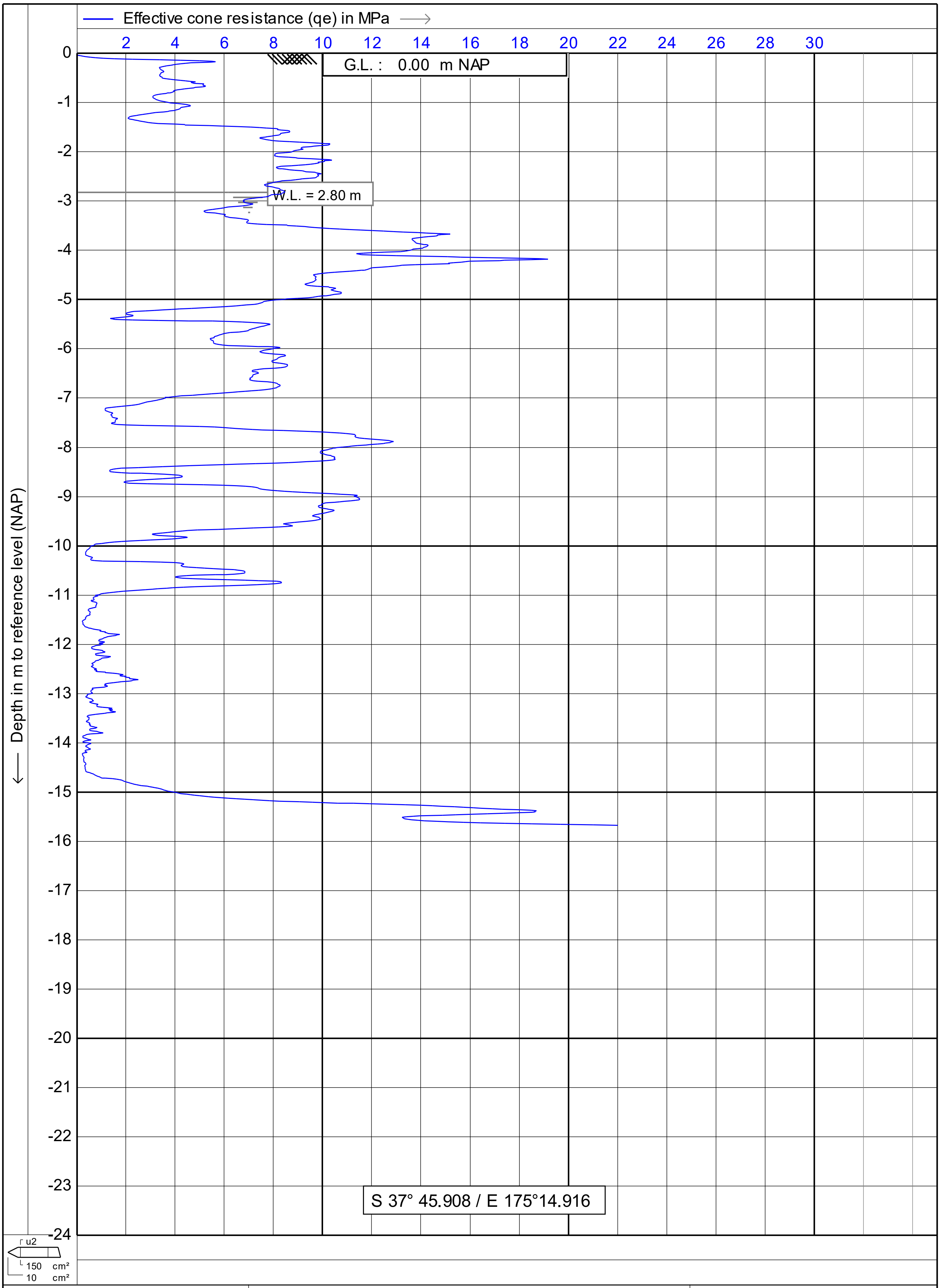

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

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CONE PENETROMETER TESTING

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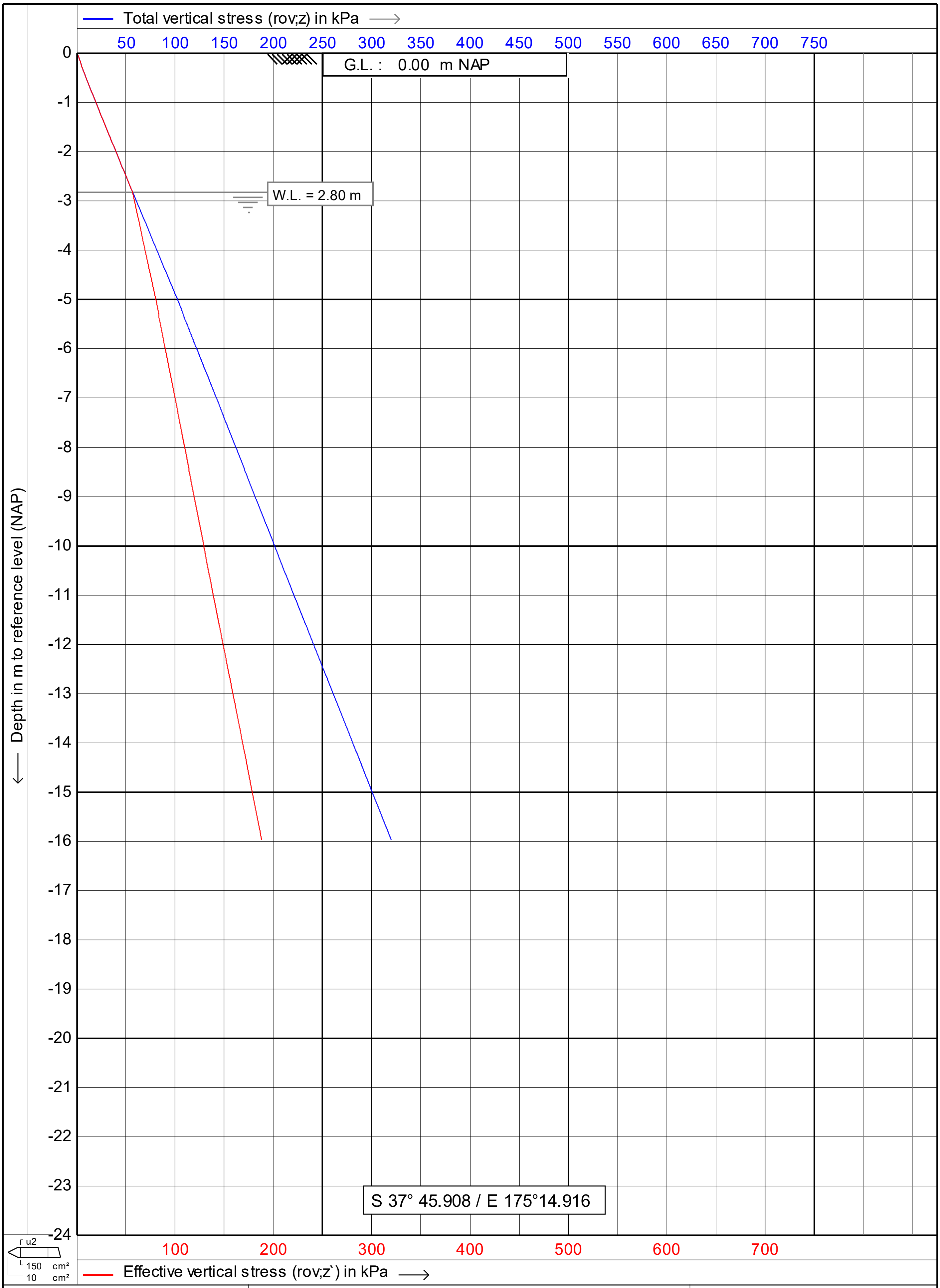

ISO 22476-1:2012 Application class 1 Test type TE1

Project	: **TE RAPA RACECOURSE DEVELOPMENT**
Location:	**TE RAPA RACECOURSE**
Position:	**0, 0**
Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no.	: **17017/HAM2017-109**
CPT no.	: **CPT01**

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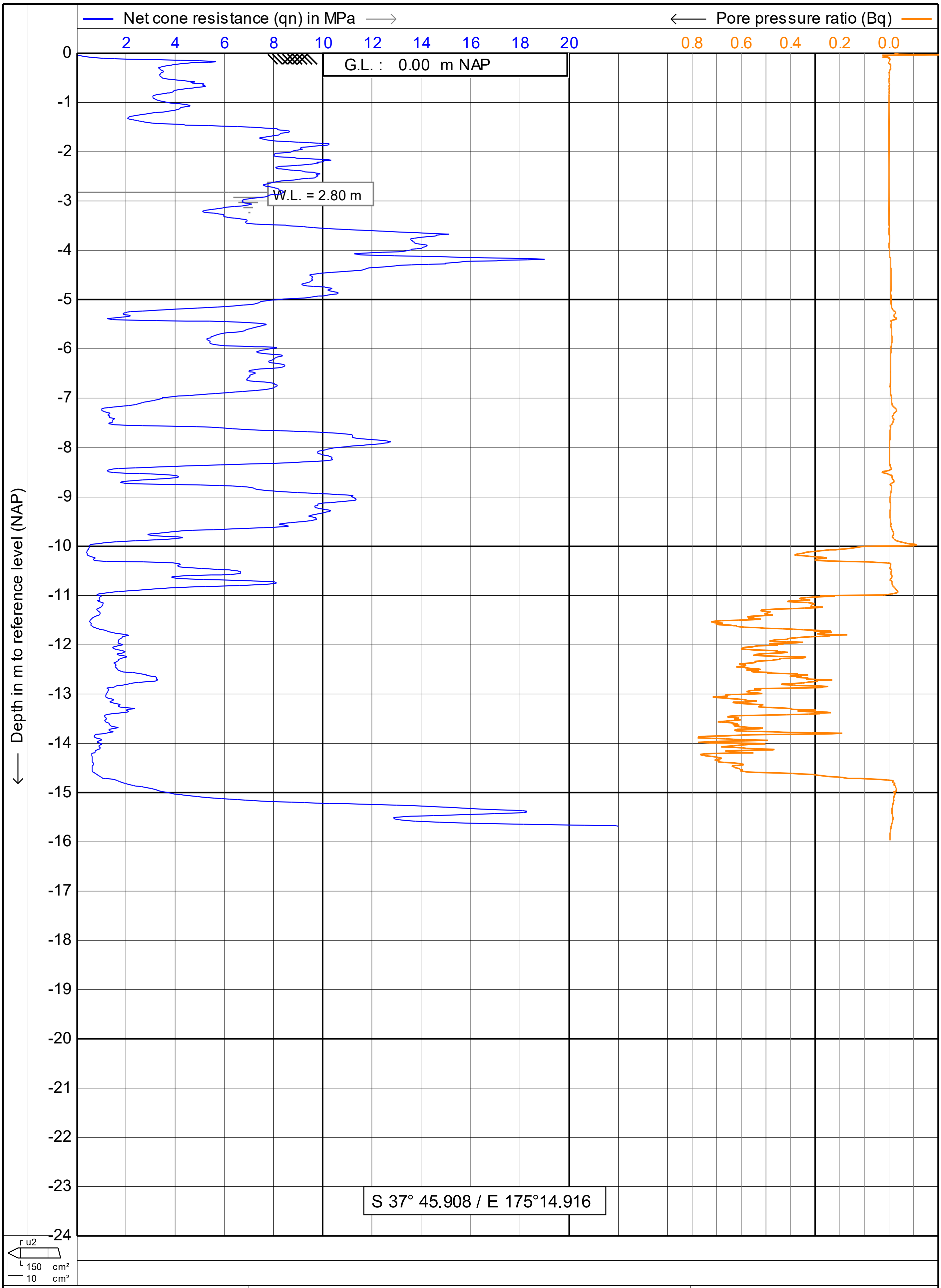

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

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Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

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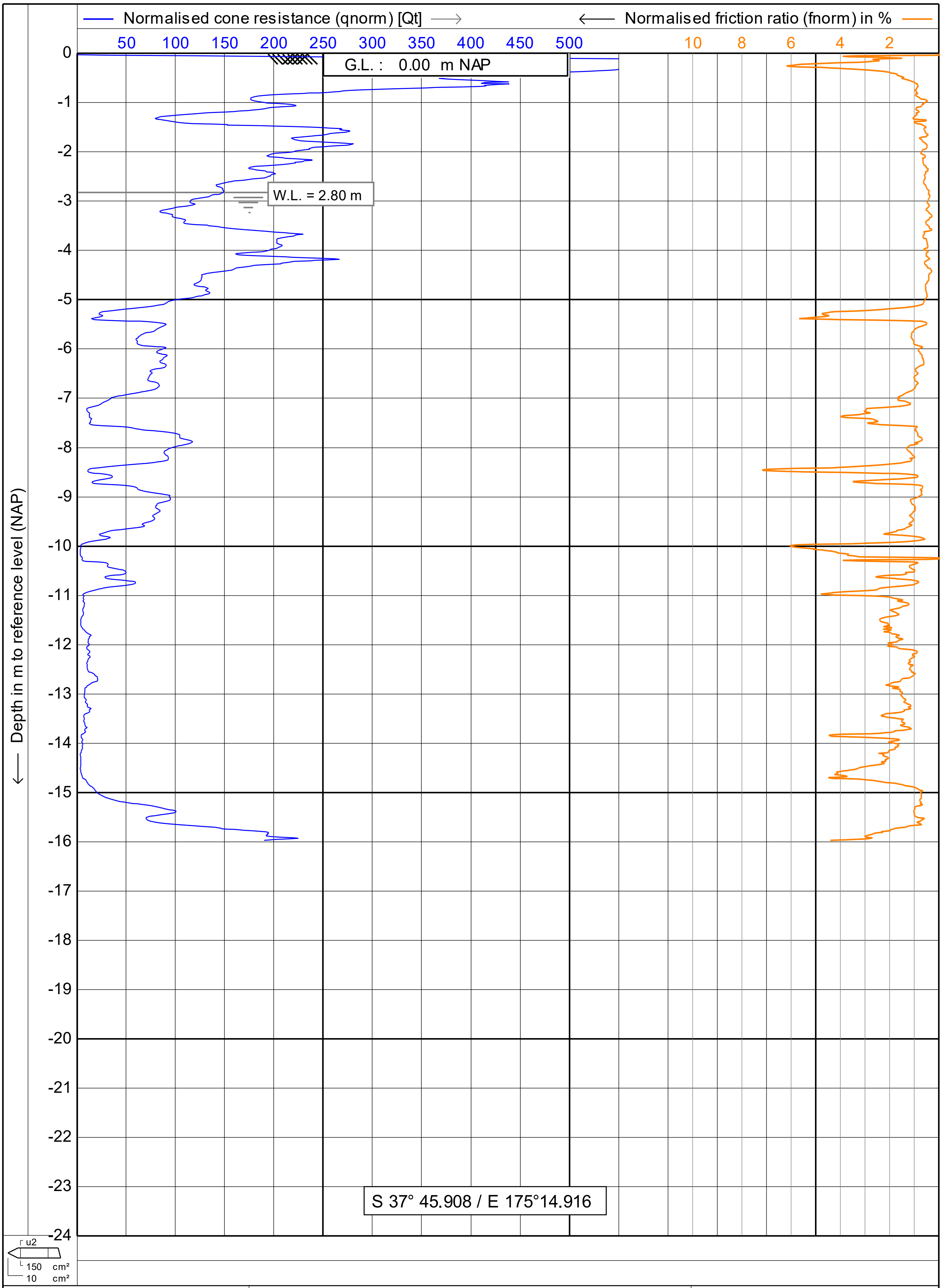

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CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

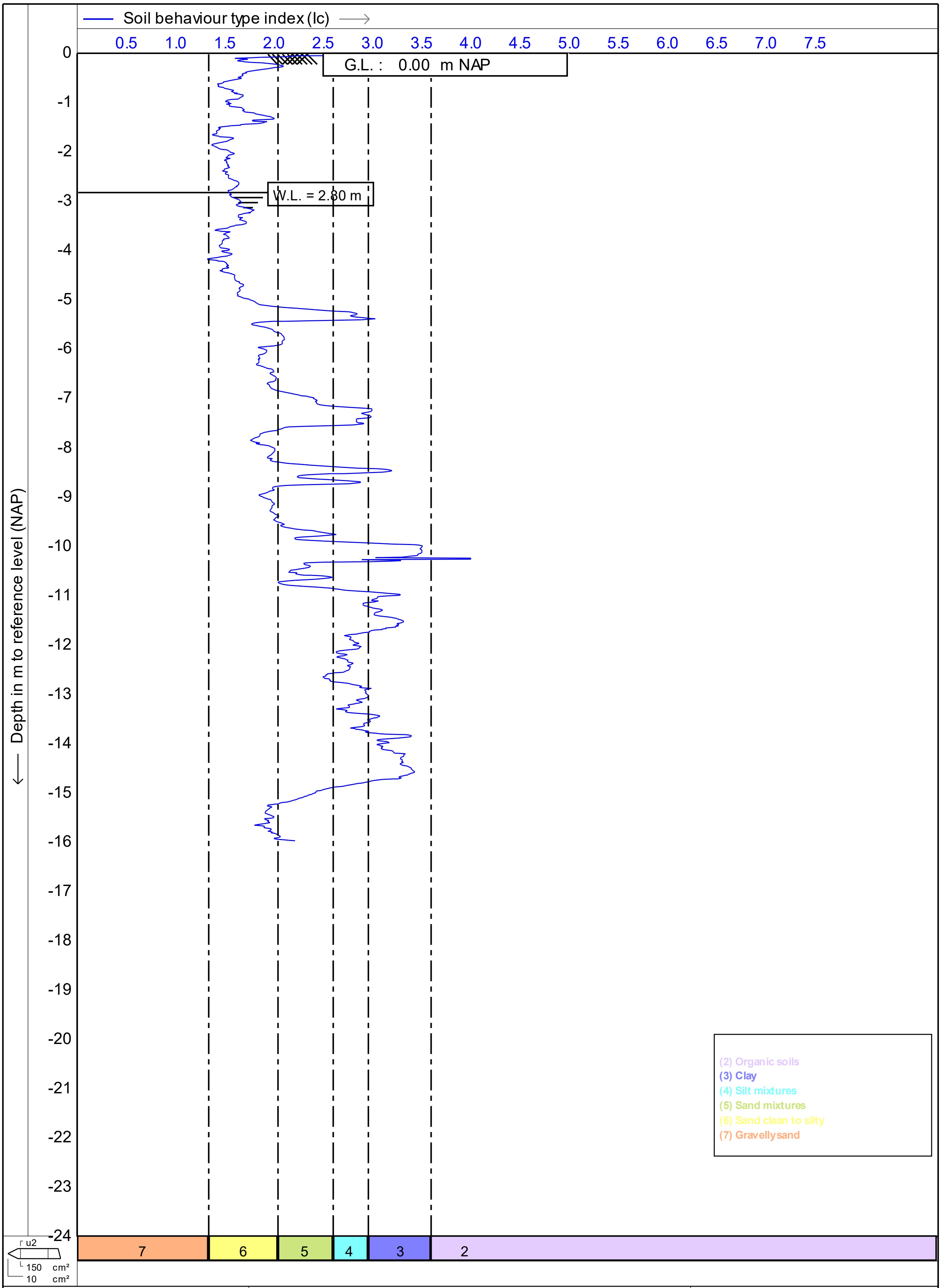
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**



CONE PENETROMETER TESTING

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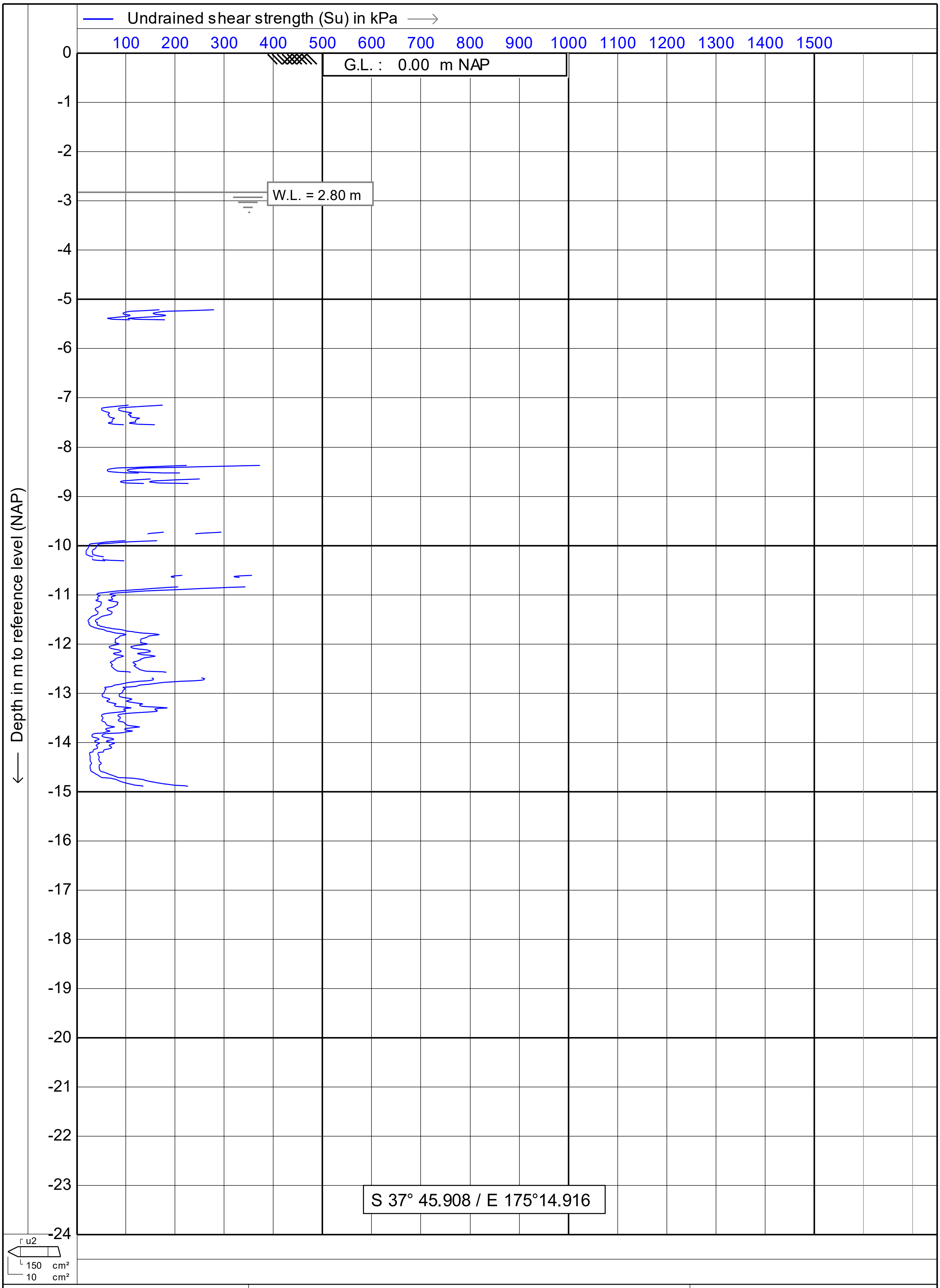
ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no.	: **17017/HAM2017-109**
CPT no.	: **CPT01** **9/15**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

10/15

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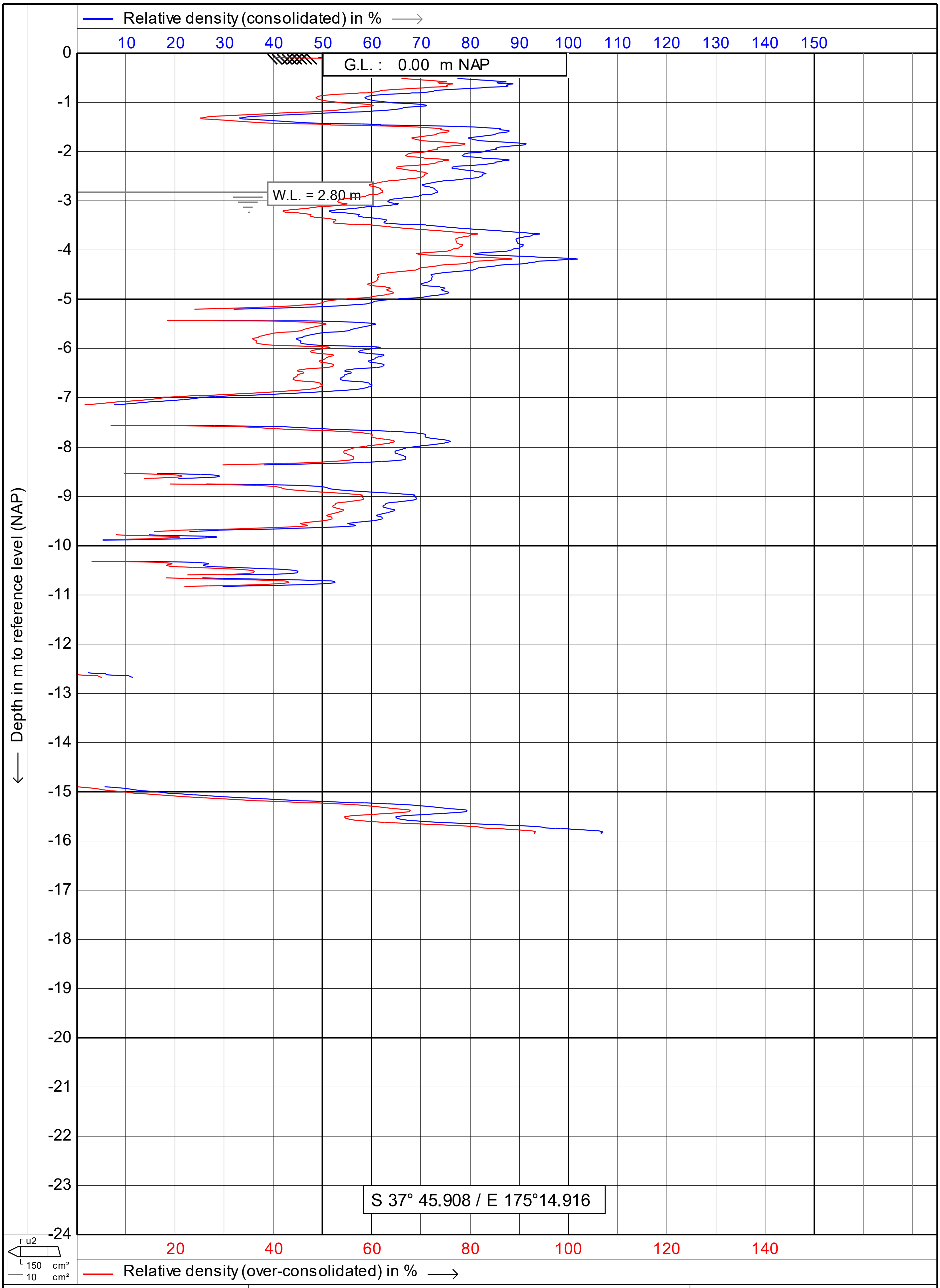

CPT it CONE PENETROMETER TESTING	ISO 22476-1:2012 Application class 1 Test type TE1	Date : **23-May-17**
	Project : **TE RAPA RACECOURSE DEVELOPMENT**	Cone no. : **S10CFIIP.S16082**
	Location: **TE RAPA RACECOURSE**	Project no. : **17017/HAM2017-109**
	Position: **0, 0**	CPT no. : **CPT01** **11/15**

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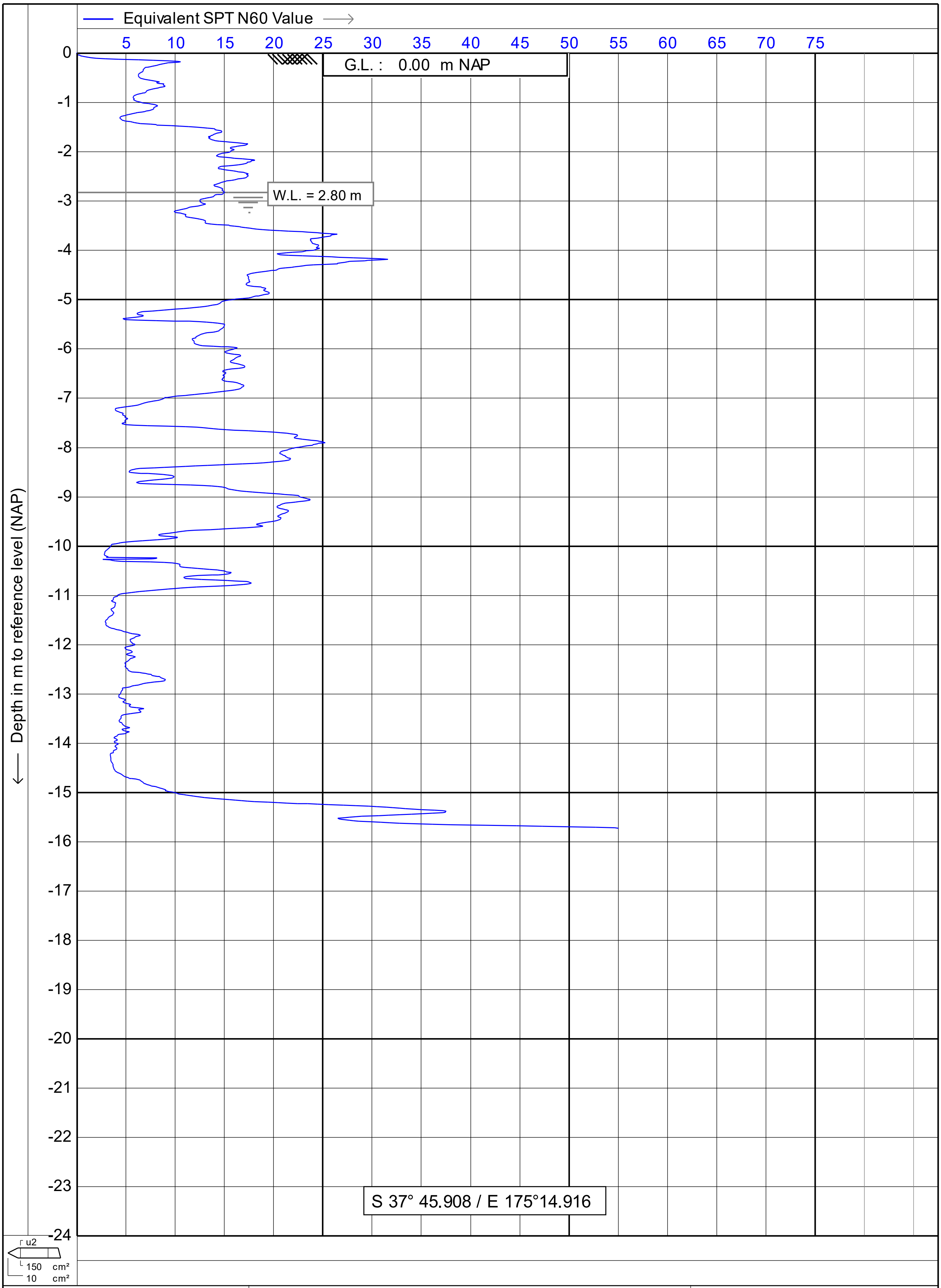


CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

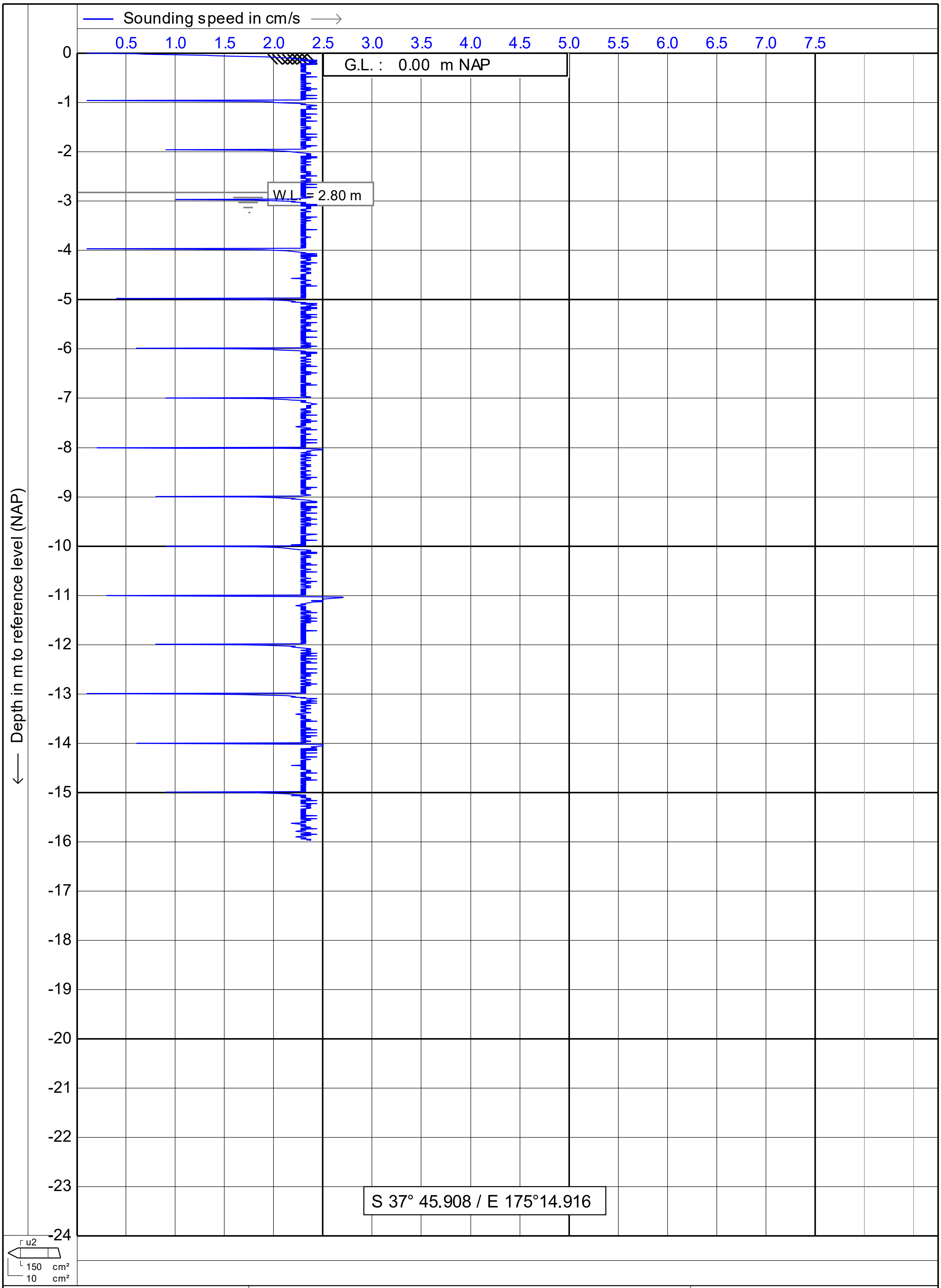
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

