# Appendix E

## Geotechnical investigation report

Consulting Geotechnical Engineers

ACN 005 777 060

# WAKOOL SHIRE COUNCIL

# NOORONG ROAD

# 34.6 KM EAST OF SWAN HILL

# PROPOSED REPLACEMENT GEE GEE BRIDGE OVER THE WAKOOL RIVER

# GEOTECHNICAL INVESTIGATION

# REPORT NO N1662R1 APRIL 2015

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## DOCUMENT INFORMATION

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## CONTENTS

## 1.0 GENERAL

### 1.1 Purpose of investigation

This report presents the results of a geotechnical investigation performed at the site of the proposed replacement Gee Gee Bridge over the Wakool River, located on Noorong Road, 34.6 km east of Swan Hill. The proposed bridge is to replace two separate bridges, which are the main channel bridge over the Wakool River, plus the flood relief bridge crossing a relatively low level river flat to the north of the river.

A locality plan is shown in Appendix A, Figure 1.

The purpose of the investigation was to:

- Determine the sub-surface conditions at the site.
- Provide an earthquake sub-soil class in accordance with AS 1170.4 – 2007.
- Provide recommendations on footing type, depth, capacity and testing.
- Provide estimates of footing settlement.
- Discuss construction.

### 1.2 Proposed bridge

It is understood that the following bridge is proposed:

*Dimensions*
- Total length. 244 m.
- Overall width. 10.24 m.
- 10 spans x 17 m per span, 2 spans x 20 m, 1 span x 34 m.

*Superstructure*
- Precast reinforced concrete T beams (4 No x 1500 mm deep) with approximately 200 mm thick reinforced concrete overlay for the three largest spans.
- Precast reinforced concrete T beams (4 No x 750 mm deep) with approximately 200 mm thick reinforced concrete overlay for the remaining spans.

*Substructure*
- Preferred footing. 5 No x 400 mm x 400 mm driven precast concrete piles for the abutments and for the piers at the 17 m and 20 m spans.
- Preferred footing. 2 No x 1200 mm diameter permanently cased bored piles, or large diameter CHS driven steel piles, for the 34 m span.
- Piles to crosshead.
- Retaining abutments.

*Bridge Loading*
- SM1600 loading.
- The following per pile loads have been advised by the Wakool Shire. It is understood these loads are preliminary and will be confirmed by a structural engineer.

| Location | ultimate limit state |
|---|---|
| Piers (17 m & 20 m) | 1800 kN |
| Piers (34 m span) | 12000 kN |
| Abutments | unknown |

- Serviceability loads are unknown at this time.

*Alignment*
- The proposed bridge horizontal alignment differs from the existing bridges with the new centreline approximately 12 m downstream.
- The proposed bridge vertical alignment is similar to the existing flood relief bridge. The proposed bridge vertical alignment differs from the existing main channel bridge and is 1 m, or so, higher.

**GENERAL** continued...

### 1.3 Existing conditions

The existing flood recovery bridge is as follows:

*Dimensions*
- Total length 112 m.
- Overall width 5.5 m.
- Two spans x 4 m, two spans x 9 m, 12 spans x about 7 m.

*Superstructure*
- Originally, 5 No 400 mm, or so, diameter timber logs with transverse timber planks and concrete deck.

*Substructure*
- Originally, 3 No 400 mm, or so, diameter driven timber piles at the abutments and piers.
- Piles to crosshead
- Timber retaining abutments with 3 m, or so, long timber wingwalls.
- One timber pile at the north east abutment is marked with XVI, probably indicating a pile toe depth of 16 feet below crosshead.

The superstructure and substructure appear to have been repaired may times, with extensive alterations including additional steel beams within the superstructure, and additional driven steel and driven timber piles in the substructure. Most of the piers have been propped with timber logs supported on timber beams on the subgrade. Some of the piers have been propped with adjustable steel trusses supported on large steel beams which rest on timber beams which rest on the subgrade. Dates carved on the timber repairs range from the 1980s to the 2000s.

*Environment*
- Noorong Road runs south west (from Swan Hill) to north east (towards Wakool) at the bridge site, turning to the east immediately beyond the north east abutment.
- Deck to flood plain approximately 4 m.
- There is about 2.5 m of fill at the south west abutment, and about 2 m of fill at the north east abutment.
- The flood plain is undulating, relatively flat towards the river and gently rising towards the north.
- The flood plain is vegetated with grass and trees, mostly river red gums.
- There is an unsealed access track to the north west of the bridge.

The existing main channel bridge is as follows:

*Dimensions*
- Total length 73 m.
- Overall width 5.5 m.
- Five approach spans x 9 m per span and one timber truss span x 28 m.

*Superstructure*
- 5 No 400 mm diameter timber logs with transverse timber planks with asphalt surfacing.

Various steel and timber repair work / reinforcing has been conducted, with the timber beams within and adjacent to the truss span. These are dated from the 1990s to the 2000s.

*Substructure*
- 3 or 4 No 400 mm, or so, diameter driven timber piles at the abutments and piers.
- Additional 400 x 400 mm, or so, square driven timber piles at the piers supporting the truss span.
- Additional 310 UC steel piles have been driven at the pier closest to the south west abutment.
- Piles to crosshead
- Timber retaining abutments with 3 m, or so, long timber wingwalls.

## GENERAL

**Existing Conditions** continued...

*Environment*

- Noorong Road runs south west (from Swan Hill) to north east (towards Wakool) at the bridge site.
- Deck to river bed approximately 10 m.
- Depth of water in river was approximately 2.5 m at the time of drilling.
- There is about 2 m of fill at the north east abutment.
- Scour was observed in the south west river banks.
- The north east river bank is approximately 3.5 H : 1 V.
- The south west river bank is approximately 2 H : 1 V.
- The river banks are vegetated with patchy grass within a few metres of the water, and trees, mostly river red gums.
- The stream alignment for 100m, or so, upstream of the existing bridge runs north east-south west before turning south east-north west.
- The stream alignment for 100m, or so, downstream of the existing bridge is relatively straight.

A 58 m, or so, fill embankment of approximately 2.0 m – 2.5 m height connects the flood recovery bridge to the main channel bridge.

Significant movement was noted in both the flood recovery and the main channel bridges when large (B-Double) trucks were crossing during the investigation.

Photos of the bridges are shown below.

*Main Channel Bridge*

*Image 1 - Main channel bridge from the east*

*Image 2 – Main channel bridge, towards Wakool*


*Image 3 - Main channel bridge, north east abutment*

*Image 4 – View downstream*

## GENERAL

**Existing Conditions** continued...

*Image 5 - View upstream*

*Image 6 – North east bank, looking upstream*

*Image 7 - South west bank from north east bank*

*Image 8 – Underside of bridge from north east bank*

*Image 9 - Truss span repair works dated May 2008*

*Image 10 – Drilling at proposed south west abutment*

## GENERAL

**Existing Conditions** continued...

*Flood Recovery Bridge*

*Image 11 - Flood recovery bridge from south*

*Image 12 – Flood recovery bridge from north*

*Image 13 – Access track and fill at south west abutment*

*Image 14 – CPT rig to north of bridge*

*Image 15 – Steel truss props*

*Image 16 – Steel beam replacing timber log*

## 2.0 SUB-SURFACE CONDITIONS

### 2.1 Reported geology

The Geological Survey of New South Wales, 1: 250,000 Series, Deniliquin Sheet, indicates the site surface geology is unconsolidated sediments of the Shepparton Formation (clay, silt, sand, & gravel), which were mostly deposited in the late Tertiary and Pleistocene Periods (10,000 to 5,000,000 years ago). The sediments are 80, or so, m thick.

Previous work in the vicinity of the site suggested the sub-surface conditions were expected to be interbedded medium dense to dense sand, potentially cemented, and stiff to hard clay.

### 2.2 Field work

To assess the site sub-surface conditions thirteen Cone Penetration Tests (CPTs) and three rotary drill boreholes were conducted to a maximum depth of 34 m below the existing surface level. The test locations are shown in Appendix A, Figure 2. Engineering logs of the boreholes, plots of the CPTs including soil type interpretation, a summary of descriptive terms used in logging, and a description of the cone penetration test are included in Appendix A.

The CPT and borehole numbers have been chosen to represent the proposed abutment or pier numbers as shown on the supplied concept sketch drawings, i.e. “CPT P3” was performed at the proposed Pier 3 location, and “BH Abut A” was performed at the proposed Abutment A location.

The recovered soil samples will be disposed of after six months following the issuing of this report.

### 2.3 Sub-surface profile

The boreholes and CPTs encountered varying sub-surface conditions consistent with the reported geology of the site.

Despite the varying conditions, the boreholes and CPTs show a distinct trend of four main strata within the investigation depth, showing high plasticity clay, over clay interbedded with sand, over sand interbedded with clay, over clay interbedded with sand. The thickness of the two upper clay strata increases with distance from the Wakool River. The tests closest to the river (BH P11 & CPT P11) did not encounter the two upper clay strata. The thickness of the sand layer is variable but generally increases towards the river.

The sub-surface profile encountered in the boreholes/CPTs is summarised below.

*Table 1 - Sub-surface profile*

| Stratum | | depth to top, m | depth to base, m | thickness, m |
|---|---|---|---|---|
| SILTY CLAY | hard, high plasticity (not encountered in CPTs P9, P10, P11), includes a thin layer of calcrete in BH Abut B | 0.0 | 0.8 – 3.2 | 0.8 – 3.2 |
| CLAY, SANDY CLAY, SILY CLAY | very stiff to hard, low to medium plasticity, interbedded with medium dense SAND layers up to 2 m, or so, thick. (not encountered in CPT P11) | 0.8 – 3.2 | 3.0 – 9.6 | 2.2 – 8.2 |
| SAND, CLAYEY SAND, SILTY SAND, GRAVELLY SAND | medium dense to very dense, fine to coarse grained, interbedded with CLAY layers up to 2 m, or so, thick. | 0.0 – 9.6 | 14.4 – 21.7 | 4.9 – 21.7 |
| CLAY, SANDY CLAY, SILTY CLAY | stiff to hard, low to medium plasticity, interbedded with dense to very dense SAND layers up to 2 m, or so, thick. (not penetrated in CPTs P2, P9, P10) | 14.4 – 21.7 | >21.5 - >33.9 | >1.3 - >16.1 |

CPTs P2, P9, & P10 refused within the sand stratum.

**SUB-SURFACE CONDITIONS** continued...

### 2.4 Calcareous soils

Samples were taken from the upper clay and sand strata within the CPTs and boreholes, and tested with hydrochloric acid on site to check if they contained any calcareous soil.

None of the sand samples fizzed when the HCL was applied, which indicates the sand is not calcareous.

One sample of hard clay, from 2.5 m depth at BH Abut B, was observed to fizz vigorously when the HCL was applied. This is likely to be a thin calcrete layer.

### 2.5 Groundwater

The boreholes were dipped one week after they were drilled, with depths to groundwater as follows:

Groundwater encountered in borehole BH Abut A in the clay stratum at a depth of 6.8 m.
Groundwater encountered in borehole BH P 12 in the sand stratum at a depth of 2.8 m.
Groundwater encountered in borehole BH Abut B in the clay stratum at a depth of 6.4 m.

These depths correspond to an RL of 63.4 m to 63.8 m. The RL of the river surface was about RL 63.3 m at the time of drilling.

## 3.0 DISCUSSION & RECOMMENDATIONS

### 3.1 Earthquake site sub-soil class

The Earthquake Site Sub-Soil Class in accordance with AS 1170.4-2007, Structural design actions, Part 4: Earthquake actions in Australia, Section 4, is judged to be **Class $D_e$**.

The Hazard Factor (Z) in accordance with AS 1170.4 – 2007 is **0.06**.

### 3.2 Footing recommendations

#### 3.2.1 Footing type and capacity

Design geotechnical strength pile capacities have been calculated based on the method by Bustamante and Gianeselli, 1982, which is a recommended method for pile design based on CPT. The method involves factors based on soil type, soil strength, and pile type which are applied directly to the corrected cone resistance values to determine ultimate shaft adhesion pressures and end bearing pressures. The top 2 m of the sub-surface at each pier location has been ignored in the capacity calculations to allow for disturbance during installation, or after installation due to erosion.

*Abutments and shorter spans*

The proposed driven 400 mm x 400 mm precast reinforced concrete piles are considered an appropriate footing system to support the proposed 1800 kN ultimate limit state pile load at the piers for the shorter spans and abutments. The piles will gain their capacity from a combination of shaft adhesion from the clay and sand strata, plus end bearing which will be greatest in the dense sand strata. The depths at which this capacity can be achieved is shown in the table below for each test location.

*Table 2 – Recommended pile depths and capacities for 400 x 400 RC piles at abutments and short spans*

| Location | Pile toe depth below ground, m | Pile toe RL, m AHD | Design Geotechnical Strength Shaft Adhesion Capacity, kN | Design Geotechnical Strength End Bearing Capacity, kN | Design Geotechnical Strength Total Capacity, kN |
|---|---|---|---|---|---|
| Abutment A | 26.0 | 44.1 | 1440 | 360 | 1800 |
| Pier 1 | 19.0 | 50.2 | 1275 | 525 | 1800 |
| Pier 2 | 18.6 | 50.2 | 1210 | 590 | 1800 |
| Pier 3 | 16.6 | 51.6 | 1080 | 720 | 1800 |
| Pier 4 | 24.2 | 44.1 | 1510 | 290 | 1800 |
| Pier 5 | 18.5/17.5* | 49.5/50.5* | 945/955* | 655/845* | 1800 |
| Pier 6 | 18.7 | 49.3 | 1165 | 635 | 1800 |
| Pier 7 | 19.8 | 50.1 | 1297 | 503 | 1800 |
| Pier 8 | 20.1 | 50.5 | 1248 | 552 | 1800 |
| Pier 9 | 18.4 | 50.9 | 1191 | 609 | 1800 |
| Pier 10 | 19.5 | 51.6 | 1090 | 710 | 1800 |
| Abutment B | 19.5 | 50.7 | 1261 | 539 | 1800 |

* Note that the analysis at Pier 5 showed that the maximum available design geotechnical strength pile capacity was 1600 kN for a 400 mm x 400 mm pile. Options available are to install an additional pile at this pier, install larger diameter concrete piles at this pier, or rely on set-up (discussed in Section 3.2.1). If a 550 mm octagonal prestressed concrete pile is driven at Pier 5, it would be expected to achieve a design geotechnical strength pile capacity of 1800 kN at a depth of 17.5 m (RL 50.5 m AHD)

It can be seen from the table above that there are two dense sand strata on which the piles will achieve capacity, at around RL 44 m, and RL 50 m. Piles founded within the sand stratum at around RL 50 m are predicted to resist the proposed 1800 kN pile loads at most locations, except Abutment A and Pier 4 where deeper embedment is required. Although the end bearing capacity is lower when founded on this lower stratum, the shaft adhesion is higher and design geotechnical strength capacity exceeds 1800 kN.

 continued...

## DISCUSSION & RECOMMENDATIONS

### Footing recommendations

**Footing type and capacity** continued…

*Large span*

The proposed continuously cased bored piles at the large span are not considered ideal. When a driven pile is mobilised during installation, the shaft capacity is exceeded which allows mobilisation of the toe, so that both shaft and end bearing capacity can be relied upon. When a bored pile is installed, the shaft capacity is yet to be exceeded and large settlements will occur before the end bearing capacity is mobilised. Additionally, a bored pile is expected to be more difficult to install than a driven pile.

The proposed large-diameter driven CHS piles may be appropriate, however the gain in capacity may be less than expected when compared to a concrete pile, as less shaft adhesion is allowed. For example, at the position of CPT P11, the maximum pile capacity would be achieved at about 17.5 m depth. A 400 x 400 mm driven precast reinforced concrete pile will achieve a design geotechnical strength capacity of about 1800 kN. A 610 mm driven CHS pile will achieve a design geotechnical strength capacity of about 2300 kN.

Greater capacity is actually available below this depth, however, for the case of a 400 x 400 pile, below a depth of 20 m the capacity drops below 1800 kN and does not exceed this again until below 25 m depth, reaching a new maximum of 2100 kN at 27 m depth.

An alternative may be to consider installing a group of driven precast concrete piles, and to reduce the number required, 550 mm octagonal prestressed driven piles could be used. A single 550 mm pile would achieve a design geotechnical strength capacity of 2400 kN at 17.5 m depth or RL 48.6 m, which would require ten piles to be installed at this pier to resist the approximate ultimate limit state pier load of 24 MN. The piles would be required to be installed with a spacing of 2.5 pile diameters.

Note that this capacity is based on the test closest to the proposed Pier 11. For Pier 12, the closest test is CPT Abut B, which shows a design geotechnical strength capacity of 2400 kN is achieved at a depth of about 21 m, or RL 50.2 m corresponding well with Pier 11.

The recommended pile depths and capacities for the large span are shown in the table below.

*Table 3 - Recommended pile depths and capacities for 550 mm octagonal PSC driven piles for large span*

| Location | Pile toe depth below ground*, m | Pile toe RL, m AHD | Design Geotechnical Strength Shaft Adhesion Capacity, kN | Design Geotechnical Strength End Bearing Capacity, kN | Design Geotechnical Strength Total Capacity, kN |
|---|---|---|---|---|---|
| Pier 11 | ~ 14.9 | 48.6 | 1210 | 1190 | 2400 |
| Pier 12 | ~ 14.3 | 50.2 | 1369 | 1031 | 2400 |

* Estimated depth below ground at pier, not at test location.

*Driving*

The driven piles will gain their capacity from a combination of shaft adhesion and end bearing. The end bearing capacity available is much greater in the dense sand than the surrounding clay. For this reason it is very important to ensure the piles are not driven beyond the recommend RLs without assessing the capacity first. If the piles are driven beyond a particular sand end bearing layer, it may be necessary to continue driving.

For the piles driven to about RL 50 m (all locations except Abutment A and Pier 4), if the piles are driven beyond the recommended RL, they will require driving to the next dense sand layer at approximately RL 44 m, an additional 6 m, or so.

## DISCUSSION & RECOMMENDATIONS

### Footing recommendations

**Footing type and capacity** continued…

For the piles driven to about RL 44 m (Abutment A and Pier 4), if the piles are driven beyond the recommended RL, they will require further driving until either another dense layer of sand is encountered (is it not clear where this might be), or accumulation of shaft adhesion capacity is determined to be sufficient. Again, this would be an addition 6 m, or so.

Alternatively, the pile may be allowed to set-up, which is discussed below.

If large sets are noted at the recommended pile depths during construction, please contact this company immediately.

*Pile set-up*

Experience has shown that piles in clay achieve a much higher test capacity than the load that is predicted by static soil mechanics. This is due to the limits involved in the geotechnical design parameter calculations and also due to the effect of set-up with driven piles. Set-up is the increase in shear strength due to the dissipation over time of pore pressures generated during pile driving.

For example, two PDA tested piles that were driven at the Old Kerang Road bridge over the Loddon River achieved the ultimate shaft adhesion and end bearing pressures shown in Table 4 below. PDA testing is discussed in Section 3.5 of this report.

*Table 4 - PDA test piles at Old Kerang Road bridge over the Loddon River*

| test pile | test on driving | | test one month after driving | |
|---|---|---|---|---|
| | shaft adhesion, kPa | end bearing, kPa | shaft adhesion, kPa | end bearing, kPa |
| 1 | 30 | 5900 | 85 | 4950 * |
| 2 | 35 | 6950 | 135 | 6600 * |

* Low set achieved on test and end bearing not fully mobilised. Actual end bearing would be higher.

The test piles were driven to depths of 17.5 m and 12.5 m in alluvial clay of a similar soil formation (Coonambidgal Formation), as the soil formation at this site.

