Our Ref: 890323-R1(01)-FRA

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Dear Sir/Madam,

RE: QUALITATIVE HYDROLOGY AND FLOOD RISK ASSESSMENT
LOWER STUMBLE EXPLORATION SITE, BALCOMBE, HAYWARDS HEATH

1 INTRODUCTION

RSK Land & Development Engineering Ltd were commissioned by the client, Angus Energy Ltd, to provide a Flood Risk Assessment (FRA) to support a planning submission for the re-use and re-investigation of an Oil Exploration Site at Balcombe, Haywards Heath.

The purpose of the report is to demonstrate that flood risk will not increase as a result of the re-activated exploration site and confirm that an appropriate strategy to manage and dispose of surface water runoff is in place for the duration of its operation. The drainage strategy must demonstrate that runoff from the development will be controlled for its operational period (in this case for a further 3 years) taking account of the vulnerability of its users, without increasing flood risk elsewhere.

This report has been prepared in line with the National Planning Policy Framework (NPPF), its corresponding Planning Practice Guidance (PPG), and the Defra non-statutory technical standards.

The comments given in this report and opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

1.1 Site History

The site has an established planning history, having been first used for exploratory drilling from 1986-1987 with the pad subsequently retained for use by Balcombe Estate (the current landowners) for forestry product storage.

The Balcombe 2Z Hydrocarbon Borehole was established in 2013 for gas and oil exploration, and the site has since been subject to several planning applications.

More recently, Angus Energy submitted an application for planning permission (planning ref. WSCC/071/19) in September 2019 for a two-stage activity, firstly to remove previously used drilling fluids from the wellbore, followed by an EWT to be carried out over a period of three years. This application was subsequently withdrawn.

1.2 Application Details

The proposed work on the Balcombe 2Z Well will take place in four distinct phases, with planning and regulatory approvals at each phase. These are as follows, with further information provided in Section 2:

- **Phase 1 – Removal of Wellbore Fluids:** phase 1 of the works has been designed to remove wellbore fluids which are currently preventing the natural formation fluids from entering the well. This phase would effectively clean up the well in preparation for undertaking an EWT.
- **Phase 2 – Pad Membrane:** For the site to meet established onshore oil and gas standards, a site-wide impermeable membrane will be installed by a civil engineering contractor.
- **Phase 3 – Extended Well Test:** The objective of the EWT is to enhance subsurface data so Angus Energy can start estimating potential production reserves, assess the commerciality of the well and obtain empirical data e.g. water cut data, flow rates and hydrocarbon composition. The EWT is a continuation of the exploration phase to prove that a hydrocarbon resource exists.
- **Phase 4 – Plug and Site Restoration:** Phase 4 involves removing all of the surface plant and equipment from the site as well as plugging the wellbore to the prevailing HSE standards. Upon completion the site will be restored, with 50% of the pad to become deciduous woodland in accordance with the High Weald AONB Management Plan 2019-2024.

In order to demonstrate exceptional circumstances and ensure that the development does not compromise the landscape qualities of the High Weald AONB, the proposal has been modified to decrease impact to visual amenity, and a habitat restoration plan will be implemented during Phase 4 of the operation. Please refer to the Landscape and Visual Appraisal and associated plans and drawings for further details.

Please refer to section 8 of the accompanying planning statement for further details of the development proposals.