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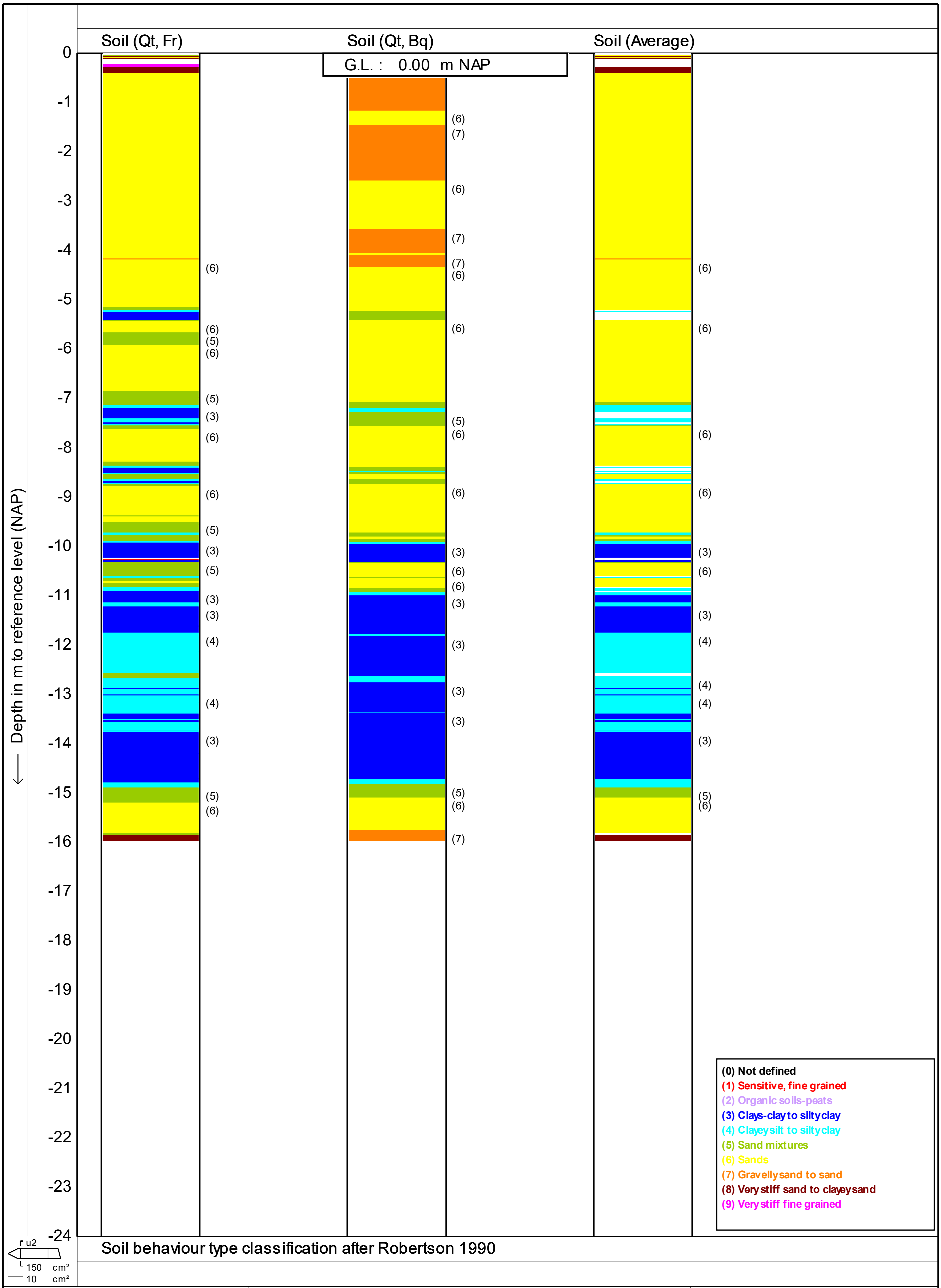


Soil behaviour type classification after Robertson 1990

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

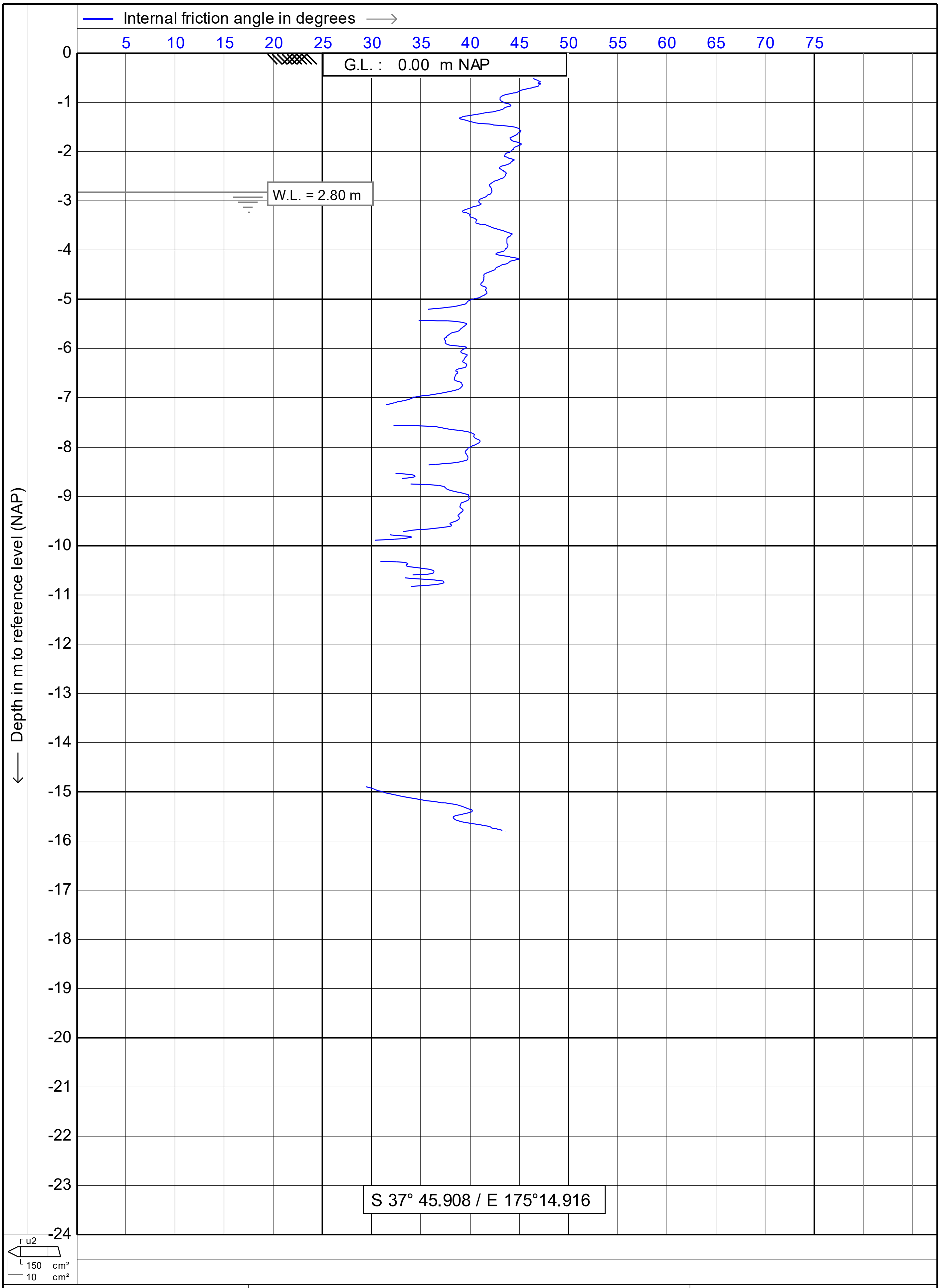
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

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Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01**

15/15

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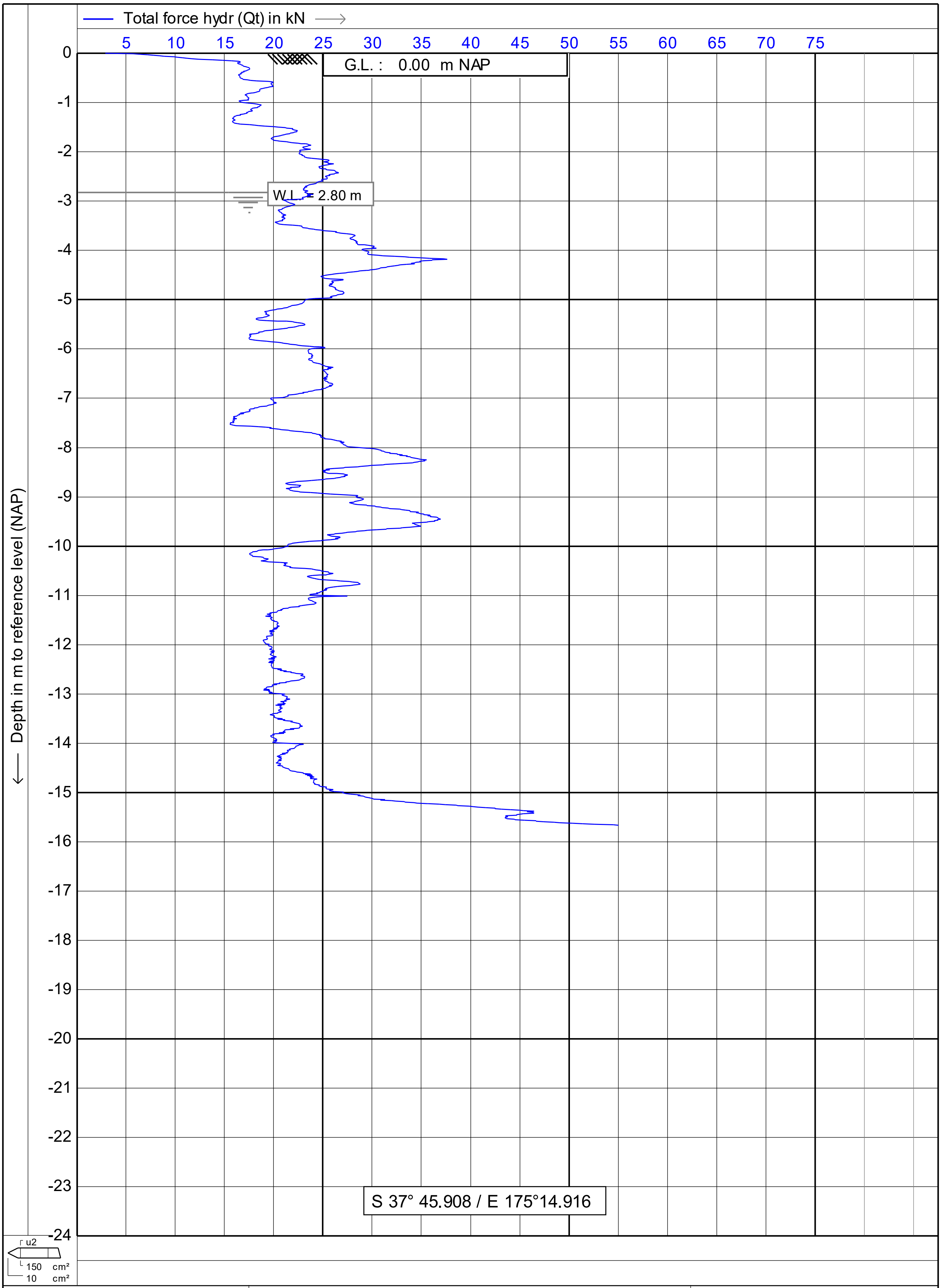

CPT it

CONE PENETROMETER TESTING

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ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

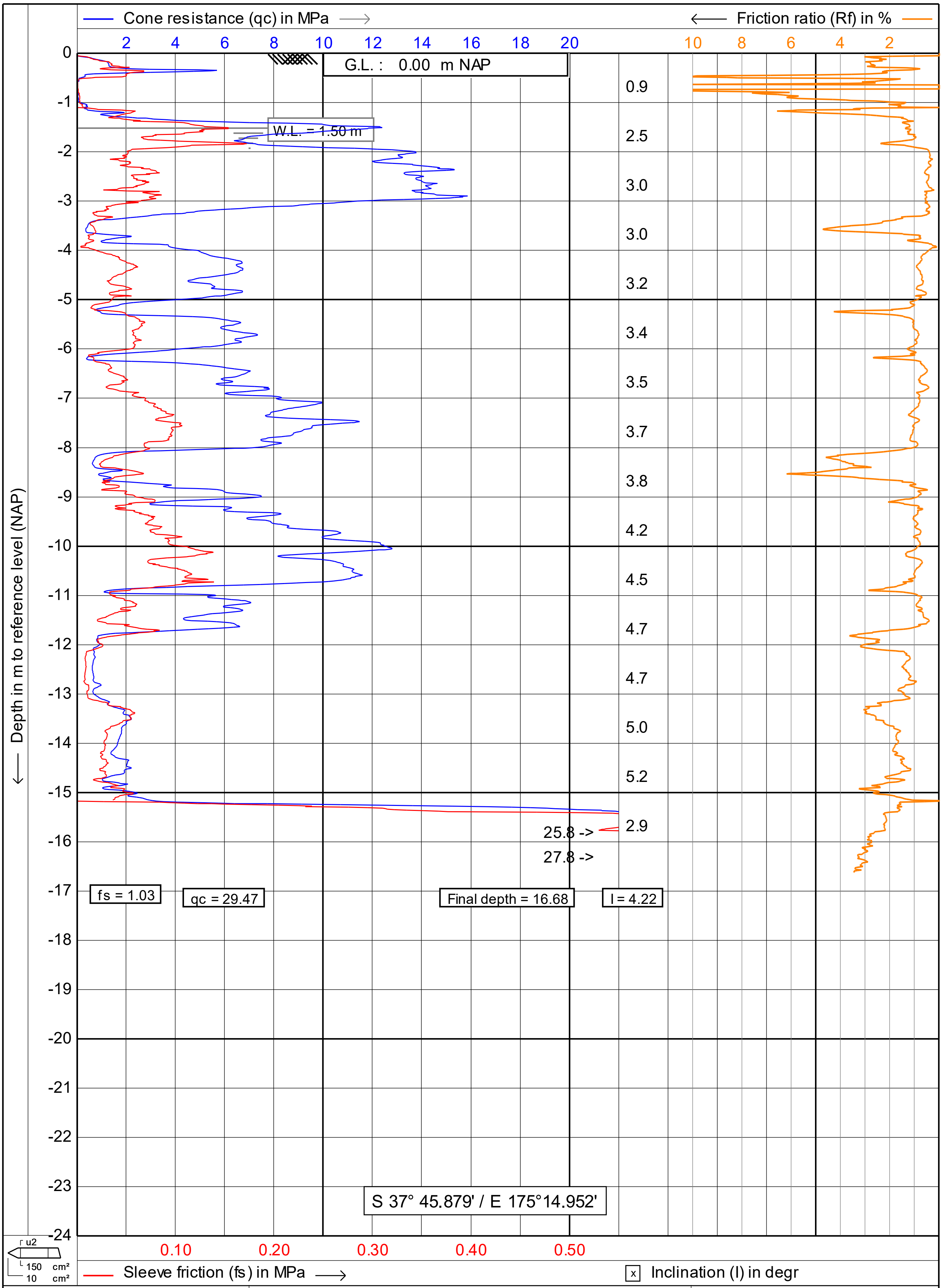
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT01** **16/15**



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

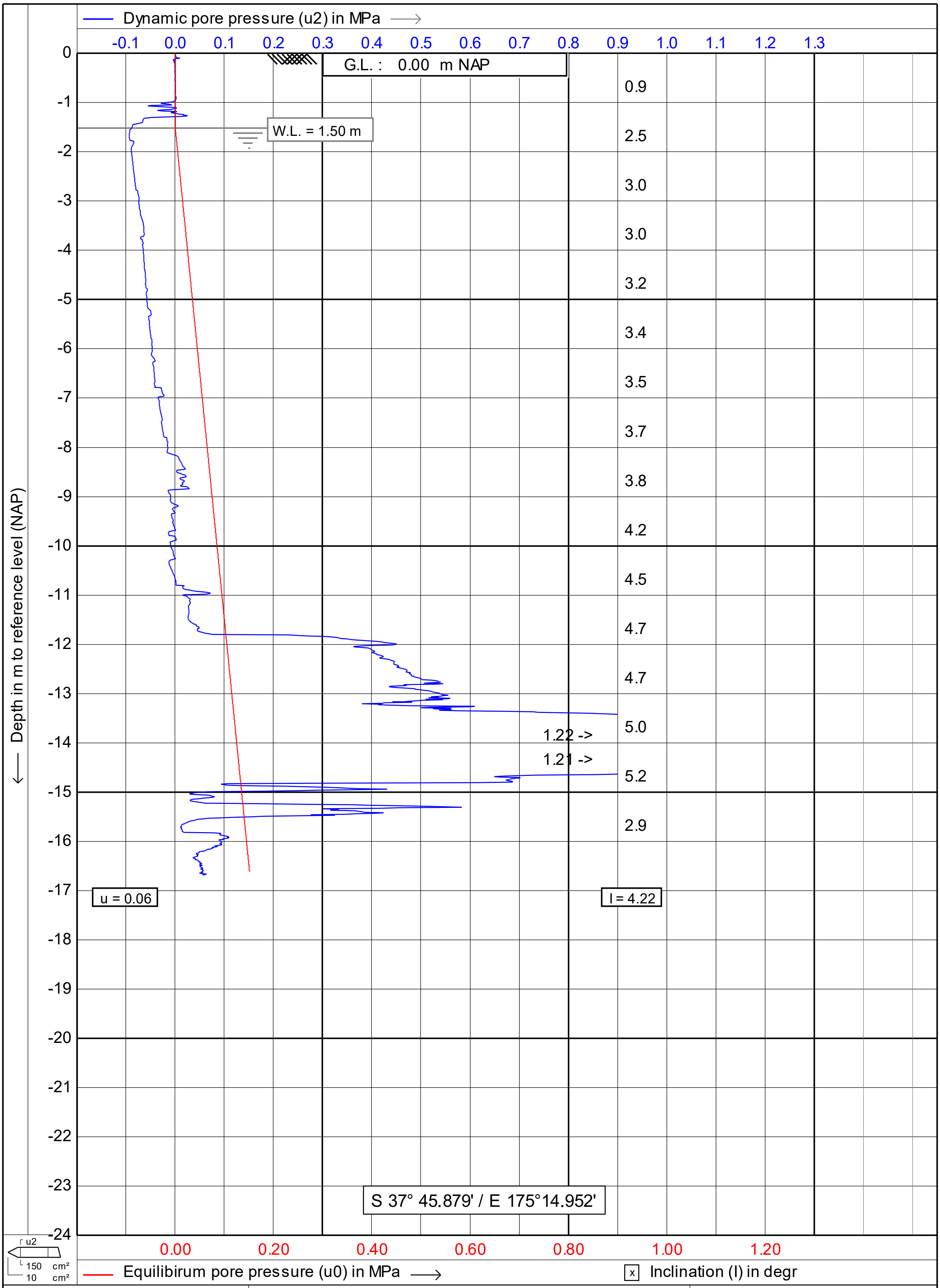
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

1/15



CONE PENETROMETER TESTING

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ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

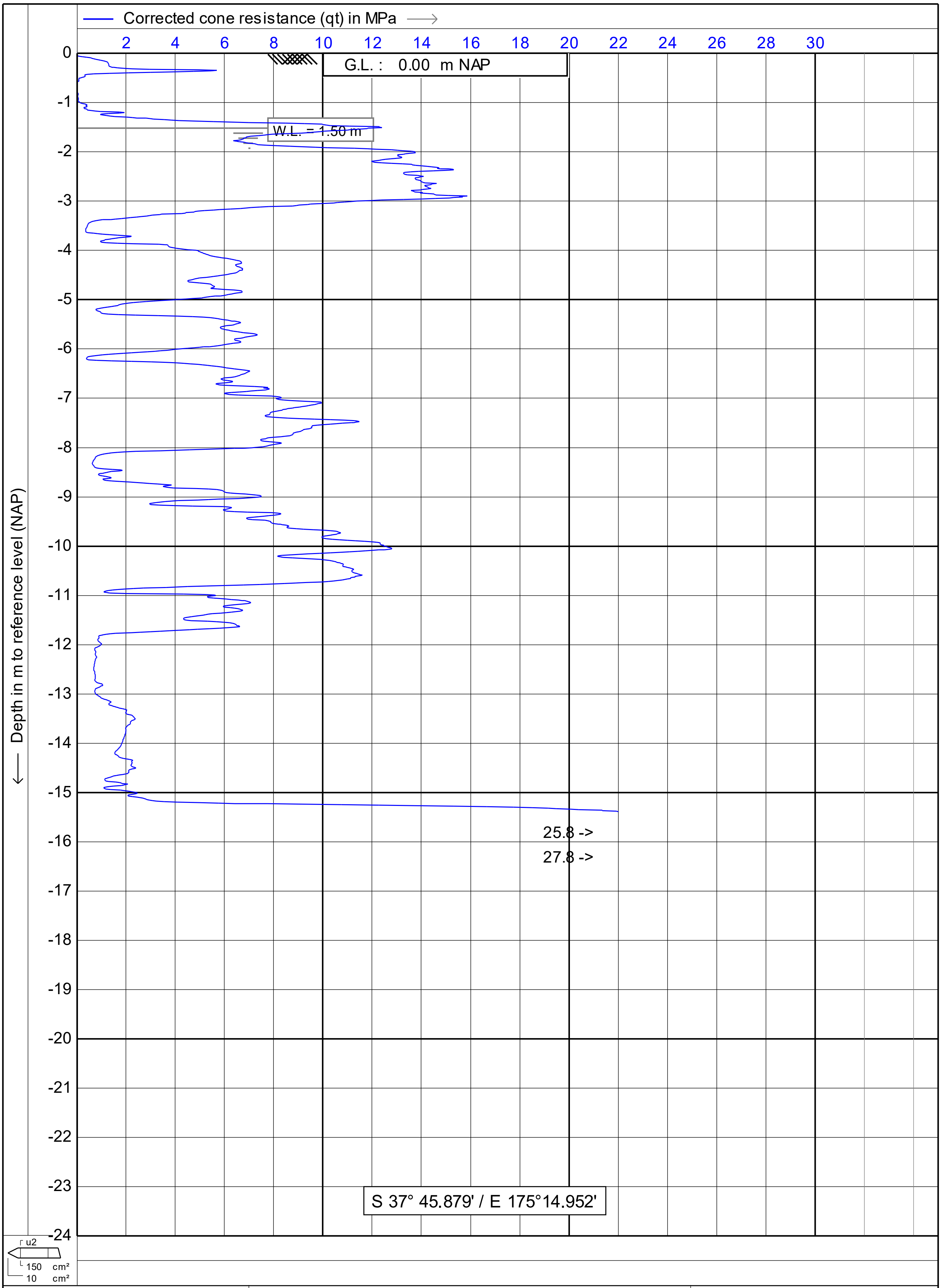
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

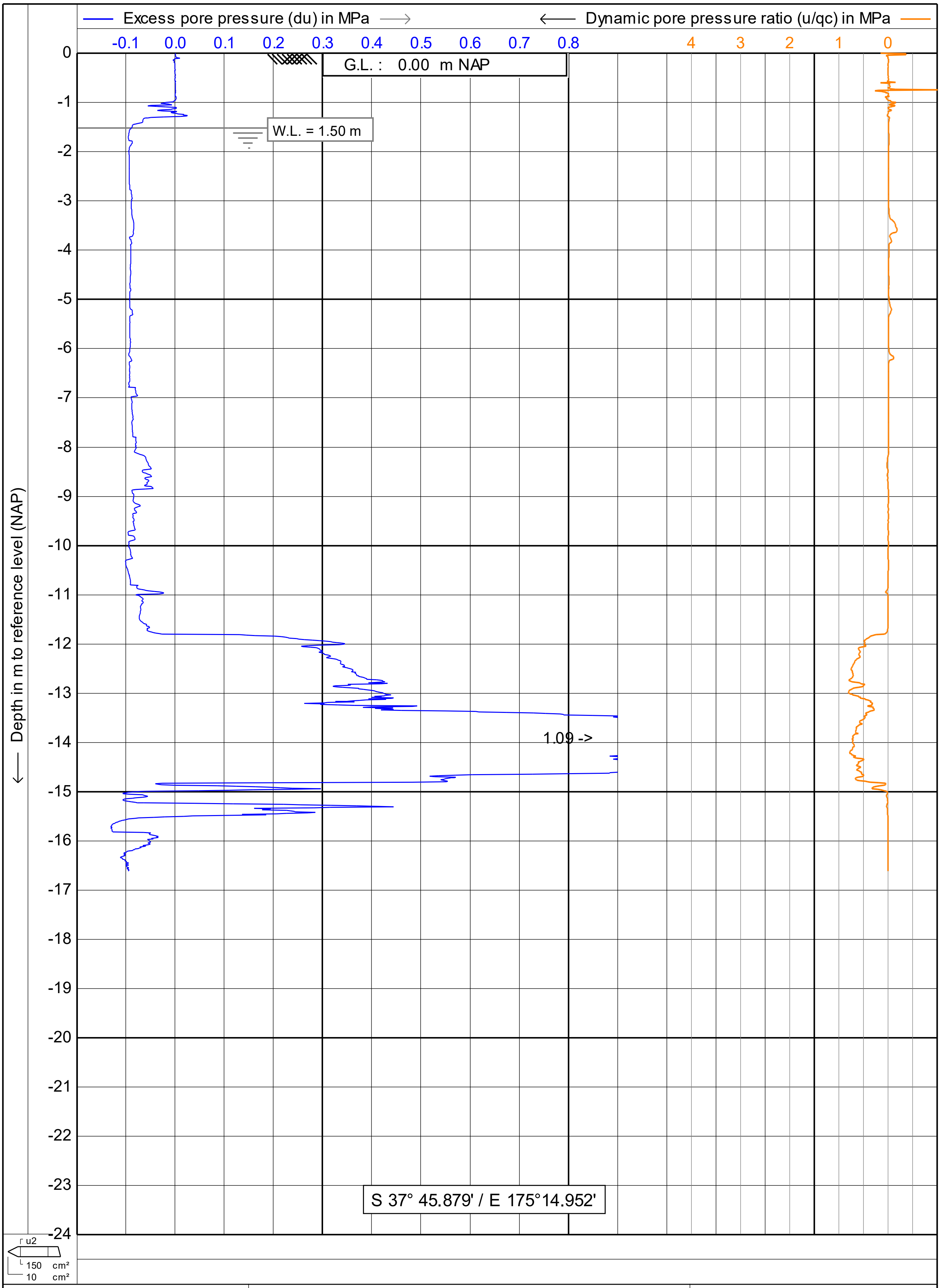
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02** **3/15**

1.47



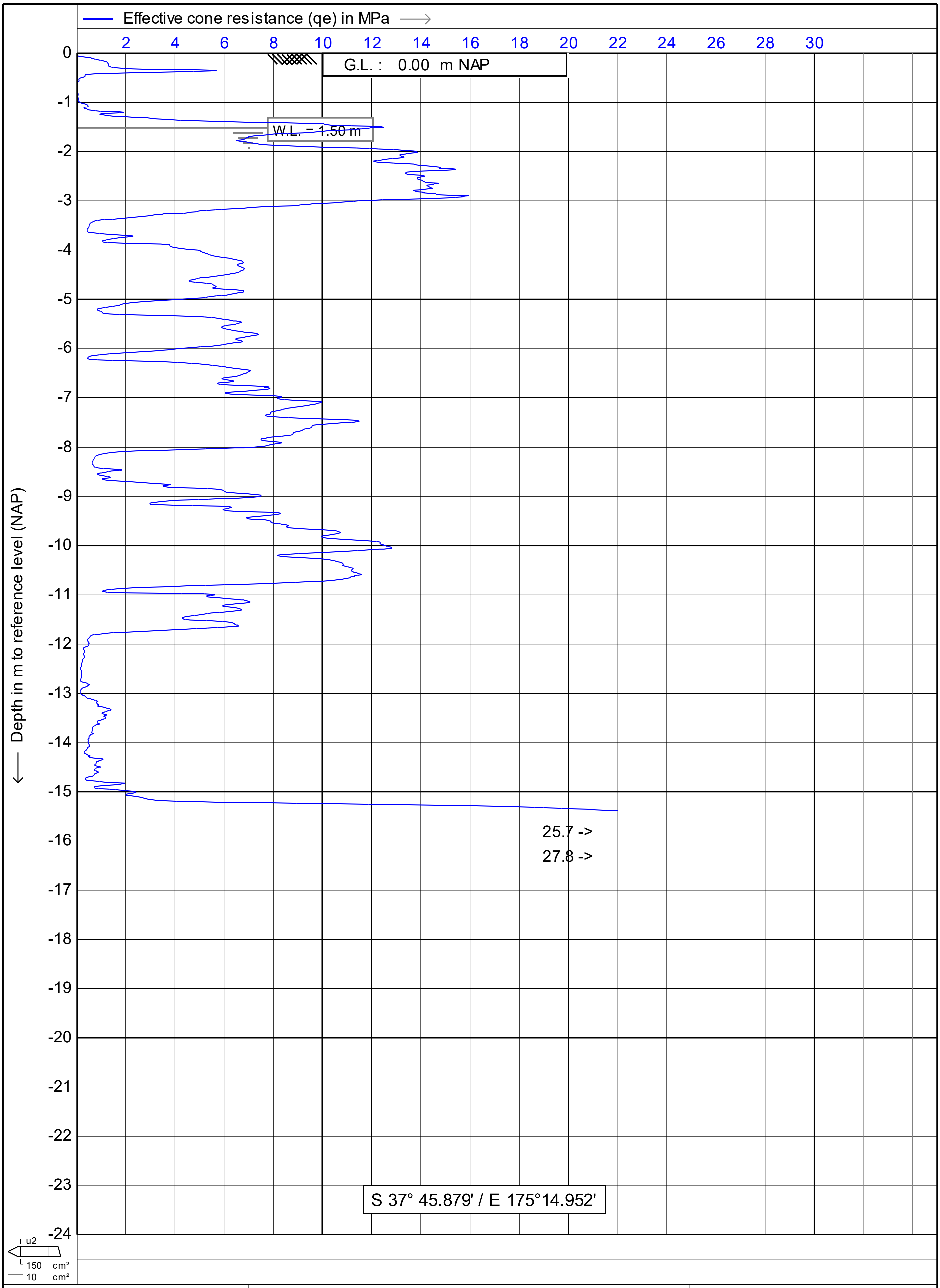
CPT it CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT02** **4/15**

1.47



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

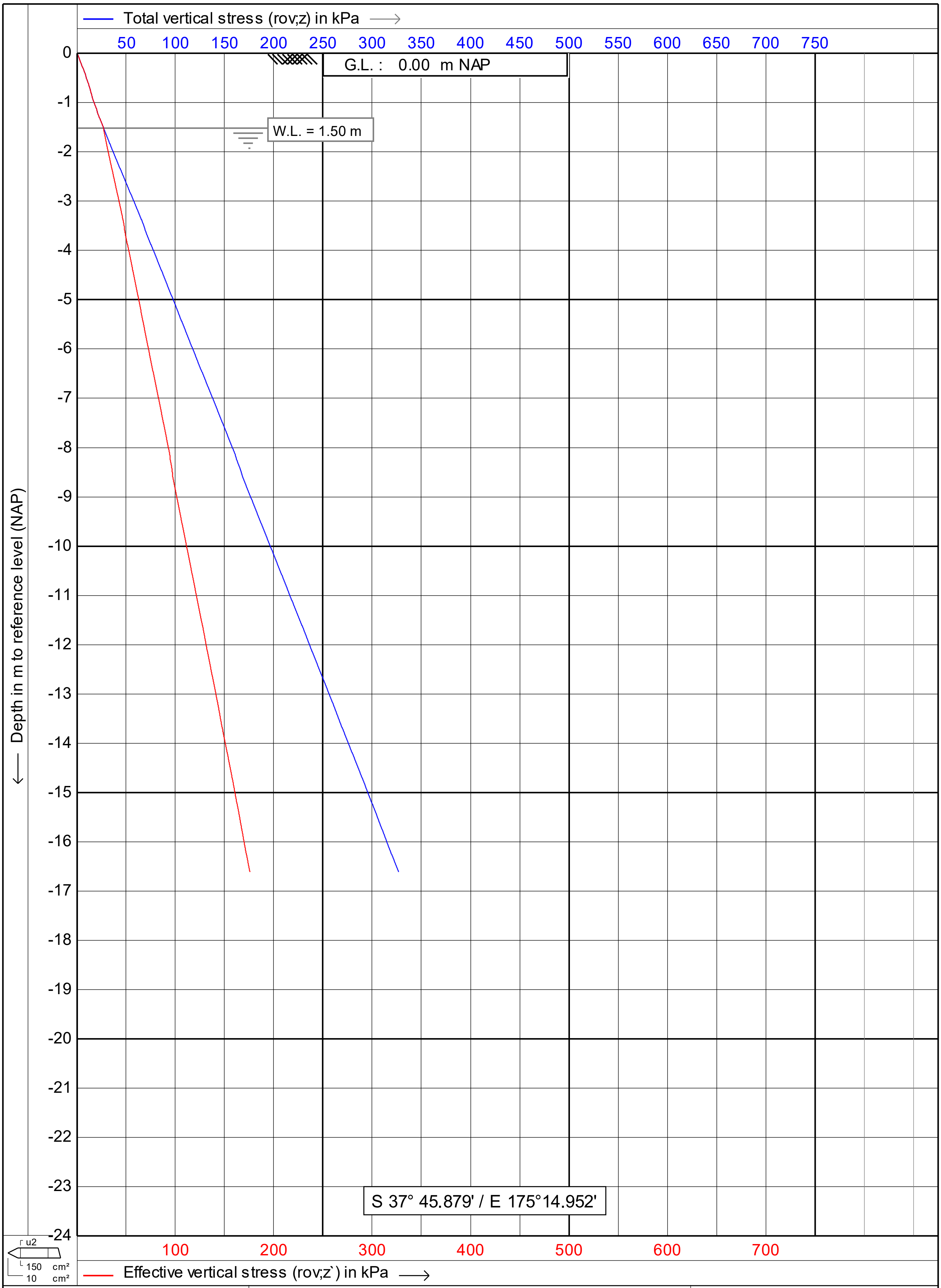
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02** **5/15**

1.47



CONE PENETROMETER TESTING

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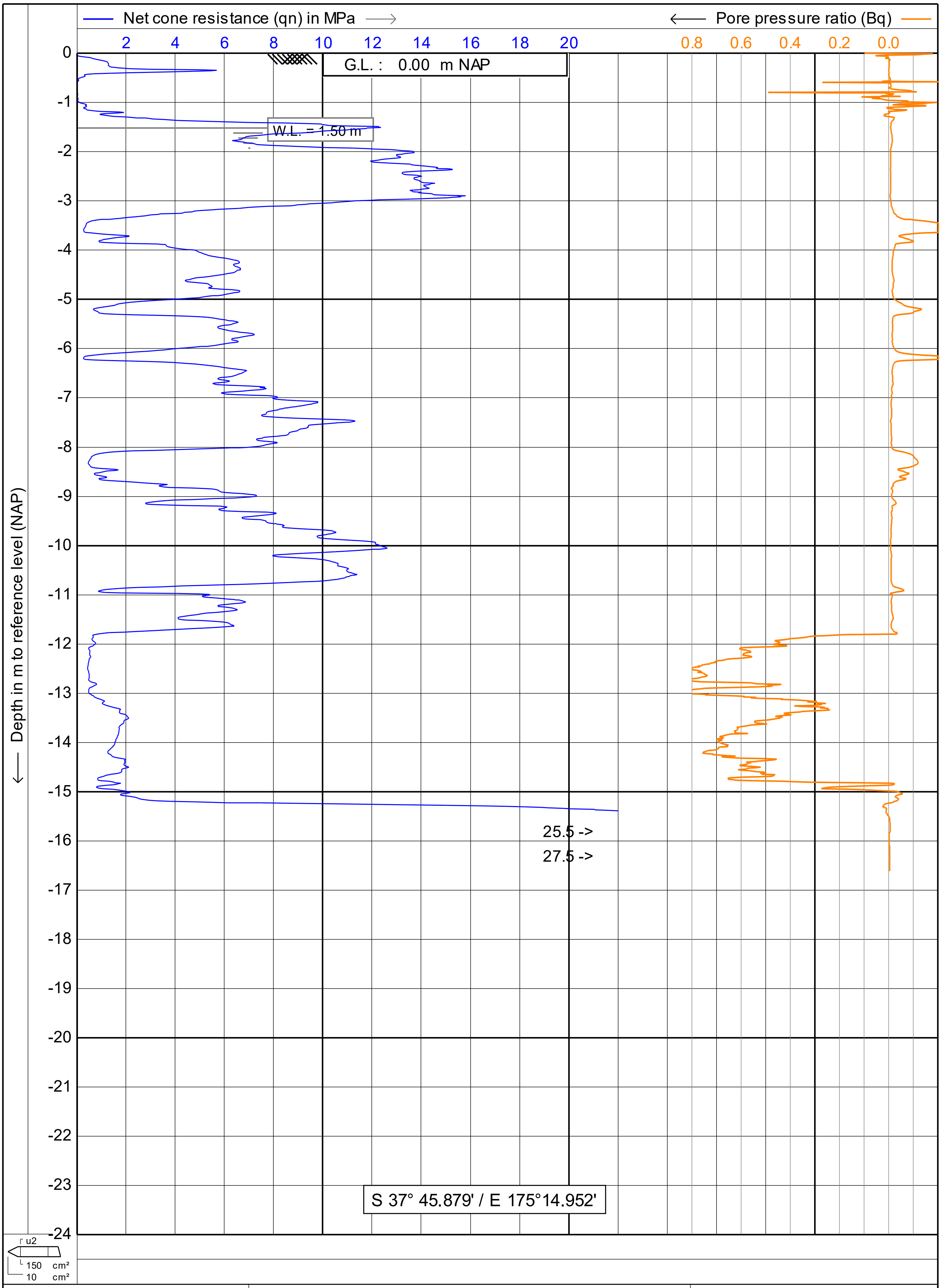
ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no.	: **17017/HAM2017-109**
CPT no.	: **CPT02** **6/15**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