It can be seen from the results in Table 4 that the shaft adhesion pressures, while very close to those predicted by static soil mechanics during initial pile driving, after one month are much higher.

If large sets are noted at the recommended pile depths during construction, or this depth is exceeded, it would be a reasonable approach to allow the pile to set up for a week or two before PDA testing the pile to determine the capacity.

*Lateral Capacity*

Lateral performance of the piles can be assessed by this company once the pile details are confirmed and the lateral loads (including traffic, thermal, and flood loads, if applicable) are supplied.

## DISCUSSION & RECOMMENDATIONS

**Footing recommendations** continued…

### 3.2.2 Design geotechnical pressures

For pile design, characteristic shaft adhesion and end bearing pressures are often assigned to a generalisation of the various strata encountered in the investigation. Due to the varying sub-surface conditions at this site, it is not appropriate to apply characteristic pressures to the strata and for that reason the design pressures were assessed in detail for each CPT to determine pile capacity. The shaft adhesion and end bearing pressures are also dependent on the type of pile being used.

If the pile types discussed above are changed, or values of shaft adhesion pressures are required, please contact this company.

The maximum design geotechnical end bearing pressure that would be applied to the sand strata is 4750 kPa. This equates to an ultimate geotechnical end bearing pressure of 9500 kPa. For non-calcareous sands it is recommended to keep the ultimate geotechnical end bearing pressures below 10,000 kPa. As discussed in Section 2.4, the sand encountered in the investigation was determined to be non-calcareous. The calcrete layer identified at BH Abut B will not affect pile performance.

### 3.2.3 Footing settlement

The theoretical maximum post construction settlement of the proposed driven piles is 5 mm when subject to ultimate limit state loads. The settlement under serviceability loads will be less.

### 3.2.4 Footing testing

PDA tests should be performed on each type of pile installed at the site. We recommend a minimum of 15% of each pile type is tested.

The remaining pile capacities can be confirmed by driving to a minimum set and energy determined by CAPWAP analysis.

The characteristic ultimate limit state axial load (the capacity the piles must achieve in the field) can be determined by dividing the design structural ultimate limit state load on the piles by the geotechnical strength reduction factor (GSRF, $\Phi_g$). VicRoads BTN 2014/002, Section 4.3, states that the geotechnical strength reduction factor ( $\Phi_g$), shall be calculated using the following equation, which is derived from AS2159 (2009):

$\Phi_g = \Phi_{gb} + (\Phi_{tf} - \Phi_{gb})K > \Phi_{gb}$ where,

$\Phi_g$ = geotechnical strength reduction factor
$\Phi_{gb}$ = basic geotechnical strength reduction factor (determined from AS2159 (2009) Clause 4.3.2)
$\Phi_{tf}$ = intrinsic geotechnical strength reduction factor
= 0.8 for dynamic load testing of performed piles (representative piles)
= 0.75 for dynamic load testing of other than performed piles (represented piles)
= 0.4 for determination of pile capacity based on the Hiley formula
$K$ = testing benefit factor (determined from AS2159 (2009) Clause 4.3.1)
= $1.13p/(p + 3.3) \leq 1$ (for dynamic load testing)
$p$ = percentage of the total piles that are tested and meet the specified acceptance criteria

An earlier VicRoads Bridge Technical Note (BTN 1996/001, Version 2.0, June 2005) has the following definitions for representative (performed) and represented (other than performed) piles.

*Representative Pile – A pile that represents a number of piles (which are to be driven to a resistance) for the purpose of determining driving parameters using Dynamic Testing.*

*Represented Pile – A pile whose capacity is calculated by extrapolation of the results from the testing of a representative pile(s).*

**DISCUSSION & RECOMMENDATIONS**

**Footing recommendations**

**Footing testing** continued…

Representative and represented piles have different geotechnical strength reduction factors as a result of a reduction in confidence in the capacity determinations for the represented piles.

The testing benefit factor, K, is based on a number of factors which includes the level of geotechnical supervision during installation.

At this stage, $\Phi_g$ cannot be determined until the pile types, the amount of testing, and the level of supervision are confirmed. Once this has been confirmed, this company can provide a recommended PDA program and the appropriate $\Phi_g$.

It is not recommend relying on the Hiley method alone to determine pile capacities.

This company can provide a fee to perform PDA testing at the site.

**3.3 Abutment fill settlement**

The addition of 2 m, or so, of fill at the north east abutment will induce settlement within the underlying strata. The theoretical maximum post construction settlement of the proposed abutment fill is 20 mm. This settlement is mostly due to compression of the clay strata and may occur slowly.

**3.4 Construction**

As noted in Section 3.2.1, re-tests after set-up (say, after at least one week) may be required to confirm that piles have achieved the required test loads.

It is understood that a practicable maximum pile length for handling a 400 mm x 400 mm or 550 mm octagonal concrete pile is about 15 m. This will require splicing of the piles. If the piles are driven to the recommended depths, and care is taken not to exceed these depths as discussed in Section 3.2.1, it is unlikely greater depths will be required. However, it is recommended splices are installed at both ends of the pile in case driving to a greater depth is required.

**3.5 Validity**

If sub-surface conditions different from those described above are encountered during construction the recommendations contained in this report may not be valid and the company should be contacted.

**BLACK GEOTECHNICAL PTY LTD**

# APPENDIX A

| | |
|---|---|
| **Figure 1** | **Locality Plan** |
| **Figure 2** | **Test Location Plan** |
| **Figure 1A** | **Soil Classification Sheet** |
| **Figure 1C** | **Description of Cone Penetration Test** |
| **Logs** | **Bores BH Abut A, BH Abut B, BH P11** |
| **Plots** | **CPT Abut A, CPT Abut B, CPT P1 to CPT P11, inclusive** |

Plot Date: 2015-04-01 12:49:12 File: Z:\BLACK\2015 Job Files\N1662 - Gee Gee Bridge, Wakool\Drawings\Figure 1.dwg Version 2.4, 23 DECEMBER 2014


NORTH


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| REVISION | DETAILS OF AMENDMENT | DATE |
|---|---|---|
| A | First Issue | 01/04/15 |

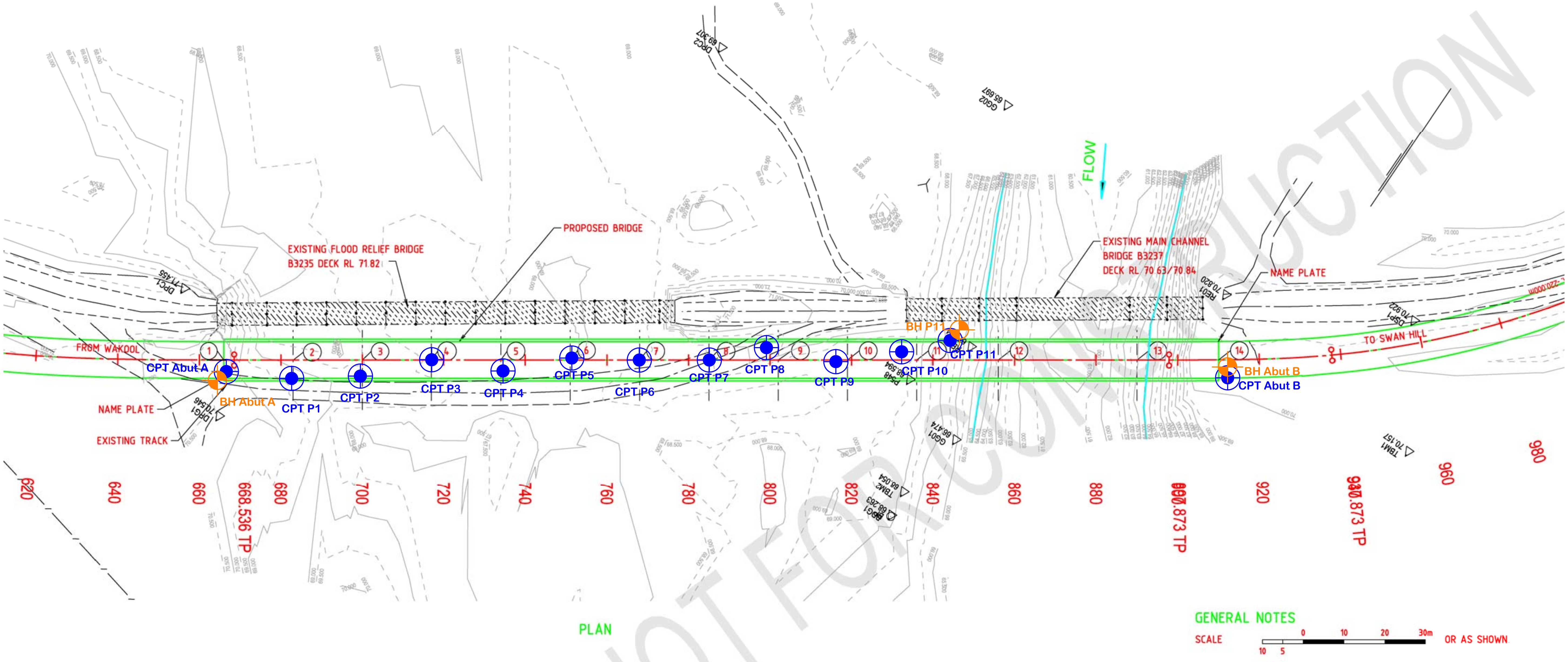
PROJECT TITLE / ADDRESS

GEE GEE BRIDGE REPLACEMENT OVER WAKOOL RIVER

DRAWING TITLE

LOCALITY PLAN

| COORDINATE DATUM / PROJECTION | ELEVATION DATUM | SCALE | SIZE | DRAWN | CHECKED | PROJECT NO. | DRAWING NO. | REV. |
|---|---|---|---|---|---|---|---|---|
| - | - | N.T.S | | BB | NS | N1662 | FIGURE 1 | A |




GENERAL NOTES

SCALE 0 10 20 30m OR AS SHOWN

LEGEND

CPT

BOREHOLE

DRAWING BASED ON SUPPLIED RTA DRAWING KD1051CS2 - CONCEPT SKETCH OPTION 2 - SHEET A

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| REVISION | DETAILS OF AMENDMENT | DATE |
|---|---|---|
| A | First Issue | 01/04/15 |

ELEVATION DATUM: -

COORDINATE DATUM / PROJECTION: -

PROJECT TITLE / ADDRESS: GEE GEE BRIDGE REPLACEMENT OVER WAKOOL RIVER

DRAWING TITLE: TEST LOCATION PLAN

| SCALE | SIZE | DRAWN | CHECKED | PROJECT NO. | DRAWING NO. | REV. |
|---|---|---|---|---|---|---|
| 1:1000 | A3 | BB | NS | N1662 | FIGURE 2 | A |


Version 2.4, 23 DECEMBER 2014
File: Z:\BLACK\2015 Job Files\N1662 - Gee Gee Bridge, Wakool\Drawings\Figure 2.dwg
Plot Date: 2015-04-01 10:35:19

| BLACK GEOTECHNICAL | DESCRIPTIVE TERMS & GRAPHIC SYMBOLS FOR SOIL | FIG. 1A<br>Doc. Ver. 2.5 |
|---|---|---|

**CLASSIFICATION BASED ON UNIFIED SOIL CLASSIFICATION. AS1726 – 1993**

## WATER

| | | |
|---|---|---|
| ▽ | Water level at time of drilling. | GROUNDWATER NOT OBSERVED<br>Groundwater observation was not possible due to water used in drilling process. Groundwater may be present. |
| ▼ | Static water level. | |
| ▶— | Water inflow to borehole or test pit. | GROUNDWATER NOT ENCOUNTERED<br>No groundwater was encountered at time of drilling or excavation in the borehole or test pit. |
| —◀ | Water loss in borehole. | |

## SAMPLES AND TESTS

| | | | |
|---|---|---|---|
| SPT | Standard Penetration Test (AS1289.6.3.1 – 2004). Blows per 150 mm. N = Blows for 300 mm after 150 mm seating. | SV | Shear Vane. Measures Shear Strength ($s_u$). Peak Strength/Residual Strength. |
| DCP | Dynamic Penetrometer Test (AS1289.6.3.2 – 1997). Blows per 100 mm. | N | SPT with sample collected from spoon. |
| U63 | Undisturbed sample (Push Tube) – 63 mm diameter. 50 mm tube may be used (U50). | N* | SPT with no sample collected in spoon. |
| PP | Pocket Penetrometer. Measures Unconfined Compressive Strength (UCS). | Nc | SPT with solid cone. No sample. |
| D | Disturbed sample. | N'(60) | Corrected normalised N-value. Also known as $N_{1,60}$ . |
| B | Bulk disturbed sample. | R | DCP / SPT refusal. |

## SOIL GRAPHICS (Sample)

| | | |
|---|---|---|
| CLAY (CL, CI, CH) | FILL | SILT (ML, MH) |
| GRAVEL (GW, GP) | SAND (SW, SP) | COBBLES AND BOULDERS |

Graphic representation of mixed materials, such as silty clay, would be a combination of these symbols.

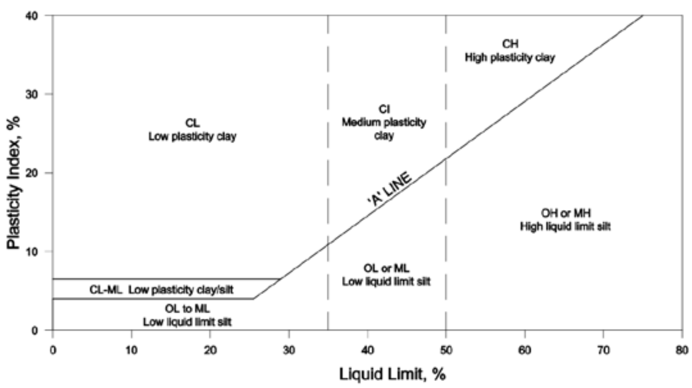
## DRILLING METHOD

| | | | |
|---|---|---|---|
| SSA | Solid Stem Auger | WB | Washbore |
| HSA | Hollow Stem Auger | ODEX | ODEX Retractable Bit System |
| HA | Hand Auger | AIRH | Down-the-hole Air Hammer |
| EX | Excavator | HE | Hand Excavation |
| BH | Backhoe | CC | Concrete Coring |
| NMLC | 52mm Diamond Core | RCB | Rock Core Barrel |
| NDD | Non-Destructive Drilling | MC | Macro Core |

## PARTICLE SIZE

| | | |
|---|---|---|
| Boulders | | > 200mm |
| Cobbles | | 63 to 200mm |
| Gravel | Coarse | 20 to 63mm |
| | Medium | 6.0 to 20mm |
| | Fine | 2.0 to 6.0mm |
| Sand | Coarse | 0.6 to 2.0mm |
| | Medium | 0.2 to 0.6mm |
| | Fine | 0.075 to 0.2mm |
| Silt | | 0.002 to 0.075mm |
| Clay | | < 0.002mm |

## PLASTICITY PROPERTIES




## PLASTICITY

| *Description* | *Liquid Limit* |
|---|---|
| Low | < 35% |
| Medium | 30 to 50% |
| High | > 50% |

## MOISTURE CONDITION

| | |
|---|---|
| Dry | Looks and feels dry |
| Moist | Feels cool, darkened in colour, no free water or remoulding |
| Wet | Feels cool, darkened in colour, free water or remoulding |
| W | Natural moisture content |
| Wp | Plastic limit |

## SECONDARY COMPONENT

| | |
|---|---|
| Trace | 0 to 5% |
| Presence just detectable by feel or eye | |
| With | 5 to 12% |
| Presence easily detectable by feel or eye | |

## CONSISTENCY

$s_u$ kPa, AS1726 Table A4

| TERM | very soft | soft | firm | stiff | very stiff | hard |
|---|---|---|---|---|---|---|
| $s_u$ kPa | 12 | 25 | 50 | 100 | 200 | |

If a soil crumbles on test it is described as friable.

## DENSITY INDEX

$I_d$ %, AS1726 Table A5

| TERM | very loose | loose | medium dense | dense | very dense |
|---|---|---|---|---|---|
| $I_d$ % | 15 | 35 | 65 | 85 | |

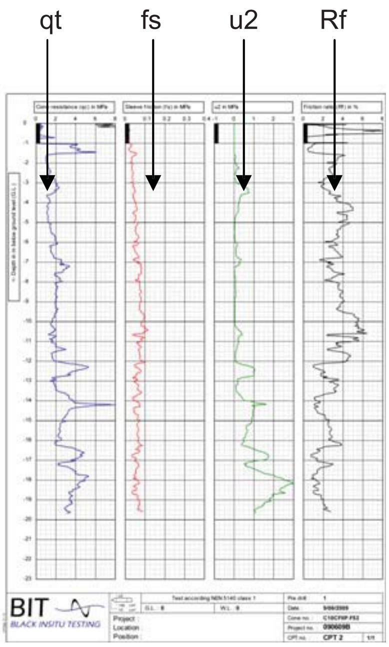
# DESCRIPTION OF CONE PENETRATION TEST

A Cone Penetration Test involves using hydraulic rams to push 36mm diameter rods into the soil from within a ballasted truck or drill rig. Attached to the end of the rods is a cone containing various strain gauges which measure the geotechnical properties of the soil as the cone is pushed into the ground. Measurements are taken every centimetre. In general, three different cones can be used in a CPT investigation.

**Standard Friction Cones** provide qc (tip resistance), fs (sleeve friction) and inclination. The qc is used to determine the strength of the soil. Using qc and fs together allows the determination of the friction ratio, Rf (= fs/qc x 100%), which helps identify soil type. Measuring inclination allows the operator to determine if the cone is being bent in the soil, and therefore prevents damage. Plots are also corrected for deviation from vertical. A 15cm cone can be used where adverse soil conditions are expected.

**Piezocones** incorporate a pore-pressure sensor (u2), along with qc, fs and inclination, allowing highly accurate identification of very thin soil layers and differentiation between similar soil types; qc is corrected for pore-pressure effects to provide qt. Piezocones also enable dissipation testing, where the dissipation of excess pore pressures is measured to estimate parameters for coefficient of consolidation and rough estimates of permeability.

*Example of a piezocone and how the data obtained is presented.*

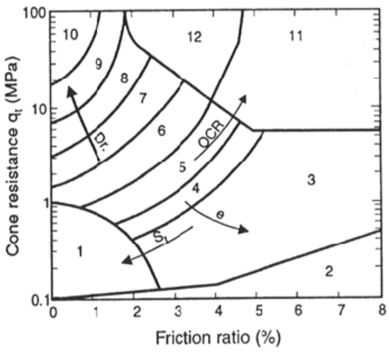

**Mechanical Cones** provide qc only, however, they are very robust and are useful for testing in adverse conditions such as detecting voids within cemented sands, probing extremely weathered rock profiles or for use in areas of fill of unknown composition.

*Example of a mechanical cone.*

Whichever type of cone is used, all data is logged electronically via on board computer systems within each truck.

**Interpreting** the soil type in the field is possible using this soil behaviour type chart from Robertson et al., 1986, by comparing cone resistance (qc) against friction ratio (Rf = fs/qc x 100). More accurate determination of soil type is possible by using normalized data after the fieldwork is complete.