2 SITE DETAILS AND PROPOSALS

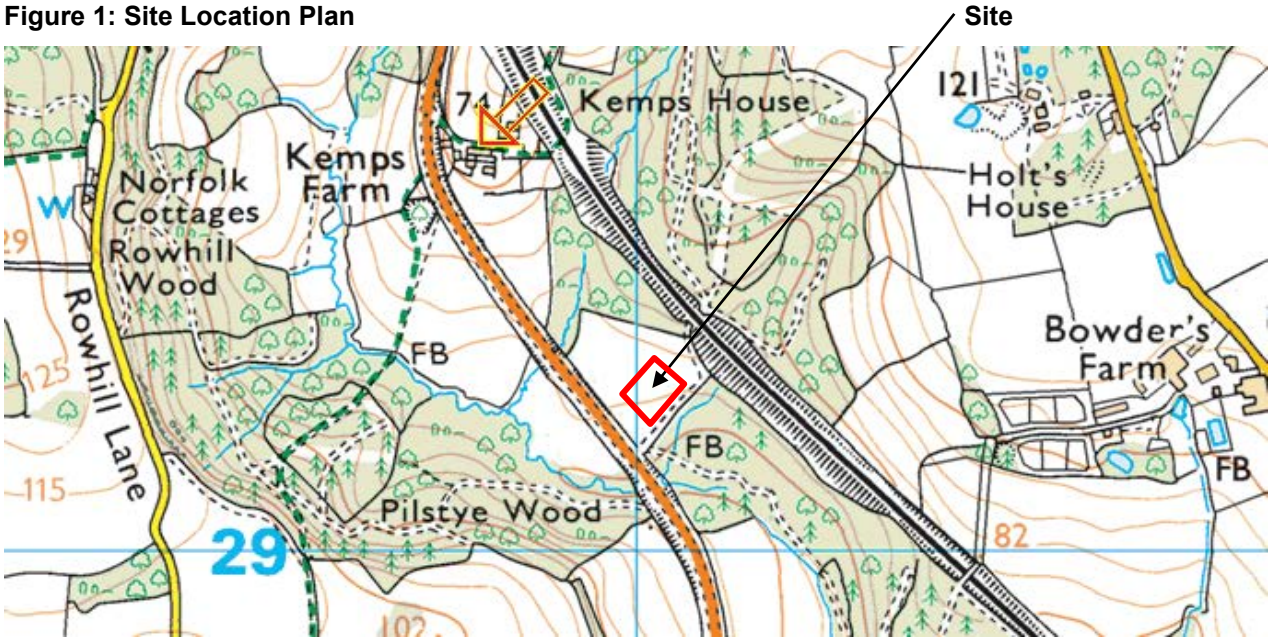
The site is located to the south of the village of Balcombe, Haywards Heath. The site currently comprises an artificially levelled area measuring approximately 0.73ha in size total.

The site comprises two distinct parts: a 28m x 18m impermeable concrete area or “pad” which accommodates the borehole, an underground storage crate and a ground water monitoring borehole. This is surrounded by an open area comprising a crushed stone base, enclosed within an earthen bund. To prevent unauthorized access a two-metre high security fence encloses the entire site on all sides.

The site is located northeast of London Road and southwest of a Railway at National Grid Reference E531020, N129243 as shown in **Figure 1**.

The development proposals for the site include no new construction or extensions and will involve the site being reactivated and put back in use. The existing infrastructure and impermeable area will not be changed. The proposed site layout is included in **Appendix B**.

Figure 1: Site Location Plan



The proposed work on the Balcombe 2Z well will take place in a phased approach, with planning and regulatory approvals covering the various phases.

Phase 1, pumping operation, is anticipated to take up to 4 weeks and will use a minimum amount of surface equipment. Assuming this is successful, Angus would then move on to phase 2, the civil engineering works to upgrade the pad containment. Once construction and installation of the pad membrane is complete, phase 3 would commence with an extended well test for 12 months depending on results. The final phase plugging and decommission of the site, phase 4, will be carried out if the project is unsuccessful in retrieving commercial volumes of hydrocarbons.

If the initial 12 months testing confirms that there are hydrocarbon reserves which could be commercially extracted, a separate planning application will be prepared for a future production phase. A period of 12 months has been allowed for the submission of a planning application for determination by WSCC.

The total duration of the project will last up to 30 months, however surface operations during this period has the potential to be confined to a much shorter duration than 30 months.