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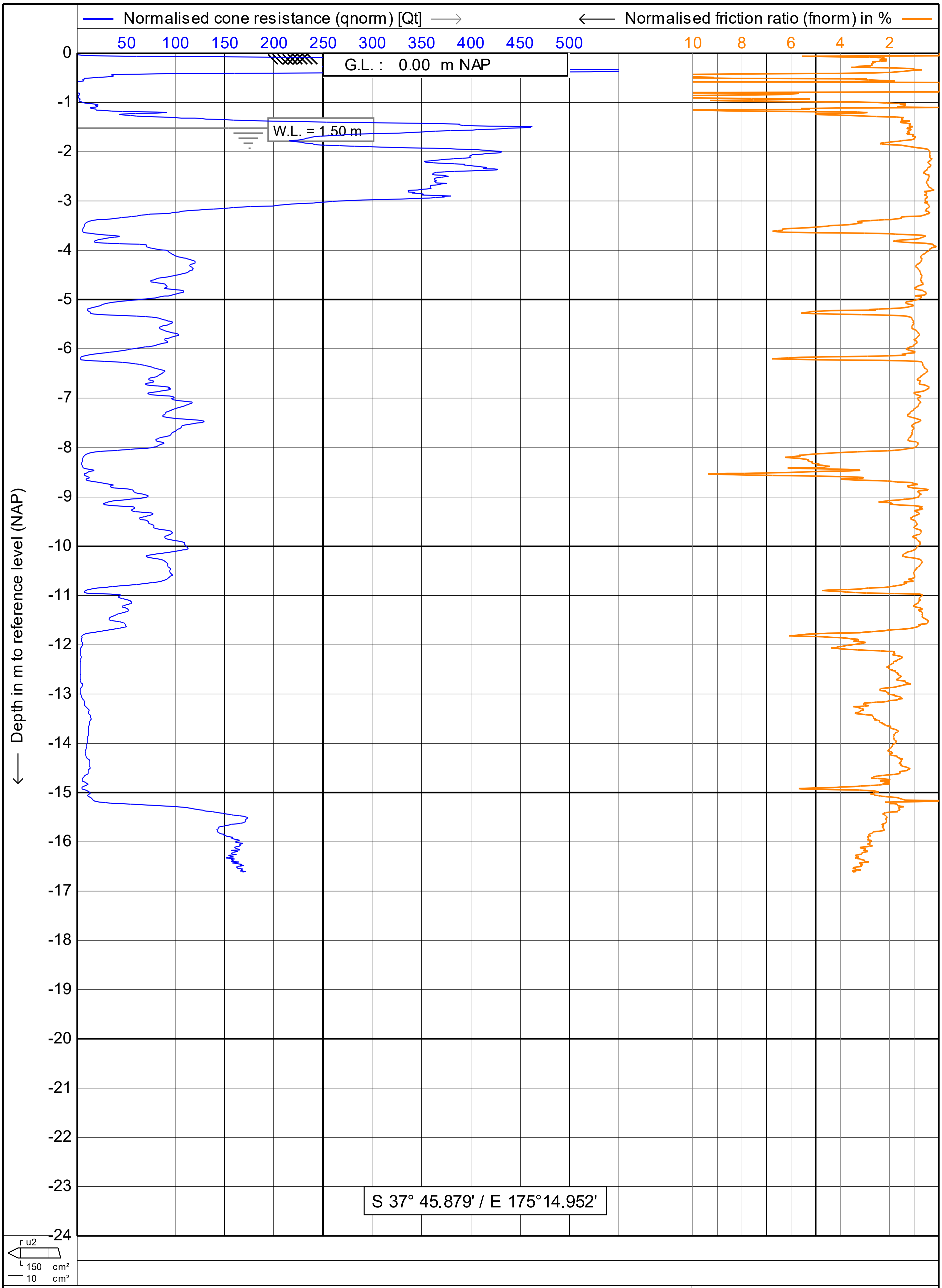
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02** **7/15**

1.47



CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

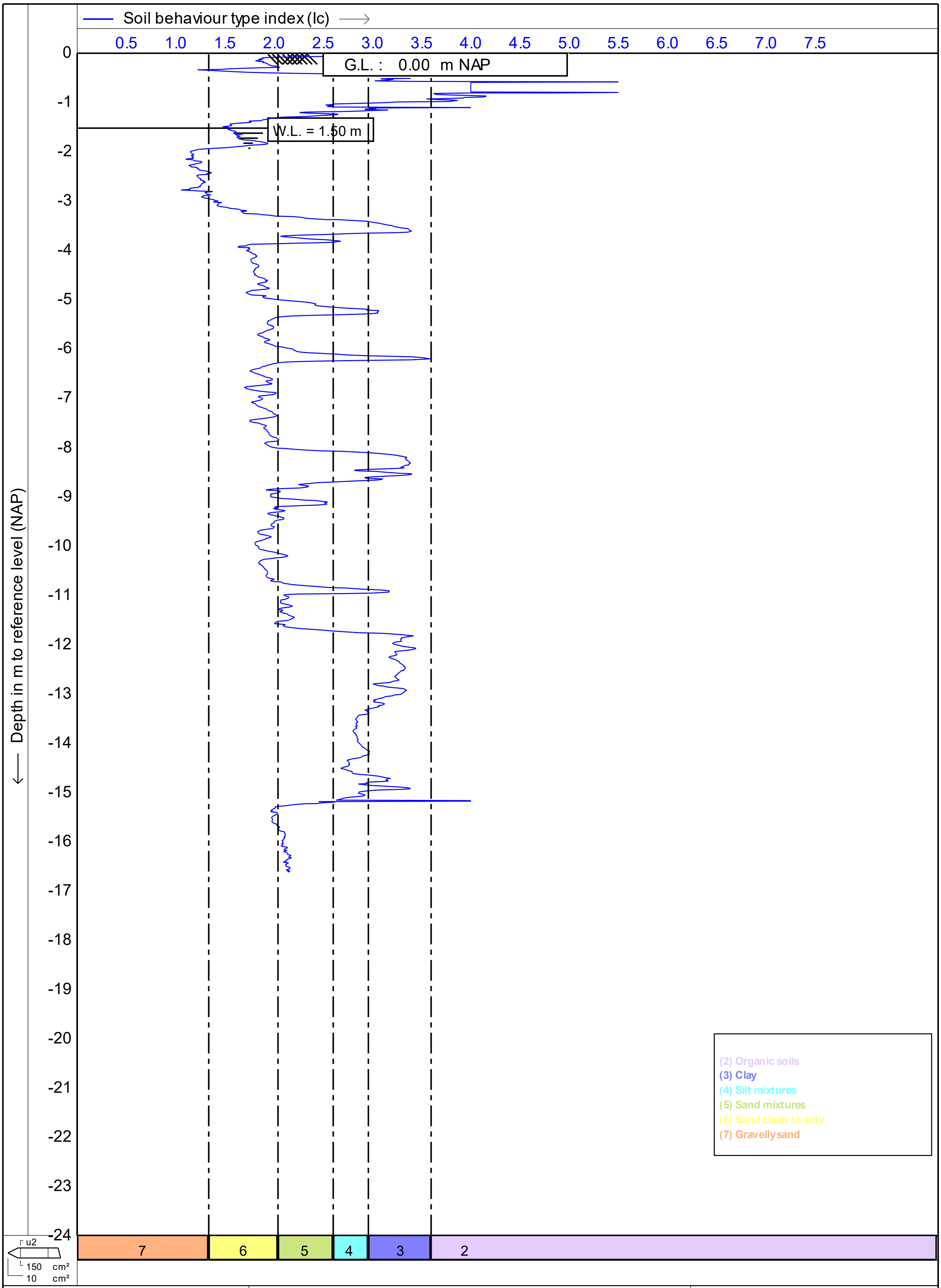
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02** **8/15**

1.47



CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

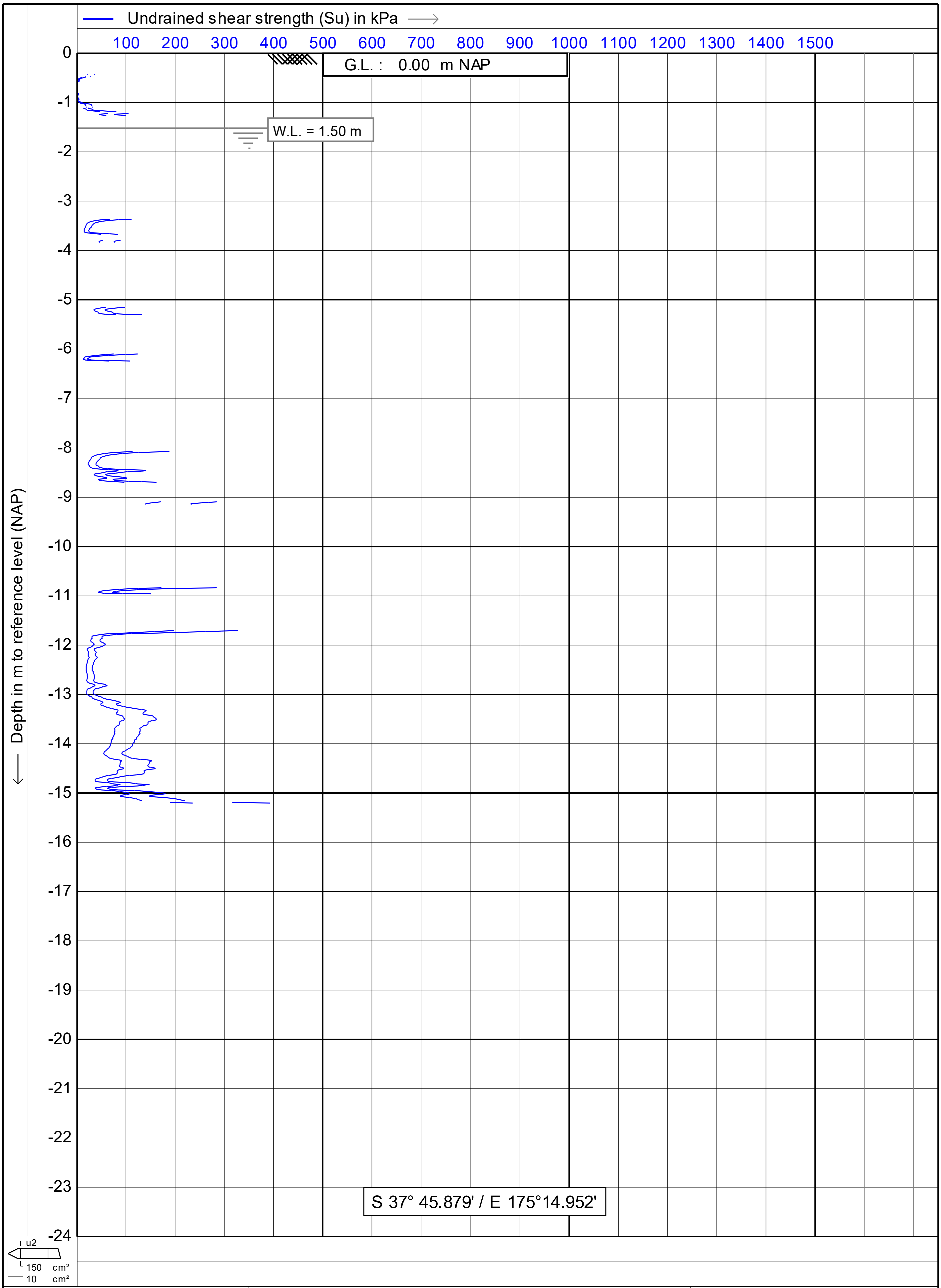
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

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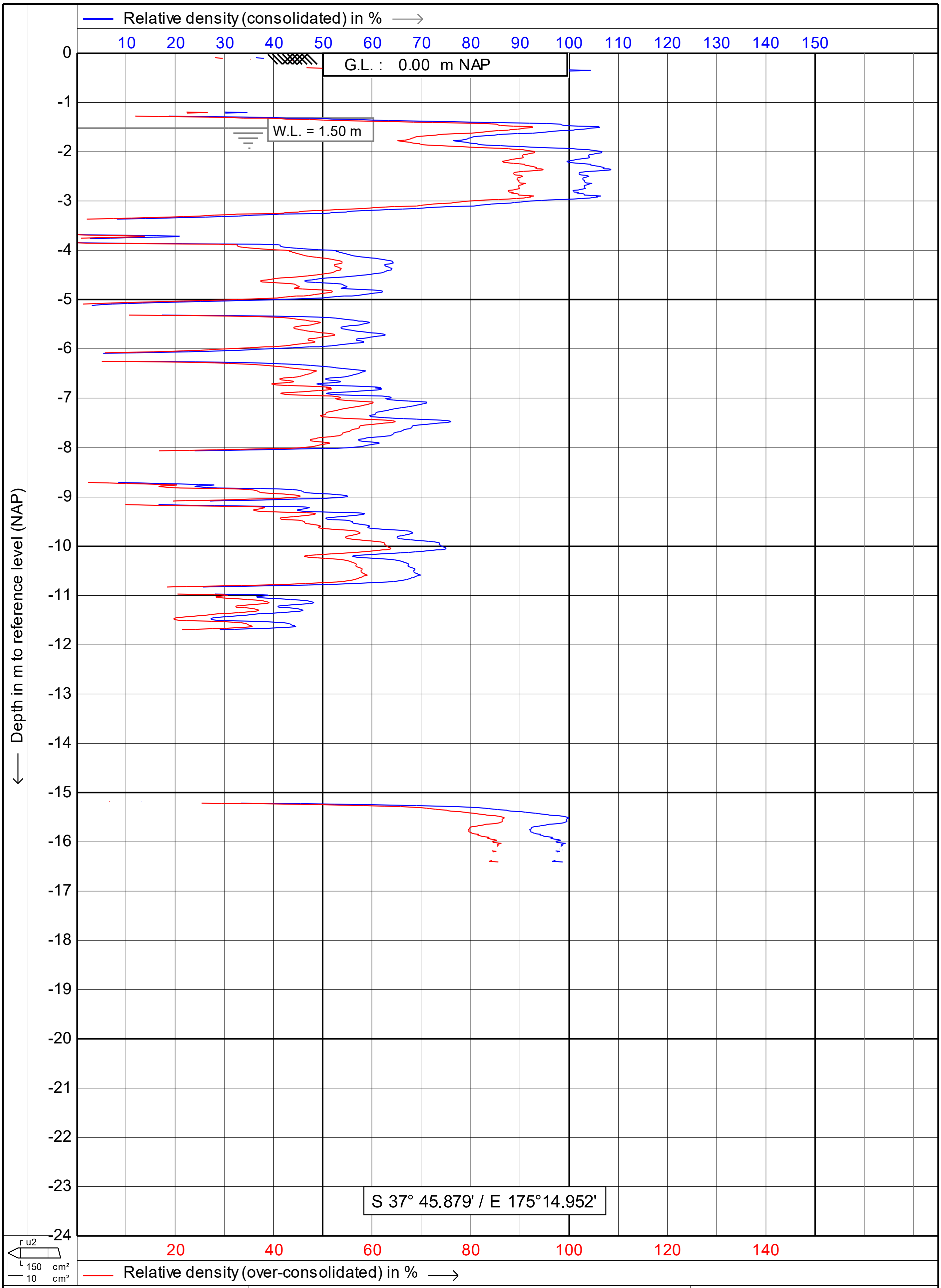
Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

CONE PENETROMETER TESTING

1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

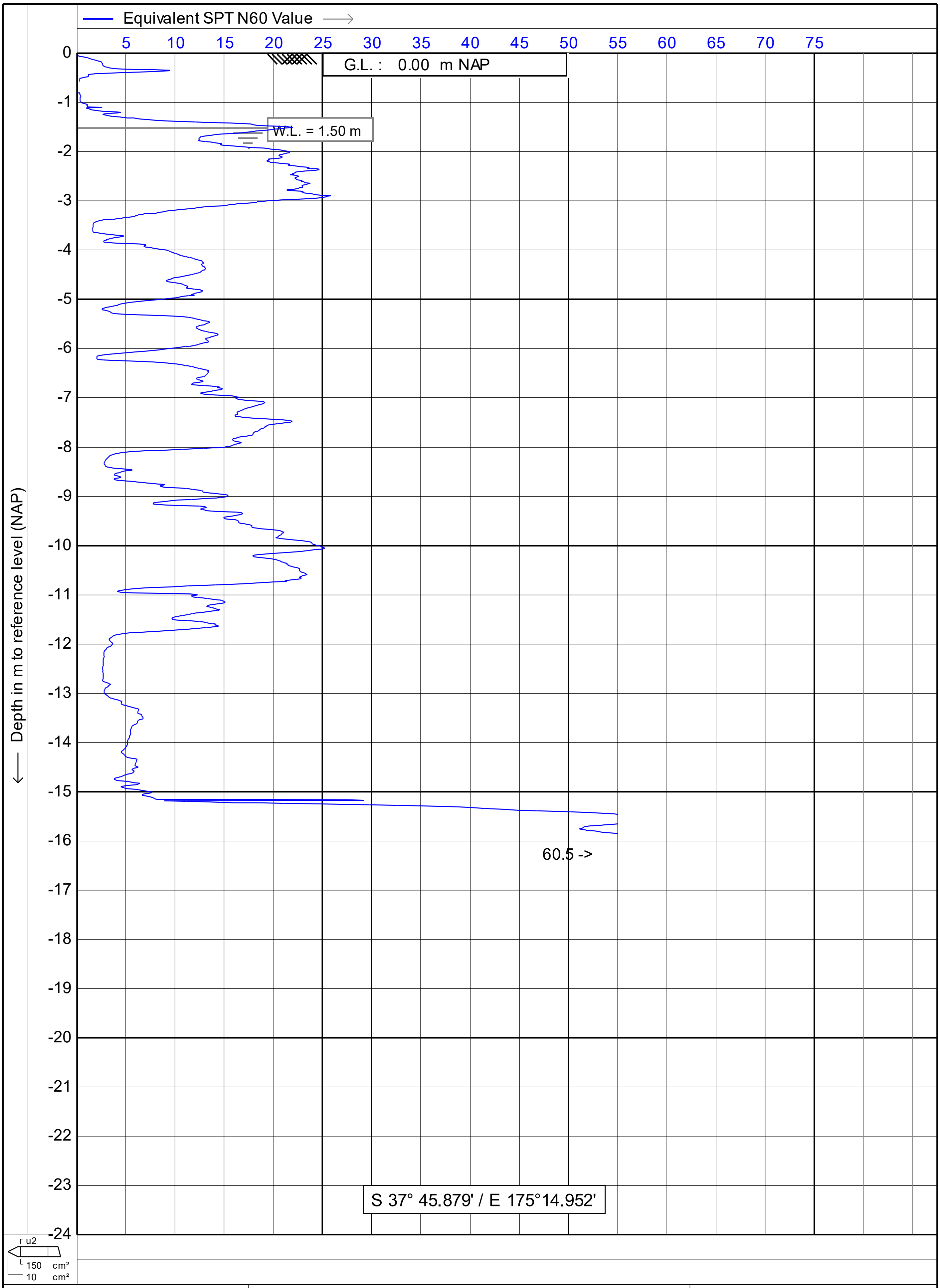
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

CONE PENETROMETER TESTING

1.47



G.L. : 0.00 m NAP

W.L. = 1.50 m

60.5 ->

S 37° 45.879' / E 175°14.952'

1.47

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

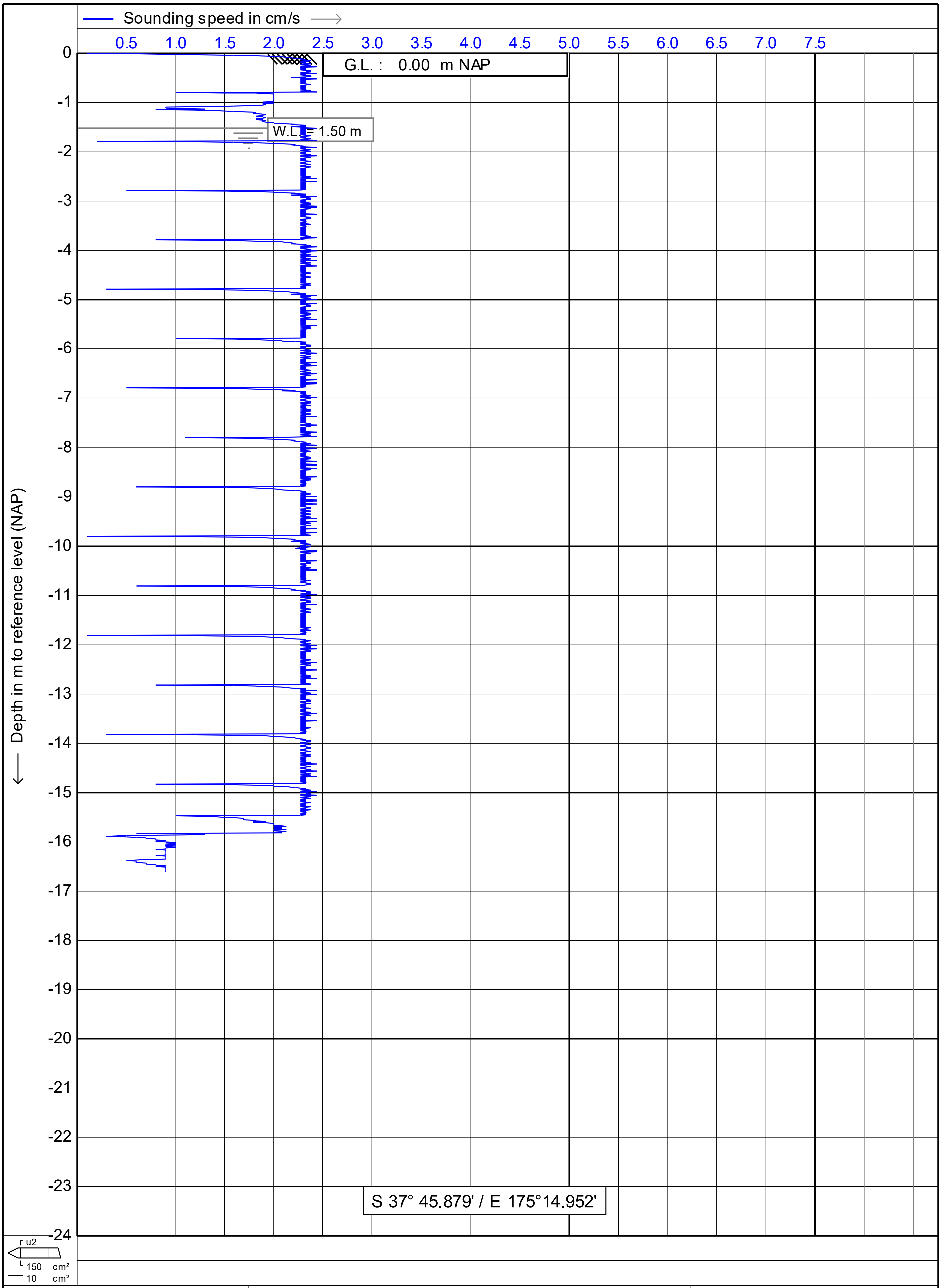
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

12/15



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CPT it CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

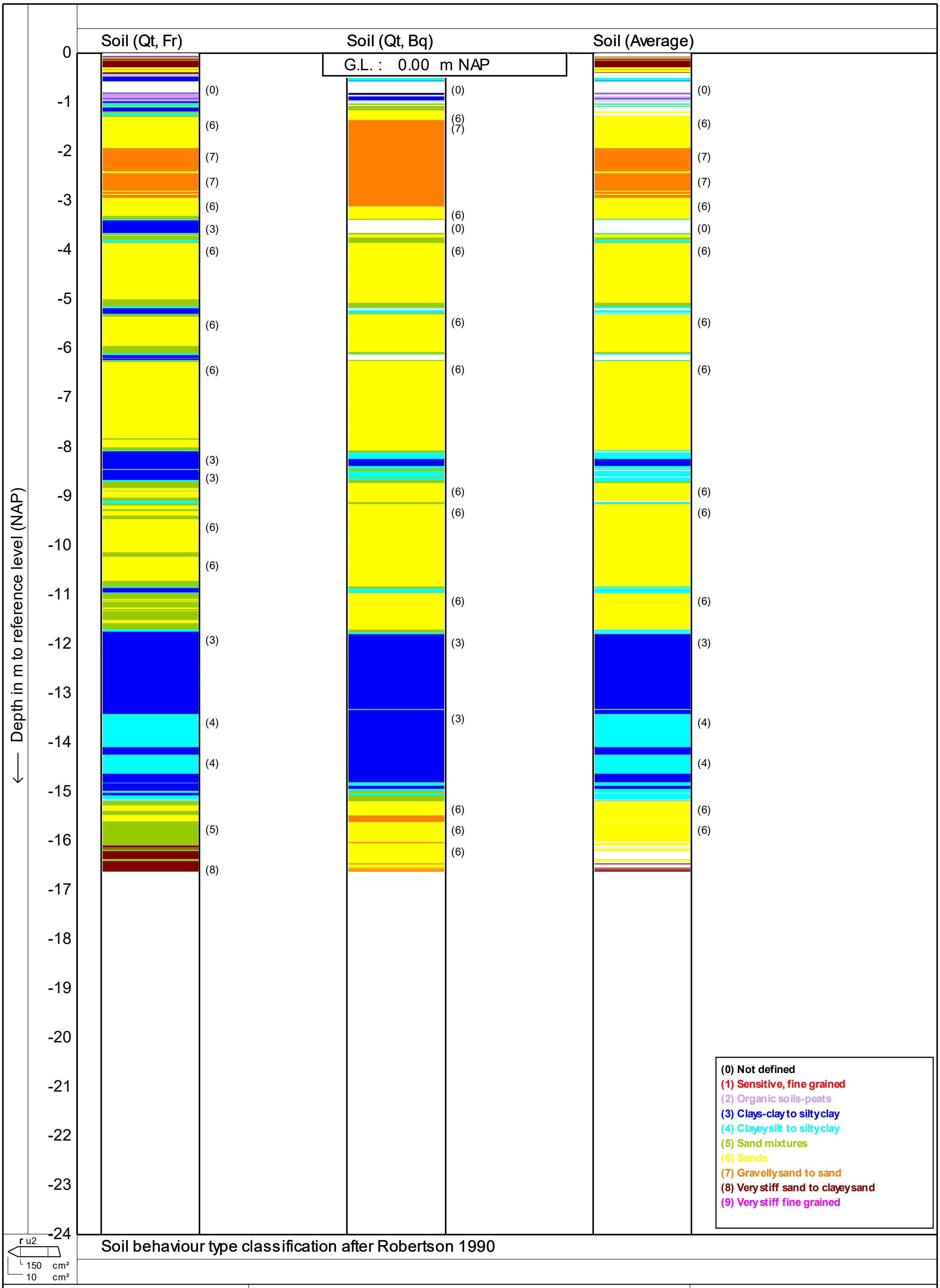
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

13/15



Soil behaviour type classification after Robertson 1990

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT02**

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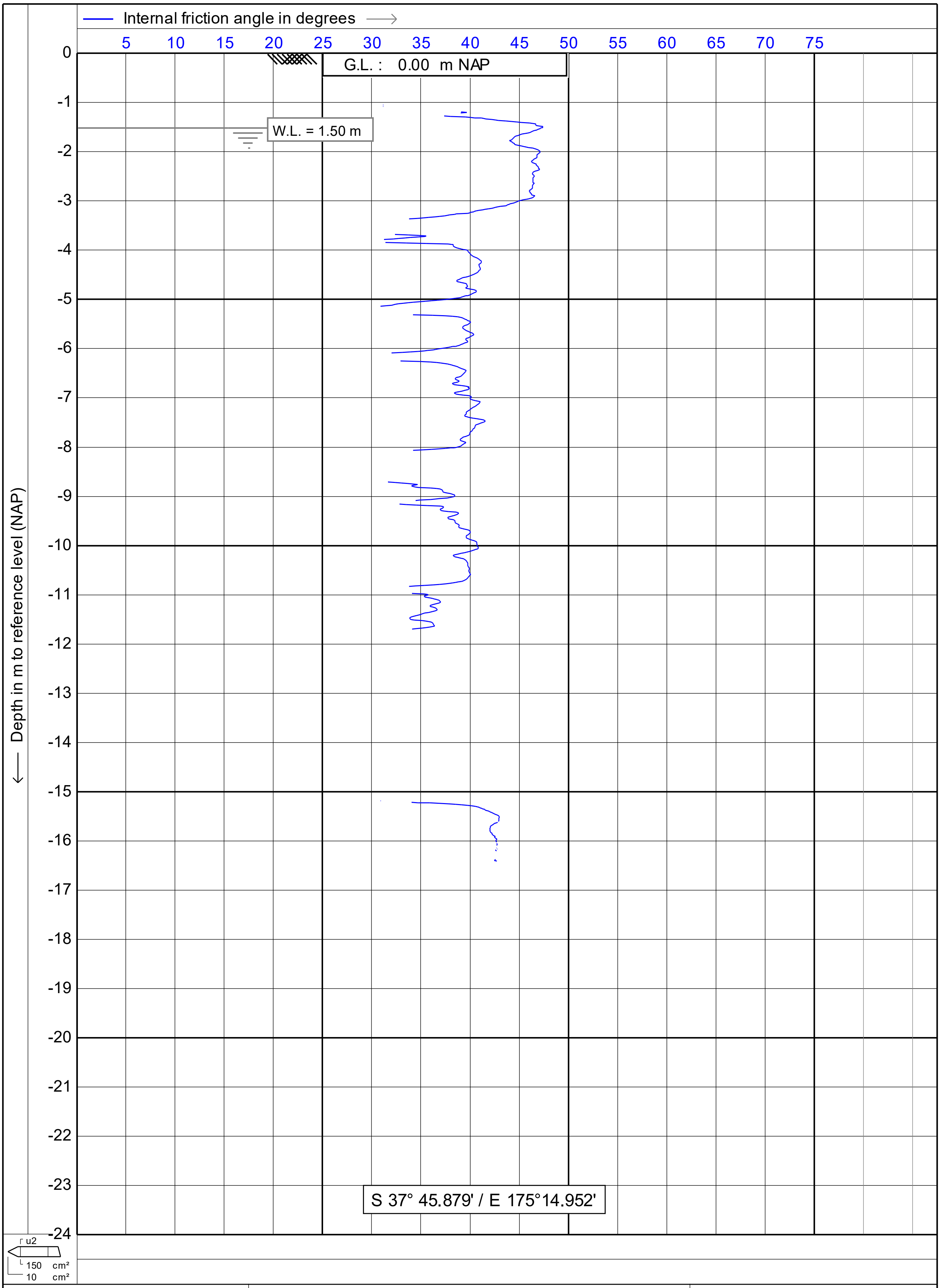


CONE PENETROMETER TESTING

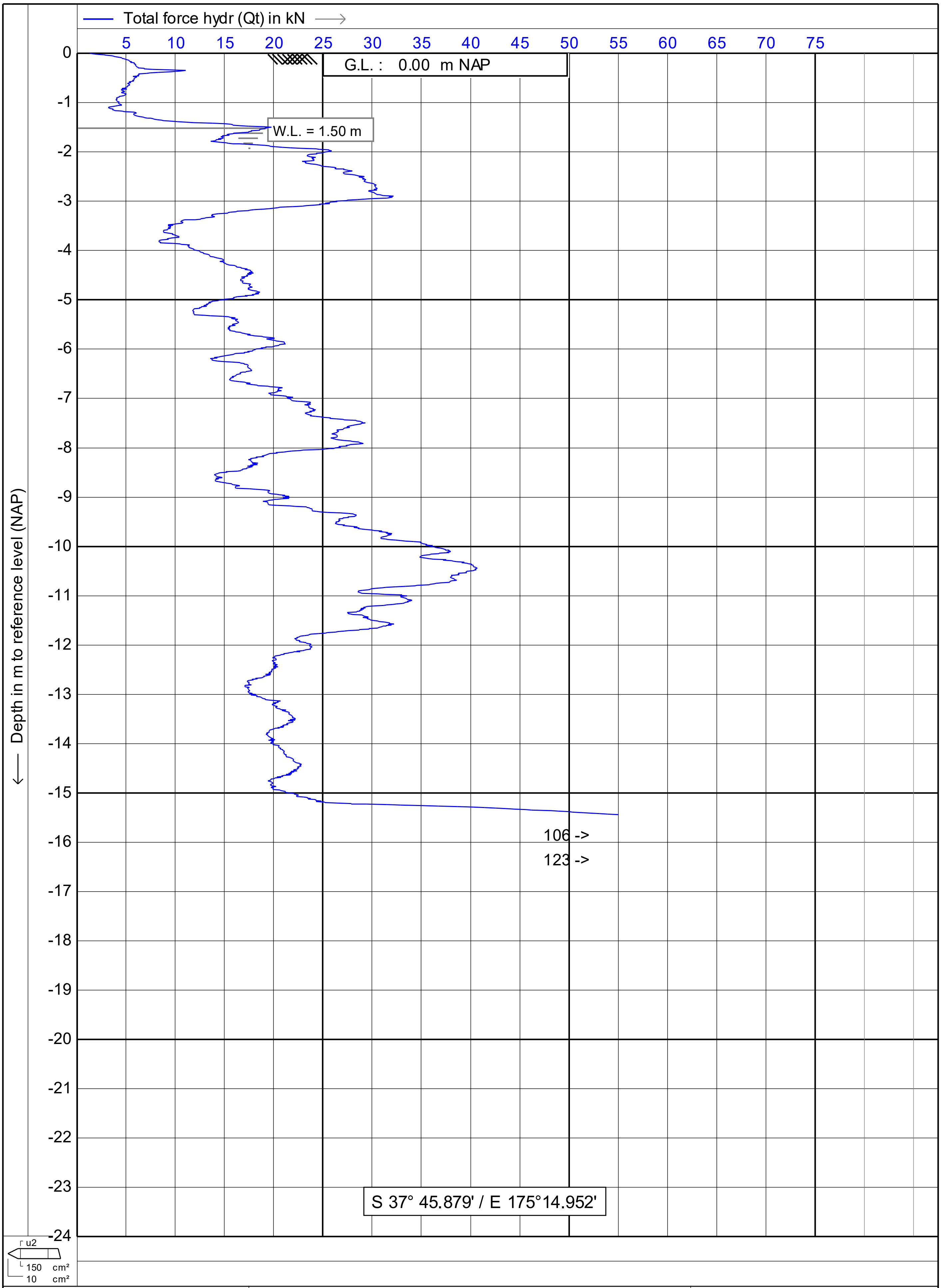
ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT02**

15/15

1.47



CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT02**
16/15

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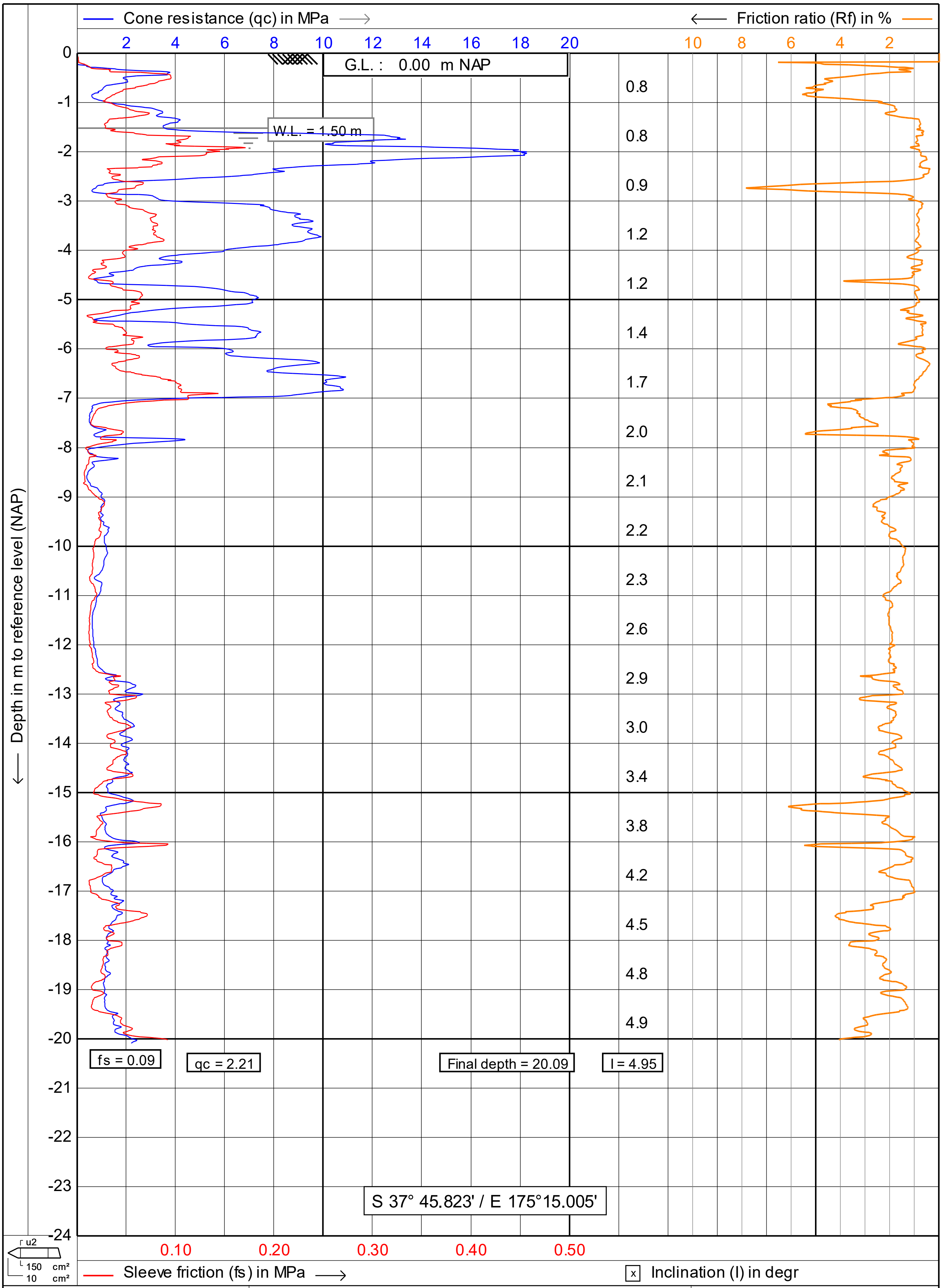


CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

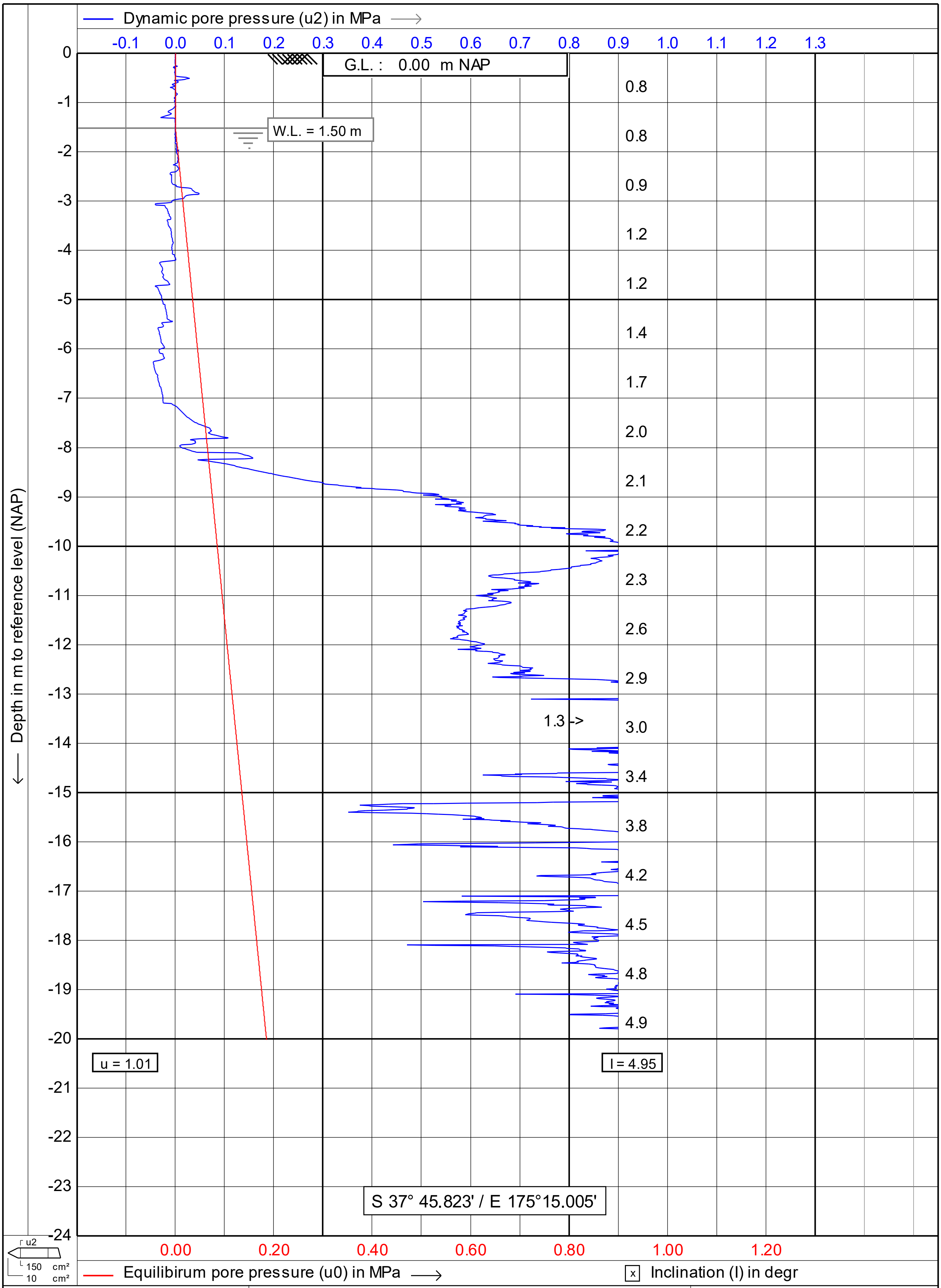
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03** **1/15**

1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03** **2/15**

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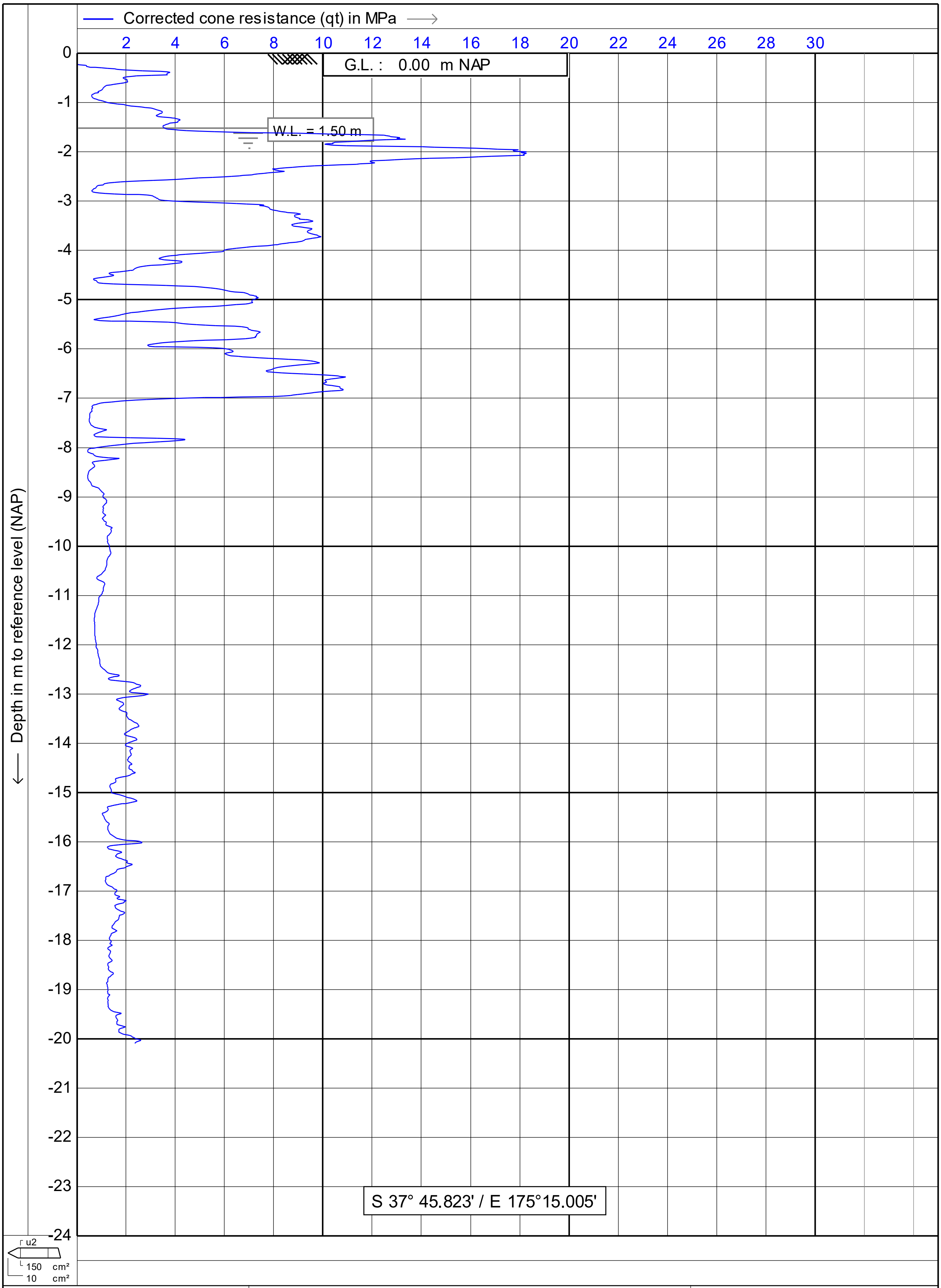


CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

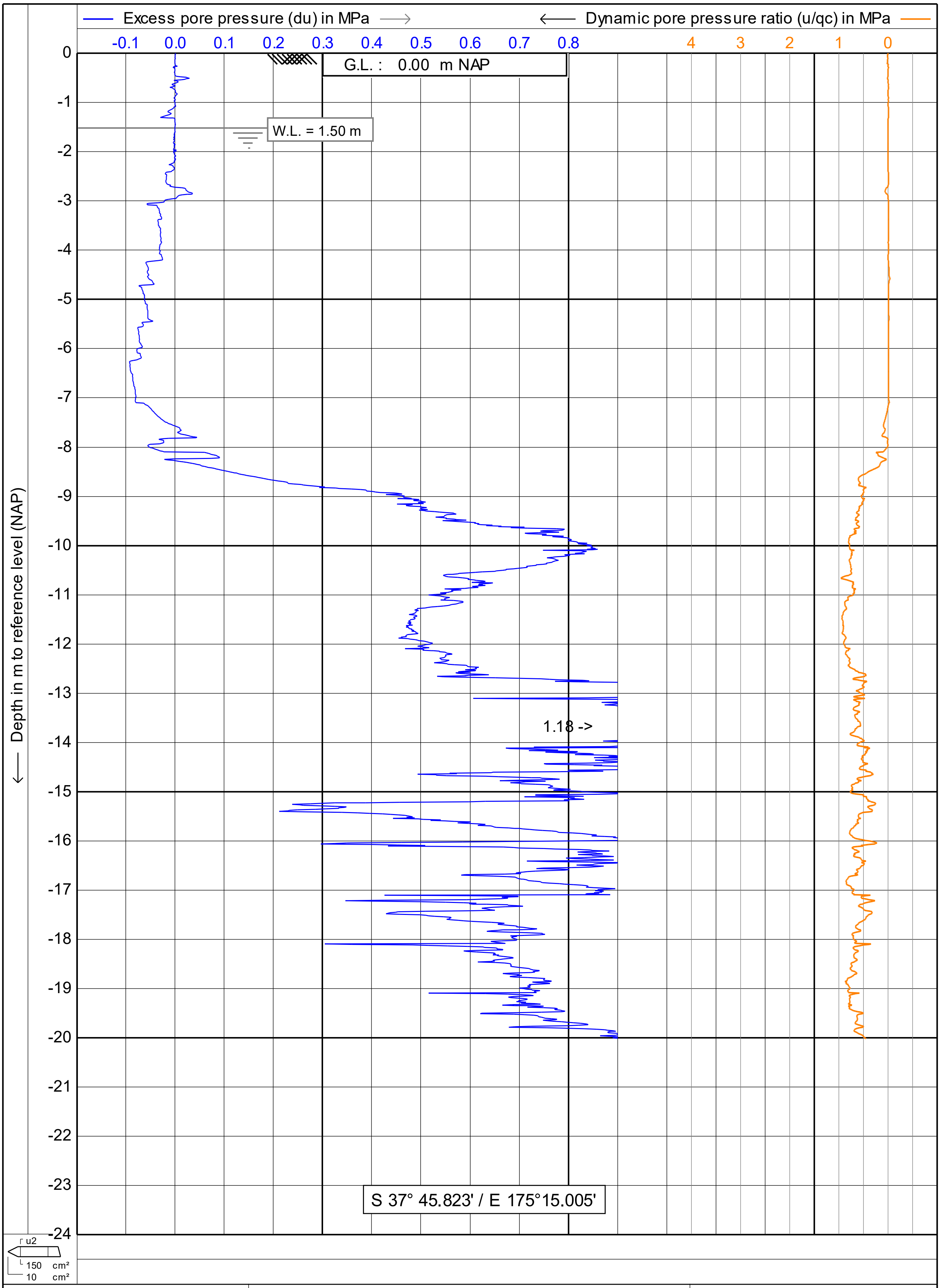
Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no. :	**17017/HAM2017-109**
CPT no.	: **CPT03** **3/15**

1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

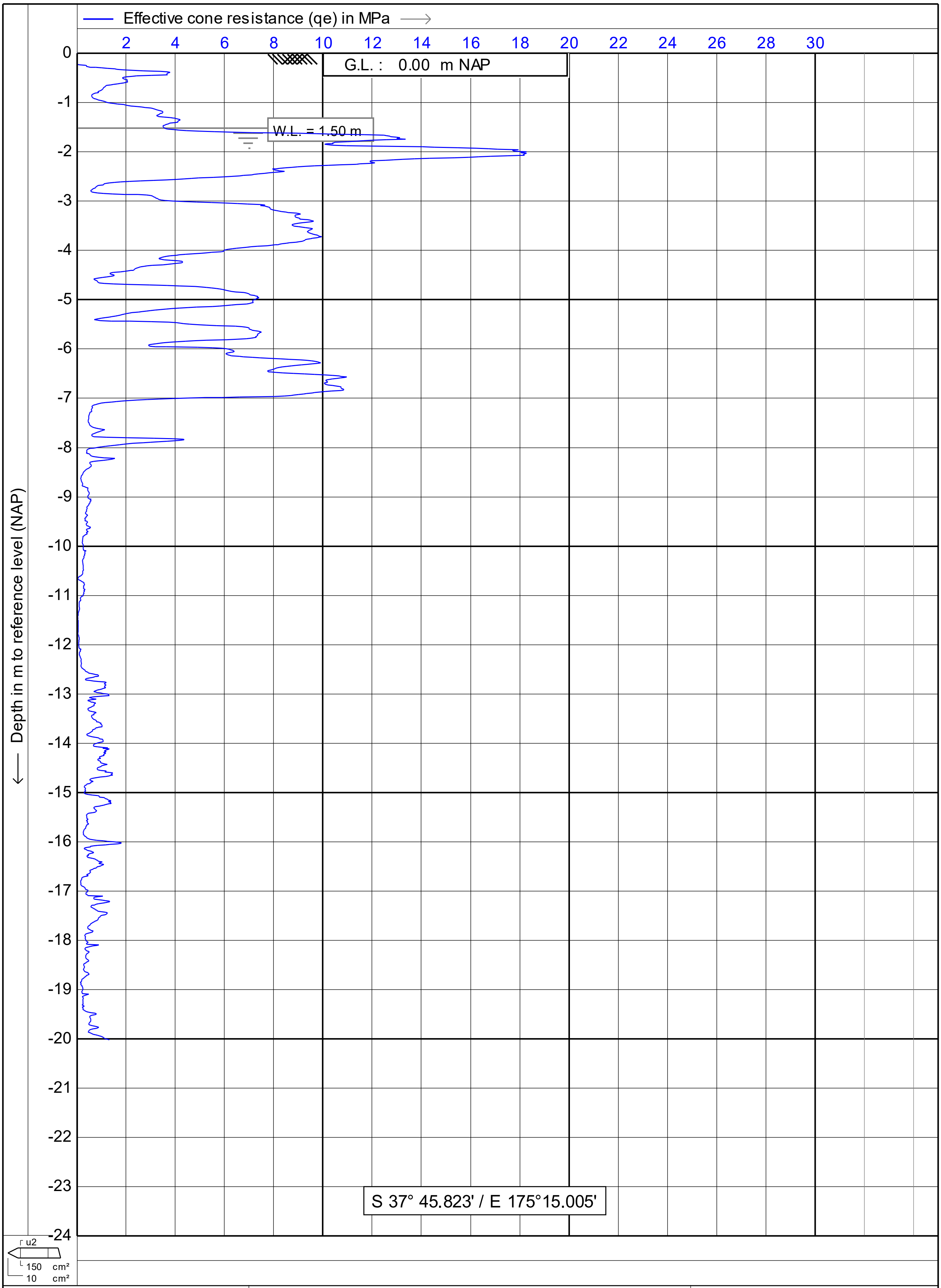
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

CONE PENETROMETER TESTING



CONE PENETROMETER TESTING

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ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

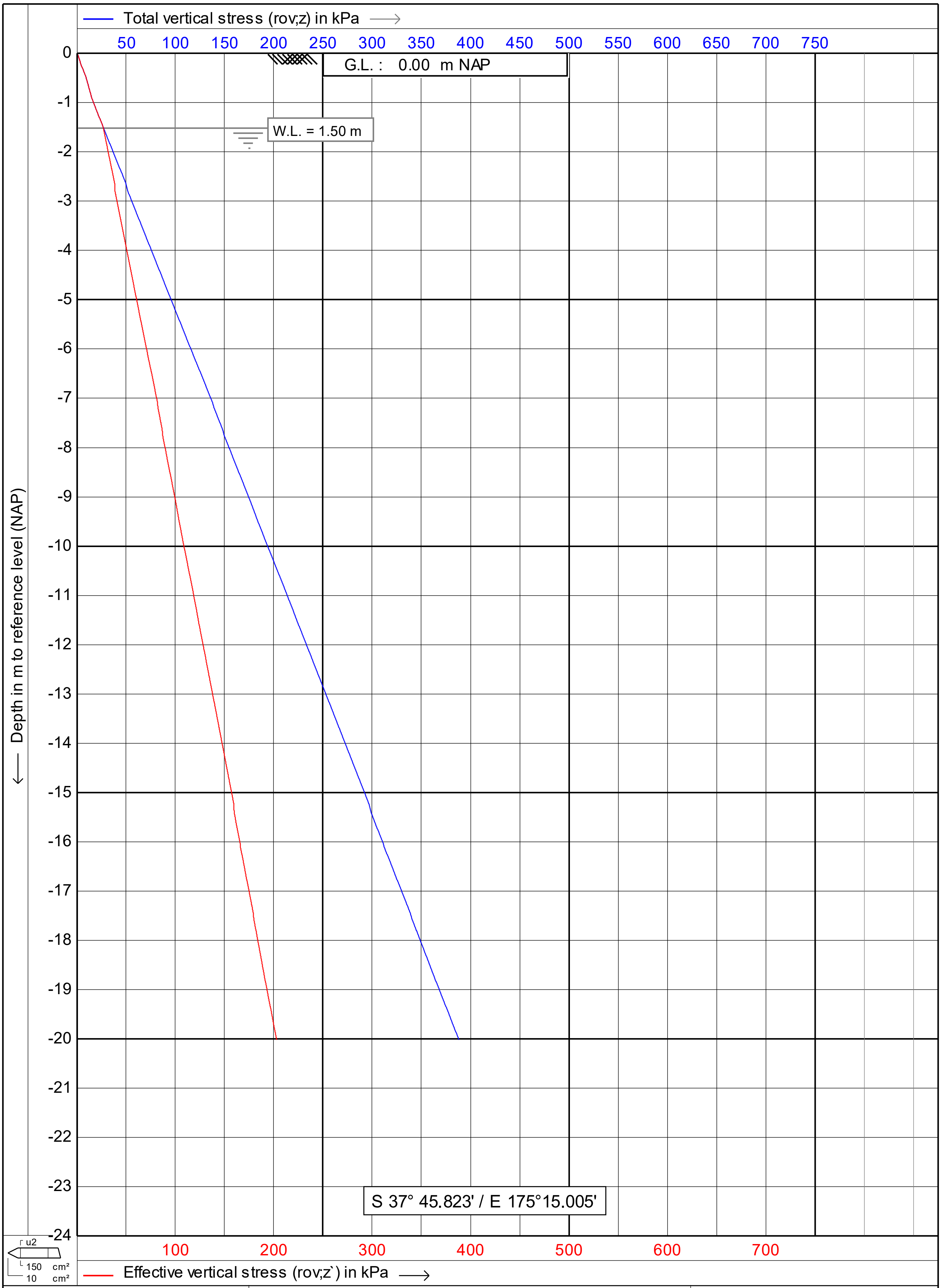
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

5/15



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

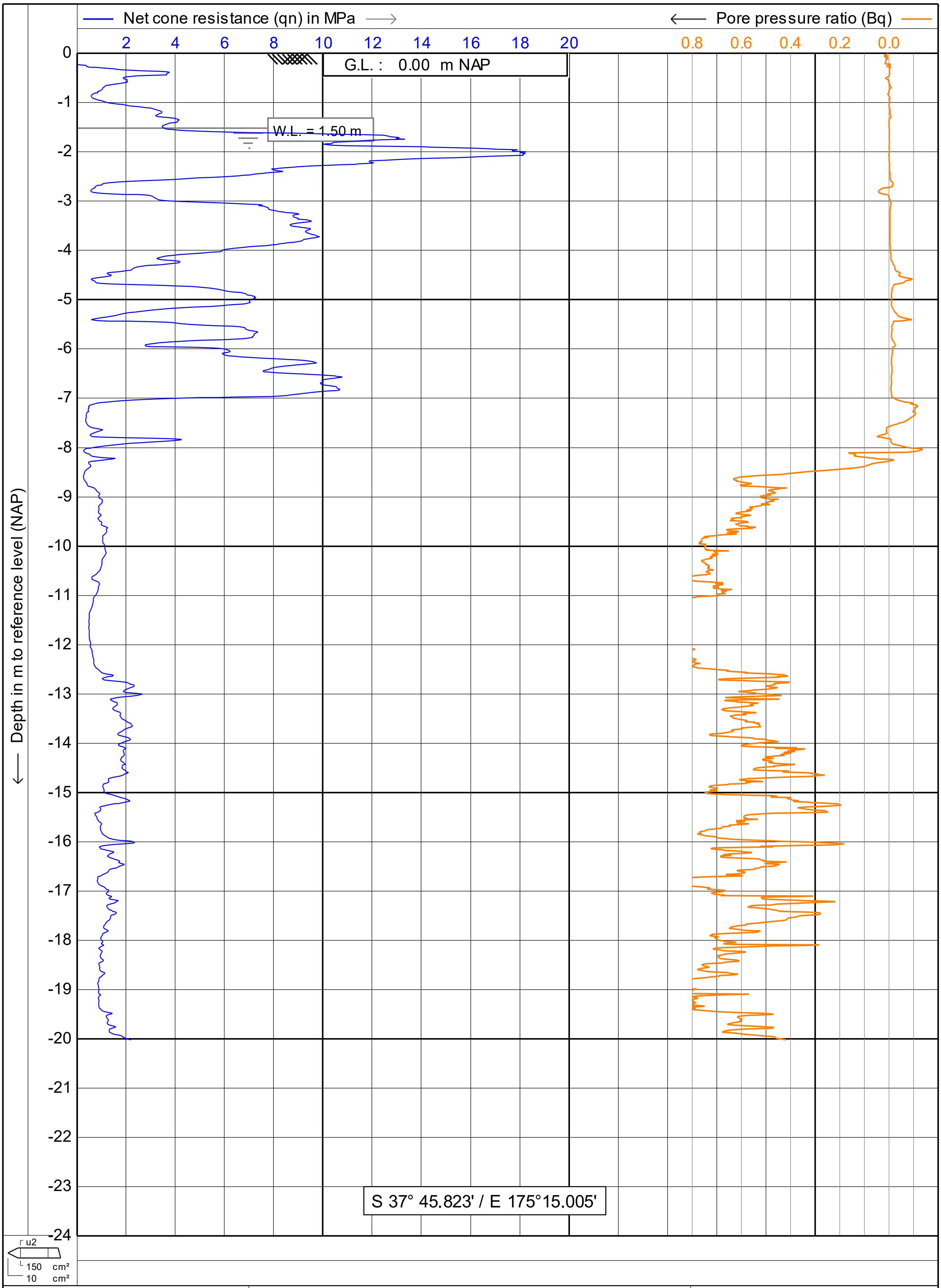
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

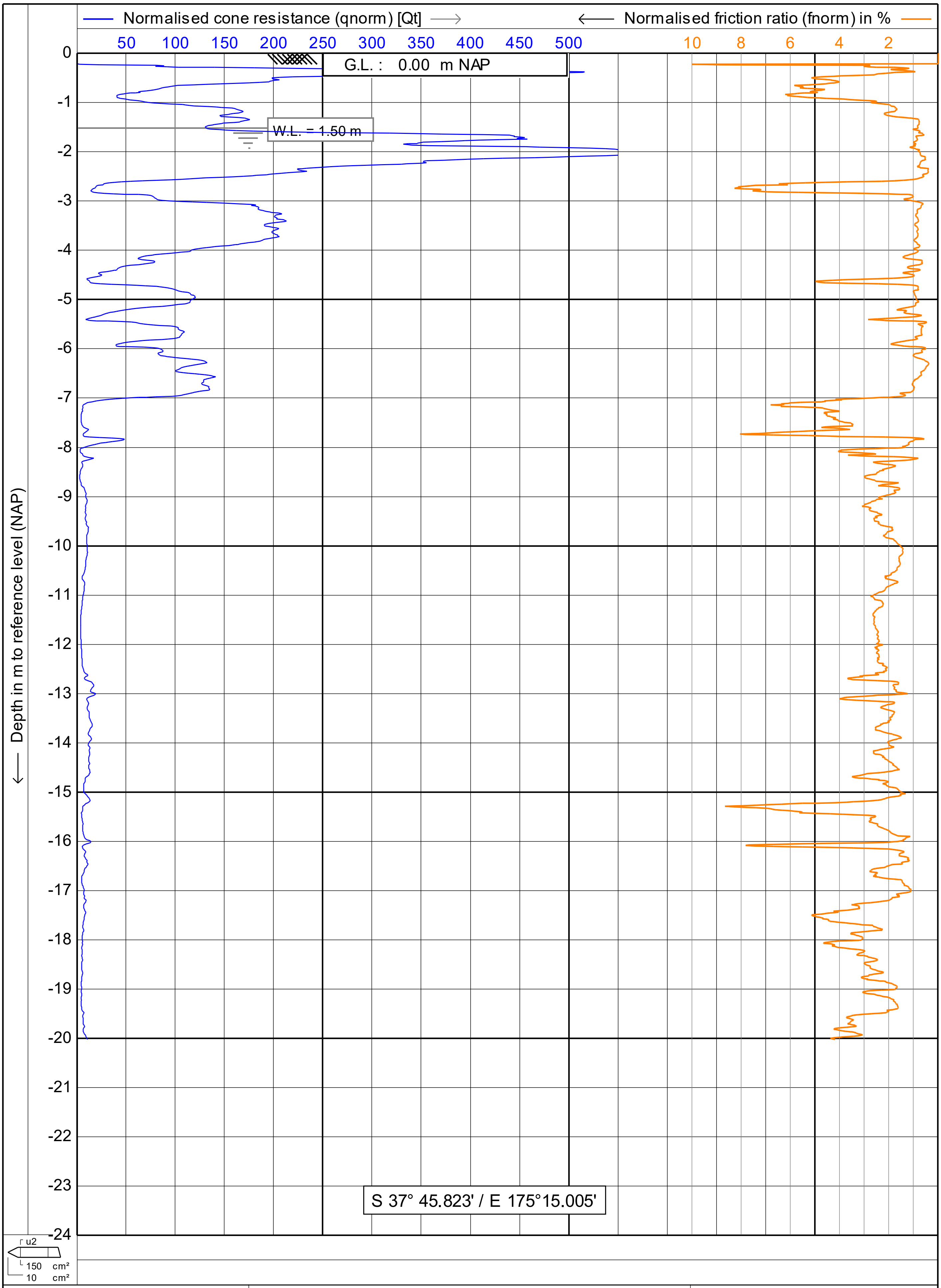
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03** **7/15**

1.47



CONE PENETROMETER TESTING

1.47

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

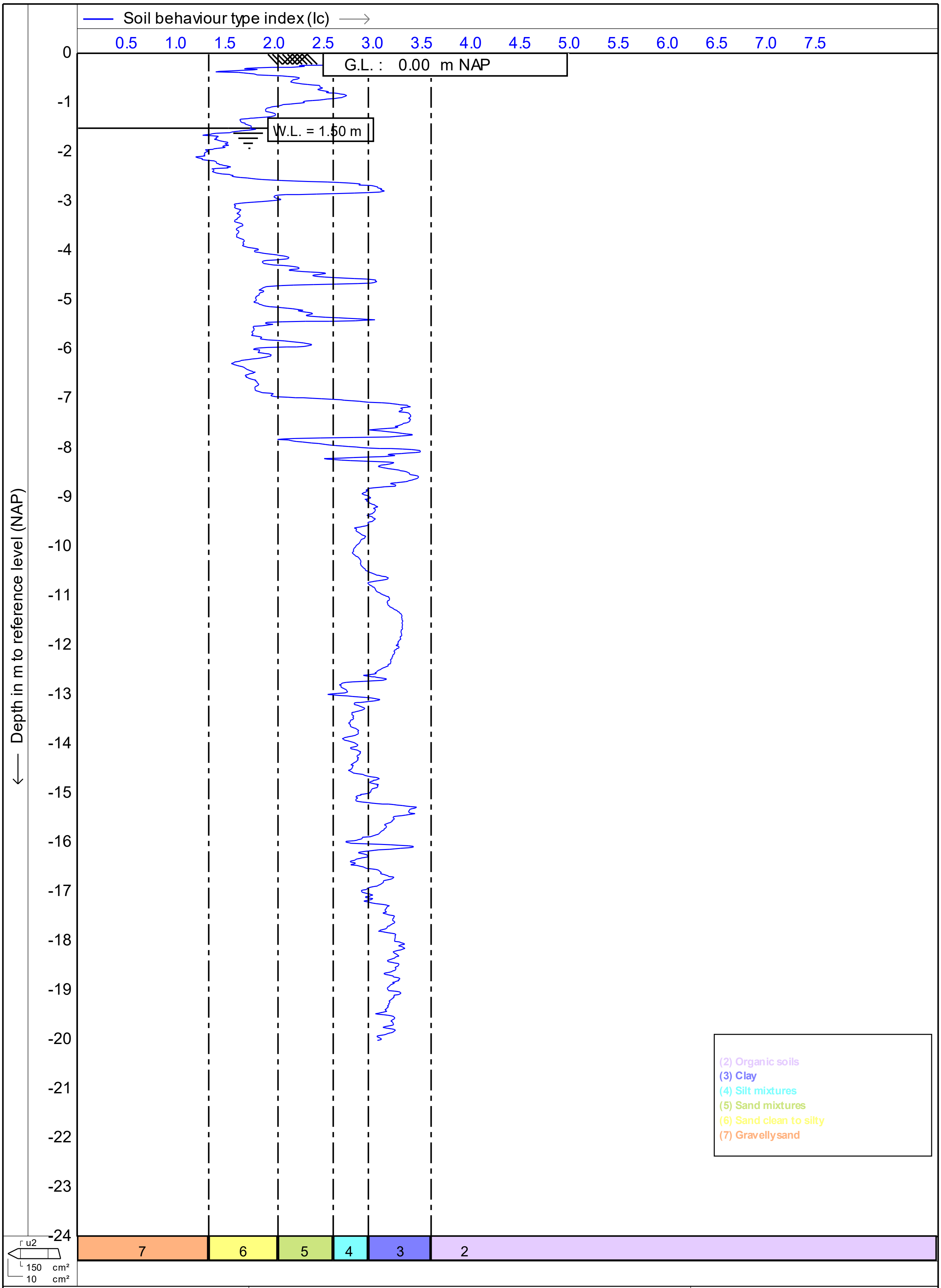
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03** **8/15**



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ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

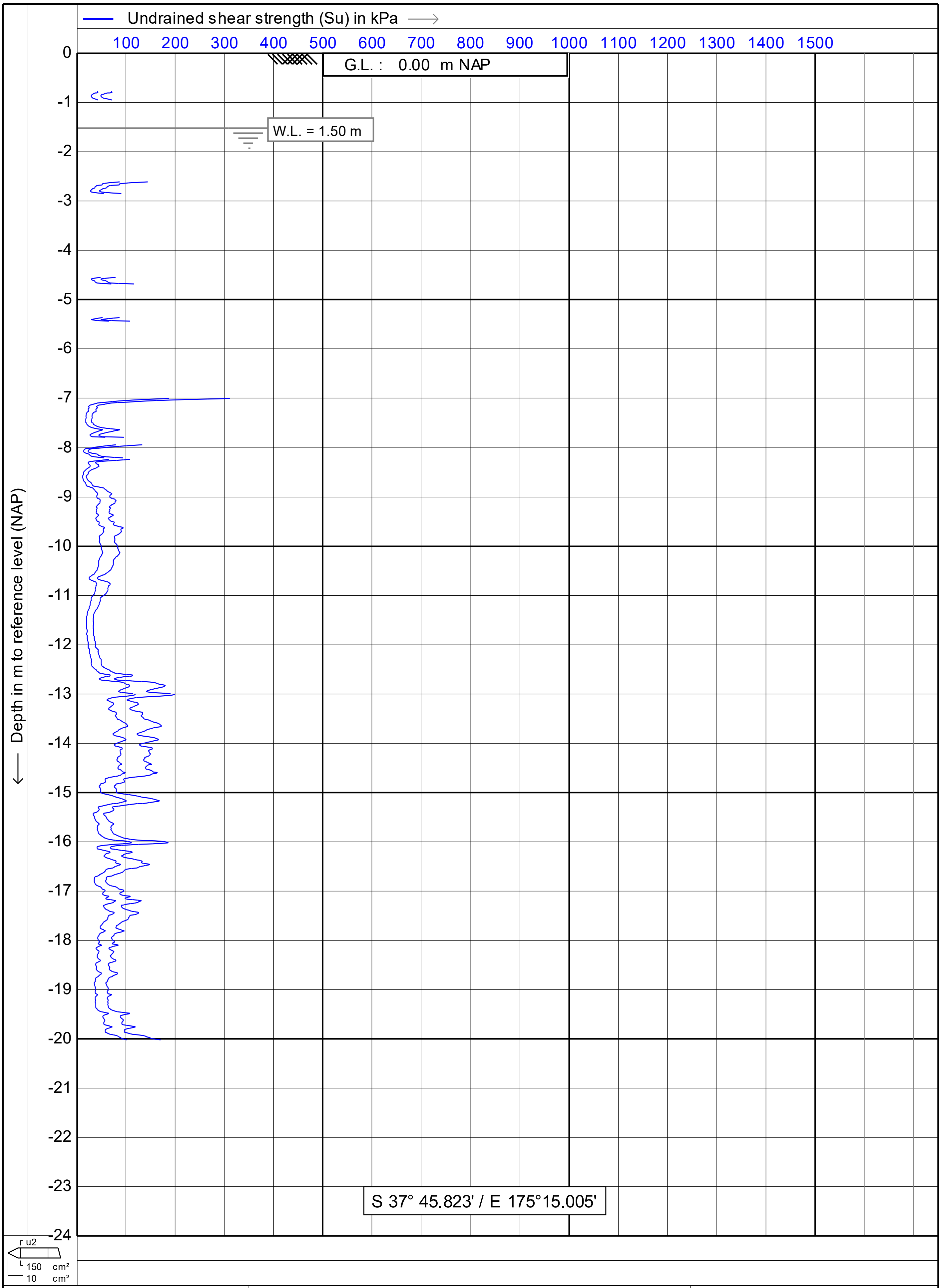
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03** **9/15**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