*CPT Soil Behaviour Type chart.*




| Zone | Soil Behavior Type |
|---|---|
| 1 | Sensitive fine grained |
| 2 | Organic material |
| 3 | Clay |
| 4 | Silty Clay to clay |
| 5 | Clayey silt to silty clay |
| 6 | Sandy silt to clayey silt |
| 7 | Silty sand to sandy silt |
| 8 | Sand to silty sand |
| 9 | Sand |
| 10 | Gravelly sand to sand |
| 11 | Very stiff fine grained* |
| 12 | Sand to clayey sand* |

* Overconsolidated or cemented

*BIT's 6x6 DAF CPT rig.*

**BLACK GEOTECHNICAL**

# LOG ID: BH Abut A

SHEET : 1 OF 1

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | Wakool Shire Council | **Contractor:** | Cardno Bowler | **Surface RL:** | 70.19 m |
| **Project:** | Gee Gee Bridges | **Drilling Rig:** | Hanjin D&B | | |
| **Location:** | Wakool | **Position:** | Refer Figure 2 | | |
| **Job No.:** | N1662 | **Logged By:** | BB | | |
| **Date:** | 05/02/2015 | **Checked By:** | GB | | |

| DEPTH (m) | DRILLING METHOD | WATER | SAMPLES AND TESTS | REDUCED LEVEL | DEPTH | UCS SYMBOL | DESCRIPTION (Soil type, consistency/density, plasticity/particle size, colour, moisture condition, secondary components) | ADDITIONAL OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|
| 0.0 | SSA | | SPT (1m) 7,8,12 N=20; SPT (2.5m) 7,9,11 N=20 | 67.19 | 3.00 | CH CI | SILTY CLAY, hard, high plasticity, dark brown mottled pale grey, W<<Wp becoming very stiff, medium plasticity, grey brown mottled orange & yellow brown, W<Wp at 0.5m | |
| 5.0 | | | SPT (4m) 7,10,14 N=24; SPT (5.5m) 4,7,9 N=16 | 64.19 | 6.00 | CI | SANDY CLAY, very stiff, medium plasticity, grey brown mottled orange, yellow brown, W<Wp | |
| | | 6.80m | SPT (7m) 5,7,9 N=16; SPT (8.5m) 5,7,10 N=17 | 60.19 | 10.00 | CI | SILTY CLAY, very stiff, medium plasticity, pale grey, mottled orange brown, W<Wp | |
| 10.0 | WB | | SPT (10m) 5,10,13 N=23; SPT (11.5m) 8,10,12 N=22 | 55.19 | 15.00 | SW | SAND, medium dense, fine to coarse grained, pale grey mottled white, wet | |
| 15.0 | | | SPT (14.5m) 9,13,13 N=26 | 50.69 | 19.50 | CL CI | SILTY CLAY, stiff, low to medium plasticity, pale grey, orange brown, W≤Wp becoming very stiff at 18.5m | |
| 20.0 | | | SPT (19m) 10,10,12 N=22; SPT (21m) 11,12,16 N=28 | 48.74 | 21.45 | CI | SANDY CLAY, hard, medium plasticity, grey, mottled red brown/dark red brown, W≤Wp | |
| | | | | | | | End BH Abut A at 21.45 m. Groundwater encountered at 6.80 m. | |
| 25.0 | | | | | | | | |

Refer to Figure 1A & 1B for a summary of descriptive terms and symbols.
Descriptions are based on visual and tactile assessment unless laboratory test results are available.

**NOTES:**

# LOG ID: BH Abut B

SHEET : 1 OF 1

BLACK GEOTECHNICAL

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | Wakool Shire Council | **Contractor:** | Cardno Bowler | **Surface RL:** | 70.19 m |
| **Project:** | Gee Gee Bridges | **Drilling Rig:** | Hanjin D&B | | |
| **Location:** | Wakool | **Position:** | Refer Figure 2 | | |
| **Job No.:** | N1662 | **Logged By:** | BB | | |
| **Date:** | 04/02/2015 | **Checked By:** | GB | | |

**DRILLING** / **MATERIAL DESCRIPTION**

| DEPTH (m) | DRILLING METHOD | WATER | SAMPLES AND TESTS | REDUCED LEVEL | DEPTH | UCS SYMBOL | DESCRIPTION (Soil type, consistency/density, plasticity/particle size, colour, moisture condition, secondary components) | ADDITIONAL OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|
| 0.0 | SSA | | | 70.09 | 0.10 | | FILL: GRAVEL, medium dense, fine to medium grained, grey, dry (20mm crushed rock hardstand) | |
| | | | SPT (1m) 5,5,8 N=13 | 67.99 | 2.20 | CH | CLAY, very stiff, high plasticity, grey brown, W≤Wp, becoming pale brown at 1.5m | |
| | | | SPT (2.5m) 12,18,23 N=41 | 67.19 | 3.00 | CI | SILTY CLAY, hard, medium plasticity, pale brown, W<<Wp, with white calcrete nodules | |
| 5.0 | | | SPT (4m) 9,11,13 N=24 | 65.19 | 5.00 | SP | SAND, medium dense, fine grained, orange brown, dry to moist | |
| | | 6.40m | SPT (5.5m) 7,10,14 N=24 | 63.69 | 6.50 | CI | SILTY CLAY, very stiff, medium plasticity, grey mottled orange, W<Wp, trace rootlets | |
| | | | SPT (7m) 6,9,9 N=18 | 61.99 | 8.20 | SC | CLAYEY SAND, medium dense, fine grained, grey, pale brown, dark red brown, moist | |
| 10.0 | WB | | SPT (8.5m) 10,17,18 N=35; SPT (11.5m) 9,9,11 N=20; SPT (14.5m) 4,6,12 N=18 | 54.19 | 16.00 | SW | SAND, medium dense, fine to medium grained, pale grey, pale brown, wet, trace clay; becoming fine to coarse grained, pale grey, no clay | |
| 15.0 | | | SPT (17.5m) 8,5,4 N=9 | 51.19 | 19.00 | CI | SILTY CLAY, stiff, medium plasticity, pale grey, W>Wp | |
| 20.0 | | | SPT (20.5m) 11,28,25/90mm N>R | 48.19 | 22.00 | SC | CLAYEY SAND, very dense, medium to coarse grained, grey mottled pale grey, wet | |
| 25.0 | | | SPT (23.5m) 6,8,9 N=17; SPT (26.5m) 7,8,6 N=14 | 43.24 | 26.95 | CH | SILTY CLAY, very stiff, medium plasticity, grey, W=Wp | |
| | | | | | | | End BH Abut B at 26.95 m. | |
| | | | | | | | Groundwater encountered at 6.40 m. | |

Refer to Figure 1A & 1B for a summary of descriptive terms and symbols.
Descriptions are based on visual and tactile assessment unless laboratory test results are available.

**NOTES:**

# LOG ID: BH P11

BLACK GEOTECHNICAL

SHEET : 1 OF 1

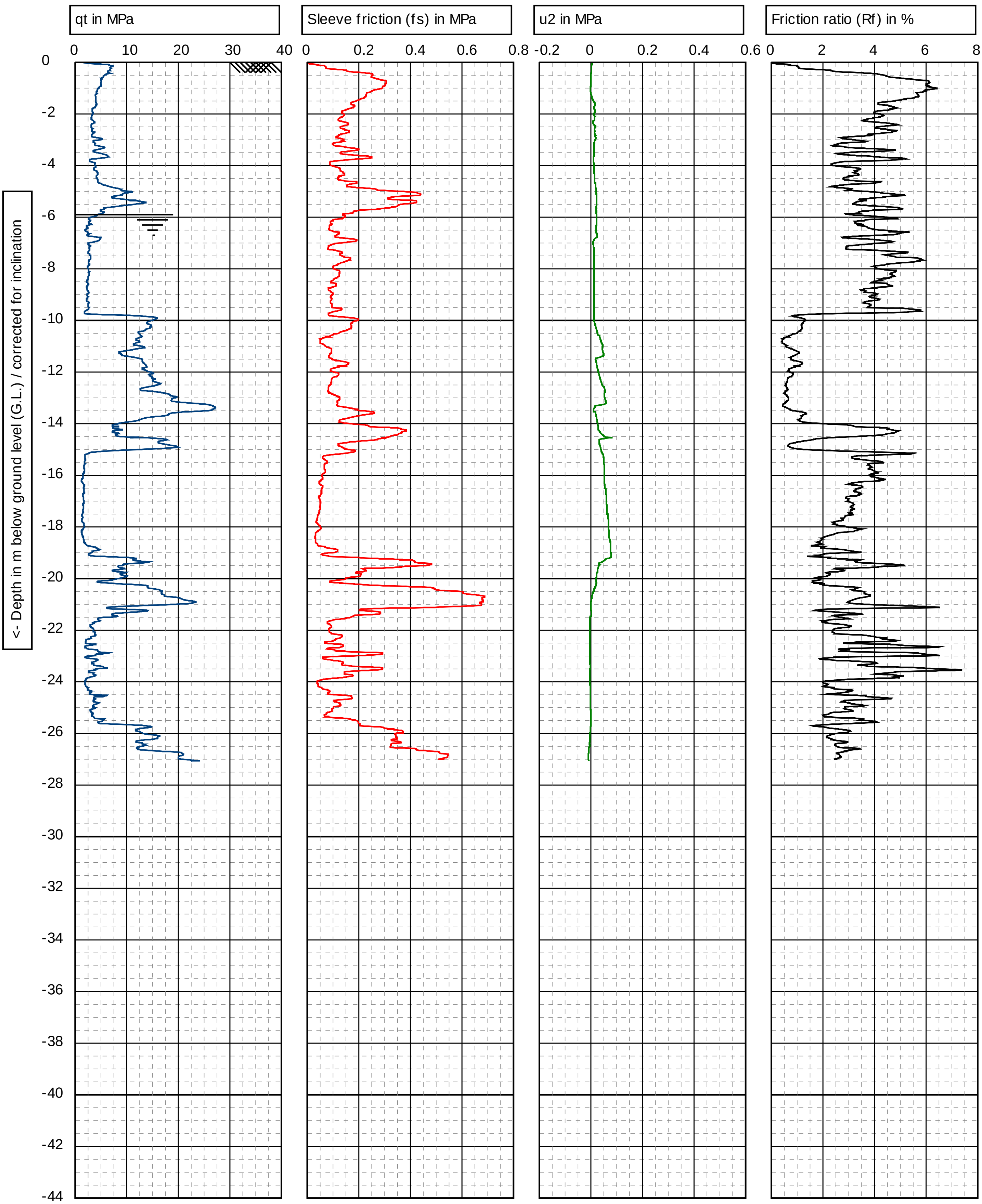
| | | | | | |
|---|---|---|---|---|---|
| **Client:** | Wakool Shire Council | **Contractor:** | Cardno Bowler | **Surface RL:** | 66.38 m |
| **Project:** | Gee Gee Bridges | **Drilling Rig:** | Hanjin D&B | | |
| **Location:** | Wakool | **Position:** | Refer Figure 2 | | |
| **Job No.:** | N1662 | **Logged By:** | BB | | |
| **Date:** | 03/02/2015 | **Checked By:** | GB | | |

## DRILLING / MATERIAL DESCRIPTION

| DEPTH (m) | DRILLING METHOD | WATER | SAMPLES AND TESTS | REDUCED LEVEL | DEPTH | GRAPHIC LOG | UCS SYMBOL | DESCRIPTION (Soil type, consistency/density, plasticity/particle size, colour, moisture condition, secondary components) | ADDITIONAL OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| 0.0 | SSA | ▽ 2.20m | SPT (1m) 5,4,5 N=9 | 64.18 | 2.20 | | SP | SAND, medium dense, fine grained, pale yellow brown, dry, with silt<br>becoming dry to moist, pale yellow brown mottled orange brown at 0.5m | |
| | | | SPT (2.5m) 4,6,7 N=13 | 63.88 | 2.50 | | ML | SANDY SILT, medium dense, fine grained sand, pale grey brown mottled orange brown, moist with root fibres | |
| | | | | 62.88 | 3.50 | | CL CI | SANDY CLAY, stiff, low to medium plasticity, pale grey, brown mottled orange brown, W<<Wp | |
| 5.0 | WB | | SPT (4m) 2,4,5 N=9<br>SPT (5.5m) 3,5,8 N=13<br>SPT (7m) 4,7,9 N=16 | 58.38 | 8.00 | | SW | SAND, loose, fine to medium grained, grey, wet<br>becoming medium dense at 4.5m<br>becoming fine to coarse grained at 6.5m | |
| | | | SPT (8.5m) 7,9,11 N=20 | 56.88 | 9.50 | | GP | SANDY GRAVEL, medium dense, fine grained, grey mottled white (quartz), wet | |
| 10.0 / 15.0 / 20.0 | | | SPT (10m) 6,11,8 N=19<br>SPT (11.5m) 2,3,8 N=11<br>SPT (14.5m) 9,14,22 N=36<br>SPT (17.5m) 9,20,25 N=45 | 45.68 | 20.70 | | SP<br>SW | SAND, medium dense, fine grained, grey, wet, with micaceous grains<br>becoming fine to coarse grained, grey mottled white with no mica<br>becoming dense, fine to medium grained at 13m | |
| | | | SPT (21.5m) 7,11,11 N=22<br>SPT (24m) 9,9,10 N=19 | 41.88 | 24.50 | | CL CI | SANDY CLAY, very stiff, low to medium plasticity, grey, W≥Wp | |
| 25.0 | | | | | | | | End BH P11 at 24.50 m.<br>Groundwater encountered at 2.20 m. | |

Refer to Figure 1A & 1B for a summary of descriptive terms and symbols.
Descriptions are based on visual and tactile assessment unless laboratory test results are available.

**NOTES:**




Refusal at 27.27m qc>25MPa

Hole closed at 8.9m

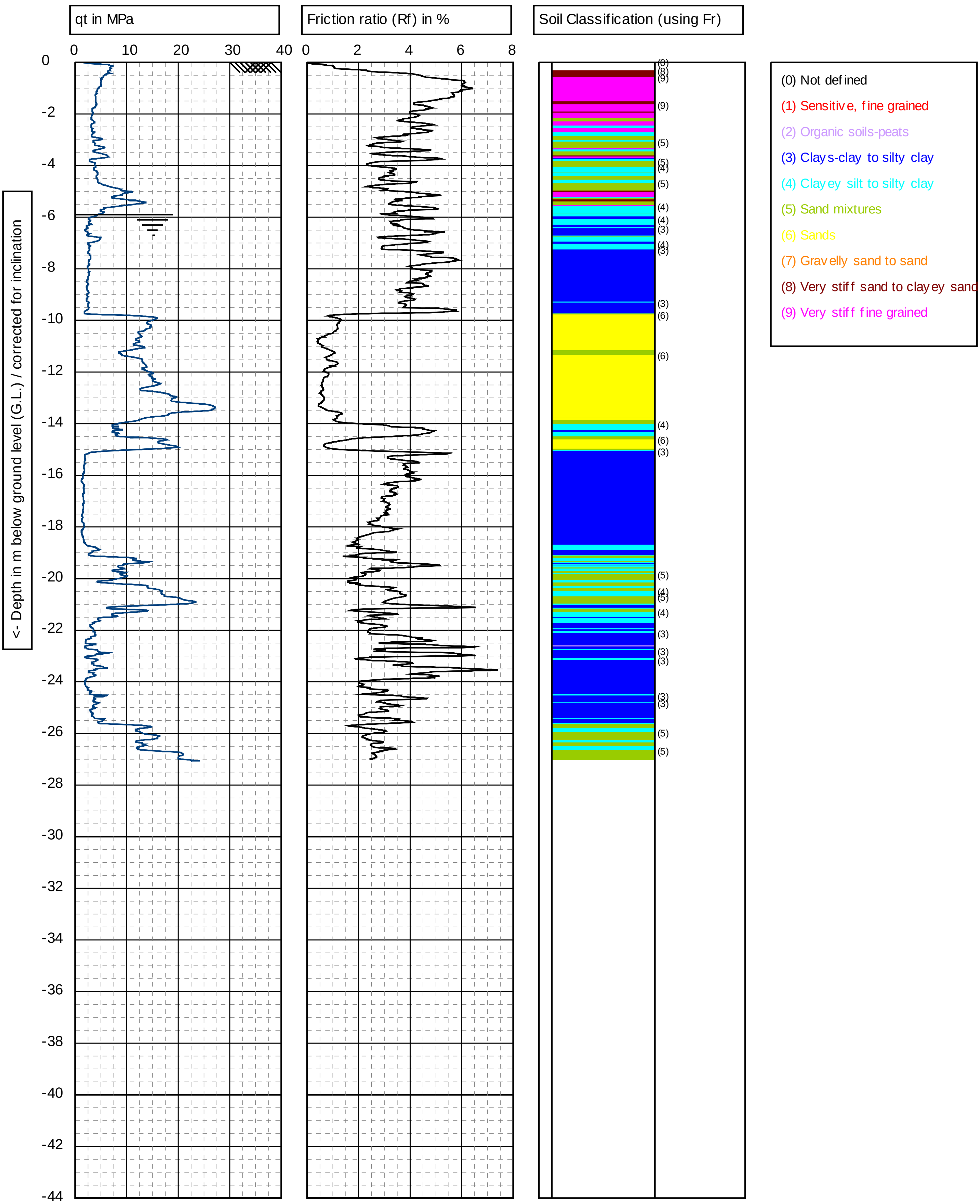
BLACK INSITU TESTING

u2
225 cm²
15 cm²

| | | | |
|---|---|---|---|
| Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
| G.L. 70.1 AHD | W.L.: **-5.9** | Date: | **6/02/2015** |
| Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | Project no.: | **D145** |
| Position: | | CPT no.: | **Abut A** 1/2 |

1.40

Processed : RB Checked: TH



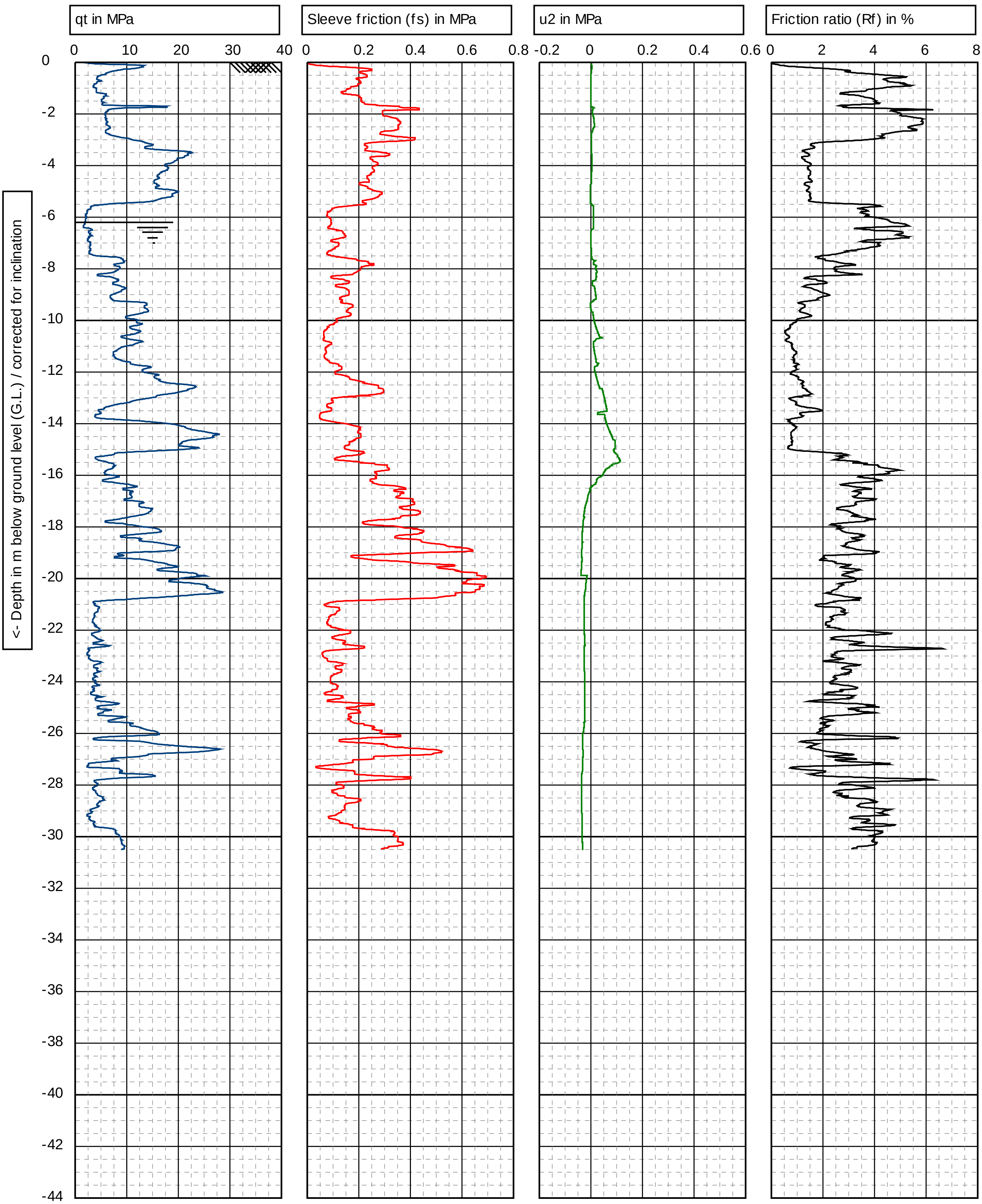

Refusal at 27.27m qc>25MPa

Hole closed at 8.9m

BLACK INSITU TESTING

| | | | |
|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | G.L. 70.1 AHD W.L.: **-5.9** | Date: | **6/02/2015** |
| | Project: **Gee Gee Bridges** | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | Project no.: | **D145** |
| 1.40 | Position: | CPT no.: | **Abut A** 2/2 |