In terms of the surface plant and equipment for the proposed operations, this will be similar equipment as approved under planning application ref: WSCC/040/17/BA.

Phase 1 – Removal of Wellbore Fluids

Phase 1 is designed to remove wellbore fluids which is preventing the natural formation fluids from entering the well. This is effectively cleaning up the well ready for an extended well test. Phase 1 will involve a simplified set of equipment since it is envisaged that when oil is seen the operation will cease. Phase 3 is designed to manage the returns of hydrocarbons. The equipment envisaged would include a linear rod pump (LRP) or equivalent (pump jack), a surge tank, a storage tank for brine and a slops tank for any contaminated brine. There would also be the same pressurised tank on site for fluid export & vapour recovery as per Environment Agency (EA) regulations. All this equipment would be in a small bunded area adjacent to the wellhead (note that the bund will comply with best industry practice guidelines i.e. CIRIA

C736). The fluids produced from the well would pass through a control valve to the surge tank, which is there to control variations in flow rate. Subsequently, the process flow path would then pass to the brine tank. Any contaminated brine containing traces of oil would pass to the contaminated fluid tank. It is anticipated that the operation would take around 7-14 days with rig up and rig down time either side of this. As a maximum case scenario, it is expected that in total stage 1 could take 4 weeks. Ancillary equipment would include a generator and a small welfare unit.

Angus intends to carry out the phase 1 operation with the minimum equipment to minimise environmental impacts and reduce any disruption to the local community. This is a continuation of the previous operation carried out in Autumn 2018. The pumping phase of operation will be 24/7 to allow the wellbore to continually flow. Mobilisation and demobilisation of equipment will be operated between the hours of Monday to Sunday 07:00hrs and 19:00hrs during this phase.

The following equipment would be on site for phase 1. This is a minimal well test package and tanks. All equipment will be bunded.

- Surge tanks;
- Low pressure separator;
- Associated pipe work & manifold;
- Oil & waste storage tanks;
- LRP–Linear Rod Pump; and
- Vapour Recovery Tank (as per EA Specifications).

Following the rig up of equipment and observation of zero pressure on the well, the well would be opened up and the sucker rod pump and rods would be run to a depth of ~2278 ft MD (694m) (where there is an XN landing nipple), which is around 357 ft (109m) measured depth from the perforations/top of the uncemented slotted liner. The linear rod pump or pump jack/nodding donkey (depending on availability) would be mounted on the existing valves installed on the well. The pumping would commence and continue until brine was reduced and oil was seen in the borehole. During all operational phases, all fluids will be trucked offsite to a licensed and approved facility.

Once the well has been cleaned up and dry oil begins to be seen, operations will cease and the well suspended. Surface equipment will be demobilised as required before the start of phase 2 surface engineering works.

A period of several weeks to months will begin where the site will become suspended as Angus analyse results and procure contractors for the next phase of operation. Due to the uncertainty of contract negotiations and the availability of specialist equipment this phase could last several months. However, it is Angus intention to minimise this duration to approximately 6 weeks. During this period there will be no surface works at the site apart from inspection and site maintenance.

Phase 2 – Pad Membrane

For the site to meet current onshore oil and gas standards a site wide impermeable membrane will be installed by a civil engineering contractor.

Angus is committed to supporting inward investment into the county of Sussex and will, subject to procurement process, procure a local engineering company to complete phase 2 of the project.