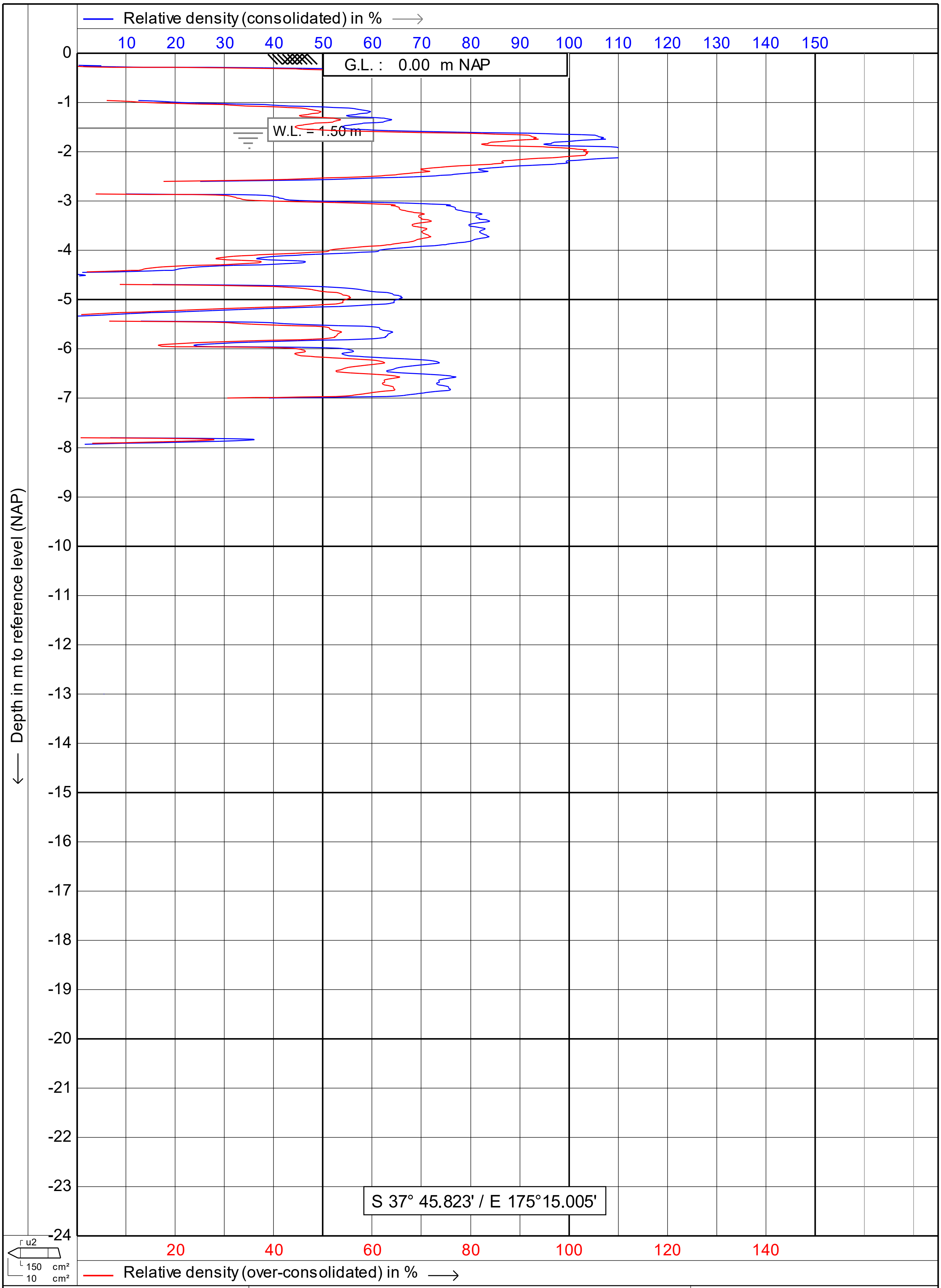
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

10/15

1.47



CONE PENETROMETER TESTING

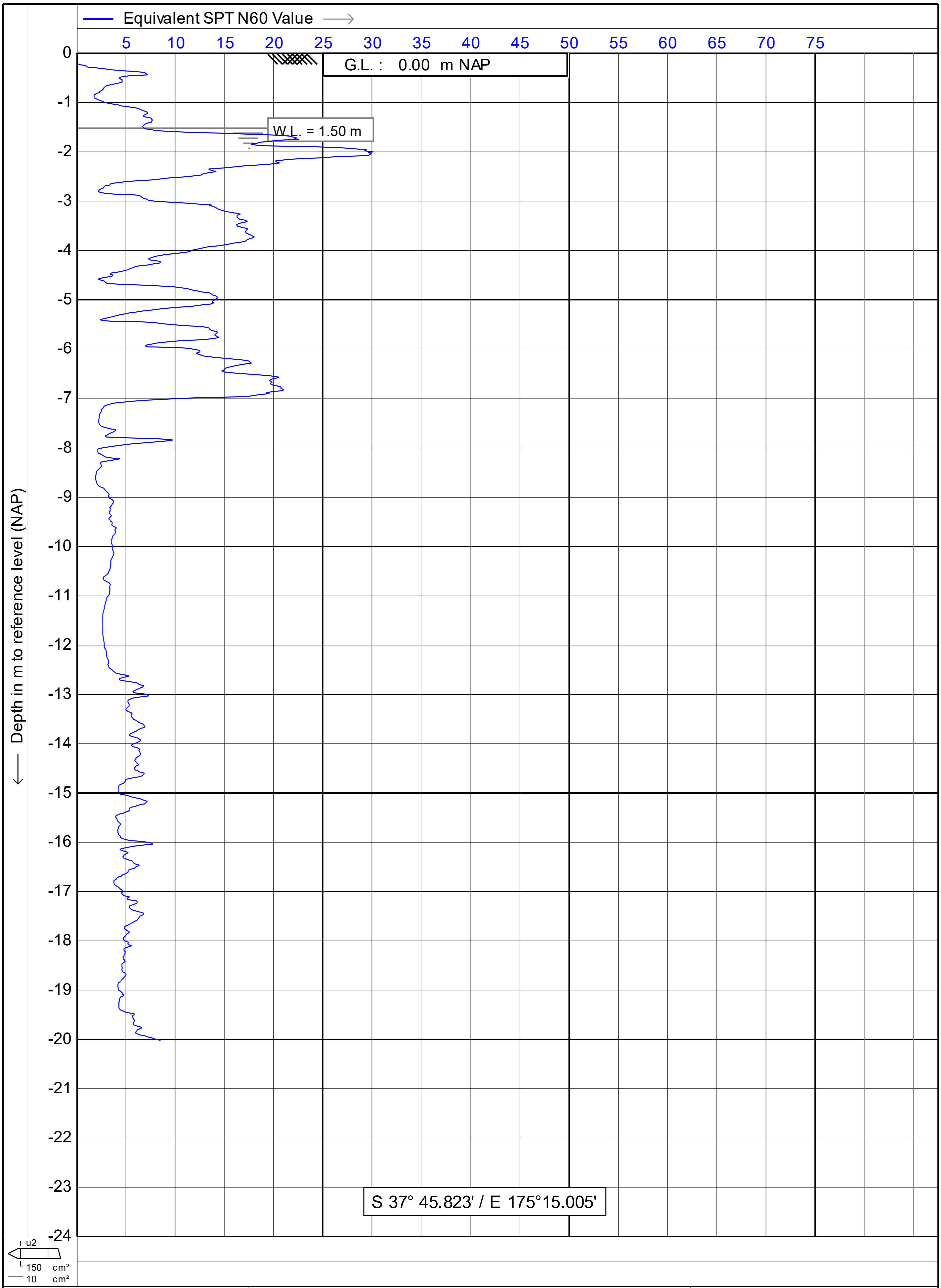
ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT03**

11/15

1.47



CPT it CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

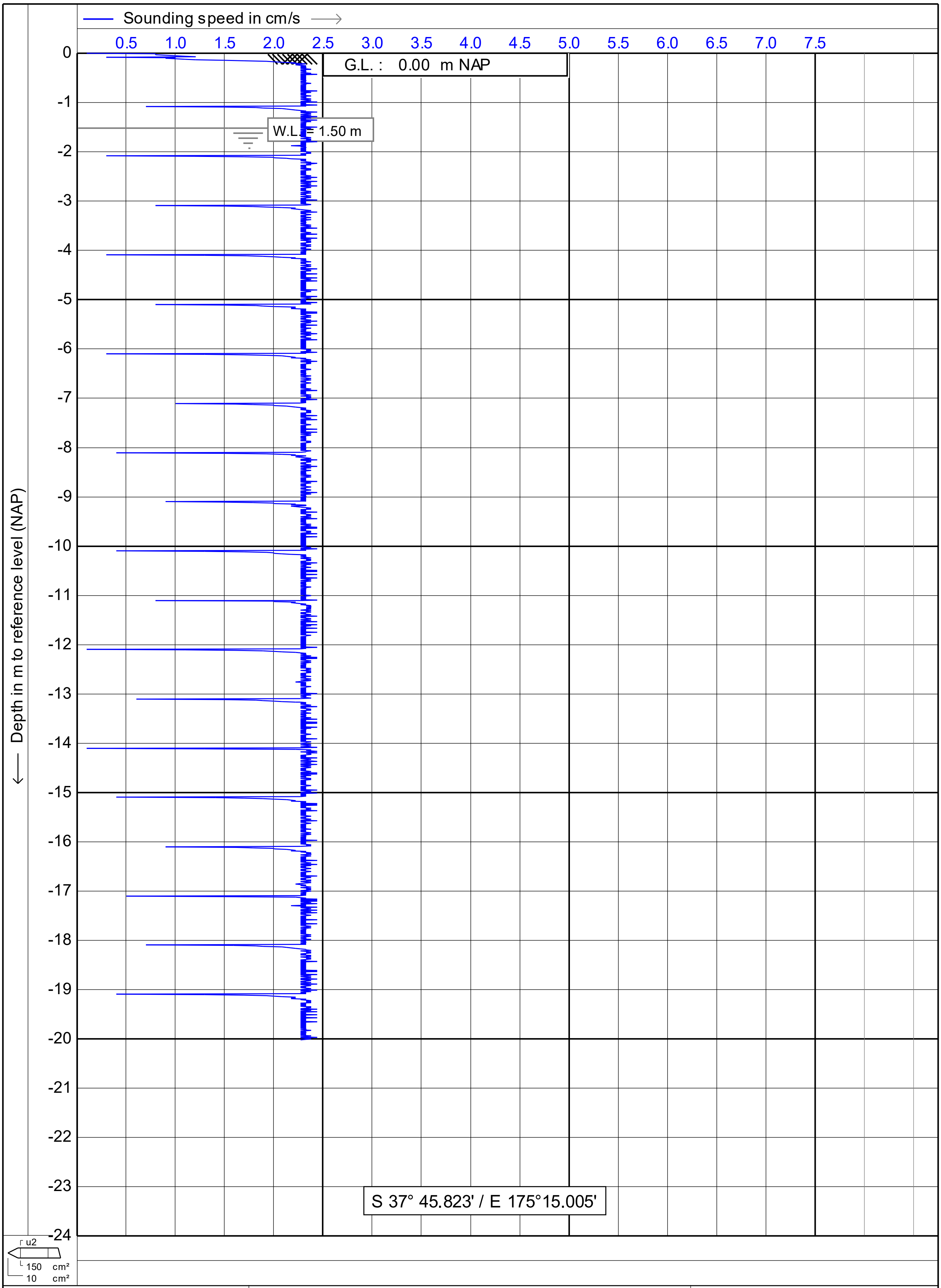
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

12/15

1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

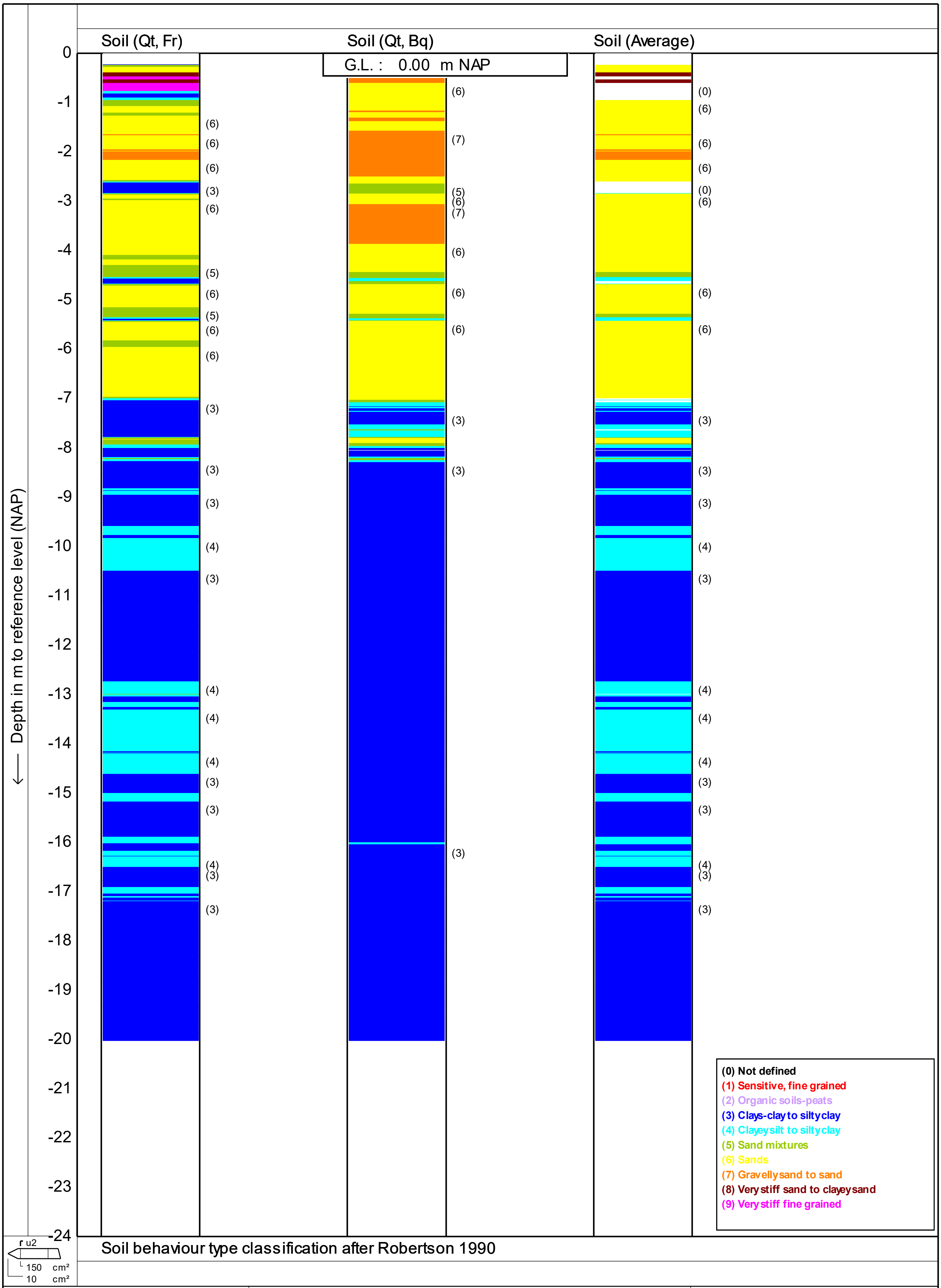
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**



Soil behaviour type classification after Robertson 1990

CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

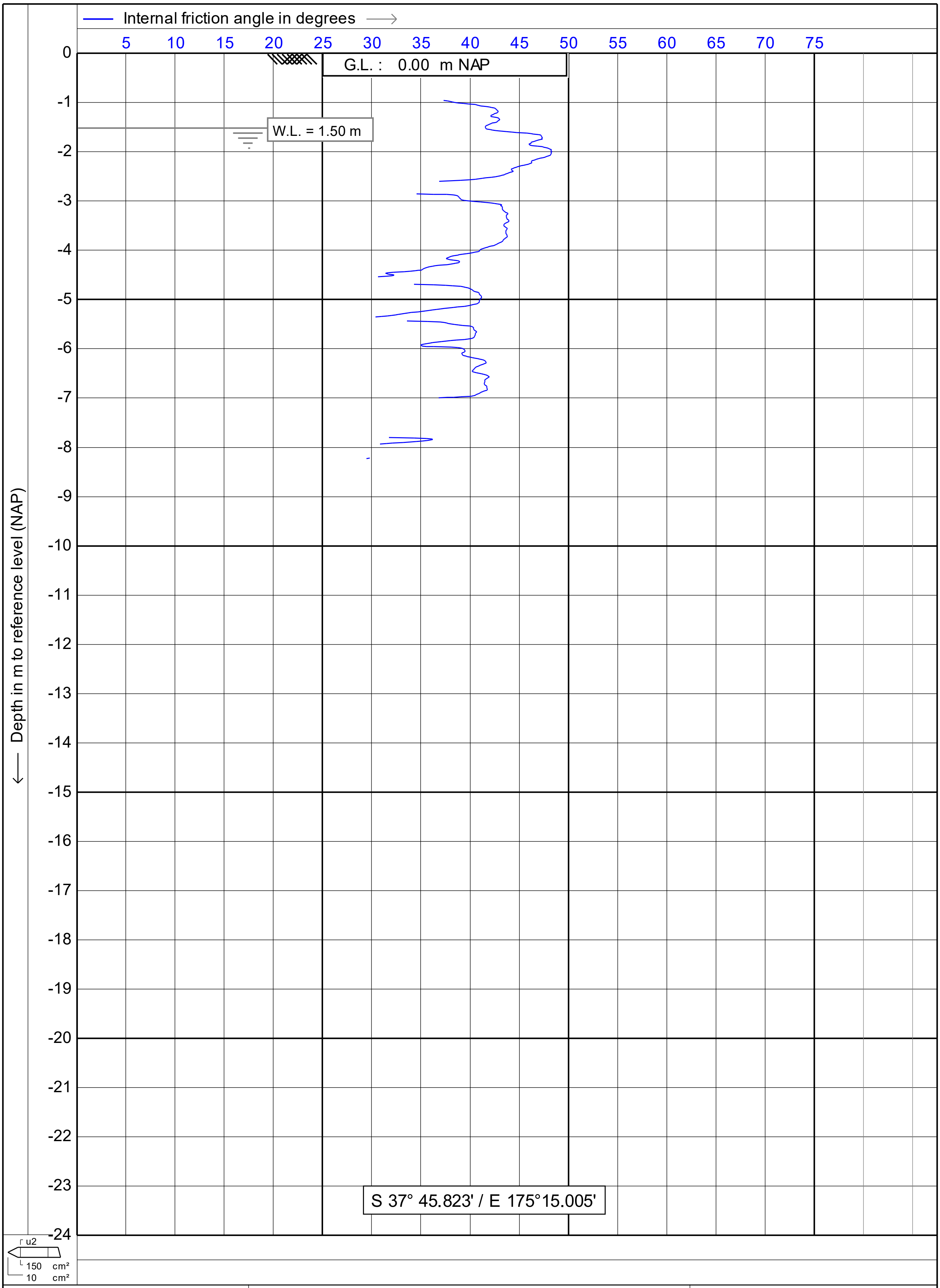
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT03**

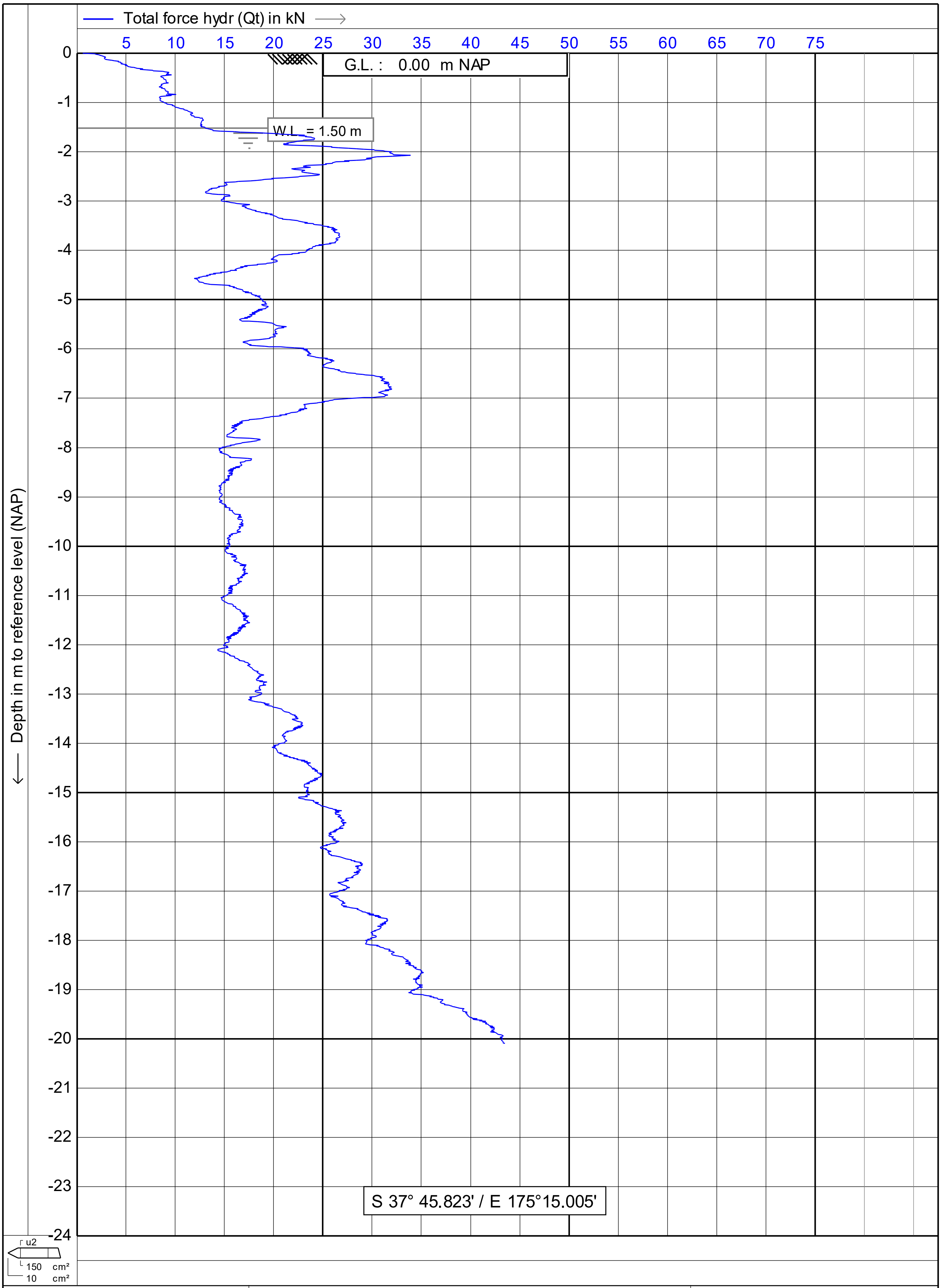
14/15

1.47



CPT it CONE PENETROMETER TESTING	ISO 22476-1:2012 Application class 1 Test type TE1	Date : **23-May-17**
	Project : **TE RAPA RACECOURSE DEVELOPMENT**	Cone no. : **S10CFIIP.S16082**
	Location: **TE RAPA RACECOURSE**	Project no. : **17017/HAM2017-109**
	Position: **0, 0**	CPT no. : **CPT03** **15/15**

1.47



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT03** **16/15**

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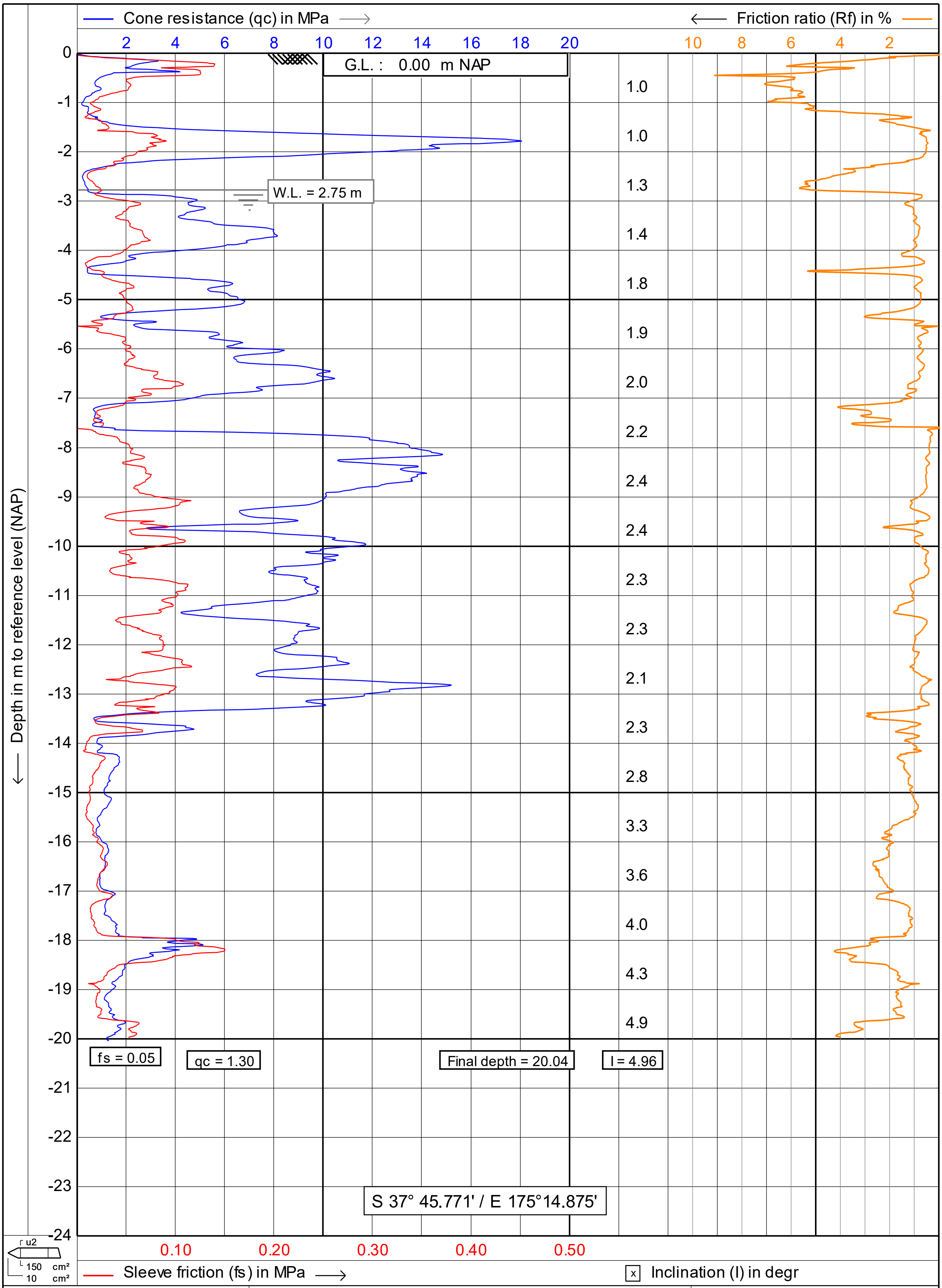


CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

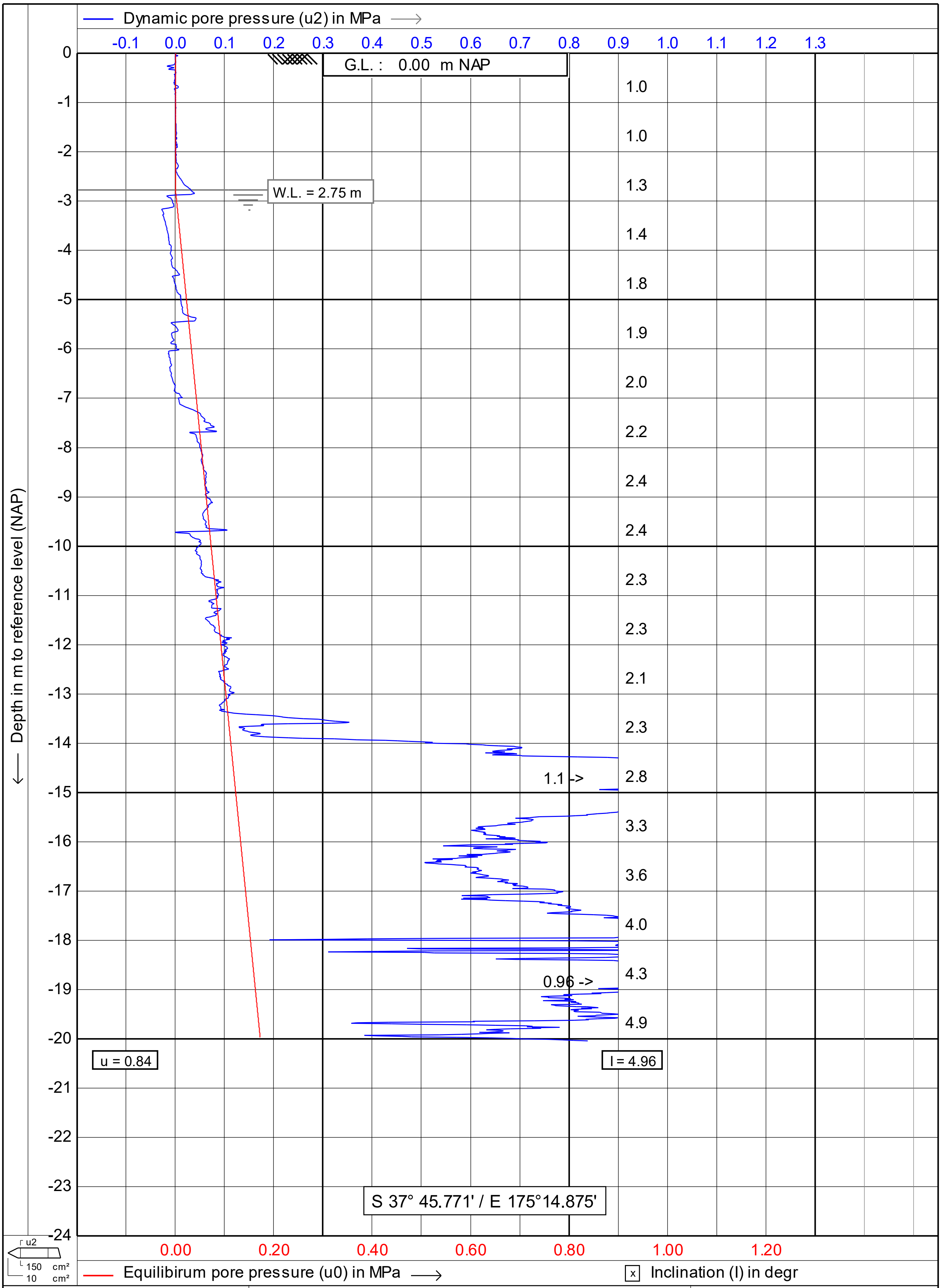
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

1/15

1.47



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

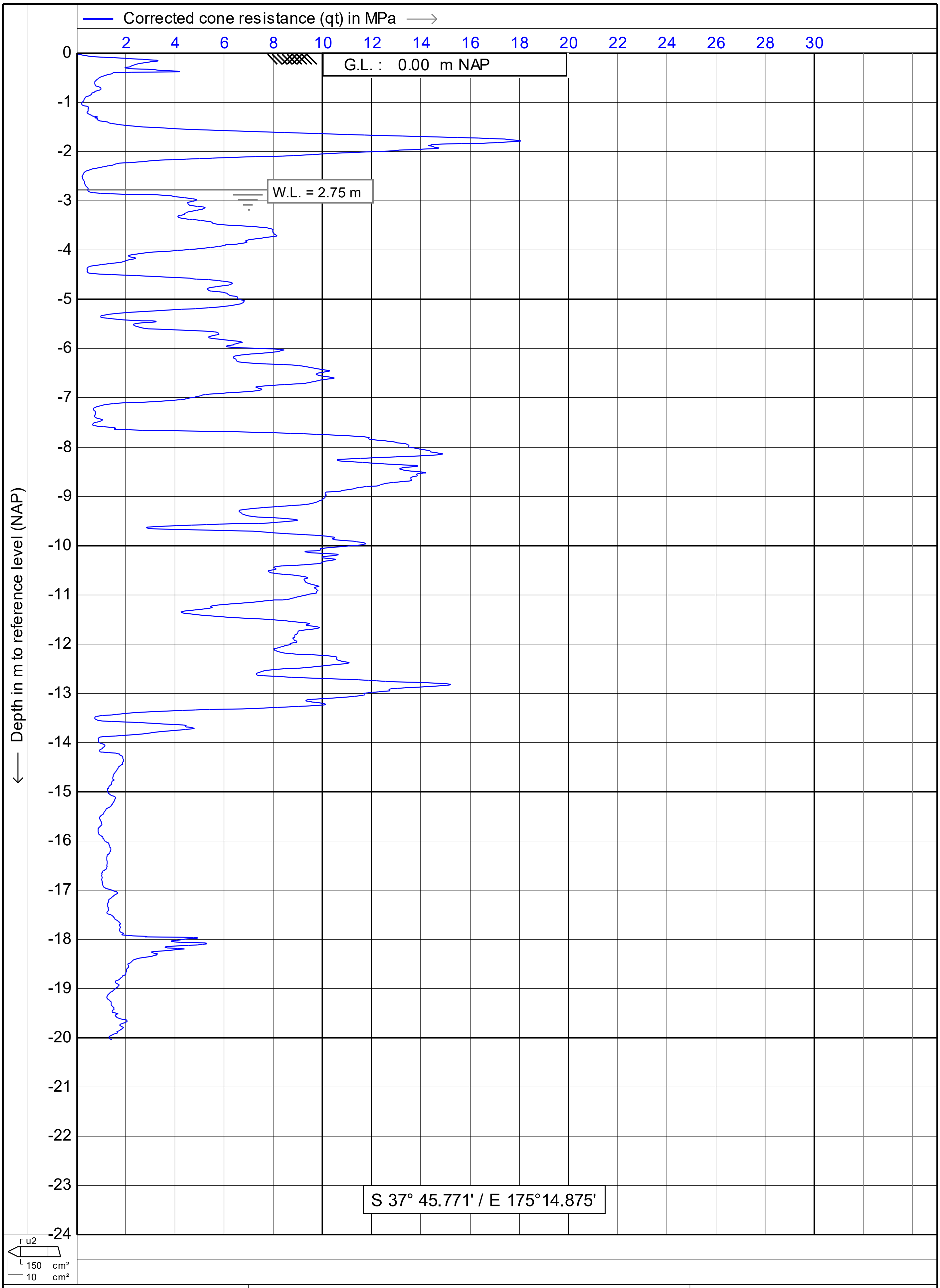
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

2/15

1.47



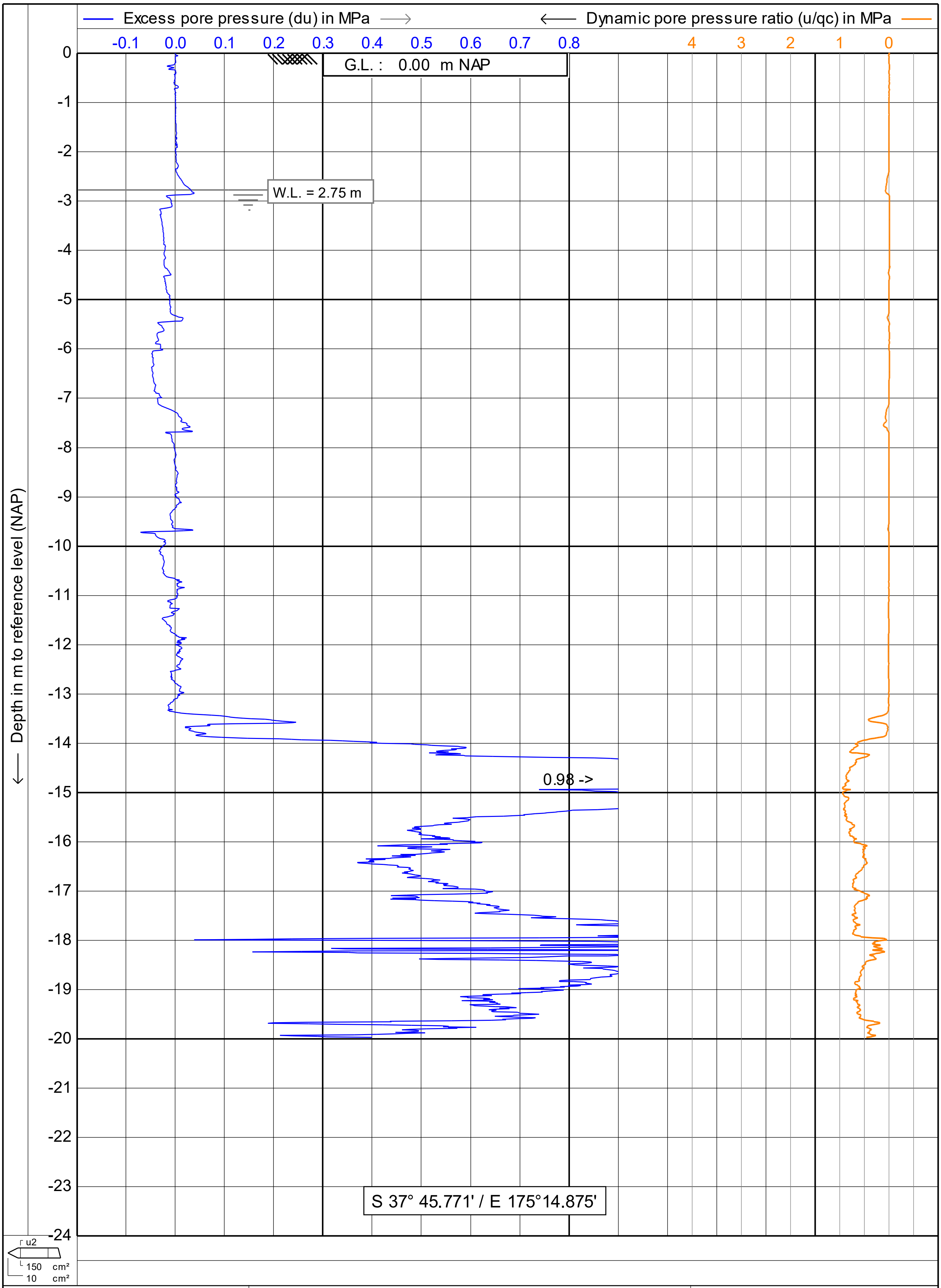
CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT04** **3/15**