Processed : RB Checked: TH




Test Complete at 30.62m qc>10MPa

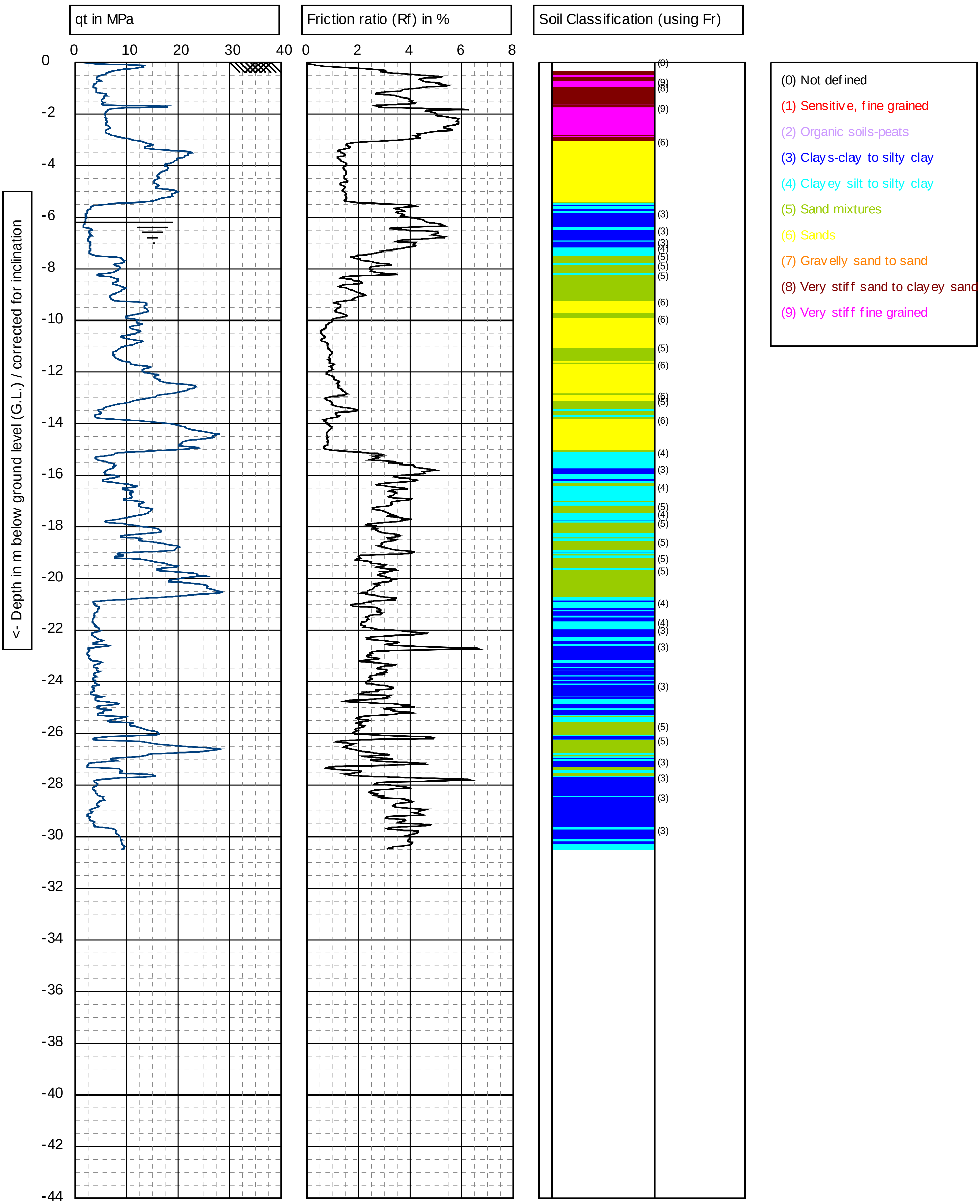
Hole closed at 7.5m

BLACK INSITU TESTING

| | | | | |
|---|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
| | G.L. 69.2 AHD | W.L.: **-6.19** | Date: | **5/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: | **D145** |
| | Position: | | CPT no.: | **P 1** 1/2 |

1.40

Processed : RB Checked: TH




Test Complete at 30.62m qc>10MPa

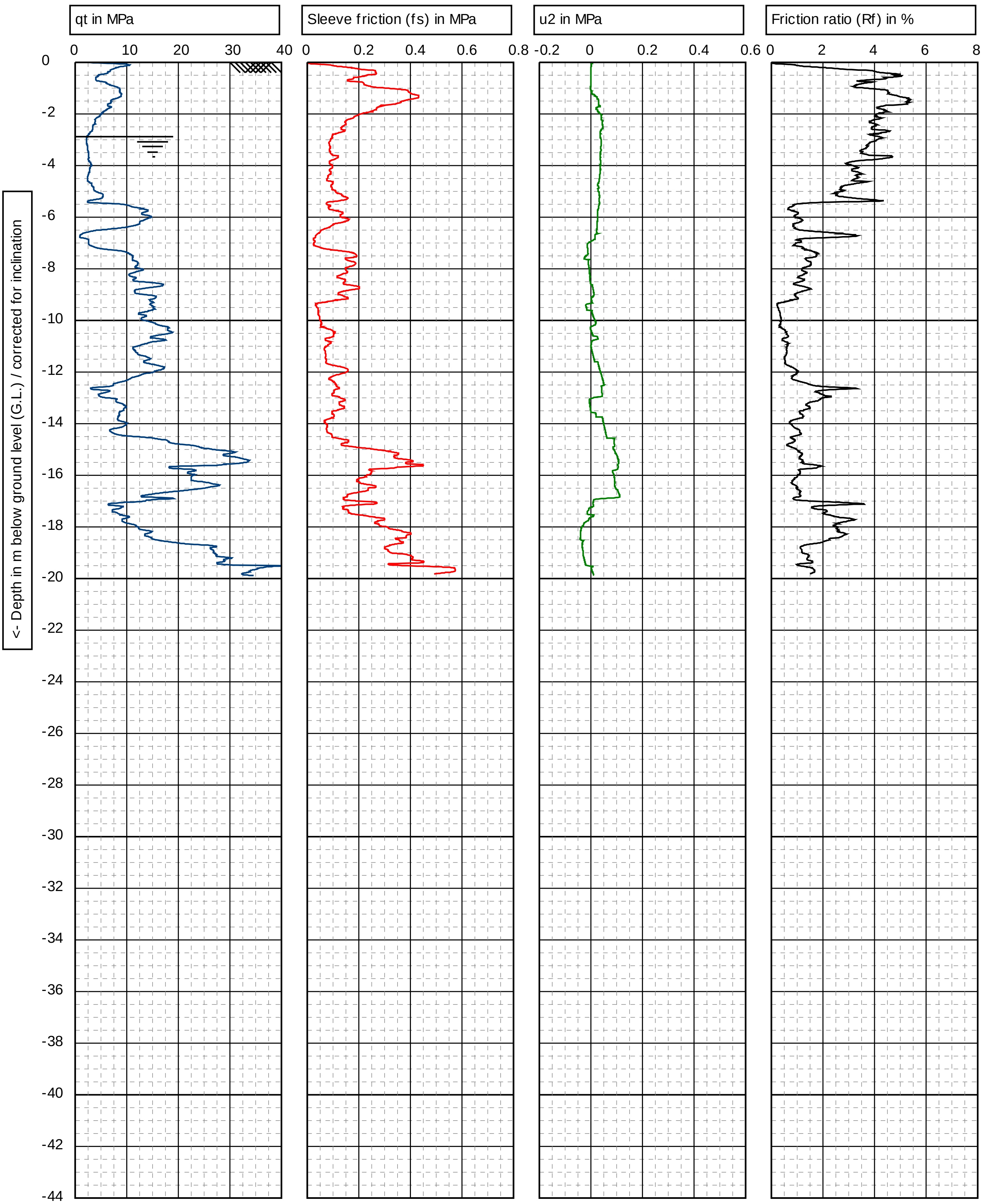
Hole closed at 7.5m

BLACK INSITU TESTING

| | | | |
|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | G.L. 69.2 AHD W.L.: **-6.19** | Date: | **5/02/2015** |
| | Project: **Gee Gee Bridges** | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | Project no.: | **D145** |
| | Position: | CPT no.: | **P 1** 2/2 |

1.40

Processed : RB Checked: TH




Refusal at 20.02m qc > 30 MPa

Hole open to 3.27m

BLACK INSITU TESTING

u2 225 cm² 15 cm²

Client : Black Geotechnical

G.L. 68.8 AHD

W.L.: **-2.87**

Project: **Gee Gee Bridges**

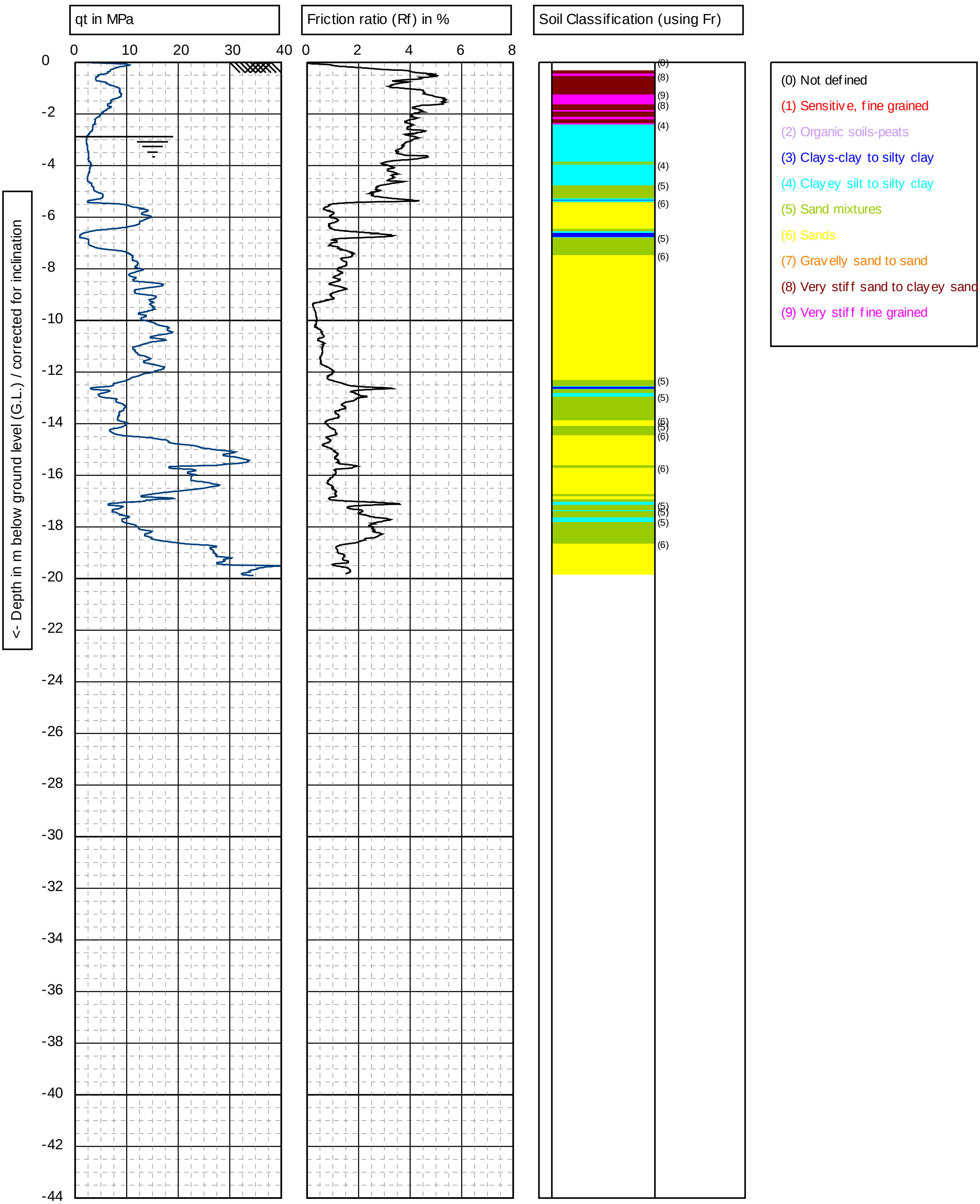
Location: **Wakool Shire**

Position:

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **7/02/2015** |
| Cone no.: | **S15CFIIP.S12299** |
| Project no.: | **D145** |
| CPT no.: | **P 2** 1/2 |

1.40

Processed : RB Checked: TH




Refusal at 20.02m qc > 30 MPa

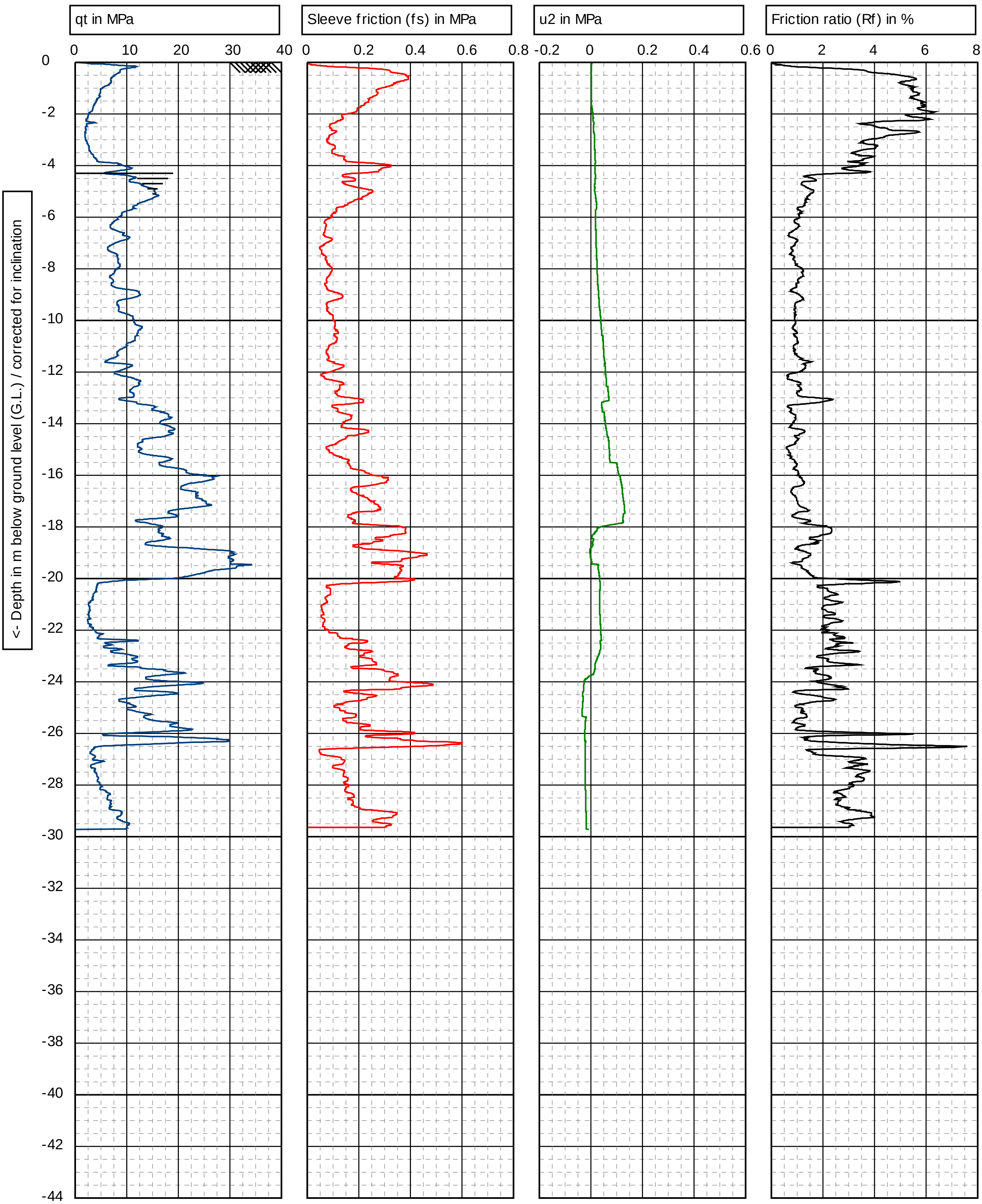
Hole open to 3.27m

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
|---|---|---|---|---|
| | G.L. 68.8 AHD | W.L.: **-2.87** | Date: | **7/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: | **D145** |
| | Position: | | CPT no.: | **P 2** 2/2 |