A detail design will be provided by the civil engineers however, the basis of design is as follows:

- Removal of the existing 300mm granular platform surface material, existing polypropylene geo-grid and existing geotextile;
- If required, screen existing granular material, removing large cobles in excess of 50mm;
- A 'V-Type' perimeter containment ditch and HDPE impermeable membrane anchor berm surrounding the active area of the wellsite;
- A fully welded 2mm thick HDPE impermeable membrane laid across the active area of the wellsite and perimeter containment ditch;
- Protective geotextiles laid below and above the HDPE impermeable membrane;
- Batten fixing the HDPE impermeable membrane to existing concrete pad, which surrounds the Balcombe- 2z drilling cellar;
- Twin-wall perforated pipe and rodding/jetting points laid within the perimeter containment ditch, above the HDPE impermeable membrane and protective geotextiles, back filled to finished platform level using 40mm single size granular material;
- A connection from the twin-wall perforated pipe system to the existing interceptor and installation of isolation valves (up and down stream of interceptor) and a sampling point downstream of the interceptor;
- A layer of extruded polypropylene geo-grid across the active area of the wellsite, above the HDPE impermeable membrane and protective geotextiles, for additional structural support; and
- A 300mm thick layer of compacted granular material above the protective geotextile and geo-grid, providing the finished wellsite platform with nominal fall toward the perimeter containment ditch.

Further details are outlined the supporting Design Philosophy Statement for a Fully Engineered Impermeable Subbase[1].

It is anticipated that civil engineering equipment including bulldozers, excavators and associated supporting equipment will be used to complete the works, subject to weather conditions, in approximately 8 weeks. The working hours for this phase will be Monday to Sunday 07:00hrs to 19:00hrs.

Phase 3 – Extended Well Test

The objective of the extended well test is to enhance subsurface data so Angus can start estimating potential production reserves, assess the commerciality of the well and obtain empirical data e.g. water cut data, flow rates and hydrocarbon composition. The extended well test is a continuation of the exploration phase to prove that a hydrocarbon resource exists.

[1] Zeatland Group / Angus Energy (2019) Balcombe Wellsite, Removal of Drilling Fluids and Extended Well Test, Design Philosophy Statement for Fully Engineered Impermeable Subbase, ZG-AE-BAL-EWT-DPS-01

It is intended that during this phase of works only equipment on site is the well test spread and storage tanks.

However, there are 3 contingency options which could be utilised to support the extraction of hydrocarbons. This includes a nitrogen lift, acid wash and the installation of a bridge plug. A nitrogen lift is a form of artificial lift by pumping nitrogen from surface into the wellbore to lift liquids to surface.

To improve the flow of petroleum within the formation, an acid, most commonly hydrochloric Acid (HCl) at 15% concentration with water, is applied to the formation through the wellbore. The operation is very much akin to acidisation of boreholes in the water well industry and results in high permeability channels through which water or petroleum can flow. An acid wash is designed to remove scale or similar deposits from perforations and well-completion components. The acid wash can be used to repair formation blinding and help restore the natural porosity of the formation. The wash is applied to the formation under pressure not exceeding the fracture pressure of the formation.

A bridge plug could be used to isolate sections of the formation which are producing water rather than hydrocarbons. By isolating part of the lateral well which is producing high water levels, returning hydrocarbons to surface requiring less processing and separation.

The decision making of when to use either all or a combination of the options will depend on the behaviour of the target formation. It is likely that the use of these contingency options would be used at the start of the extended well test, but this will depend on well data and performance.

If a contingency option is required to aid the flow of the well, a Coiled Tubing unit would be mobilised to site. This is the same surface equipment that was used during the Autumn 2018 work. It is Angus intention and primary option for the well to flow naturally and not require further intervention or treatment. The well test phase of operation will be 24/7 to allow the wellbore to continually flow. Mobilisation and demobilisation of equipment will be operated between the hours of Monday to Sunday 07:00hrs and 19:00hrs during this phase.

The following equipment would be on site for the extended well test operation. This is a full well test package and tanks. Extra equipment for contingency options (1), (2) & (3) is also listed.

- Test Separator Unit, MAWP 1440 psig;
- On board data acquisition and reporting system;
- Associated Pipework & Manifolding Package;
- Surface ESD system;
- Choke Manifold;
- Surge Tank - Second stage separator;
- Oil & waste storage tanks;
- LRP –Linear Rod Pump; and
- Flare unit
- Coil tubing unit and injector head
- Nitrogen tanks and convertor

- HCL acid wash tanks
- Vapour Recovery Tank (as per EA specifications).