1.47



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

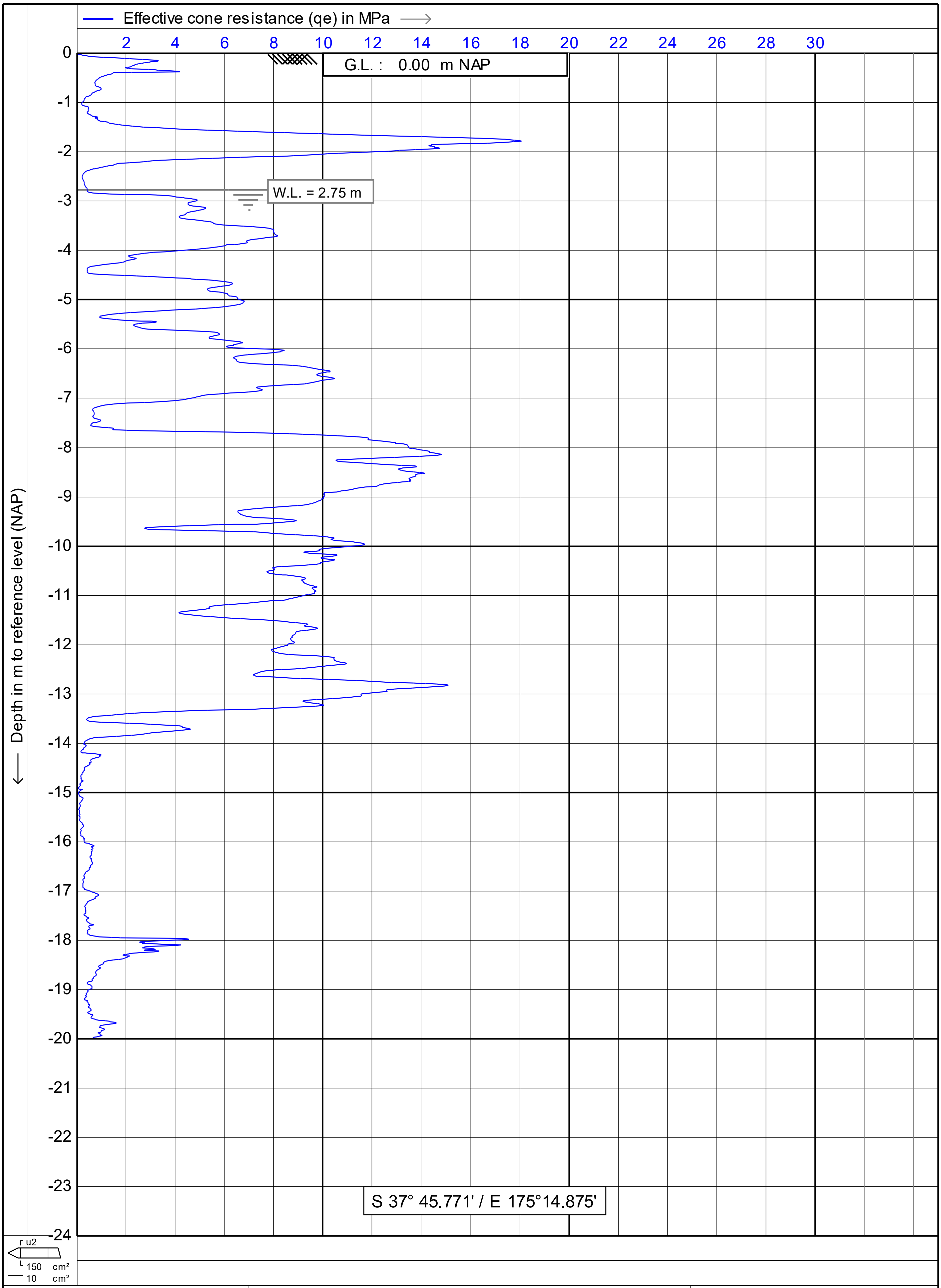
Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no.	: **17017/HAM2017-109**
CPT no.	: **CPT04** **4/15**

1.47



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CPT CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

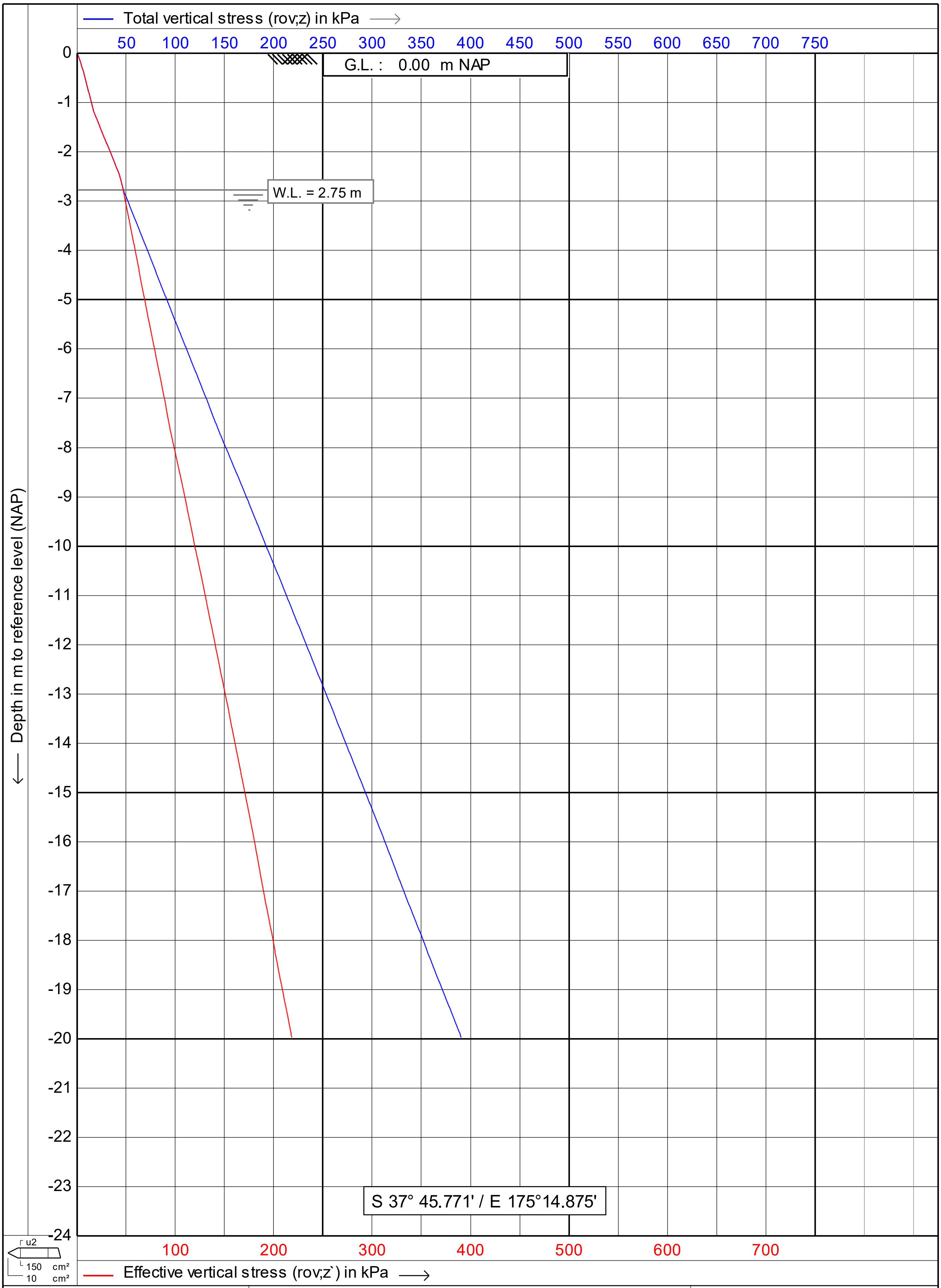
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04** **5/15**



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

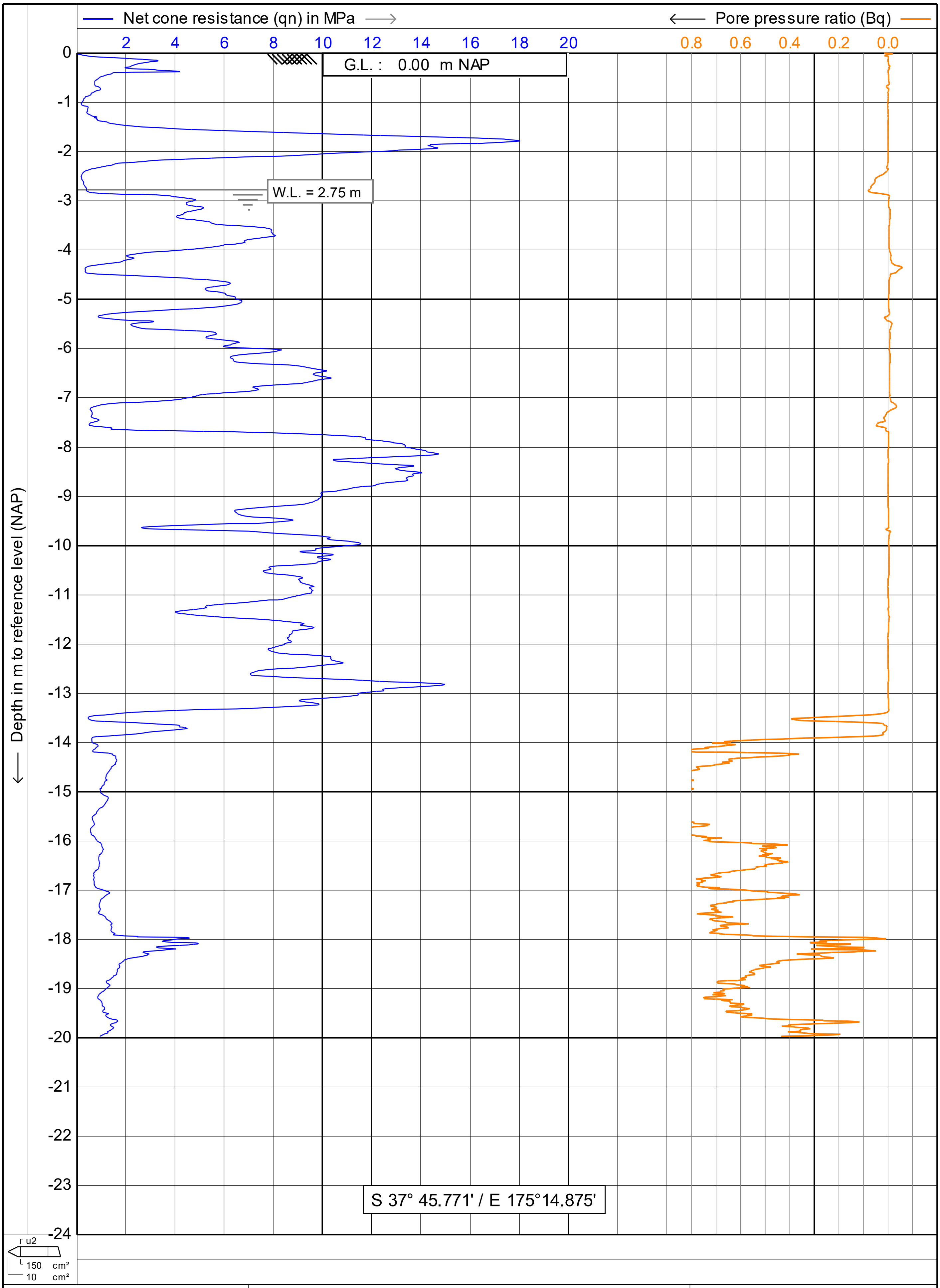
Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04** **6/15**



S 37° 45.771' / E 175°14.875'

1.47

CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

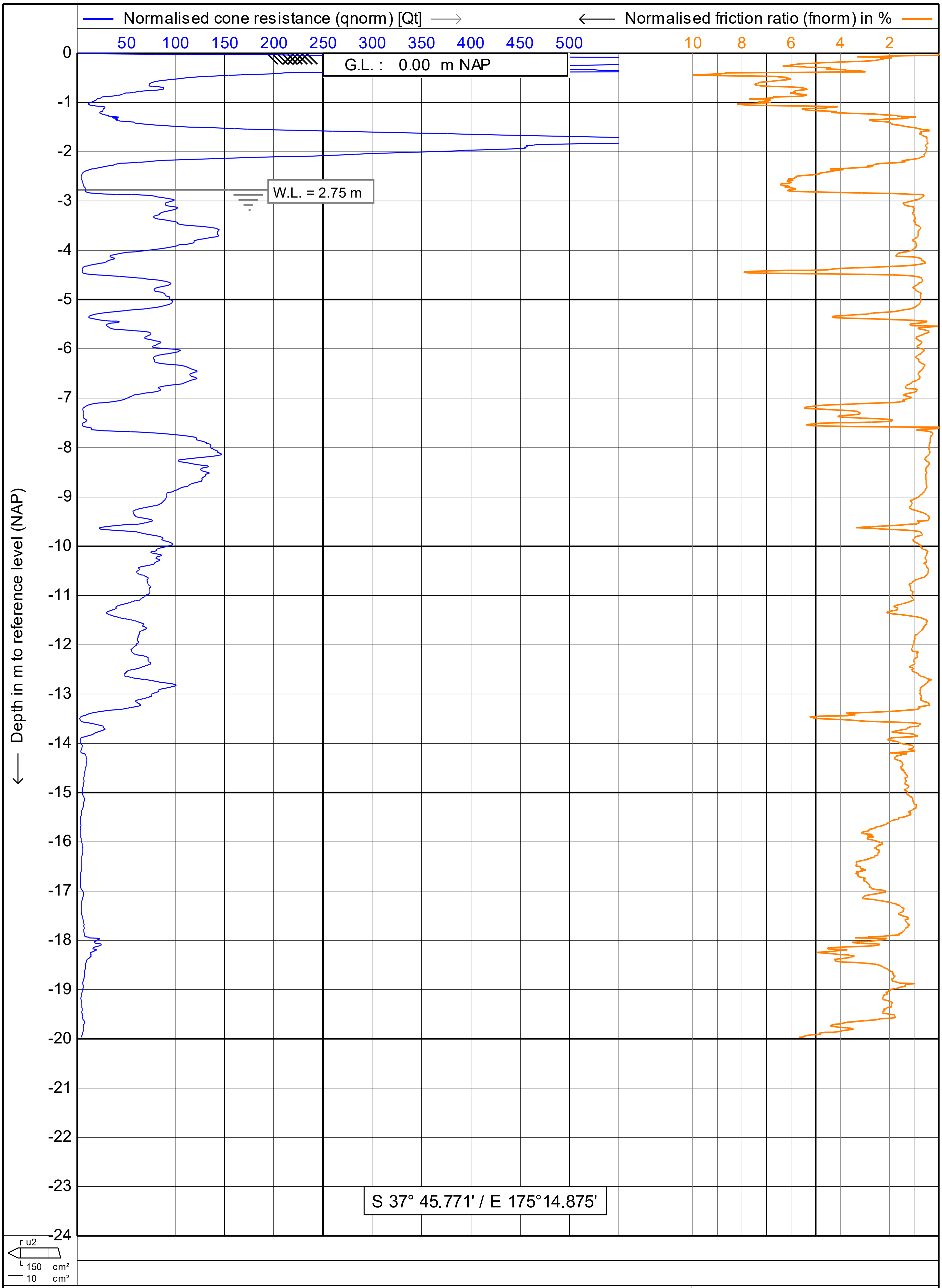
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

7/15



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no.	: **17017/HAM2017-109**
CPT no.	: **CPT04**

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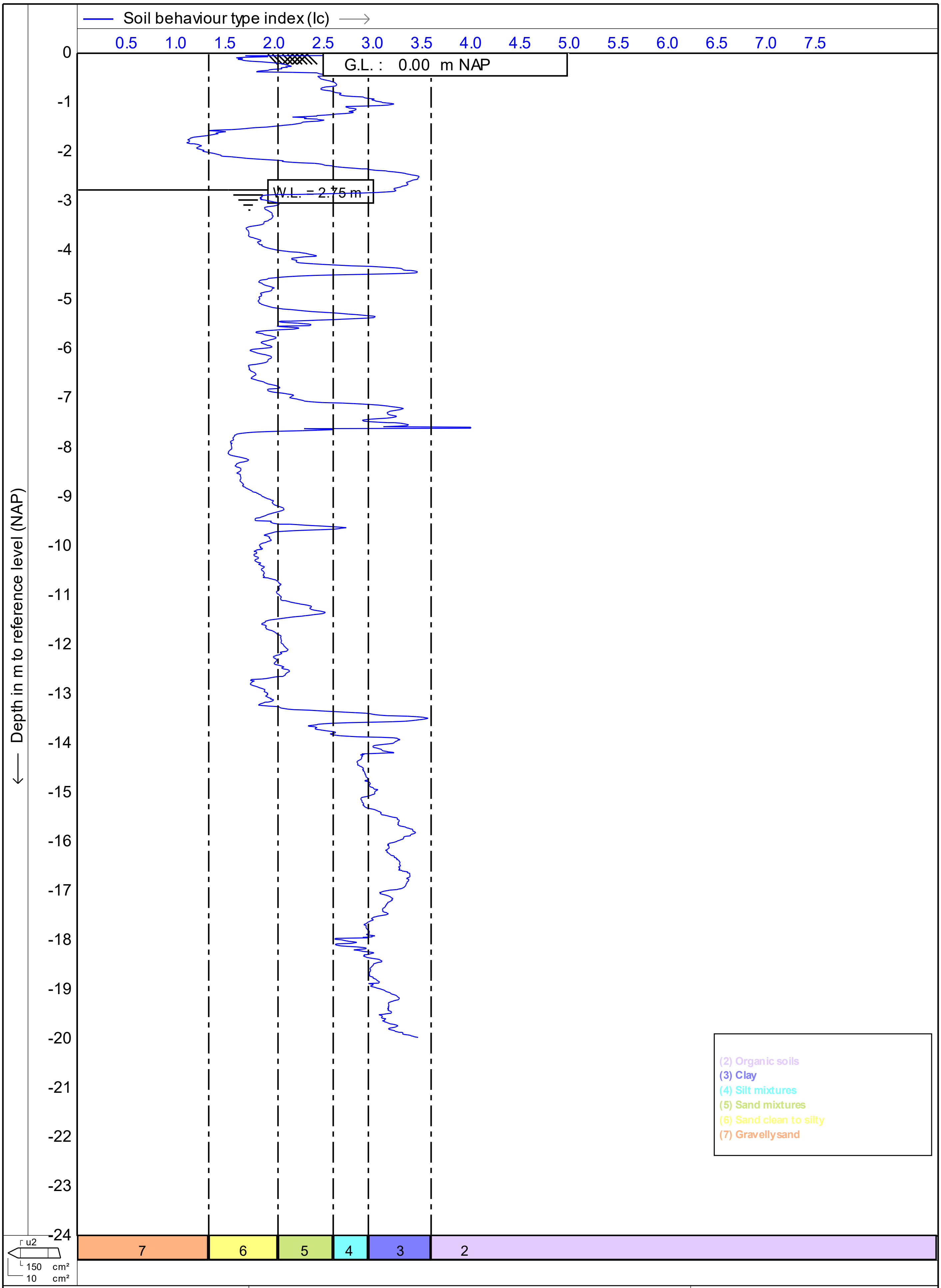


CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

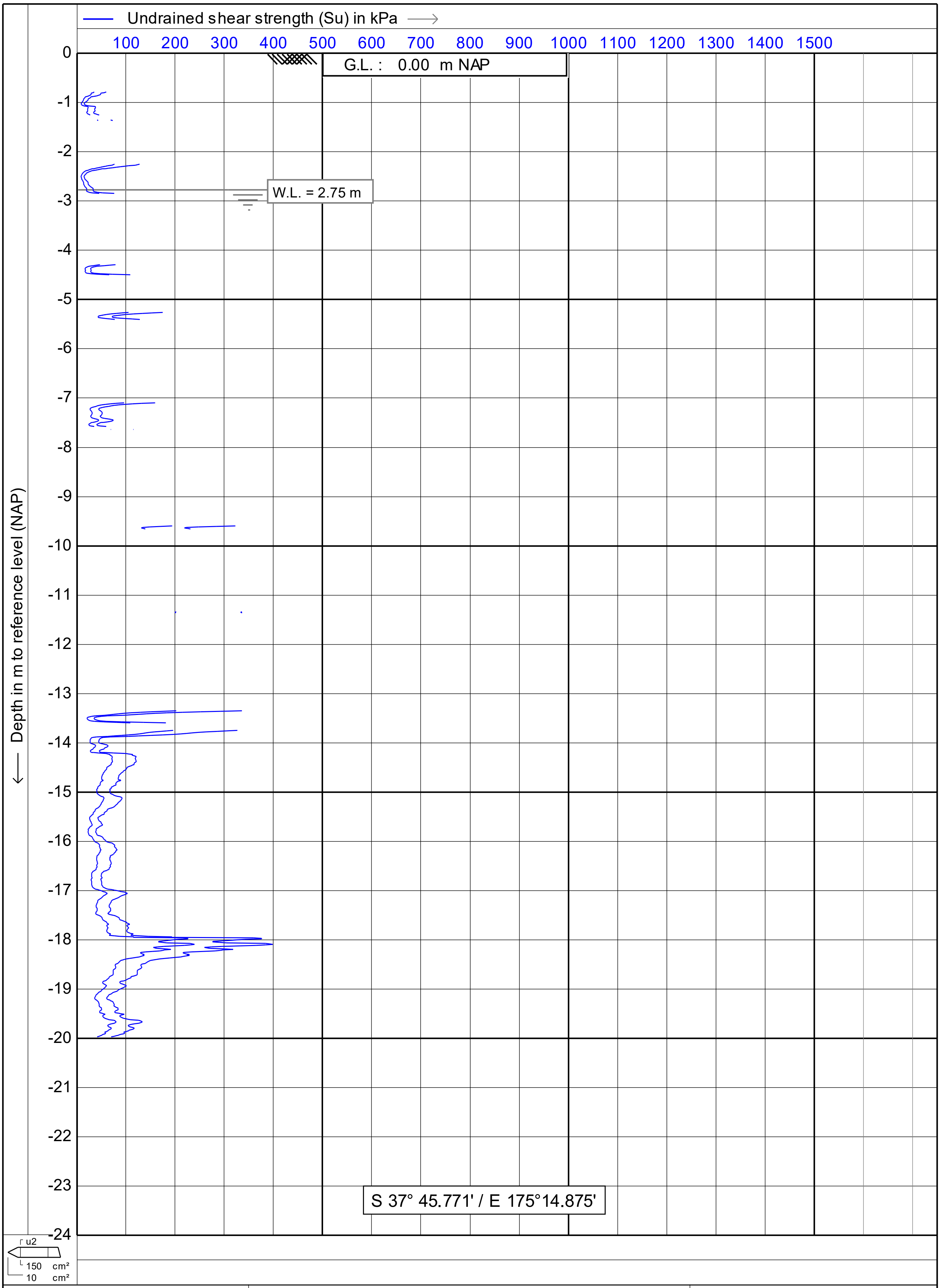
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

9/15



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

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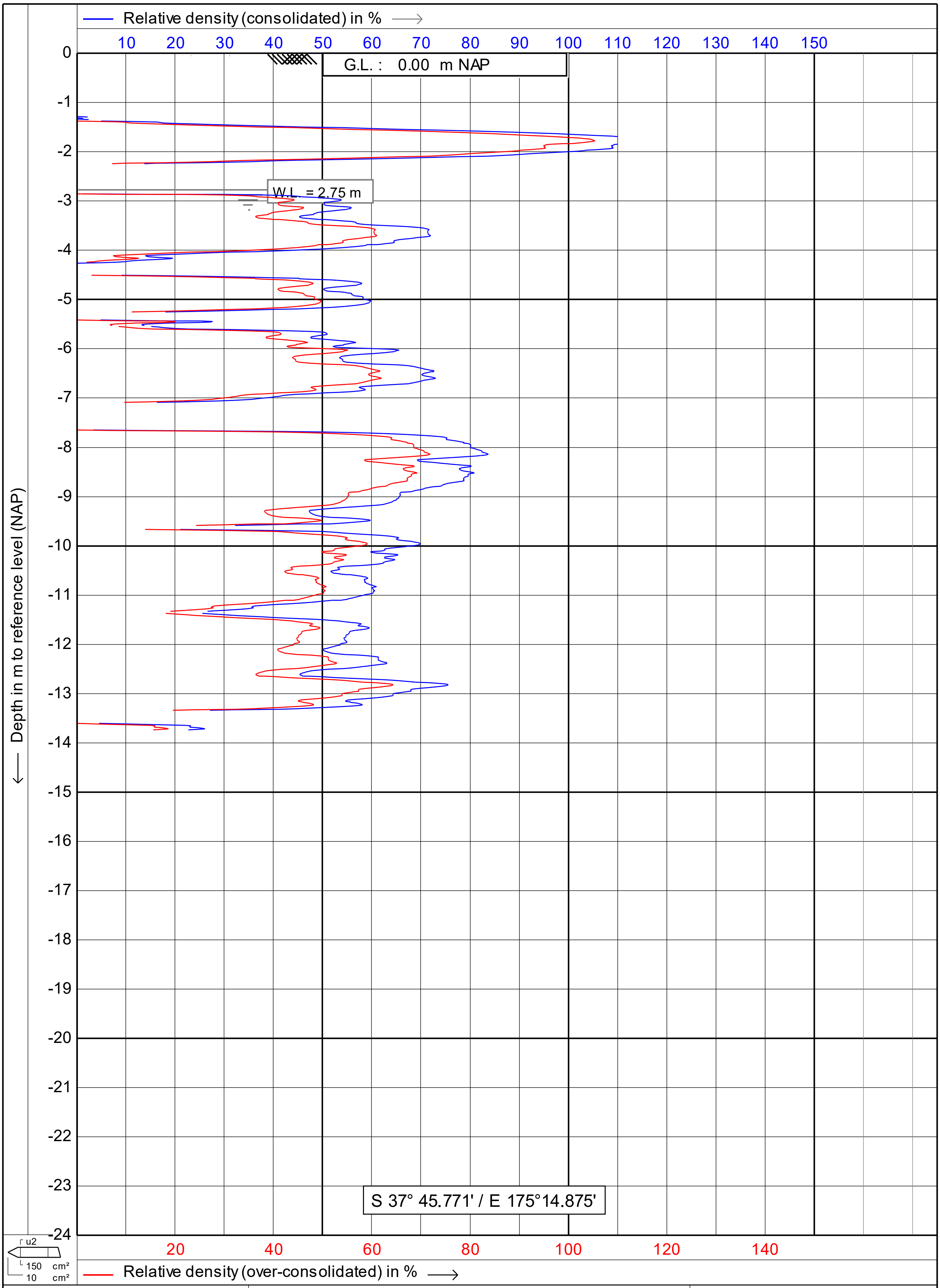
Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

10/15

1.47



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

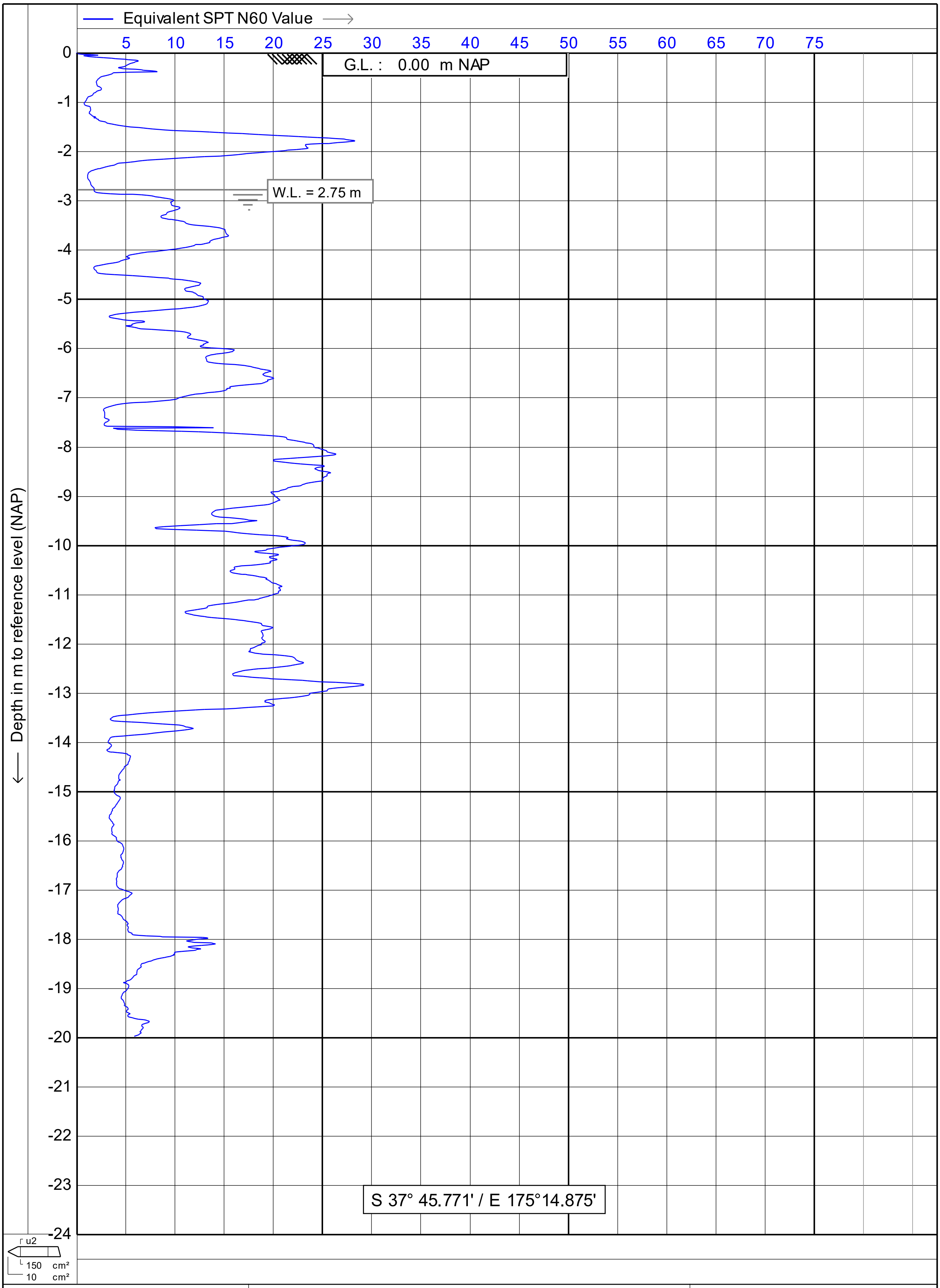
Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date	: **23-May-17**
Cone no.	: **S10CFIIP.S16082**
Project no. :	**17017/HAM2017-109**
CPT no.	: **CPT04**

11/15

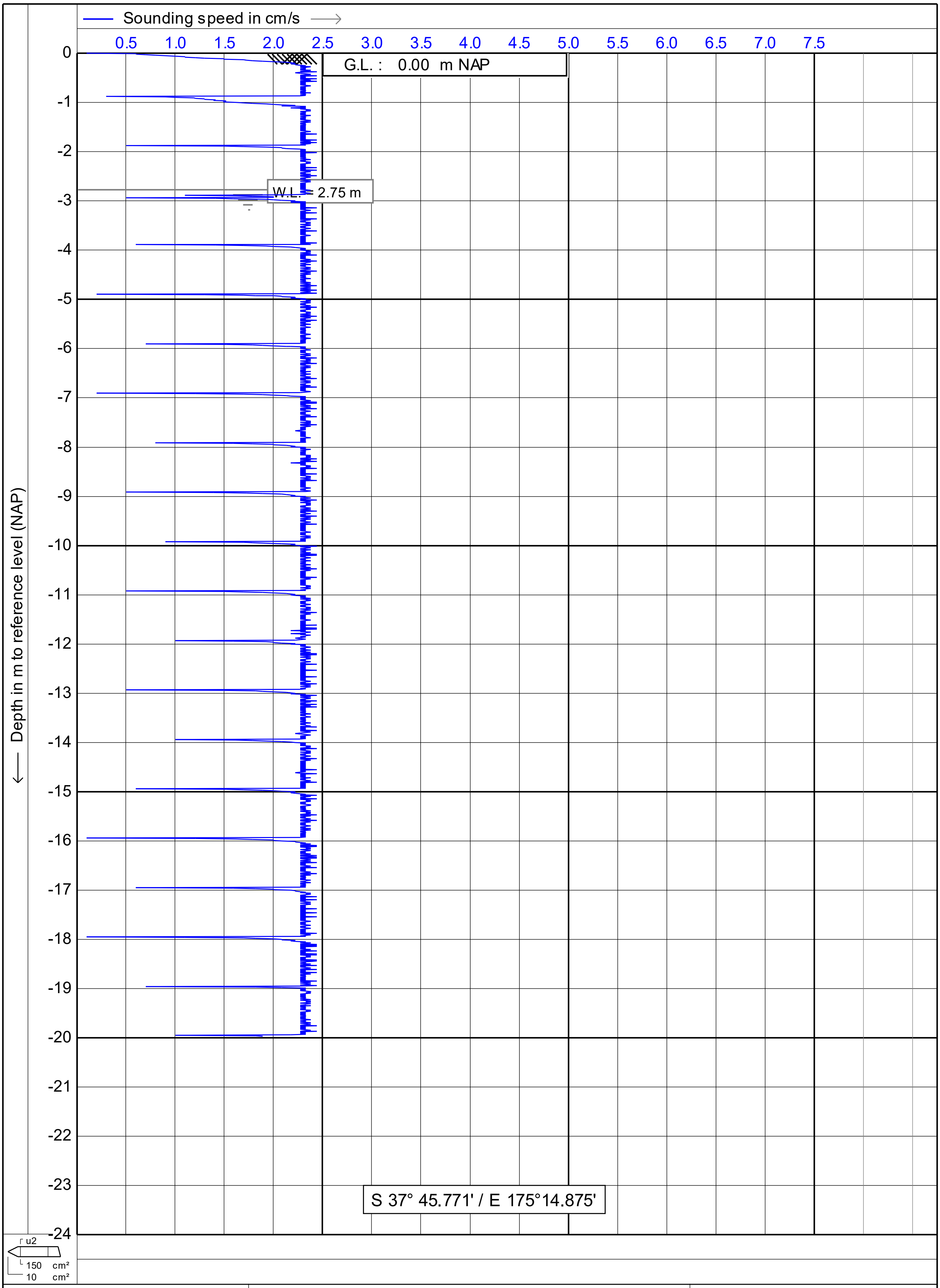
1.47



ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT04**



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

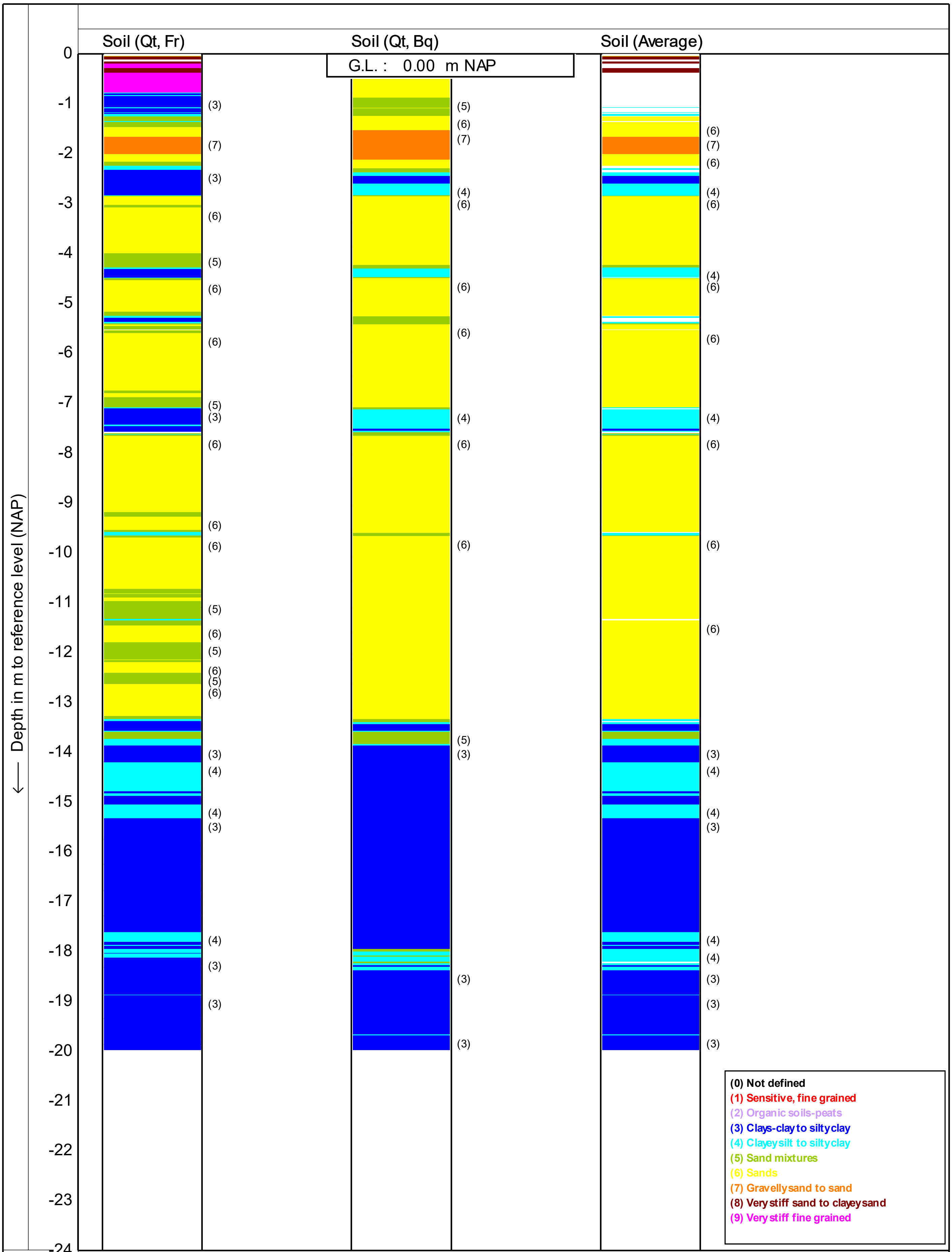
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