1.40

Processed : RB Checked: TH




Test Complete at 30m qc>10MPa

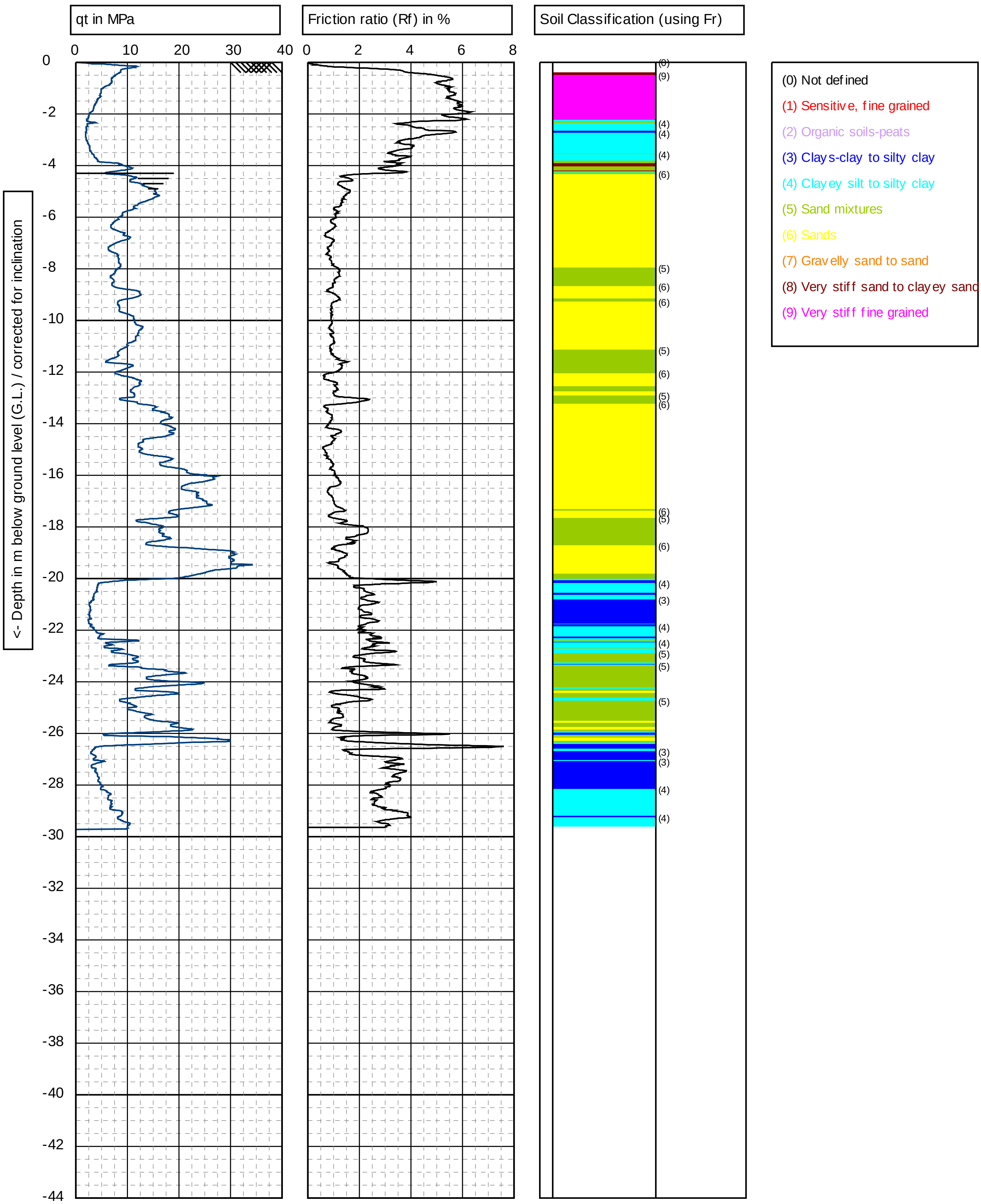
Hole closed at 4.33m

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
|---|---|---|---|---|
| | G.L. 68.2 AHD | W.L.: **-4.3** | Date: | **6/02/2015** |
| Project: | **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: | **Wakool Shire** | | Project no.: | **D145** |
| Position: | | | CPT no.: | **P 3** 1/2 |

1.40

Processed : RB Checked: TH



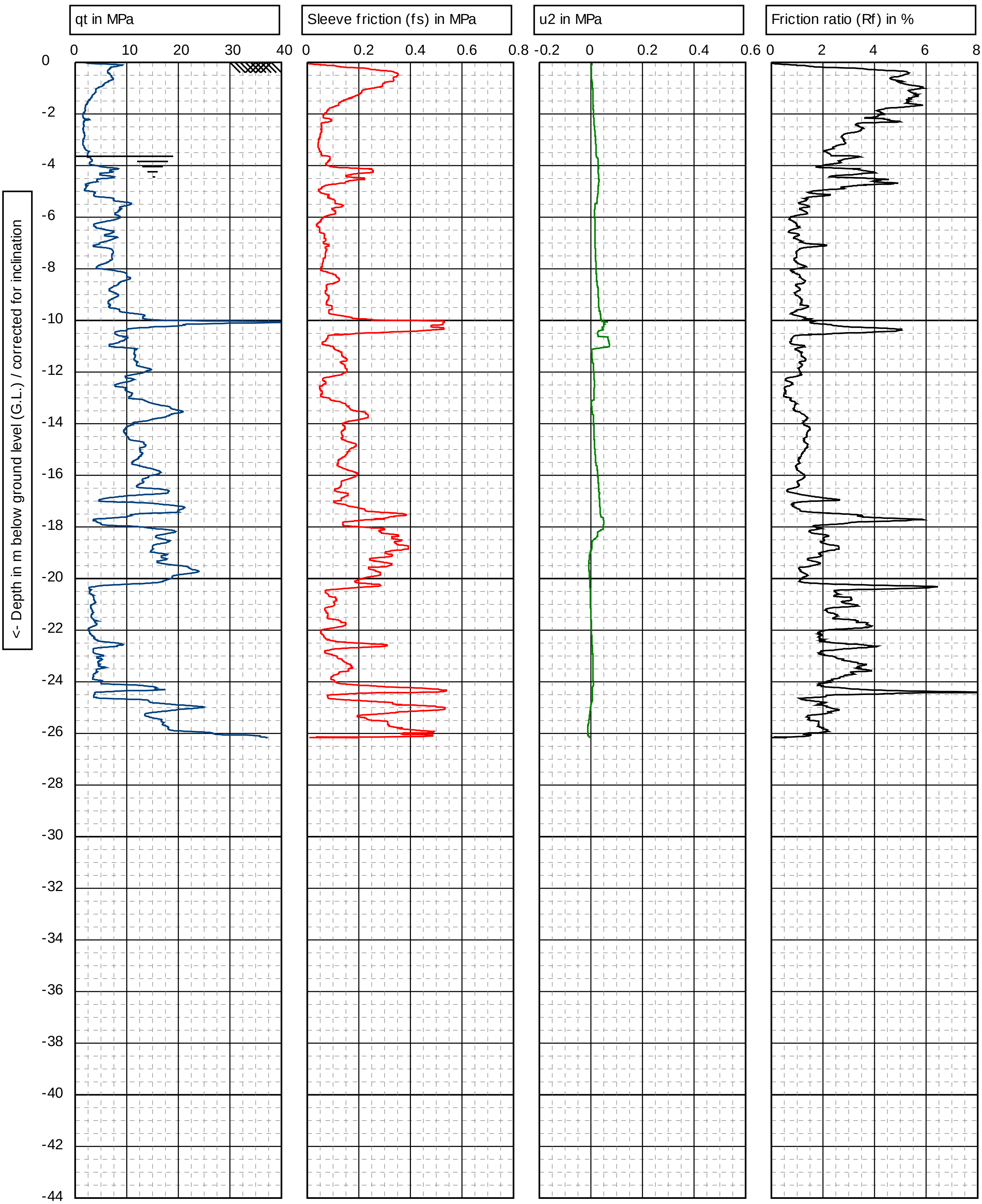

Test Complete at 30m qc>10MPa

Hole closed at 4.33m

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | 0 m Predrilled |
|---|---|---|---|---|
| | G.L. 68.2 AHD | W.L.: **-4.3** | Date: | **6/02/2015** |
| Project: **Gee Gee Bridges** | | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | | Project no.: | **D145** |
| Position: | | | CPT no.: | **P 3** 2/2 |

Processed : RB Checked: TH



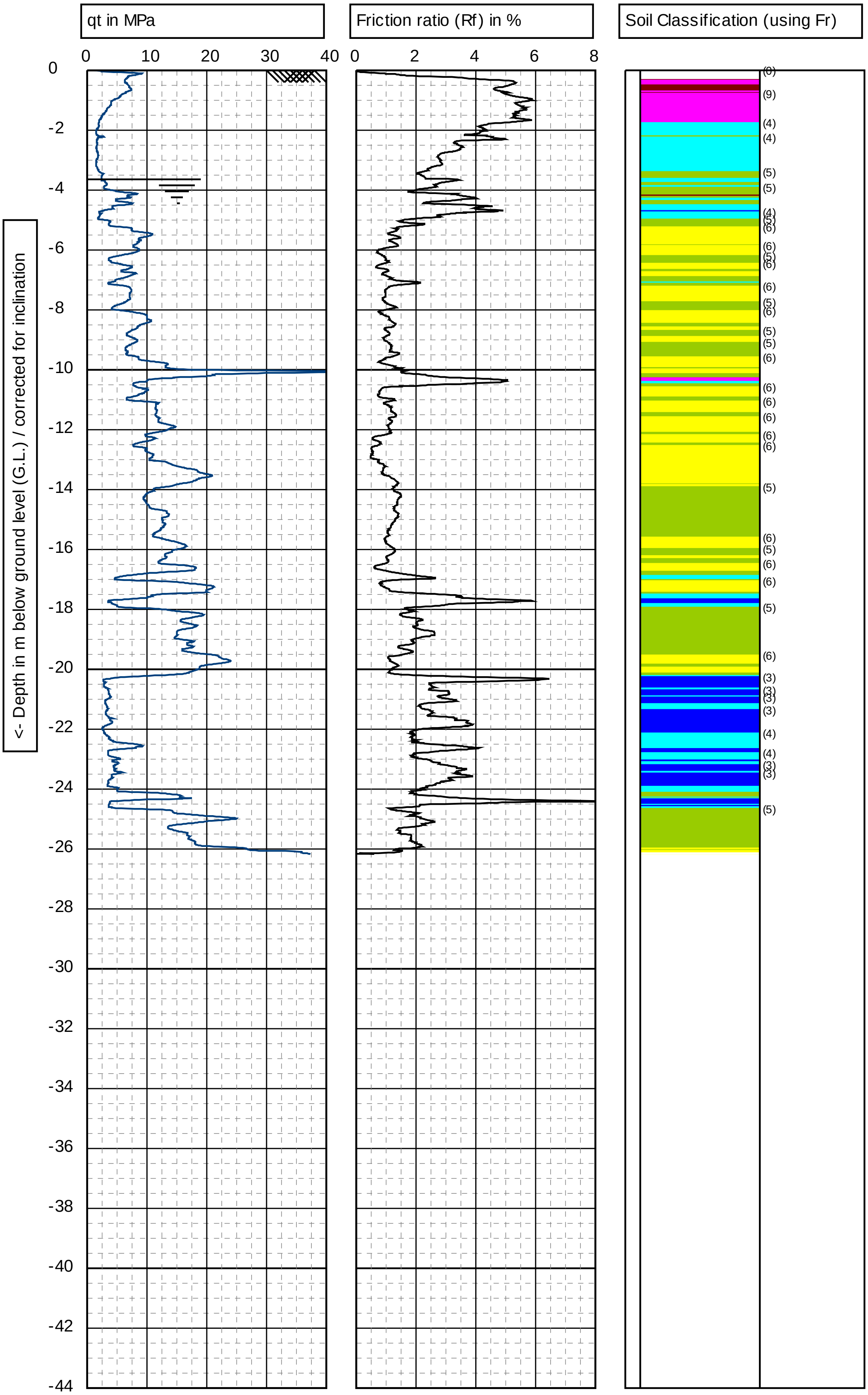

Refusal at 26.26m qc>40MPa

Hole closed at 4.4m

| | | | |
|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : **0 m Predrilled** |
| | | G.L. 68.5 AHD — W.L.: **-3.64** | Date: **6/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: **D145** |
| | Position: | | CPT no.: **P 4** — 1/2 |

1.40

Processed : RB Checked: TH




(0) Not defined
(1) Sensitive, fine grained
(2) Organic soils-peats
(3) Clays-clay to silty clay
(4) Clayey silt to silty clay
(5) Sand mixtures
(6) Sands
(7) Gravelly sand to sand
(8) Very stiff sand to clayey sand
(9) Very stiff fine grained

Refusal at 26.26m qc>40MPa

Hole closed at 4.4m

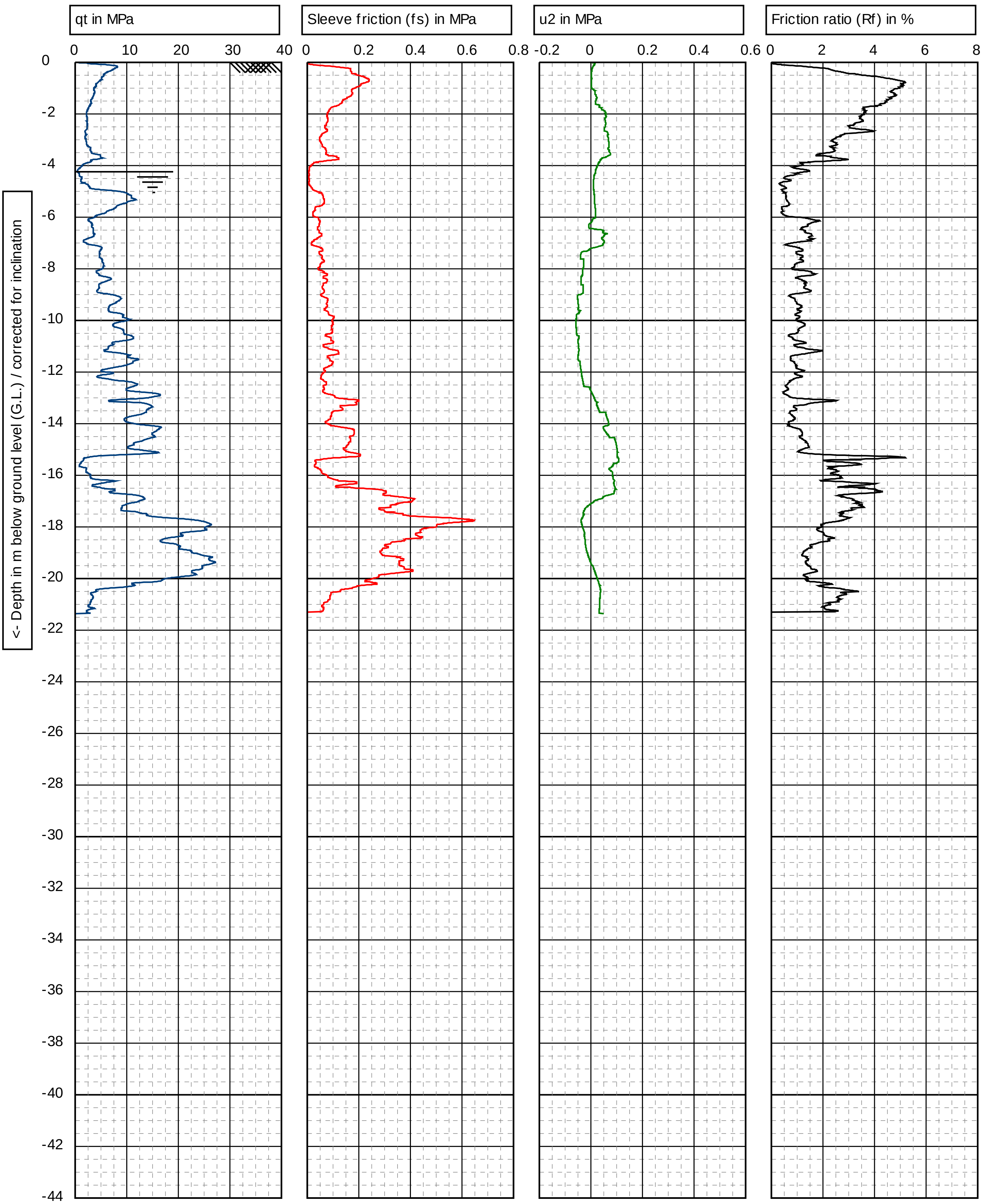
BLACK INSITU TESTING

u2 225 cm² 15 cm²

| | | | |
|---|---|---|---|
| Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
| G.L. 68.5 AHD | W.L.: **-3.64** | Date: | **6/02/2015** |
| Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | Project no.: | **D145** |
| Position: | | CPT no.: | **P 4** 2/2 |

1.40

Processed : RB Checked: TH




Test complete at 21.51m

hole open to 4.39m

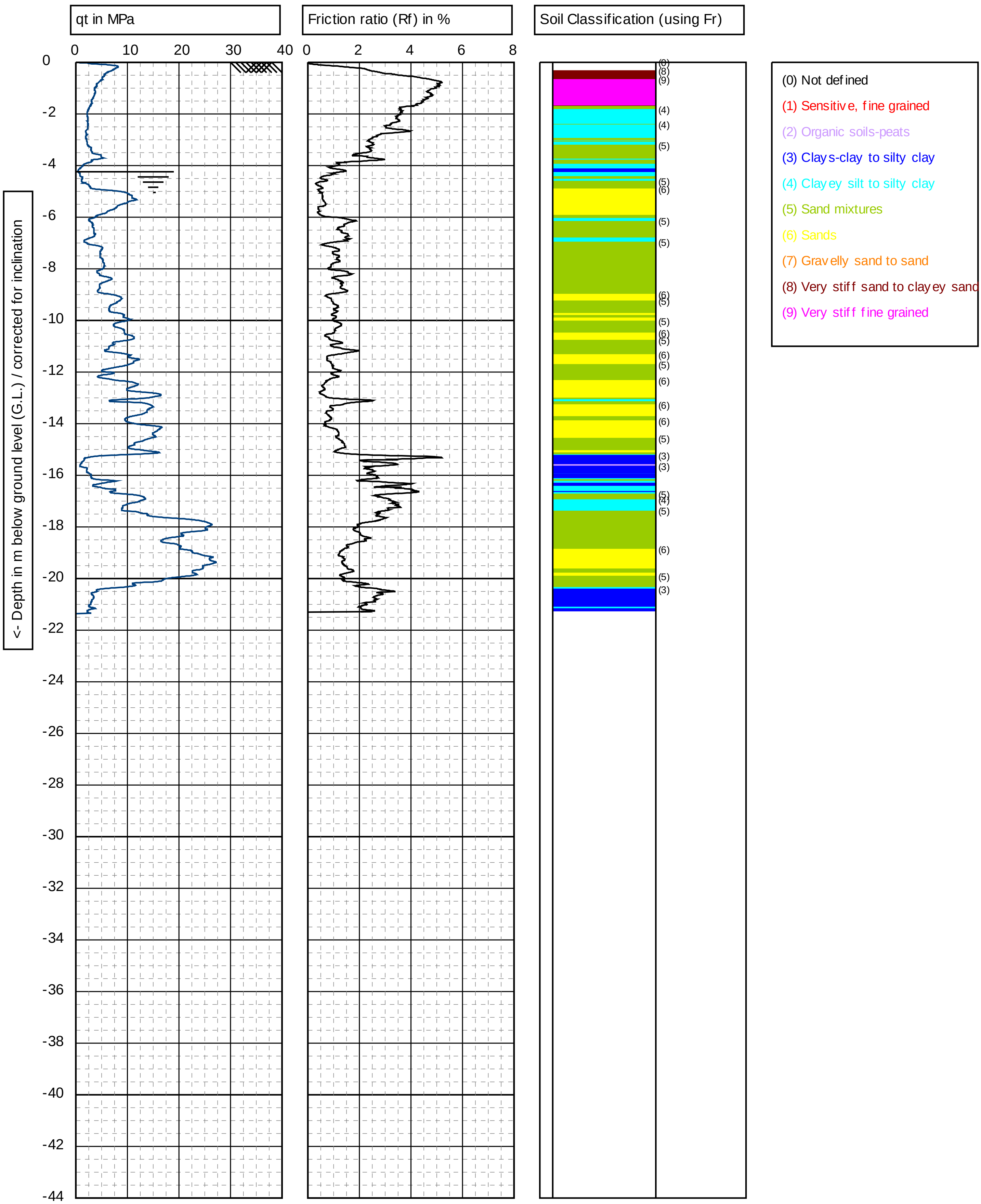
BLACK INSITU TESTING

u2 225 cm² 15 cm²

| | | | |
|---|---|---|---|
| Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
| G.L. 68 AHD | W.L.: **-4.24** | Date: | **7/02/2015** |
| Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | Project no.: | **D145** |
| Position: | | CPT no.: | **P 5** 1/2 |