A single flare unit will be on site throughout the duration of the extended well test to combust associated gas. The flare will either be the PW flare unit or an AERON unit. The flare will be selected based on flow rates and performance. For the purposes of this assessment the PW unit has been assessed as the primary flare (13.8m high) due to its landscape impact. The air quality assessment has examined both the AERON unit and PW flare. The AERON unit stands between 5.5m and 8m.

Once operations have completed mobilisation the site discharge valve will remain closed unless the ditch water can be assessed as clean and uncontaminated. Where the water requires disposal, a vacuum tanker will remove the drainage ditch water for offsite disposal at a permitted waste facility.

During the 12 months Angus will review data to assess the commercial opportunity of moving the site into production. Once the test is completed Angus will shut the well in and move to phase 4 or submit a new planning application for production to WSCC.

Phase 4 – Plug & Site Restoration

Phase 4 involves removing all of the surface plant and equipment from the site as well as plugging the wellbore to the prevailing HSE standards. The plugging of a well involves the use of a workover unit and cementing units to inject cement into the wellbore and provide a barrier preventing the unintended release of fluids.

Once the plugging of the wellbore is completed the site restoration begins. It is estimated that this will take approximately 1- 2 months to complete.

Management of Waste & HSE

During both stages of the operation, fluids will be pumped from the well by the installed sucker rod pump. As stated, during phase 1 the purpose of the operation is to remove the remaining brine from the hole to allow dry oil to flow. As a result, the main fluid produced will be brine and this will be stored in the on-site tanks. During phase 2, the main fluid produced would be oil which would also be stored in the on-site tanks. During all operations tanks will be emptied by an approved waste removal company and trucked to a similarly approved facility. At the end of the operation the tanks will then be professionally cleaned and returned to the contractor. The very same pressurised tank that was used during the initial Autumn 2018 well test will also be installed for vapour recovery in compliance with our obligations as outlined in the wellsite EPR permit under The Environmental Permitting (England & Wales) Regulations 2016.

Angus Energy operates an integrated health, safety and environmental management system which will be in place throughout the operational activity. Implementation is achieved through documentation, competency of staff and contractors, using best available techniques and an active programme of monitoring and review.

Should any emergency occur, the well would be instantly shut in at the wellhead. The adoption of normal emergency procedures applicable to oilfield operations ensure compliance with the UK onshore environmental and safety control regime. Site specific emergency response procedures are in place in consultation with the emergency services and tested prior to the commencement of any work.

Monitoring

During the proposed works there will be a variety of monitoring techniques employed for both stages of operations.

3 SITE CHARACTERISTICS

3.1 Topography

The site area is essentially level having been cut into the hillside. Published Ordnance Survey (OS) Mapping shows that the topography of the immediate surrounding area ranges from approximately 55.0mAOD to 60.0mAOD with a slope down from the railway embankment to the north-east.

3.2 Hydrology

OS Mapping shows that no watercourses are present within the site boundary. The nearest main watercourse to the site is an unnamed tributary of the River Ouse located approximately 190m southwest of the site. However, two minor ordinary watercourses are present in the woodlands 175m to the northwest and 65m to the southeast of the site. The south-eastern ordinary watercourse (also referred to as the Lower Beanham watercourse) acts as the outfall for surface water from the site during non-operational periods.

3.3 Geology

Based on published geological records for the area British Geological Survey (BGS) online mapping, the site overlies a complex array of geologies interspersed with Wadhurst Clay Formation – Mudstone, Lower Tunbridge Wells Sandstone, Ardingly Sandstone and Lower Grinstead Clays. No superficial deposits are present at the site. There are three BGS borehole references within the sites' boundaries however the information is confidential given the proposed land use of the site.