1.47



Soil behaviour type classification after Robertson 1990

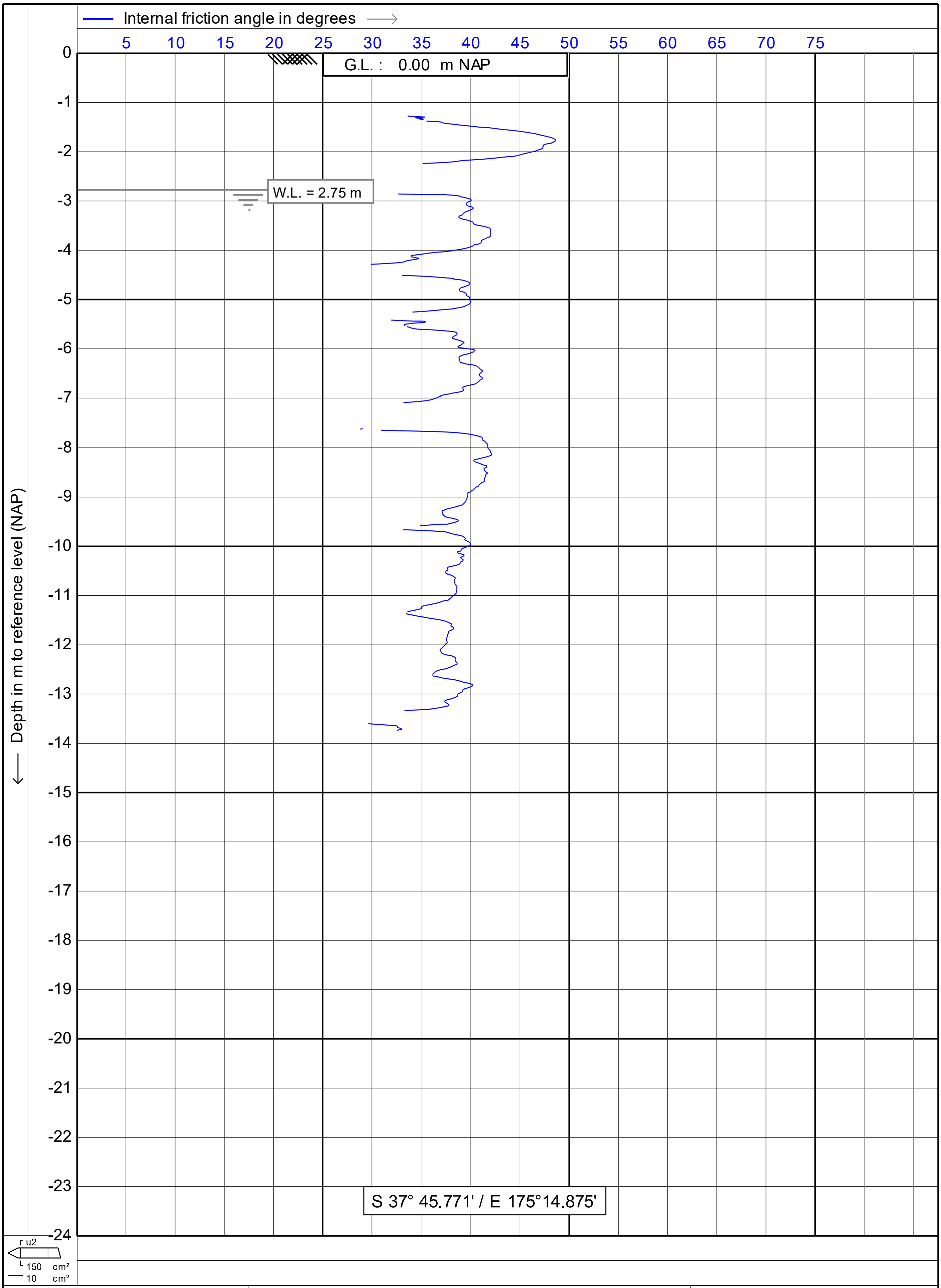
CPT it
CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**
Location: **TE RAPA RACECOURSE**
Position: **0, 0**

Date : **23-May-17**
Cone no. : **S10CFIIP.S16082**
Project no. : **17017/HAM2017-109**
CPT no. : **CPT04**

1.47



1.47

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

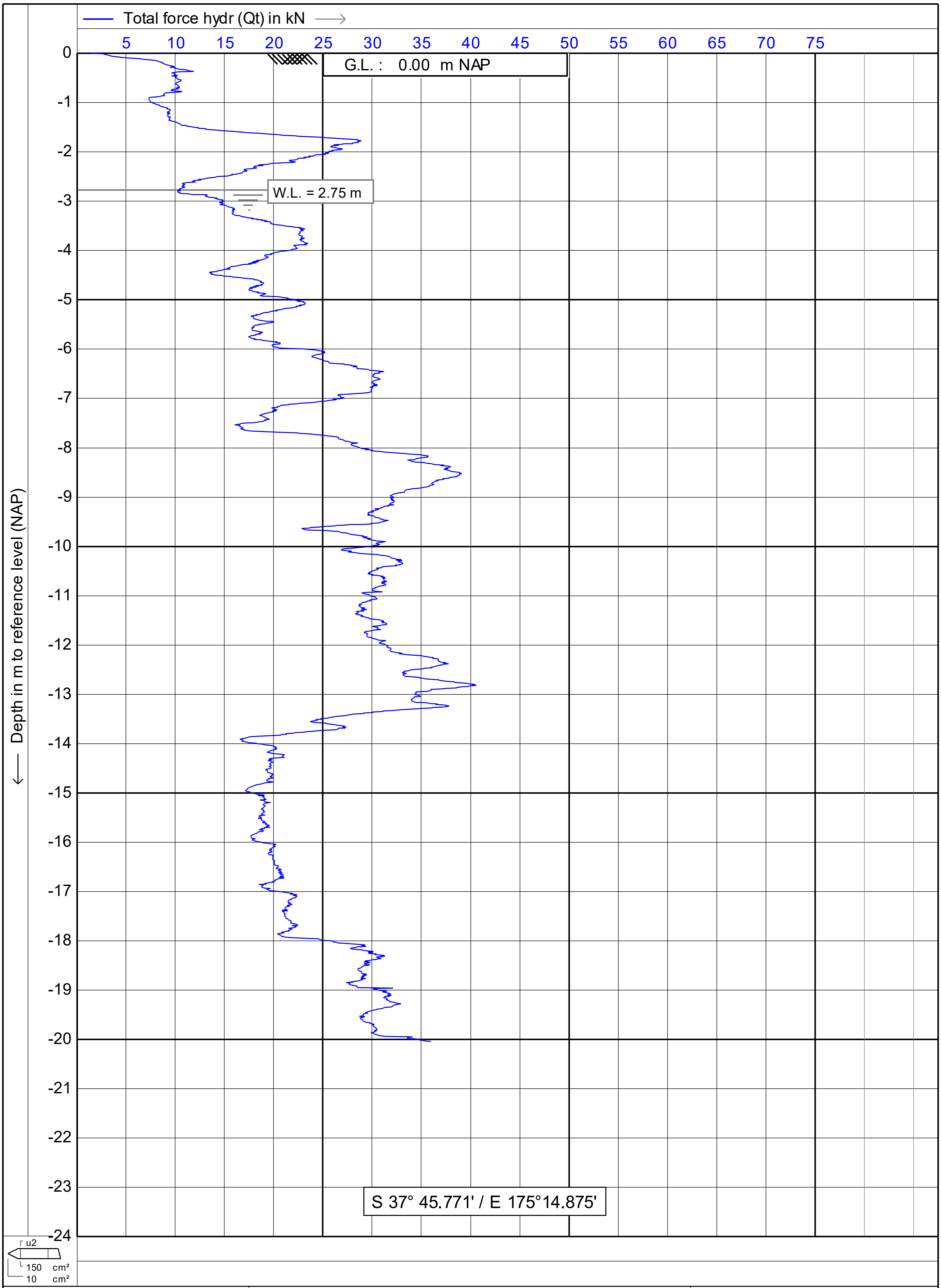
Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

15/15



CONE PENETROMETER TESTING

ISO 22476-1:2012 Application class 1 Test type TE1

Project : **TE RAPA RACECOURSE DEVELOPMENT**

Location: **TE RAPA RACECOURSE**

Position: **0, 0**

Date : **23-May-17**

Cone no. : **S10CFIIP.S16082**

Project no. : **17017/HAM2017-109**

CPT no. : **CPT04**

16/15

1.47

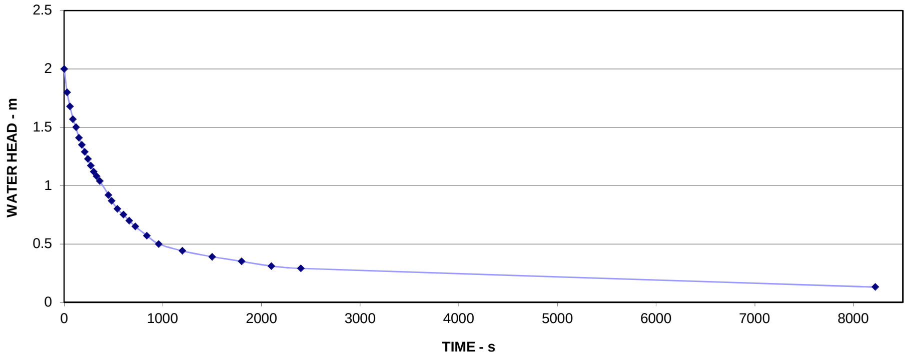
Appendix D: Percolation Test Results

CLIENT: **Te Rapa Waikato Racing Club**
PROJECT: **Te Rapa Racecourse Redevelopment**
LOCATION: **Ken Browne Drive, Hamilton**
JOB NUMBER: **HAM2016_0109**
TEST DATE: **30/05/2017**

Test ID: HA03

Refer to HA03 Engineering Log for soil description. Following presoaking of hole, groundwater was measured at 2.78m below ground level.

FALLING HEAD PERMEABILITY TEST HA03 RESULT



Reference: Appendix 4, Control of Groundwater for Temporary Works (CIRIA Report No. 113)

Borehole diameter = 100 mm

Hydraulic conductivity

$$k = \left(\frac{log\left(\frac{h_1}{h_2}\right) - log\left(\frac{\alpha h_1 + 1}{\alpha h_2 + 1}\right)}{(t_2 - t_1)} \right) \text{ x } l$$

where l = average piezometric head over chosen time interval

$$= \frac{(h_1 + h_2)}{2}$$

h_1 = piezometric head at start of chosen interval (m)
h_2 = piezometric head at end of chosen interval (m)
$t_2 - t_1$ = chosen time interval (seconds)

$$\alpha = \frac{\pi d}{\left(\frac{\pi d^2}{2}\right)} \qquad = \qquad 20.0$$

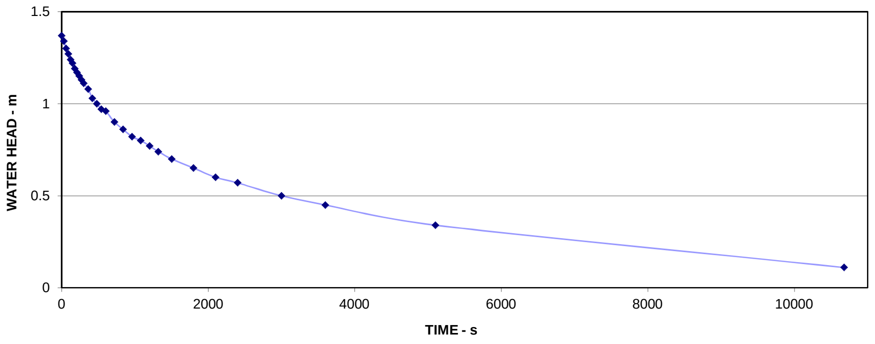
Elapsed Time		t2 - t1	Piezometric Head	l	log (h_1/h_2)	Hydraulic Conductivity	
	(s)	(secs)	h (m)	(m)		k (m/sec)	k (m/day)
0	0		2				
0.5	30	30	1.8	1.90	0.05	7.44E-05	6
1	60	30	1.68	1.74	0.03	4.86E-05	4
1.5	90	30	1.57	1.63	0.03	4.76E-05	4
2	120	30	1.5	1.54	0.02	3.20E-05	3
2.5	150	30	1.41	1.46	0.03	4.33E-05	4
3	180	30	1.35	1.38	0.02	3.04E-05	3
3.5	210	30	1.29	1.32	0.02	3.17E-05	3
4	240	30	1.23	1.26	0.02	3.32E-05	3
4.5	270	30	1.17	1.20	0.02	3.48E-05	3
5	300	30	1.12	1.15	0.02	3.03E-05	3
5.5	330	30	1.08	1.10	0.02	2.52E-05	2
6	360	30	1.04	1.06	0.02	2.61E-05	2
7.5	450	90	0.92	0.98	0.05	2.82E-05	2
8	480	30	0.87	0.90	0.02	3.83E-05	3
9	540	60	0.8	0.84	0.04	2.87E-05	2
10	600	60	0.75	0.78	0.03	2.20E-05	2
11	660	60	0.7	0.73	0.03	2.34E-05	2
12	720	60	0.65	0.68	0.03	2.50E-05	2
14	840	120	0.57	0.61	0.06	2.20E-05	2
16	960	120	0.5	0.54	0.06	2.17E-05	2
20	1200	240	0.44	0.47	0.06	1.05E-05	1
25	1500	300	0.39	0.42	0.05	7.81E-06	1
30	1800	300	0.35	0.37	0.05	6.91E-06	1
35	2100	300	0.31	0.33	0.05	7.64E-06	1
40	2400	300	0.29	0.30	0.03	4.14E-06	0
137	8220	5820	0.13	0.21	0.35	2.61E-06	0

CLIENT: **Te Rapa Waikato Racing Club**
PROJECT: **Te Rapa Racecourse Redevelopment**
LOCATION: **Ken Browne Drive, Hamilton**
JOB NUMBER: **HAM2016_0109**
TEST DATE: **30/05/2017**

Test ID: HA05

Refer to HA05 Engineering Log for soil description. Following presoaking of hole, groundwater was measured at 1.75m below ground level.

FALLING HEAD PERMEABILITY TEST HA05 RESULT



Reference: Appendix 4, Control of Groundwater for Temporary Works (CIRIA Report No. 113)

Borehole diameter = 100 mm

Hydraulic conductivity

$$k = \left(\frac{log\left(\frac{h_1}{h_2}\right) - log\left(\frac{\alpha h_1 + 1}{\alpha h_2 + 1}\right)}{(t_2 - t_1)} \right) \text{ x } l$$

where l = average piezometric head over chosen time interval

$$= \frac{(h_1 + h_2)}{2}$$

h_1 = piezometric head at start of chosen interval (m)

h_2 = piezometric head at end of chosen interval (m)

t_2 - t_1 = chosen time interval (seconds)

$$\alpha = \frac{\pi d}{\left(\frac{\pi d^2}{2}\right)} \quad = \quad 20.0$$

Elapsed Time		t2 - t1	Piezometric Head	l	log (h_1/h_2)	Hydraulic Conductivity	
	(s)	(secs)	h (m)	(m)		k (m/sec)	k (m/day)
0	0		1.37				
0.5	30	30	1.34	1.36	0.01	1.55E-05	1
1	60	30	1.3	1.32	0.01	2.11E-05	2
1.5	90	30	1.27	1.29	0.01	1.63E-05	1
2	120	30	1.24	1.26	0.01	1.66E-05	1
2.5	150	30	1.22	1.23	0.01	1.13E-05	1
3	180	30	1.19	1.21	0.01	1.73E-05	1
3.5	210	30	1.17	1.18	0.01	1.18E-05	1
4	240	30	1.15	1.16	0.01	1.20E-05	1
4.5	270	30	1.13	1.14	0.01	1.22E-05	1
5	300	30	1.11	1.12	0.01	1.24E-05	1
6	360	60	1.08	1.10	0.01	9.48E-06	1
7	420	60	1.03	1.06	0.02	1.64E-05	1
8	480	60	1	1.02	0.01	1.02E-05	1
9	540	60	0.97	0.99	0.01	1.05E-05	1
10	600	60	0.96	0.97	0.00	3.57E-06	0
12	720	120	0.9	0.93	0.03	1.11E-05	1
14	840	120	0.86	0.88	0.02	7.79E-06	1
16	960	120	0.82	0.84	0.02	8.14E-06	1
18	1080	120	0.8	0.81	0.01	4.21E-06	0
20	1200	120	0.77	0.79	0.02	6.50E-06	1
22	1320	120	0.74	0.76	0.02	6.75E-06	1
25	1500	180	0.7	0.72	0.02	6.27E-06	1
30	1800	300	0.65	0.68	0.03	5.00E-06	0
35	2100	300	0.6	0.63	0.03	5.37E-06	0
40	2400	300	0.57	0.59	0.02	3.42E-06	0
50	3000	600	0.5	0.54	0.06	4.35E-06	0
60	3600	600	0.45	0.48	0.05	3.46E-06	0
85	5100	1500	0.34	0.40	0.12	3.64E-06	0
178	10680	5580	0.11	0.23	0.49	4.16E-06	0

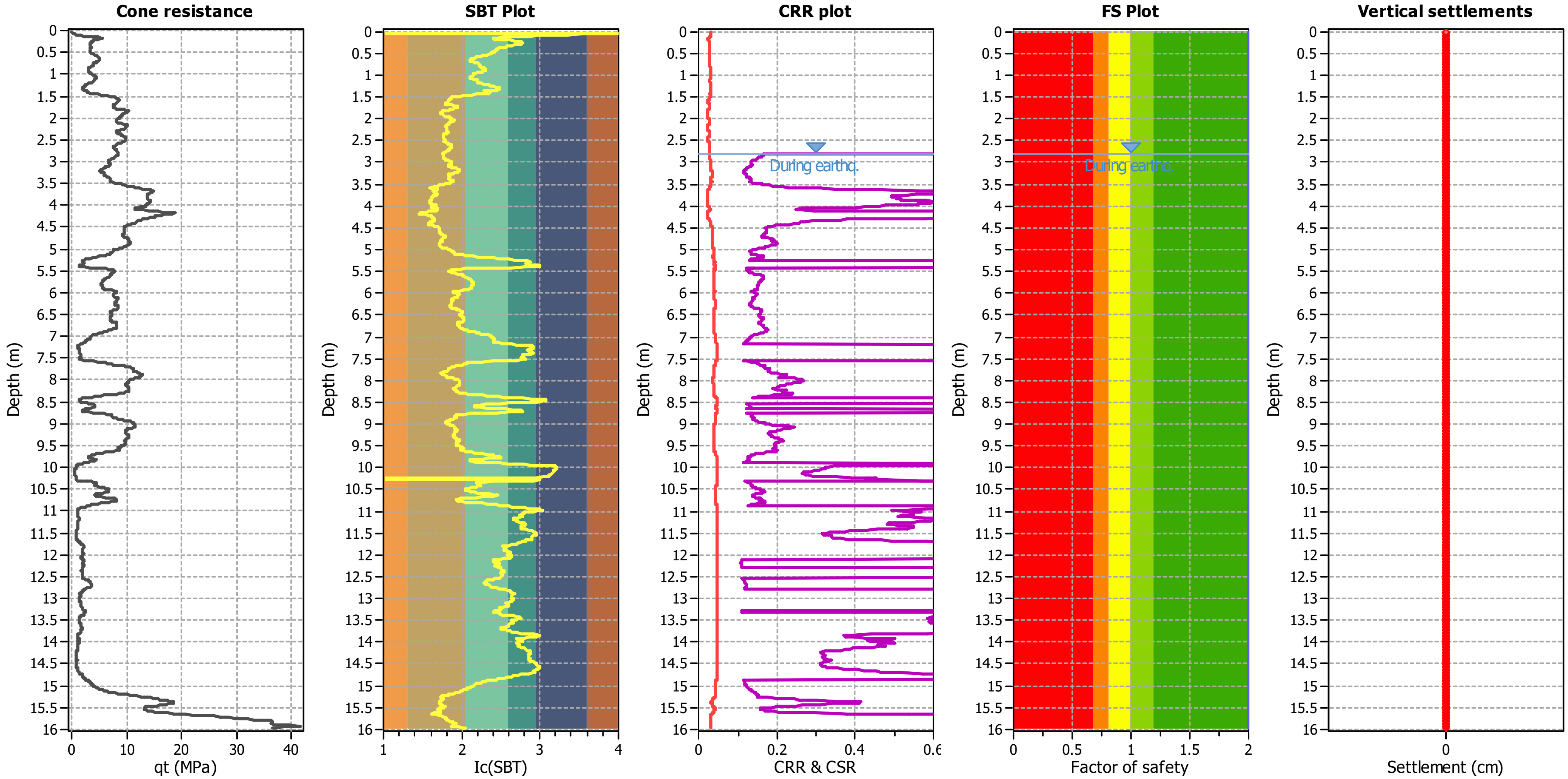
Appendix E: CLIQ Outputs

Project: **Te Rapa Racecourse Development**

Location: **Hamilton**

CPT: CPT01_SLS

Total depth: 15.97 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.80 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.80 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.06	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes	MSF method:	I&B, 2008

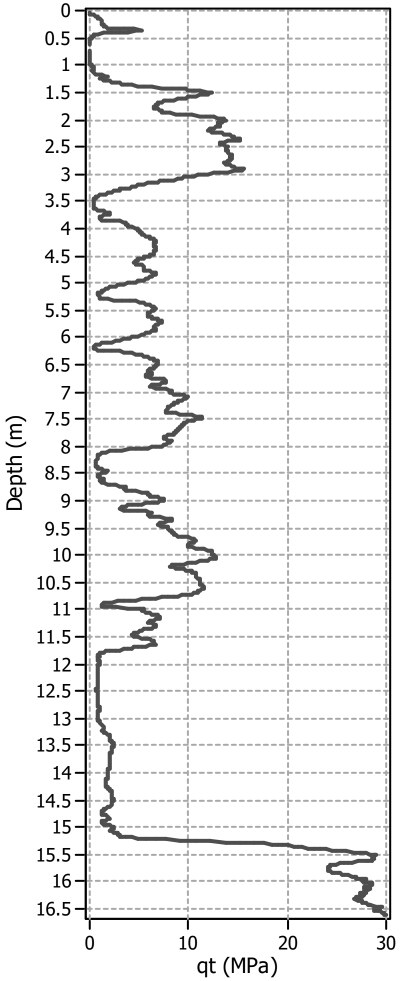
Project: Te Rapa Racecourse Development

Location: Hamilton

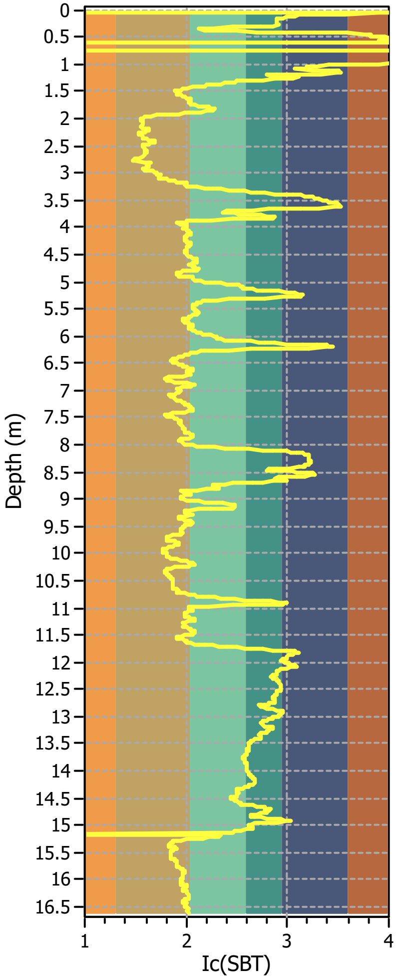
CPT: CPT02_SLS

Total depth: 16.61 m

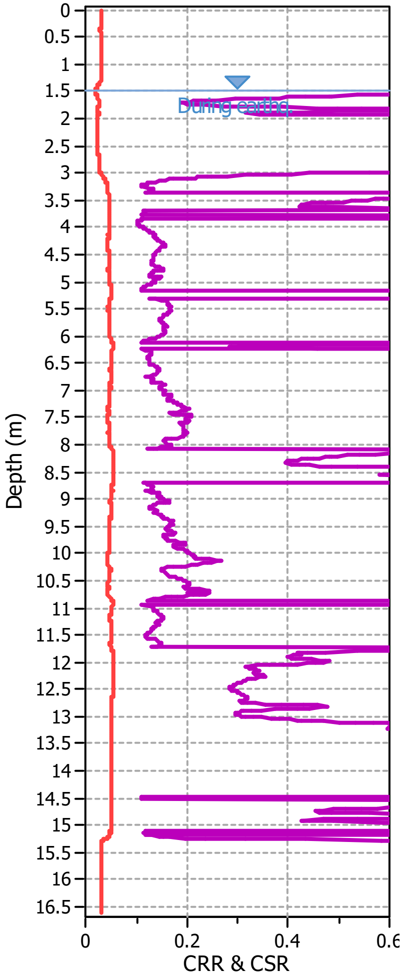
Cone resistance



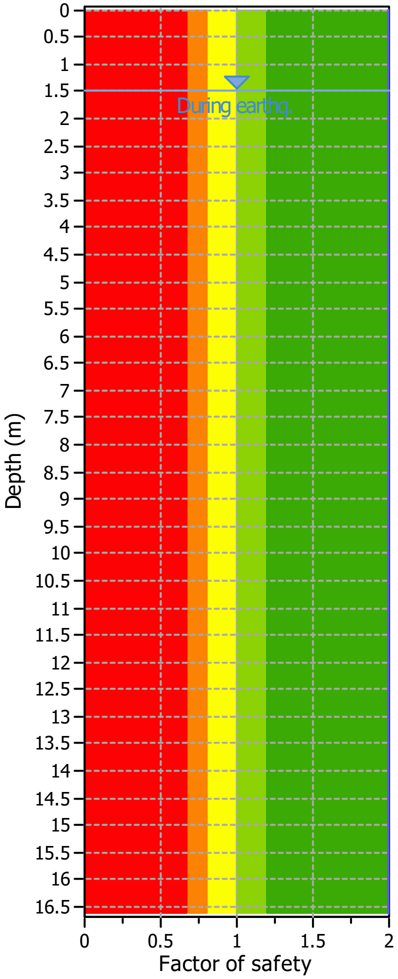
SBT Plot



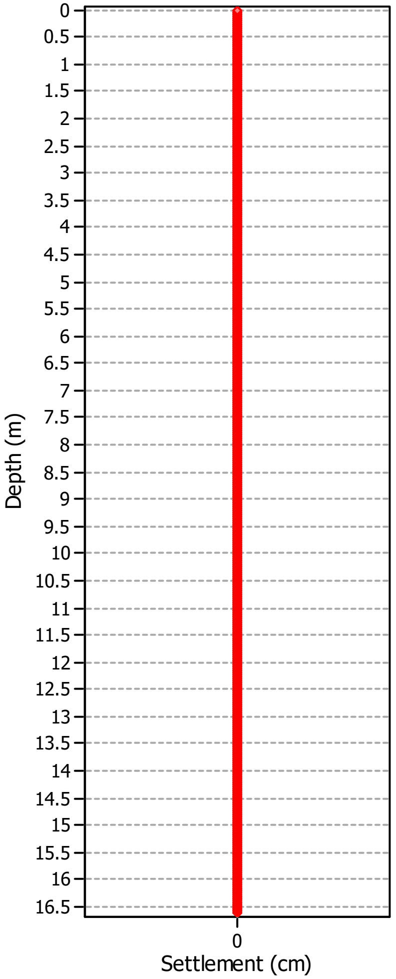
CRR plot



FS Plot



Vertical settlements



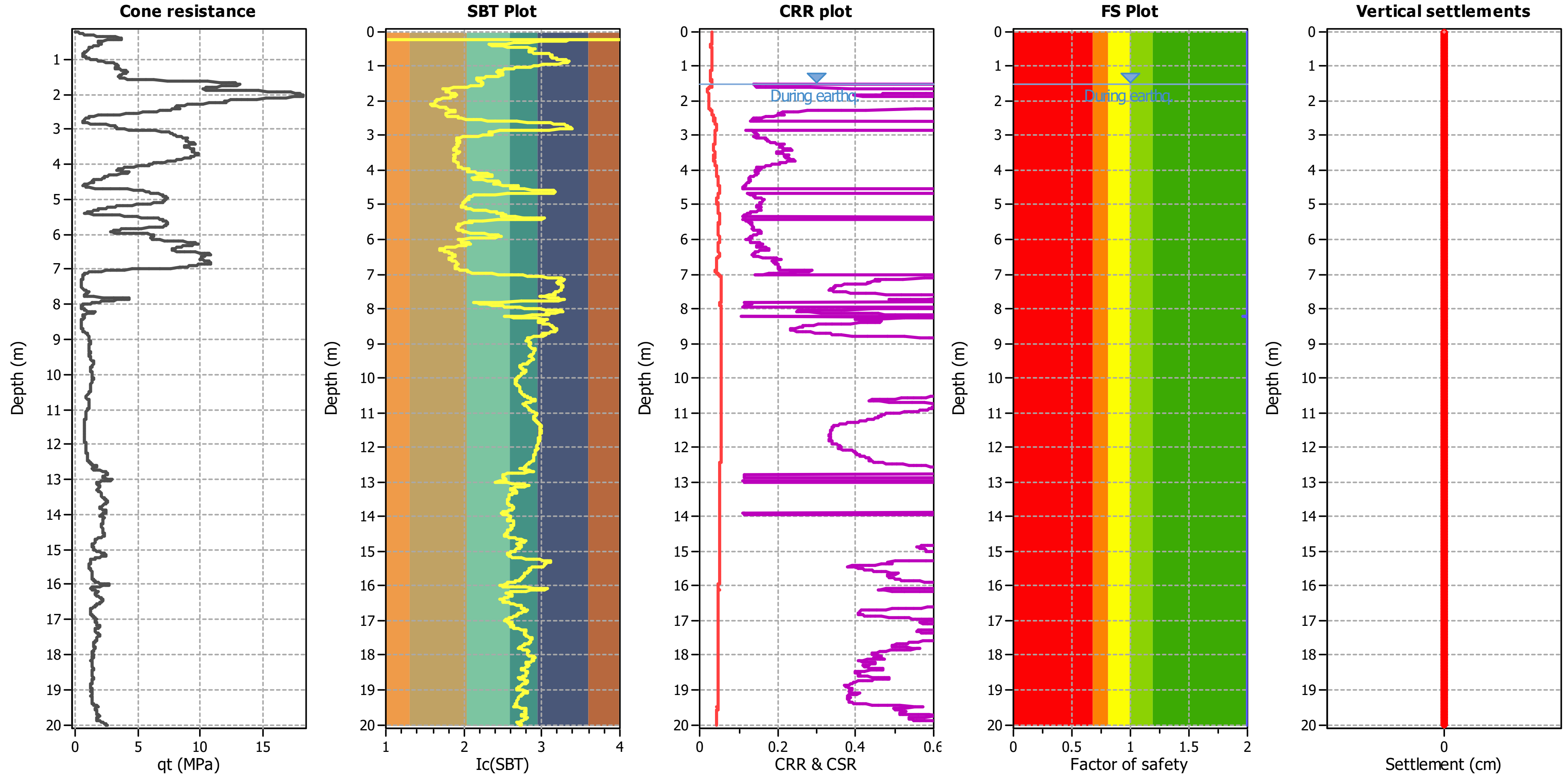
Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.06	Unit weight calculation:	17.00 kN/m^3	K_σ applied:	Yes	MSF method:	I&B, 2008

Project: **Te Rapa Racecourse Development**

Location: **Hamilton**

CPT: CPT03_SLS

Total depth: 20.02 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	I&B, 2008
Peak ground acceleration:	0.06	Unit weight calculation:	17.00 kN/m^3	K_σ applied:	Yes		

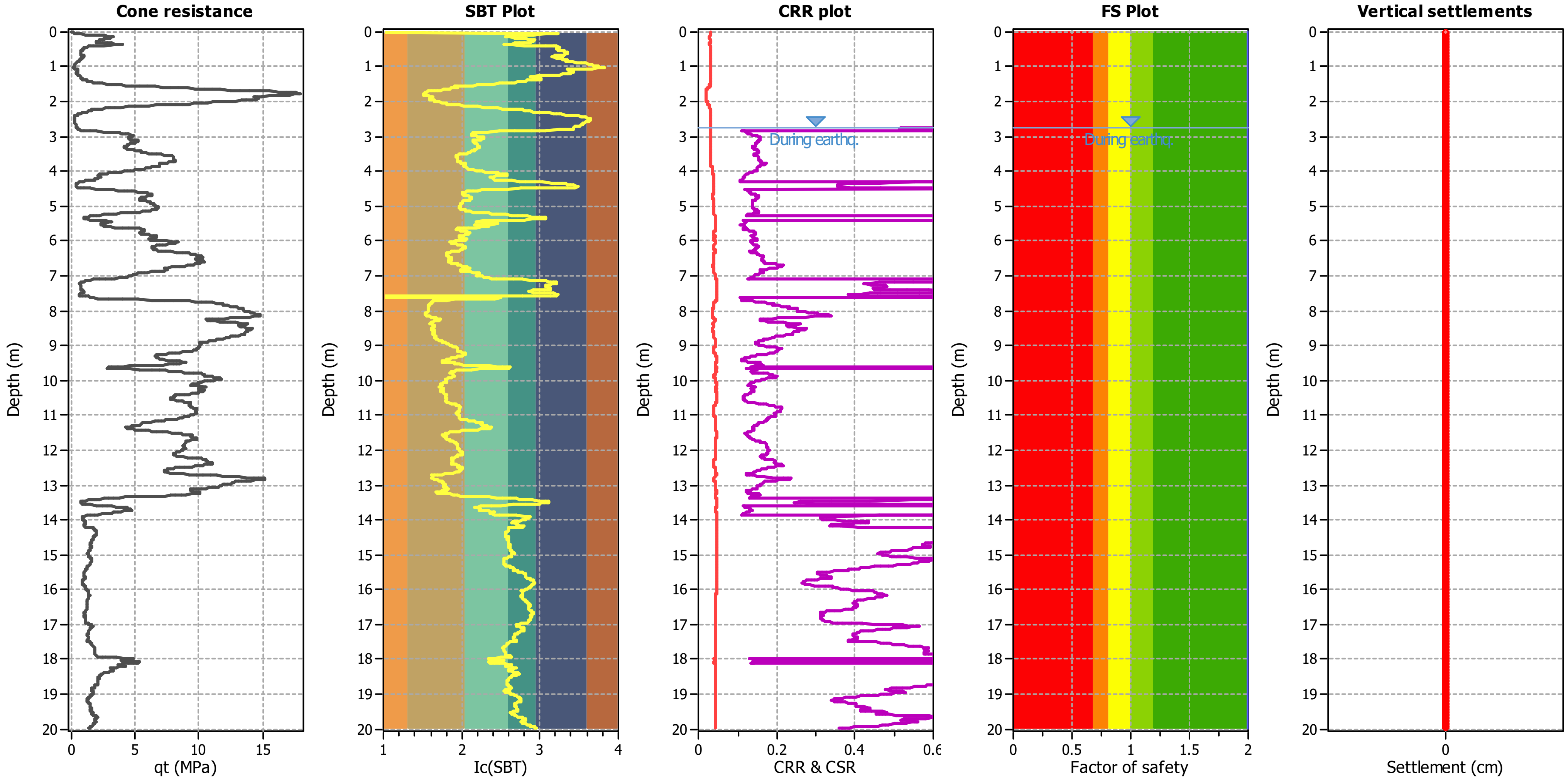
CMW Geosciences

Project: Te Rapa Racecourse Development

Location: Hamilton

CPT: CPT04_SLS

Total depth: 19.97 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.75 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.75 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.06	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes	MSF method:	I&B, 2008