1.40

Processed : RB Checked: TH



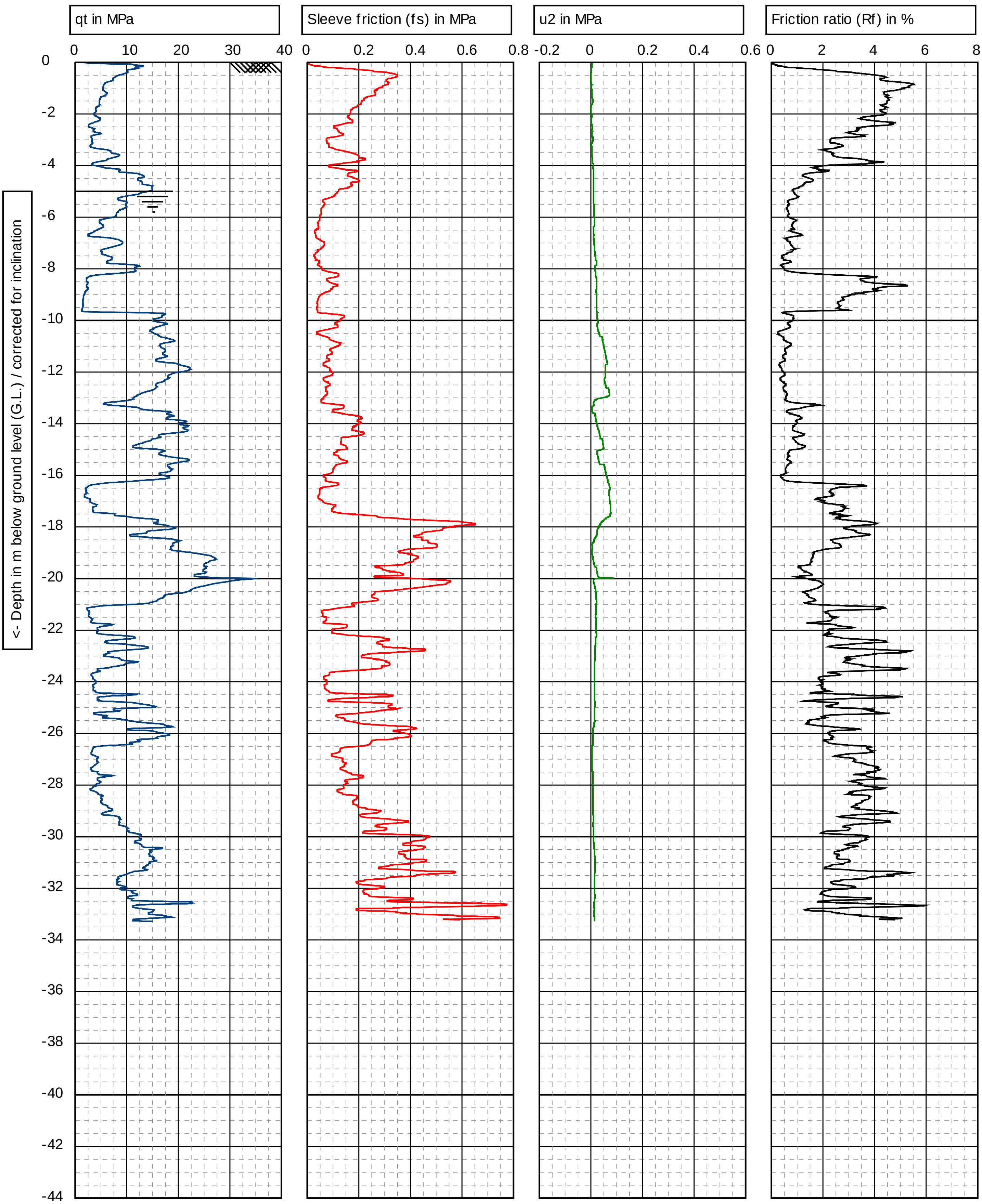

Test complete at 21.51m

hole open to 4.39m

| | | | |
|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : **0 m Predrilled** |
| | | G.L. 68 AHD — W.L.: **-4.24** | Date: **7/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: **D145** |
| | Position: | | CPT no.: **P 5** — **2/2** |

1.40

Processed : RB Checked: TH




Refusal at 33.52m qc >15MPa

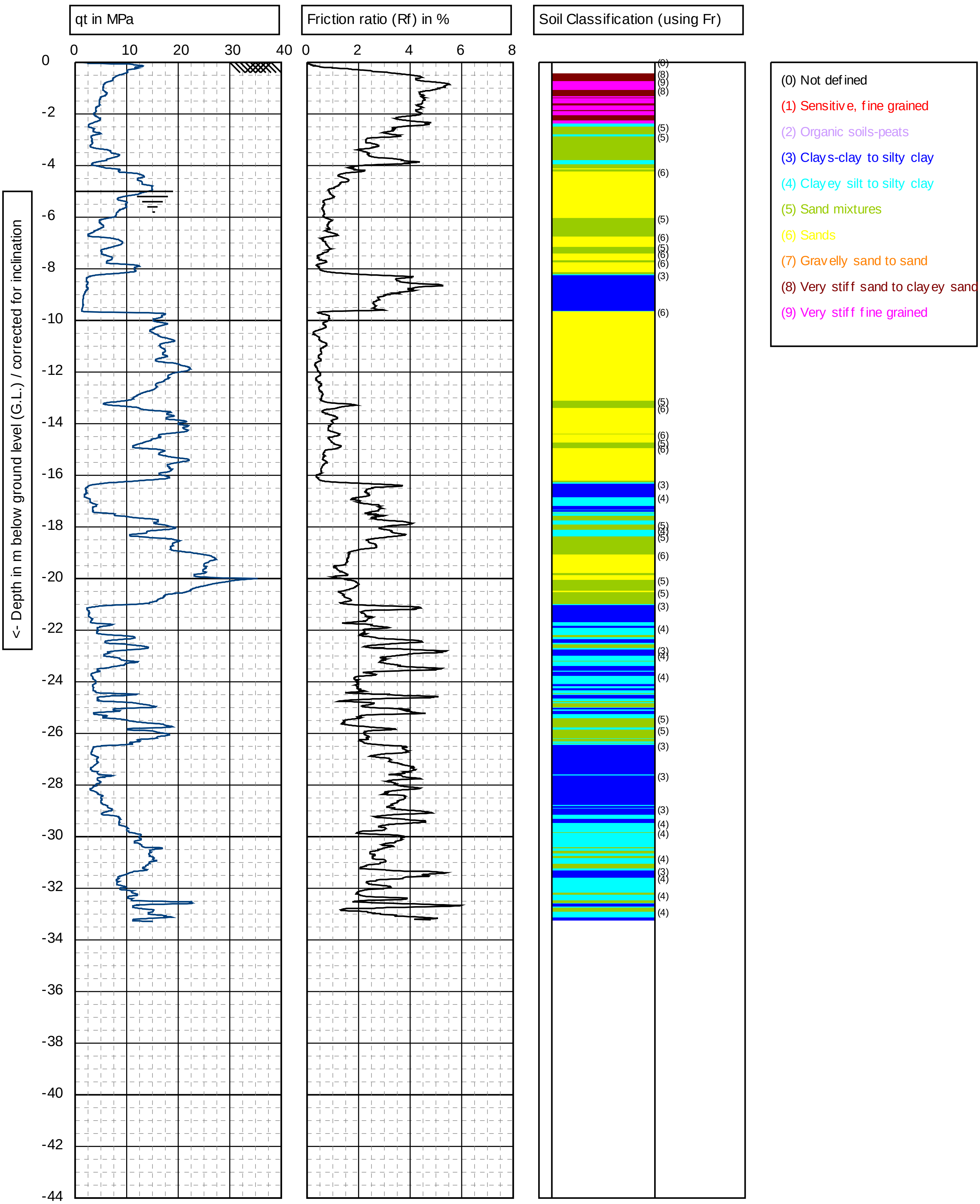
Hole closed at 4.96m dry

BLACK INSITU TESTING

| | | | |
|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | G.L. 68.6 AHD W.L.: **-5** | Date: | **4/02/2015** |
| | Project: **Gee Gee Bridges** | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | Project no.: | **D145** |
| | Position: | CPT no.: | **P 6** 1/2 |

1.40

Processed : RB Checked: TH




Refusal at 33.52m qc >15MPa

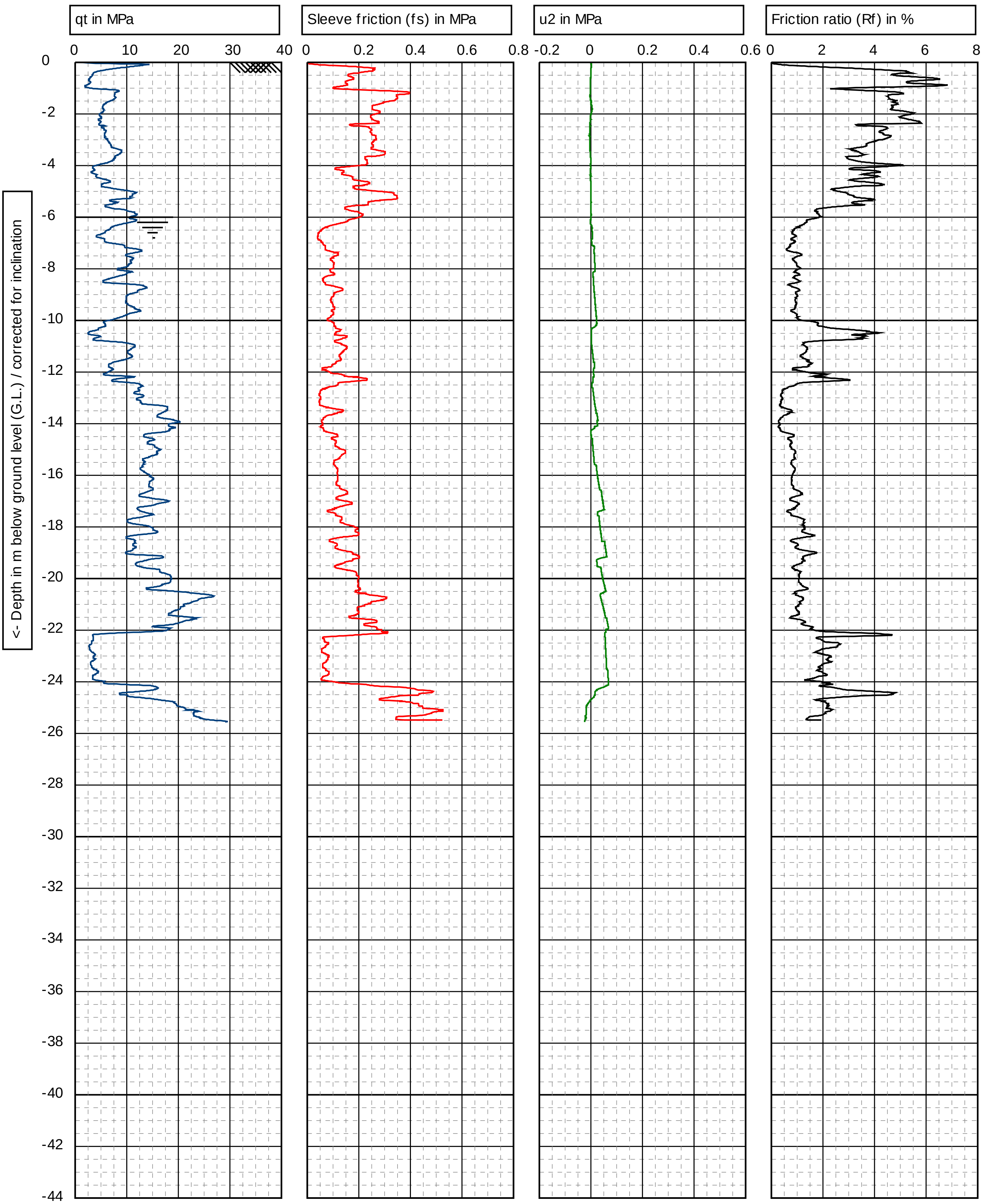
Hole closed at 4.96m dry

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | 0 m Predrilled |
|---|---|---|---|---|
| | G.L. 68.6 AHD | W.L.: **-5** | Date: | **4/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: | **D145** |
| | Position: | | CPT no.: | **P 6** 2/2 |

1.40

Processed : RB Checked: TH




Refusal at 25.73m qc >30MPa

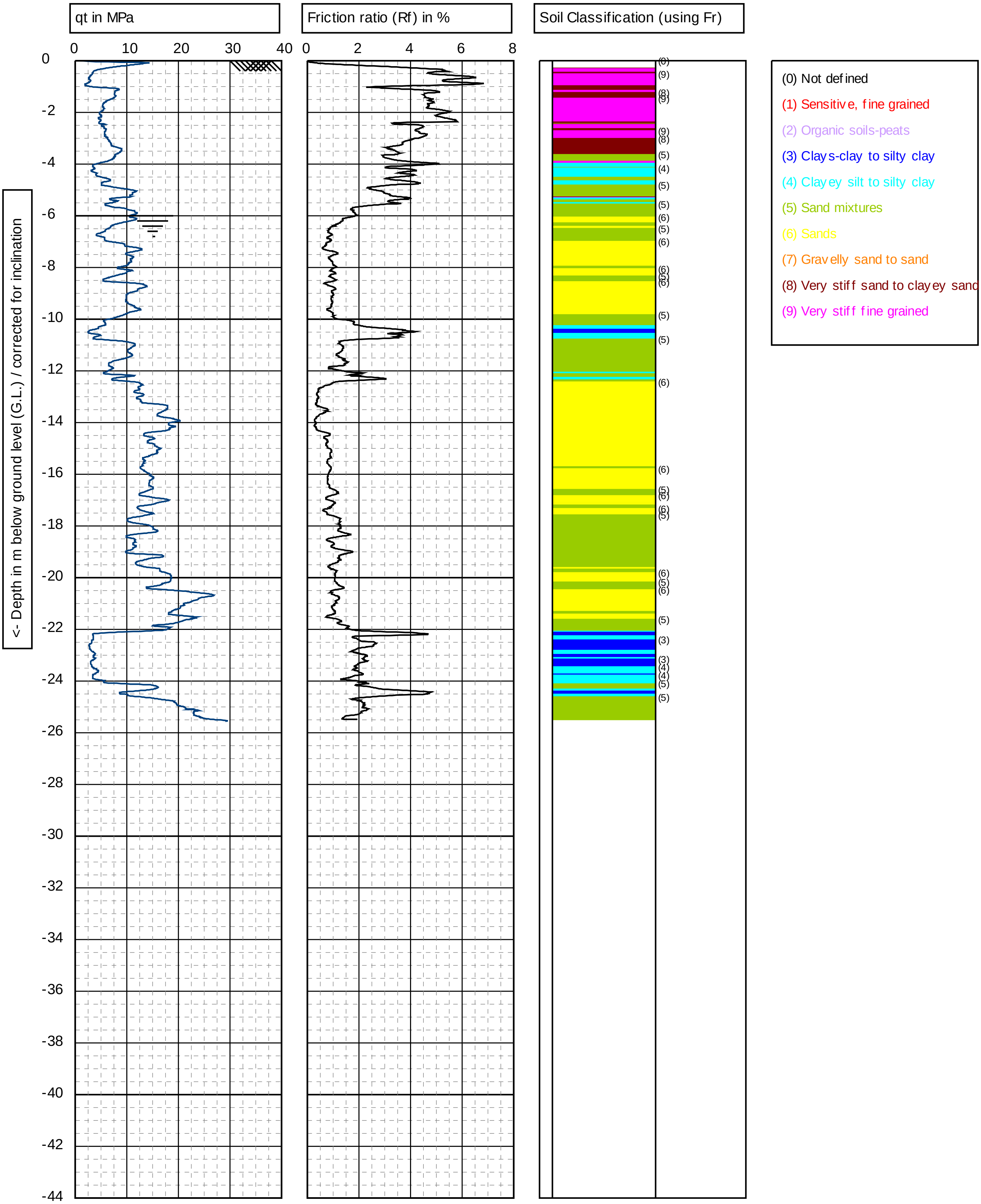
Hole closed at 6.32m

BLACK INSITU TESTING

| | | | |
|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | G.L. 69.9 AHD W.L.: **-6** | Date: | **4/02/2015** |
| | Project: **Gee Gee Bridges** | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | Project no.: | **D145** |
| | Position: | CPT no.: | **P7** 1/2 |

1.40

Processed : RB Checked: TH




Refusal at 25.73m qc >30MPa

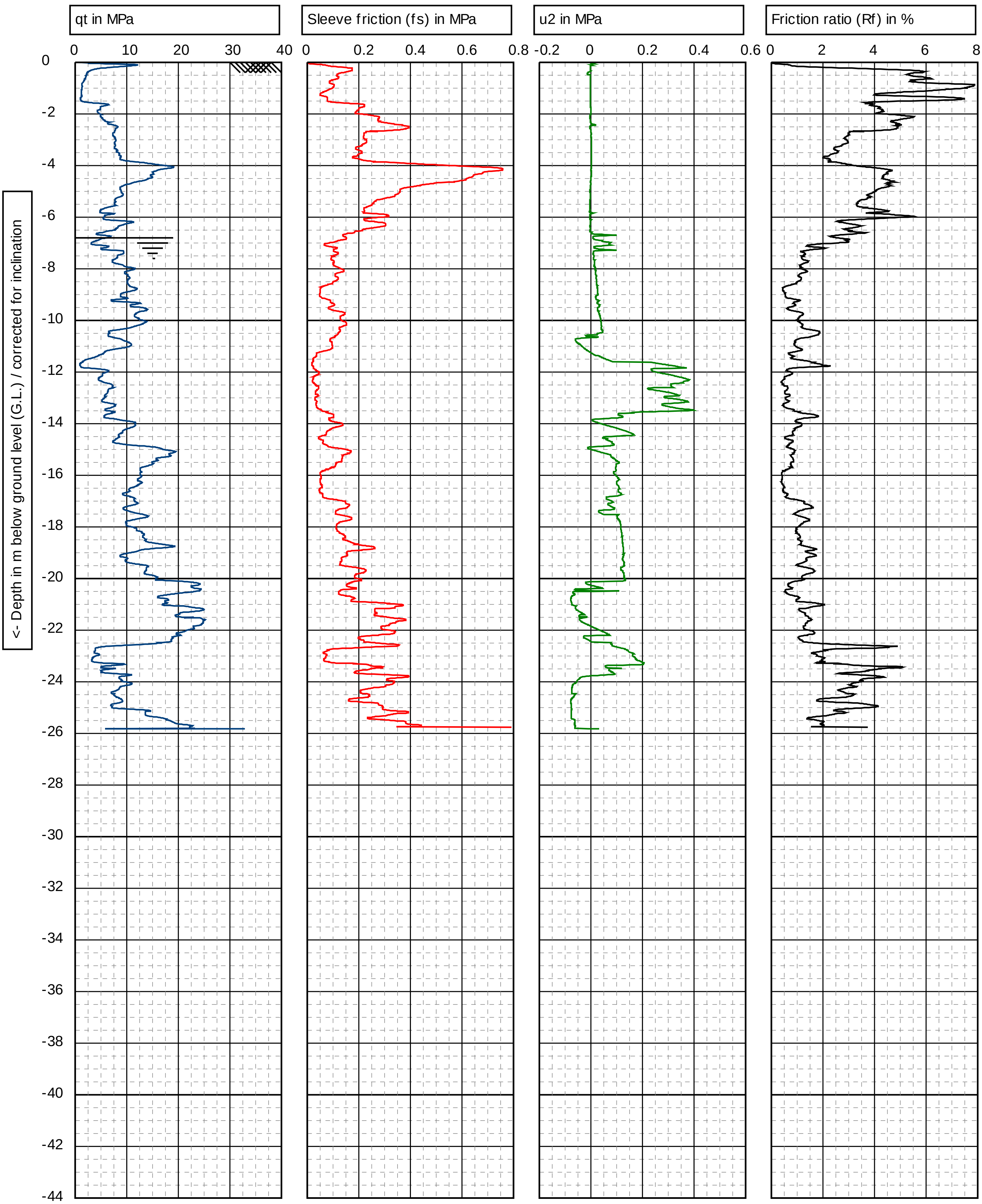
Hole closed at 6.32m

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | 0 m Predrilled |
|---|---|---|---|---|
| | G.L. 69.9 AHD | W.L.: **-6** | Date: | **4/02/2015** |
| Project: | **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: | **Wakool Shire** | | Project no.: | **D145** |
| Position: | | | CPT no.: | **P7** 2/2 |