3.4 Hydrogeology

Hydrogeological information has been obtained from the EA's online mapping service. The site is not underlain by any bedrock or superficial aquifers. Though a region of Low Vulnerability Minor Aquifer surrounds the site, the actual borehole and exploration site does not encroach into it. The site is also not located in any groundwater source protection zone.

4 FLOOD RISK DESCRIPTION

4.1 Environment Agency

4.1.1 Flood Zone Maps

The EA Flood Zone mapping study for England and Wales is available on their website at http://maps.environment-agency.gov.uk/. The current displayed map is reproduced as **Figure 2a** shows the site lies wholly within Flood Zone 1, meaning that the site is an area which is protected from the 1% Annual Exceedance Probability (AEP).

In December 2013, the EA released an additional form of mapping 'Flood risk from rivers of the sea', which is available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/

The relevant guidance note from the EA is available online through the following link: https://www.gov.uk/planning-applications-assessing-flood-risk

Figure 2a: Flood Map for Planning (Rivers and Sea)

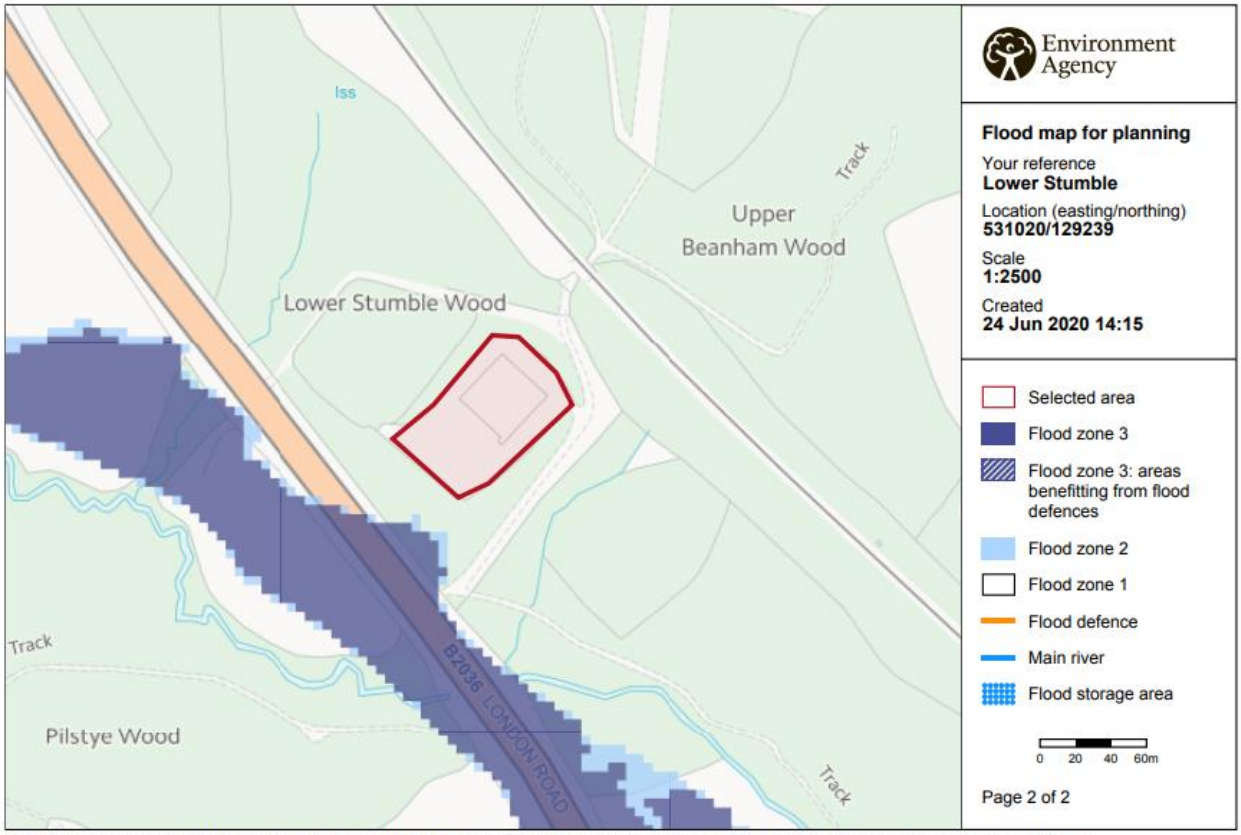


Figure 2b: Flood risk form rivers or the sea

4.2 Fluvial Flood Risk

The EA mapping confirms that the site and the surrounding areas are located within Flood Zone 1 (land assessed as having a 1 in 1000 or greater annual probability of flooding from rivers). The nearest fluvial watercourses are the two minor watercourses located 175m to the northwest and 65m to the southeast of the site in the Lower Stumble woodland and Lower Beanham woodland respectively.

The closest Ordinary Watercourse to the site is the unnamed tributary of the River Ouse, which is located 190m to south on the opposite site of and passing under London Road (B2030). Given the distance of the site from the nearest watercourses, and the sites elevation with respect to these fluvial features the risk of fluvial flooding to the site is considered to be **low**.

4.3 Surface Water Flood Risk

Intense rainfall can create conditions where the local infiltration and drainage capacity is insufficient to cope with the volume of water and so water flows overland. Surface water flooding can also occur due to a reduction in the capacity of a drainage system due to some form of blockage.

The EA's online map 'Flood risk from surface water' (reproduced as **Figure 3** overleaf) indicates that the majority of the site is considered to be in a 'very low' flood risk area, although there are two isolated 'low' and 'medium' flood risk areas. The courses of both watercourses and parts of London Road also have their

own risk zones but are separated from the site itself. The West Sussex Strategic Flood Risk Assessment (SFRA) considers the area to have a low to medium risk of surface water flows.