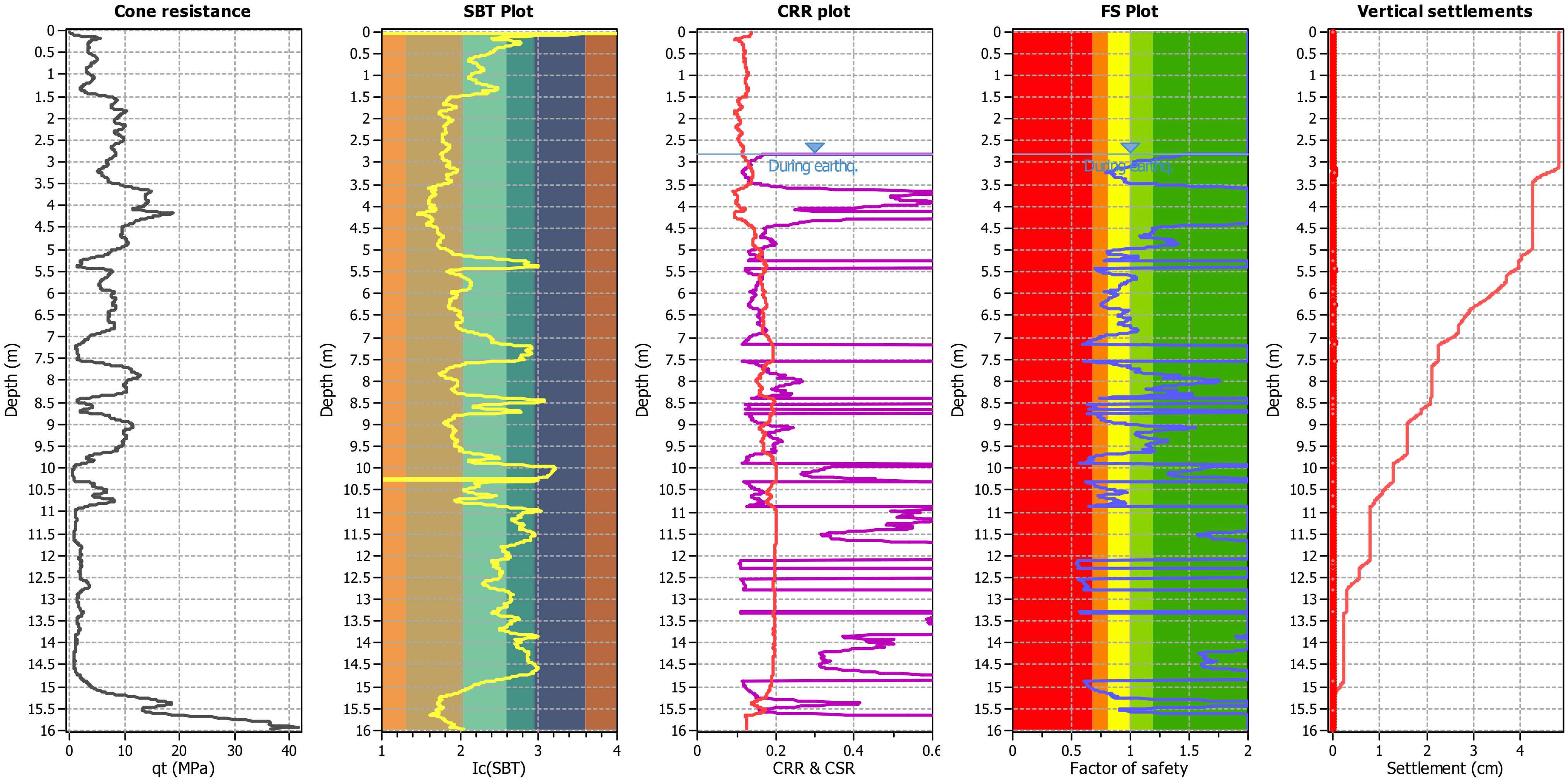
CMW Geosciences

Project: Te Rapa Racecourse Development

Location: Hamilton

CPT: CPT01_ULS_Total

Total depth: 15.97 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.80 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.25	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes	MSF method:	I&B, 2008

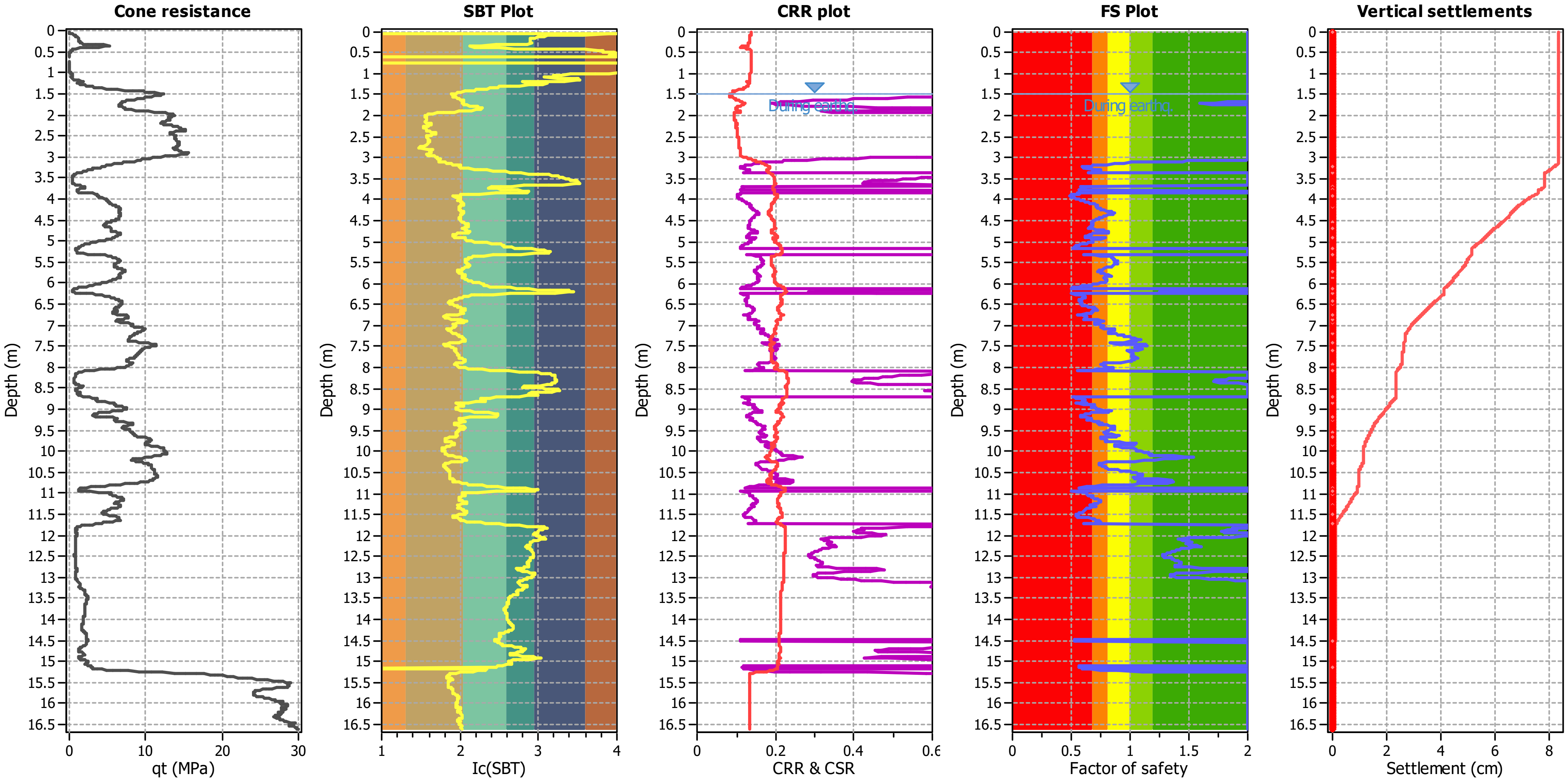
CMW Geosciences

Project: Te Rapa Racecourse Development

Location: Hamilton

CPT: CPT02_ULS_Total

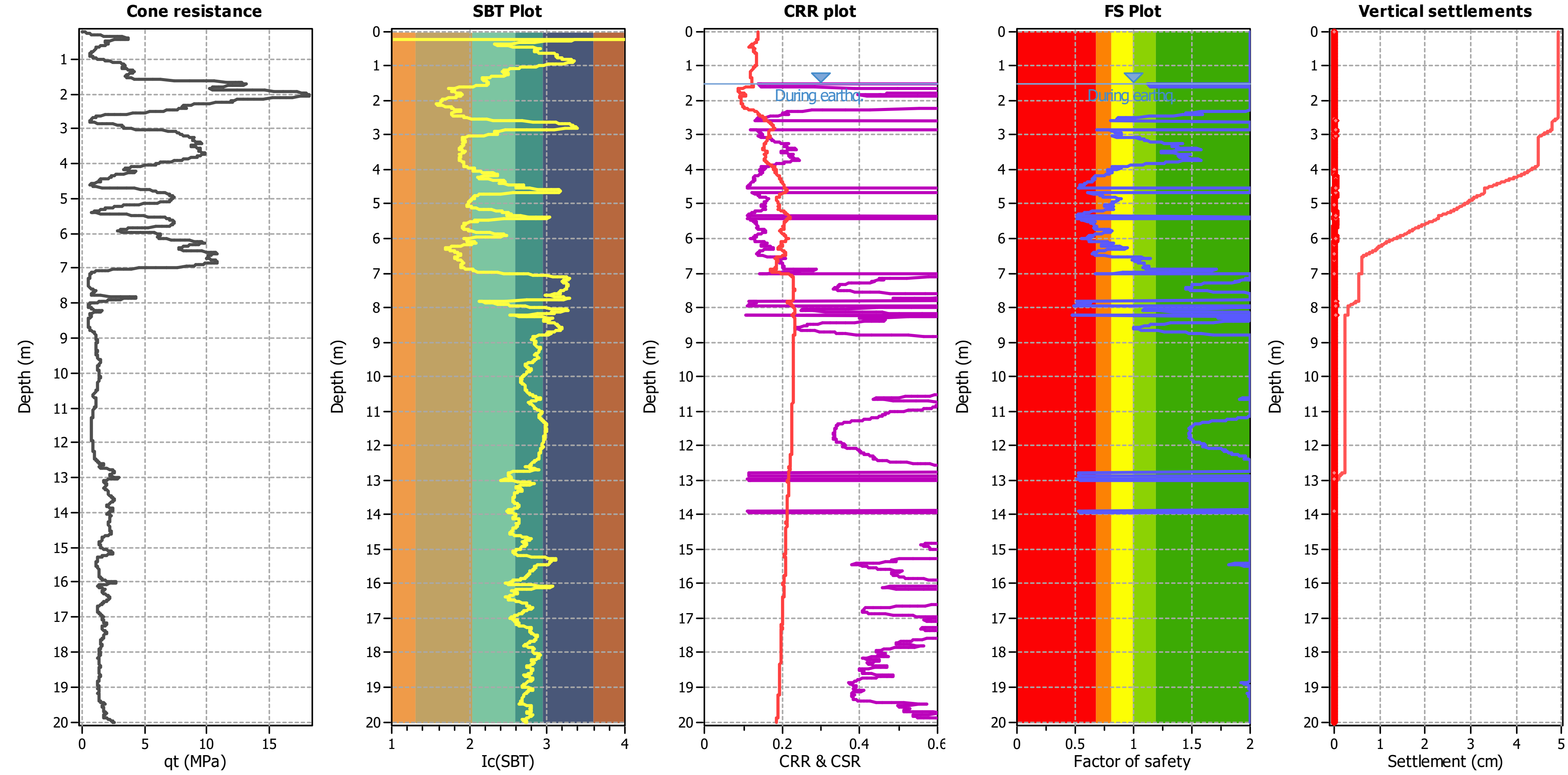
Total depth: 16.61 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.25	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes	MSF method:	I&B, 2008

Project: **Te Rapa Racecourse Development**
Location: **Hamilton**

CPT: CPT03_ULS_Total
Total depth: 20.02 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.25

G.W.T. (in-situ): 1.50 m
G.W.T. (earthq.): 1.50 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: 17.00 kN/m³

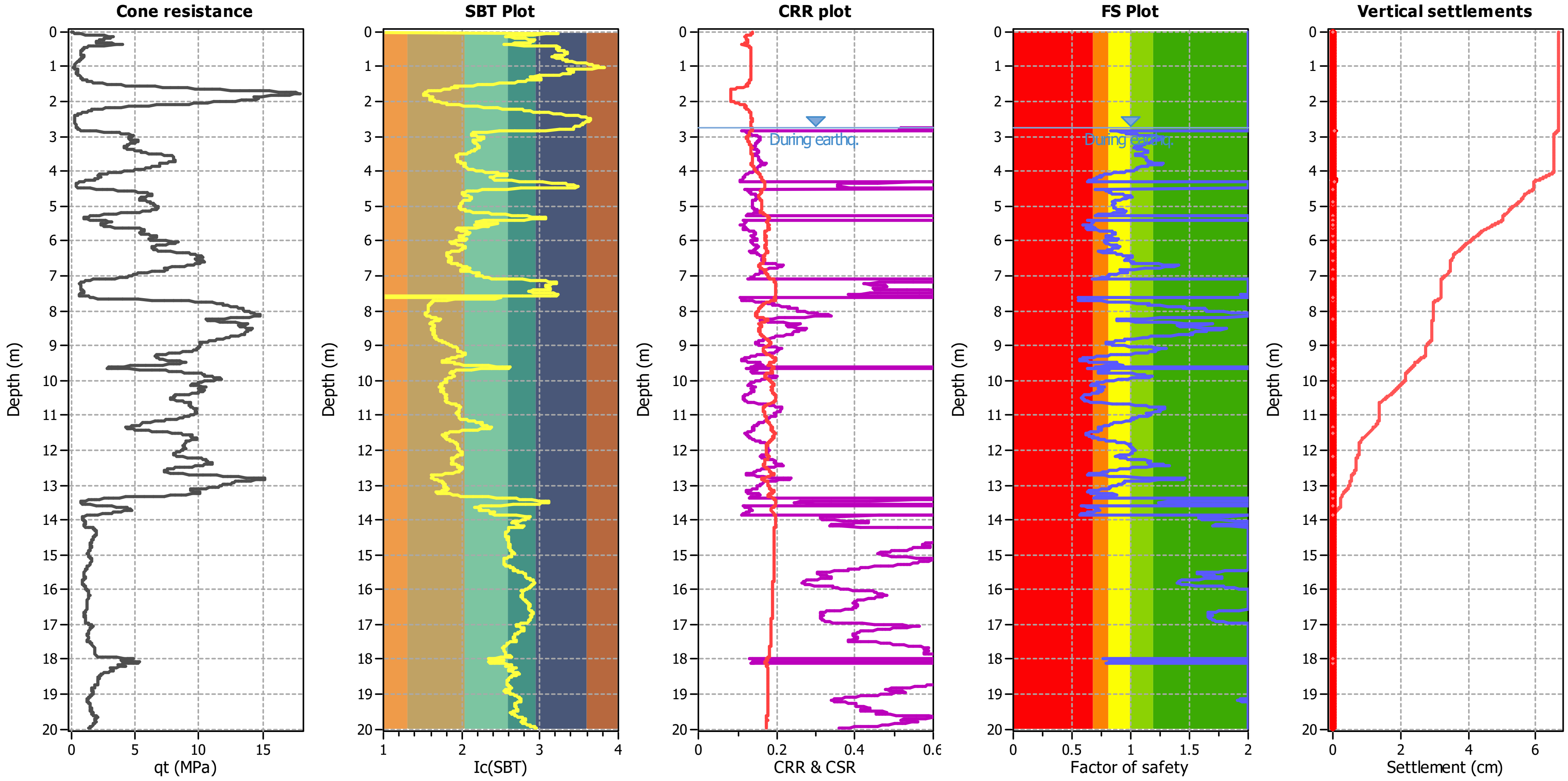
Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: I&B, 2008

CMW Geosciences

Project: **Te Rapa Racecourse Development**
Location: **Hamilton**

CPT: CPT04_ULS_Total
Total depth: 19.97 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.25

G.W.T. (in-situ): 2.75 m
G.W.T. (earthq.): 2.75 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: 17.00 kN/m³

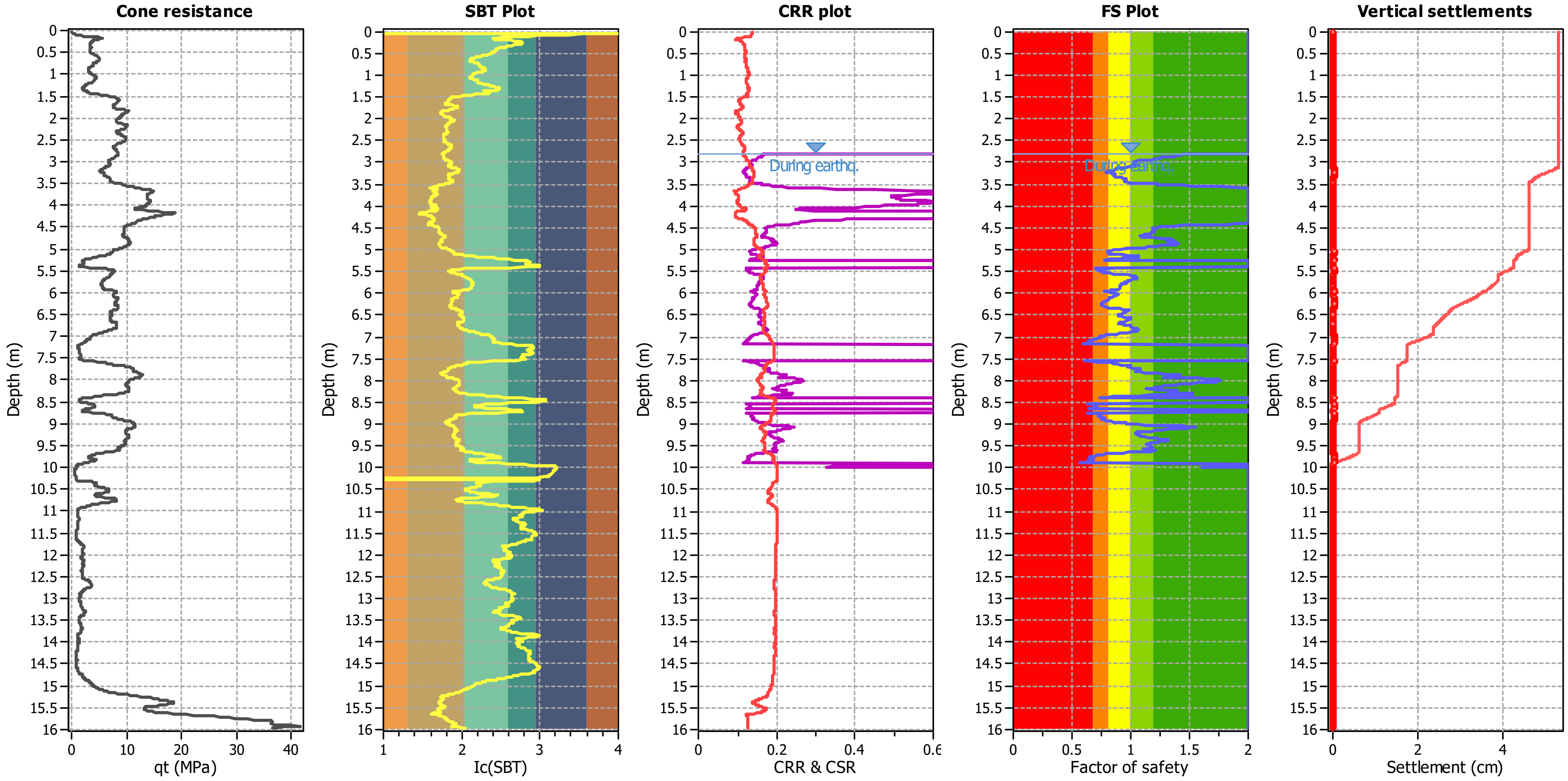
Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: I&B, 2008

CMW Geosciences

Project: **Te Rapa Racecourse Development**
Location: **Hamilton**

CPT: CPT01_ULS_Index
Total depth: 15.97 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.25

G.W.T. (in-situ): 2.80 m
G.W.T. (earthq.): 2.80 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: 17.00 kN/m³

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: Yes
Limit depth: 10.00 m
MSF method: I&B, 2008

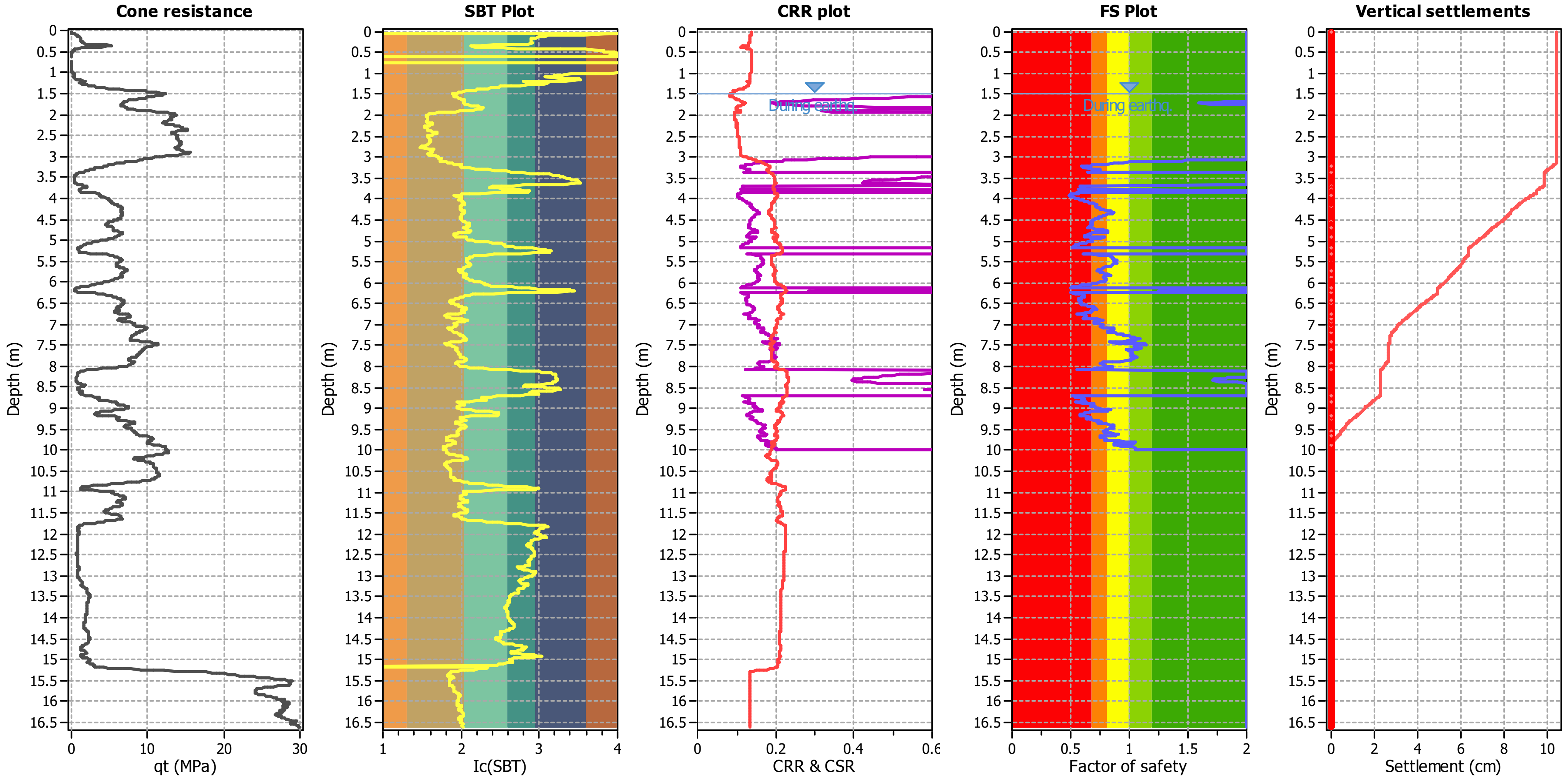
CMW Geosciences

Project: **Te Rapa Racecourse Development**

Location: **Hamilton**

CPT: CPT02_ULS_Index

Total depth: 16.61 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.90
Peak ground acceleration: 0.25

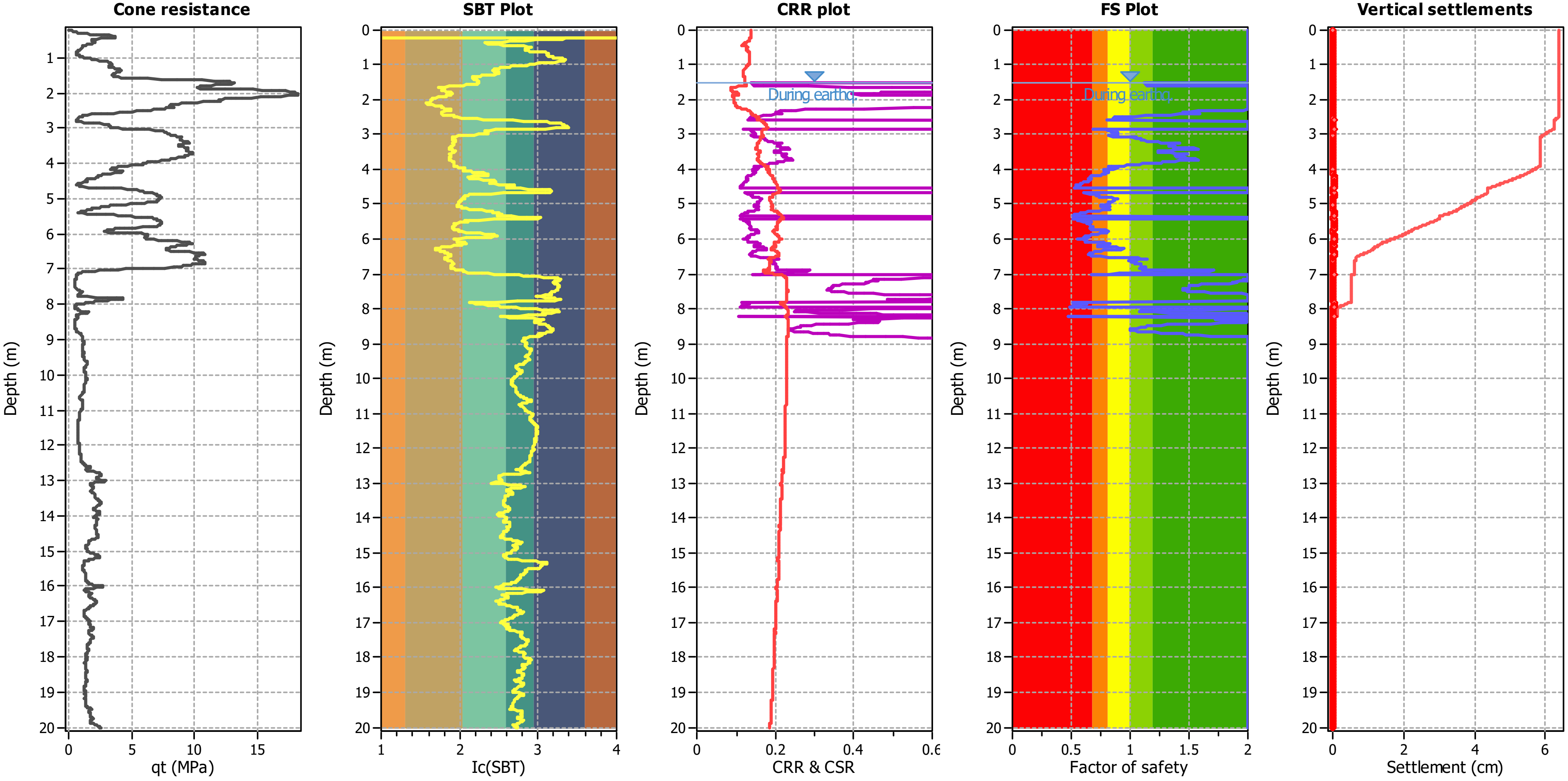
G.W.T. (in-situ): 1.50 m
G.W.T. (earthq.): 1.50 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: 17.00 kN/m3

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: Yes
Limit depth: 10.00 m
MSF method: I&B, 2008

Project: **Te Rapa Racecourse Development**
Location: **Hamilton**

CPT: CPT03_ULS_Index
Total depth: 20.02 m



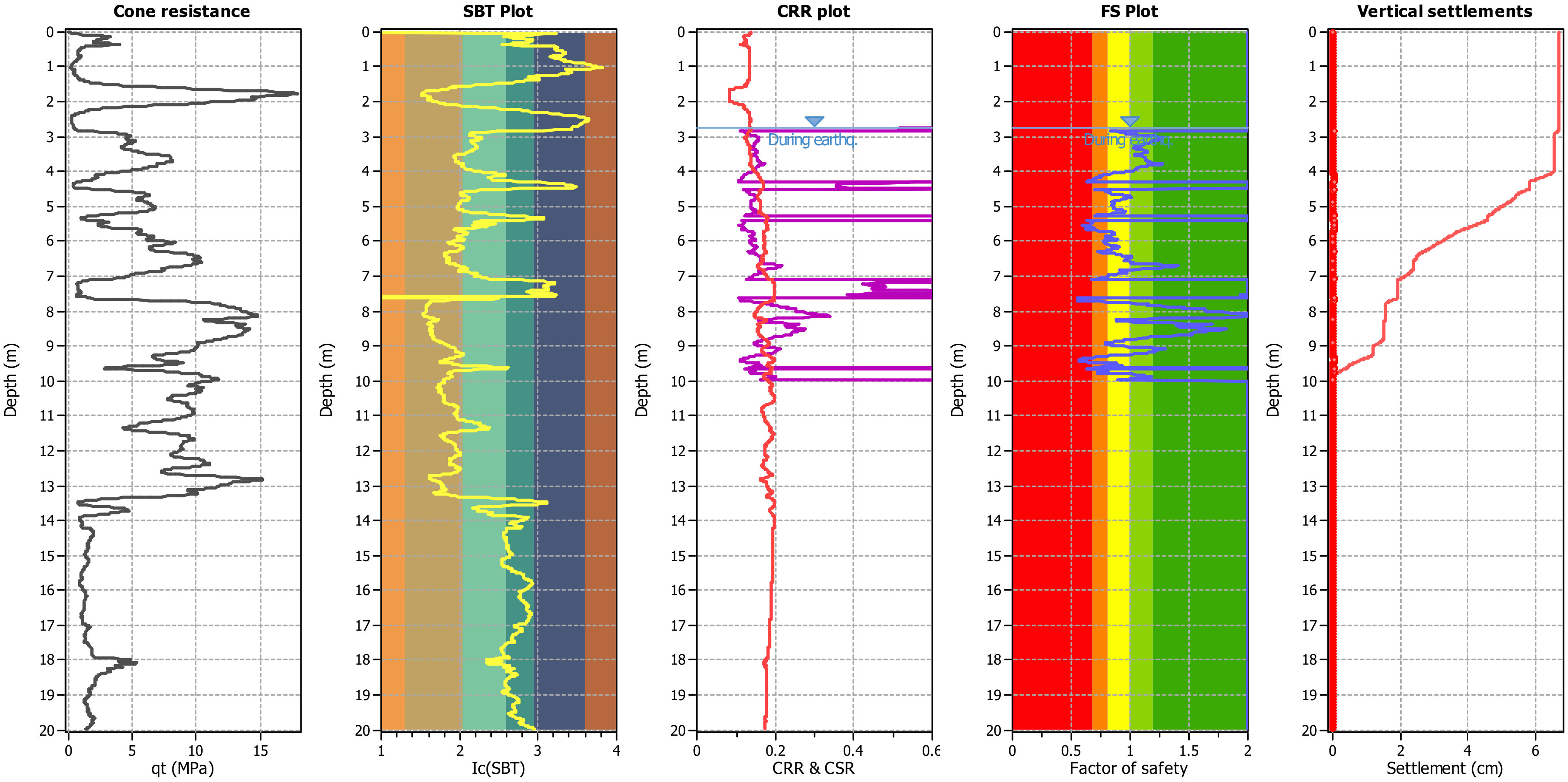
Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.50 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	I&B, 2008
Peak ground acceleration:	0.25	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes		

Project: **Te Rapa Racecourse Development**

Location: **Hamilton**

CPT: CPT04_ULS_Index

Total depth: 19.97 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.75 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.75 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	I&B, 2008
Peak ground acceleration:	0.25	Unit weight calculation:	17.00 kN/m³	K_σ applied:	Yes		

Appendix F: Safety in Design Risk Assessment

CMW Safety in Design Risk Assessment

HAM2022-0030AB, Te Rapa Racecourse Development - 07/07/2022

Design Element	Hazard	Description	Assessed Risk			Controls Incorporated in Design	Residual Risk		
			Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Earthworks	Falling from height	Injury to construction staff while constructing steep temporary or permanent earthworks cut or fill faces.	4	3	12	Temporary barrier fence or other means to be used to ensure persons cannot access to the edge of steep excavations	4	1	4
	Striking underground services	Injury to construction staff if live services are struck.	4	3	12	All sites cleared for services prior to site investigations and earthworks construction	4	1	4
	Moving Machinery	Injury to construction staff.	4	3	12	Separate moving machinery from light vehicles and person movements with fencing and/or safe distances from exposed construction staff operations.	4	1	4
	Working at edges of excavations	Injury to construction staff.	4	3	12	Install safety barriers, exclusion zones, signage as necessary to warn of hazard.	4	1	4
	Trench excavation collapse	Injury to construction staff or persons due to crushing/impact injury.	4	3	12	Follow Worksafe requirements, trench shields or benching of excavations to be used. No staff to enter the trench without appropriate and approved measures already in place.	4	1	4
	Cut / fill batter collapse	Injury to construction staff during construction.	4	3	12	Safe distances and appropriate temporary slope gradients and heights to be assessed prior to, and monitored during, construction to confirm as appropriate, safe distances and barrier fencing to be used on site where deemed necessary.	4	1	4
	Excessive noise during construction	Damage to hearing of construction staff or persons adjacent to the site.	3	3	9	Comply with appropriate allowances for noise on site, ear protection to be worn where appropriate, setback distances from adjacent sites or notified working hours to avoid conflict with adjacent property inhabitants.	3	1	3
	Machinery rollover	Machinery trafficability over soft, wet or uneven ground.	4	3	12	Appropriate construction of temporary haul roads, implement drainage and geofabrics, appropriate driver training.	4	1	4
	Contaminated Soils	Airborne or in-ground contaminants affecting construction staff.	3	3	9	Perform an Environmental assessment of the site prior to construction.	3	1	3

NOTE: It is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect).

Safety in Design Assessment Framework

Risk Matrix		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Event Will Occur 5	Medium 5	High 10	High 15	Extreme 20	Extreme 25
	Event Almost Certain to Occur 4	Low 4	Medium 8	High 12	Extreme 16	Extreme 20
	Event May Occur 3	Low 3	Medium 6	High 9	High 12	High 15
	Event Not Likely to Occur 2	Low 2	Low 4	Medium 6	Medium 8	High 10
	Event Rarely Occurs 1	Low 1	Low 2	Low 3	Low 4	Medium 5