Processed : RB Checked: TH

1.40



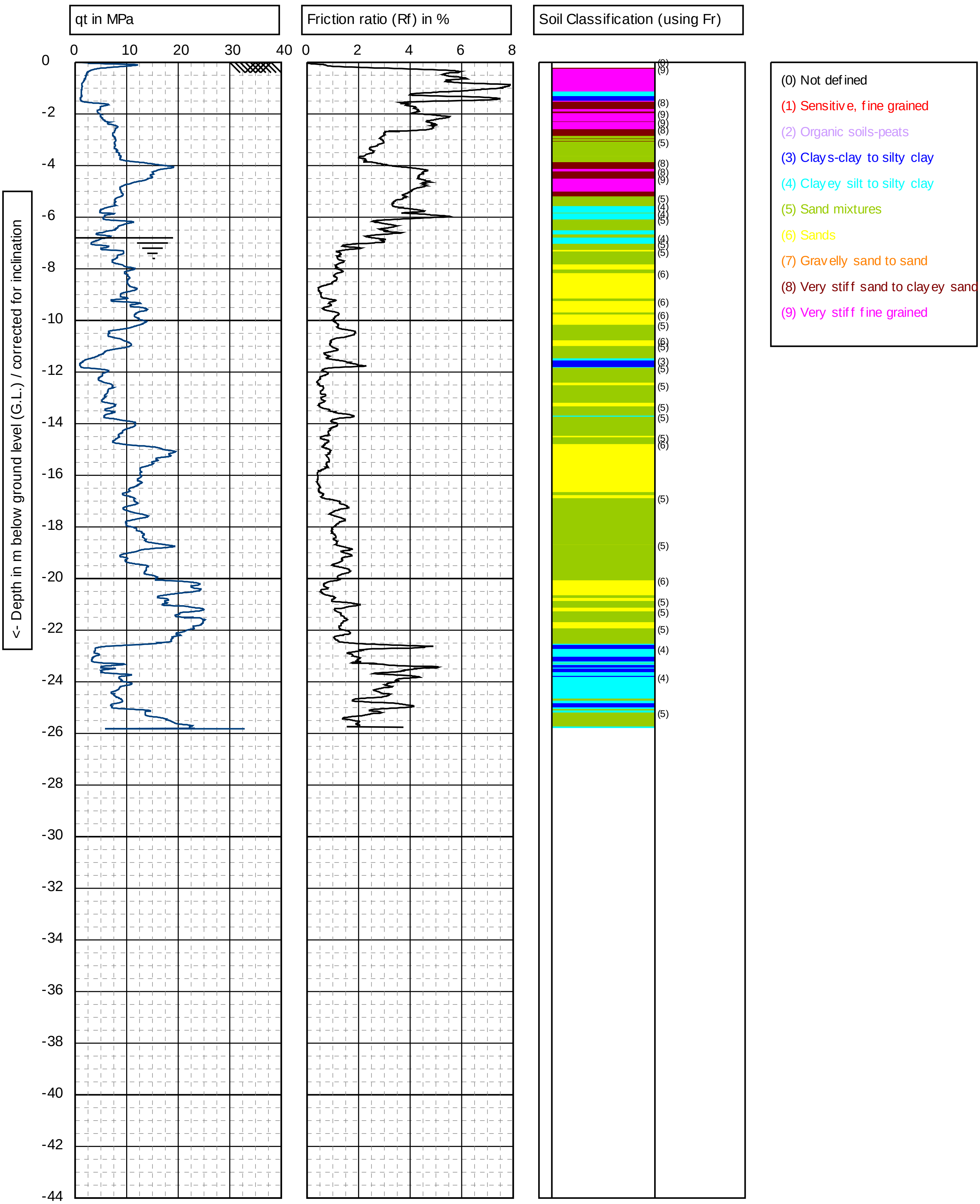

Refusal at 26.02m qc >30MPa

Hole closed at 6.84m

| | | | |
|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : **0 m Predrilled** |
| | | G.L. 70.6 AHD — W.L.: **-6.8** | Date: **3/02/2015** |
| | | Project: **Gee Gee Bridges** | Cone no.: **S15CFIIP.S12299** |
| | | Location: **Wakool Shire** | Project no.: **D145** |
| | | Position: | CPT no.: **P8** — **1/2** |

1.40

Processed : RB Checked: TH



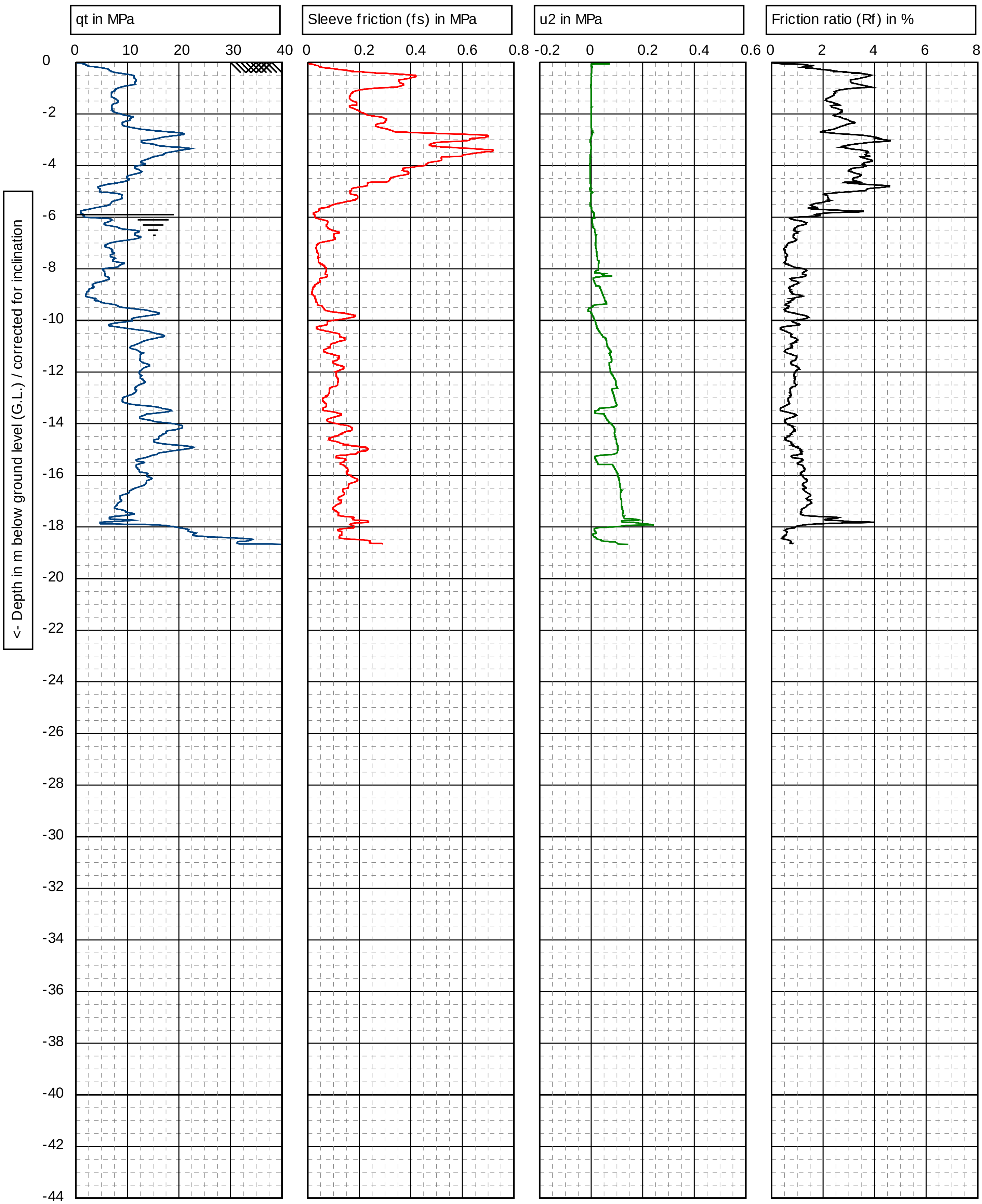

Refusal at 26.02m qc >30MPa

Hole closed at 6.84m

| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
|---|---|---|---|---|---|
| | | G.L. 70.6 AHD | W.L.: **-6.8** | Date: | **3/02/2015** |
| | Project: **Gee Gee Bridges** | | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | | Project no.: | **D145** |
| | Position: | | | CPT no.: | **P8** 2/2 |

1.40

Processed : RB Checked: TH




Refusal at 18.77m qc >40MPa

Hole closed at 4.9m dry

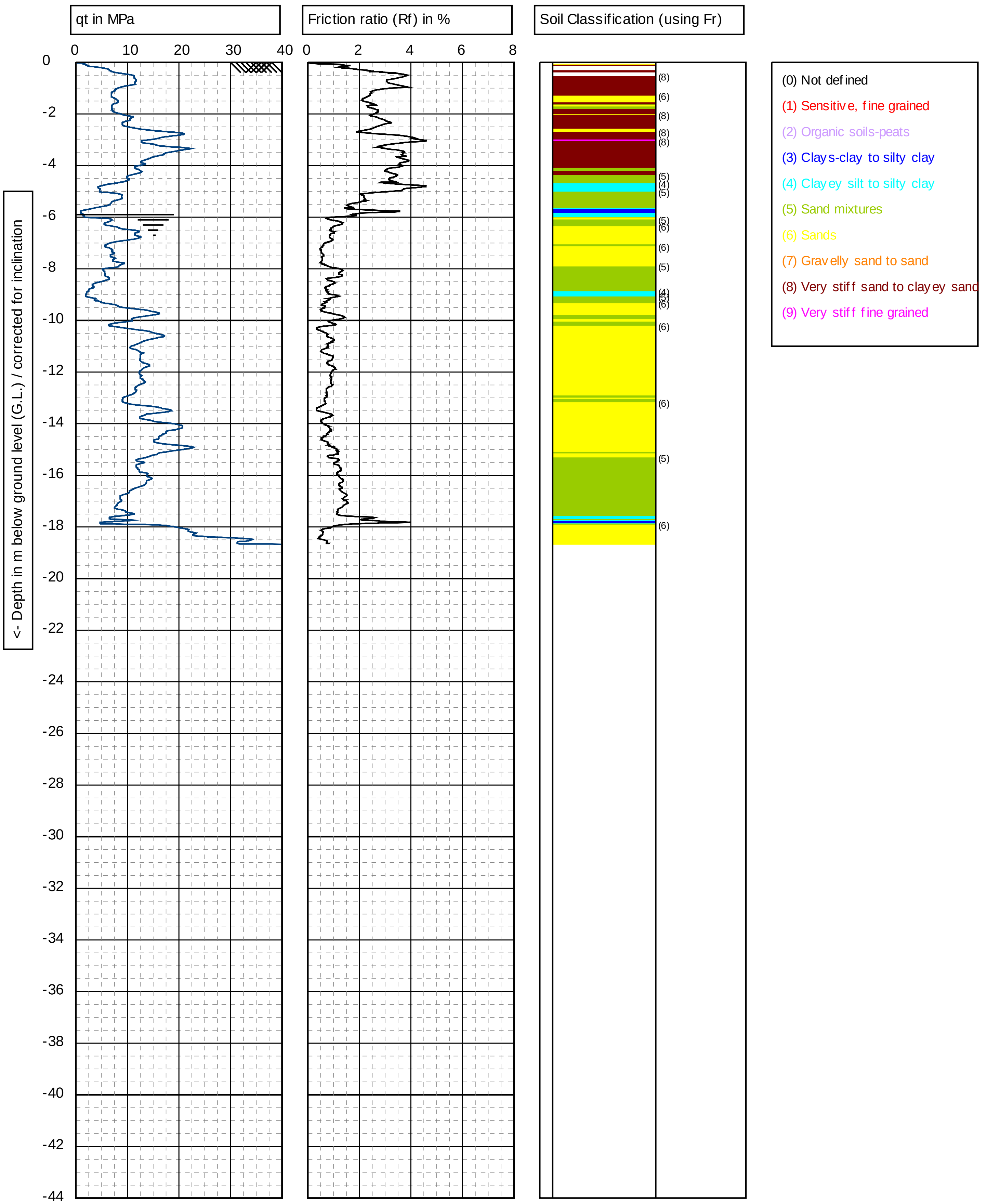
BLACK INSITU TESTING

u2 225 cm² 15 cm²

| | | | |
|---|---|---|---|
| Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
| G.L. 69.3 AHD | W.L.: **-5.9** | Date: | **3/02/2015** |
| Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | Project no.: | **D145** |
| Position: | | CPT no.: | **P 9** 1/2 |

1.40

Processed : RB Checked: TH



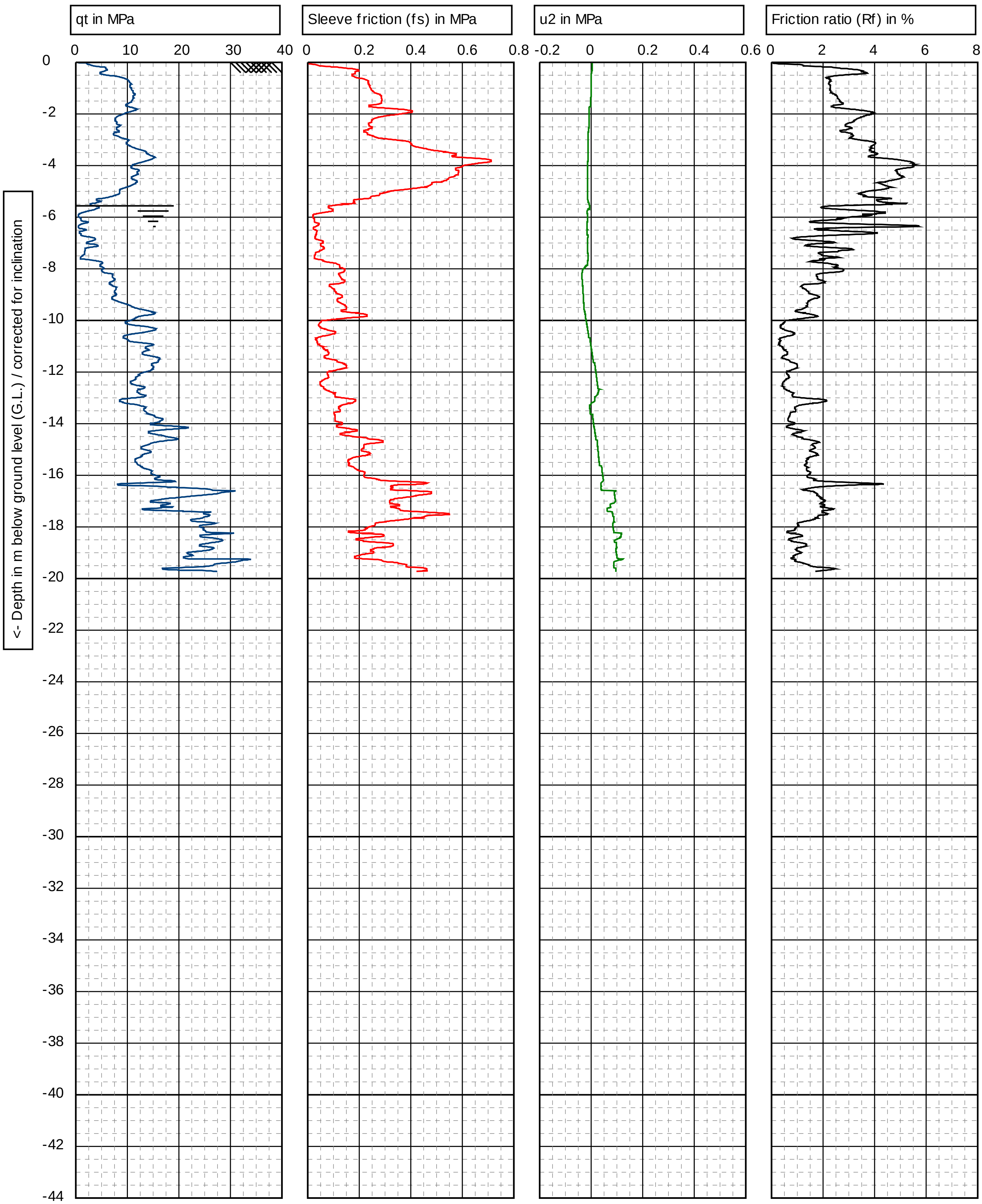

Refusal at 18.77m qc >40MPa

Hole closed at 4.9m dry

| | | | |
|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : **0 m Predrilled** |
| | | G.L. 69.3 AHD — W.L.: **-5.9** | Date: **3/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: **D145** |
| | Position: | | CPT no.: **P 9** — **2/2** |

1.40

Processed : RB Checked: TH



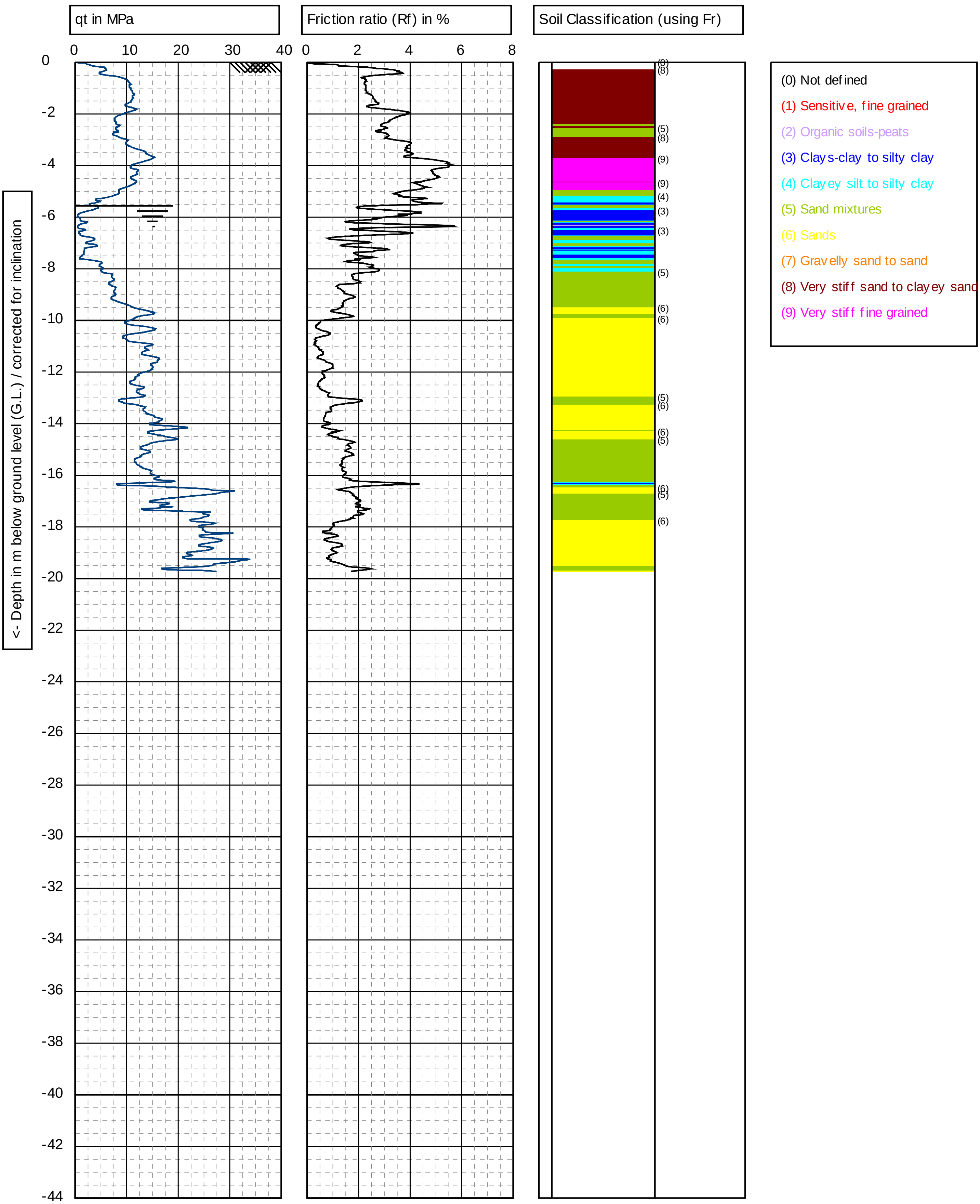

Refusal at 19.83m qc>30MPa

Hole closed at 6.10m

| | | | |
|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : **0 m Predrilled** |
| | | G.L. 68.9 AHD / W.L.: **-5.56** | Date: **3/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: **D145** |
| | Position: | | CPT no.: **P10** 1/2 |

1.40

Processed : RB Checked: TH



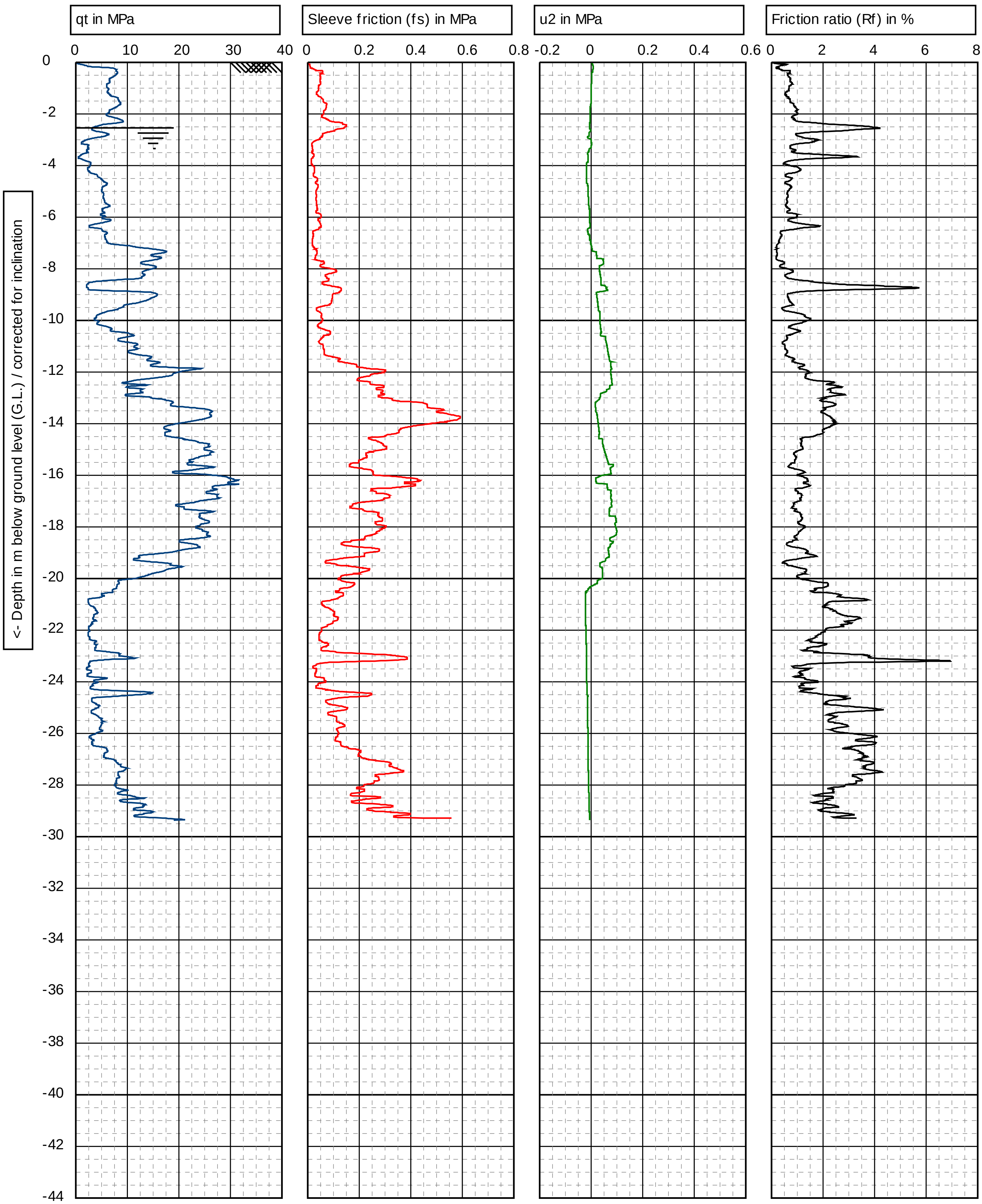

Refusal at 19.83m qc>30MPa

Hole closed at 6.10m

| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
|---|---|---|---|---|---|
| | | G.L. 68.9 AHD | W.L.: **-5.56** | Date: | **3/02/2015** |
| | Project: **Gee Gee Bridges** | | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | | Project no.: | **D145** |
| | Position: | | | CPT no.: | **P10** 2/2 |

1.40

Processed : RB Checked: TH




Refusal at 29.48m qc >20MPa

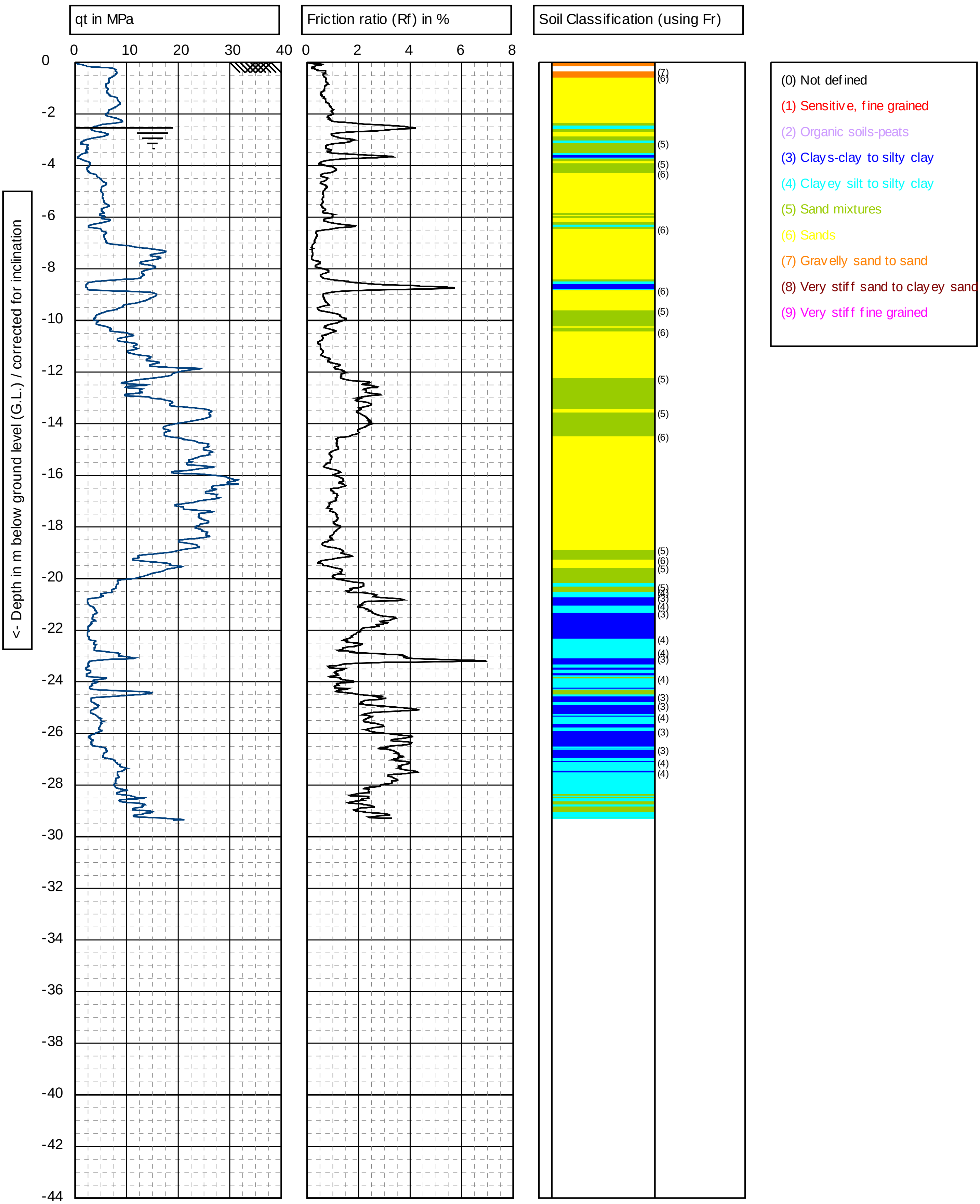
Hole closed at 3.30m

BLACK INSITU TESTING

| | | | |
|---|---|---|---|
| u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | G.L. 66.1 AHD W.L.: **-2.54** | Date: | **4/02/2015** |
| | Project: **Gee Gee Bridges** | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | Project no.: | **D145** |
| | Position: | CPT no.: | **P 11** 1/2 |

1.40

Processed : RB Checked: TH



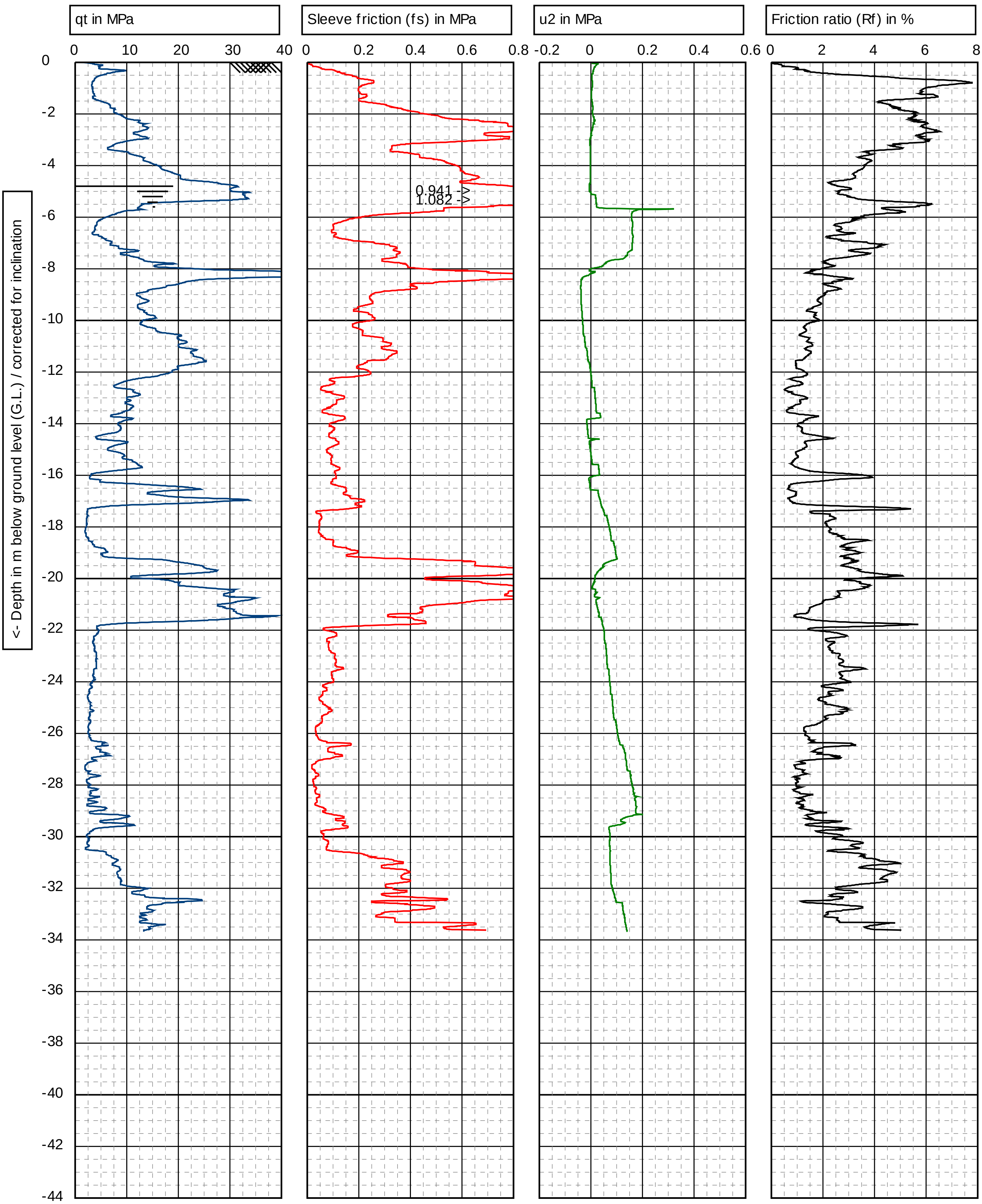

Refusal at 29.48m qc >20MPa

Hole closed at 3.30m

| | | | | |
|---|---|---|---|---|
| BLACK INSITU TESTING | u2 225 cm² 15 cm² | Client : Black Geotechnical | Predrill : | **0 m Predrilled** |
| | | G.L. 66.1 AHD W.L.: **-2.54** | Date: | **4/02/2015** |
| | Project: **Gee Gee Bridges** | | Cone no.: | **S15CFIIP.S12299** |
| | Location: **Wakool Shire** | | Project no.: | **D145** |
| | Position: | | CPT no.: | **P 11** 2/2 |

1.40

Processed : RB Checked: TH




Test Complete at 33.86m qc>18MPa

Hole closed at 7.28m

BLACK INSITU TESTING

u2 225 cm² 15 cm²

Client : Black Geotechnical

G.L. 70.2 AHD

W.L.: **-4.81**

Project: **Gee Gee Bridges**

Location: **Wakool Shire**

Position:

Predrill : **0 m Predrilled**

Date: **5/02/2015**

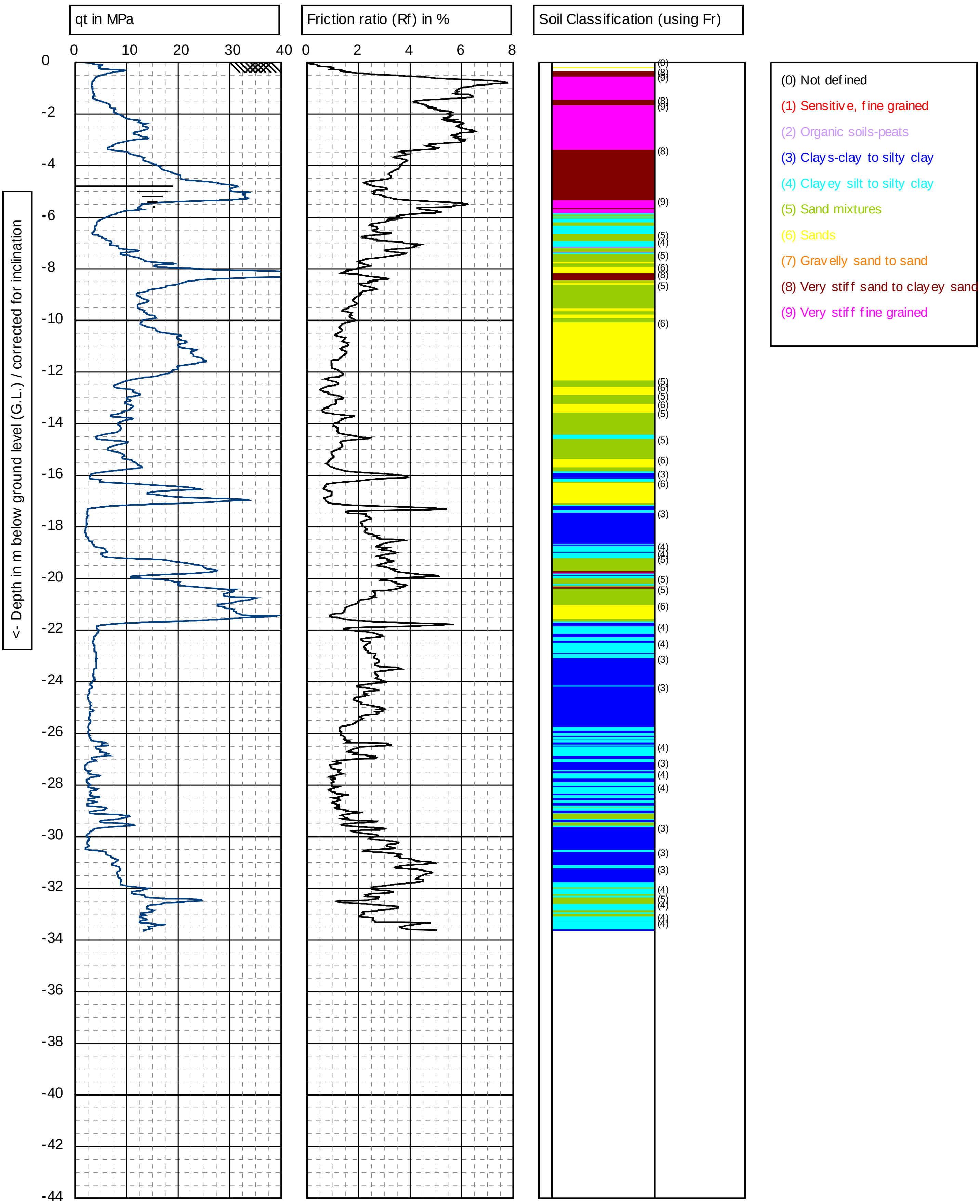
Cone no.: **S15CFIIP.S12299**

Project no.: **D145**

CPT no.: **Abut B** **1/2**

1.40

Processed : RB Checked: TH




Test Complete at 33.86m qc>18MPa

Hole closed at 7.28m

BLACK INSITU TESTING

| u2 225 cm² 15 cm² | Client : Black Geotechnical | | Predrill : | **0 m Predrilled** |
|---|---|---|---|---|
| | G.L. 70.2 AHD | W.L.: **-4.81** | Date: | **5/02/2015** |
| Project: **Gee Gee Bridges** | | | Cone no.: | **S15CFIIP.S12299** |
| Location: **Wakool Shire** | | | Project no.: | **D145** |
| Position: | | | CPT no.: | **Abut B** 2/2 |

1.40

Processed : RB Checked: TH