The site is on level ground with surrounding levels falling to the south/southwest. The railway line will intercept the majority of offsite flows from the higher ground to the northeast, however, surface water flows will likely be channelled along the access track running underneath the railway and around the eastern edge of the site.

The site is therefore concluded to be at a **low** risk from surface water flooding since no external flow paths are likely to enter the site.

Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow. Climate change guidance for rainfall intensity has been updated by the EA in late February 2016. Revised allowances for climate change should be included in the site drainage strategy.

Figure 3: Risk of flooding from surface water

4.4 Groundwater Flood Risk

Groundwater flooding occurs when the water held underground rises to a level where it breaks the surface in areas away from usual channels and drainage pathways. Groundwater flooding typically occurs following

long periods of sustained intense rainfall and is typically associated with low-lying areas underlain by permeable aquifers.

The site is located within an area that is considered to be potentially at medium risk of flooding from groundwater flooding according to Flood Map G of the SFRA prepared by West Sussex County Council (2010). However, given the underlying geology, and the site is on ground that is locally elevated above the valley floor the resultant groundwater flood risk is considered to be **low**.

Trendrevel Services Limited has undertaken multiple soil investigations at the site reported in October 2010 (see **Appendix C**) At least sixteen static cone penetration tests were performed at the site. The findings concluded that the predominant bedrock geology is Ardingly Sandstone while the sites predominate surface geology (under the concrete surface pan) is a layer of unregulated crushed aggregate overlying a firm sandy clay.

Further information on the hydrogeological regime at the site has been included in the updated Hydrogeological Risk Assessment[2] produced for the application by RSK Environment Ltd.

4.5 Flooding from Sewers

Flood events occur when the capacity of a sewer is exceeded either due to a blockage in the sewer system or excess surface water runoff entering the system. The impact of climate change is likely to be negative regarding flooding from sewers. Increased rainfall and more frequent flooding is likely to put existing sewers and drainage systems under additional pressure resulting in the potential for more frequent surcharging and potential flooding. This would increase the frequency of local sewer flooding but not significantly in terms of the proposed development.

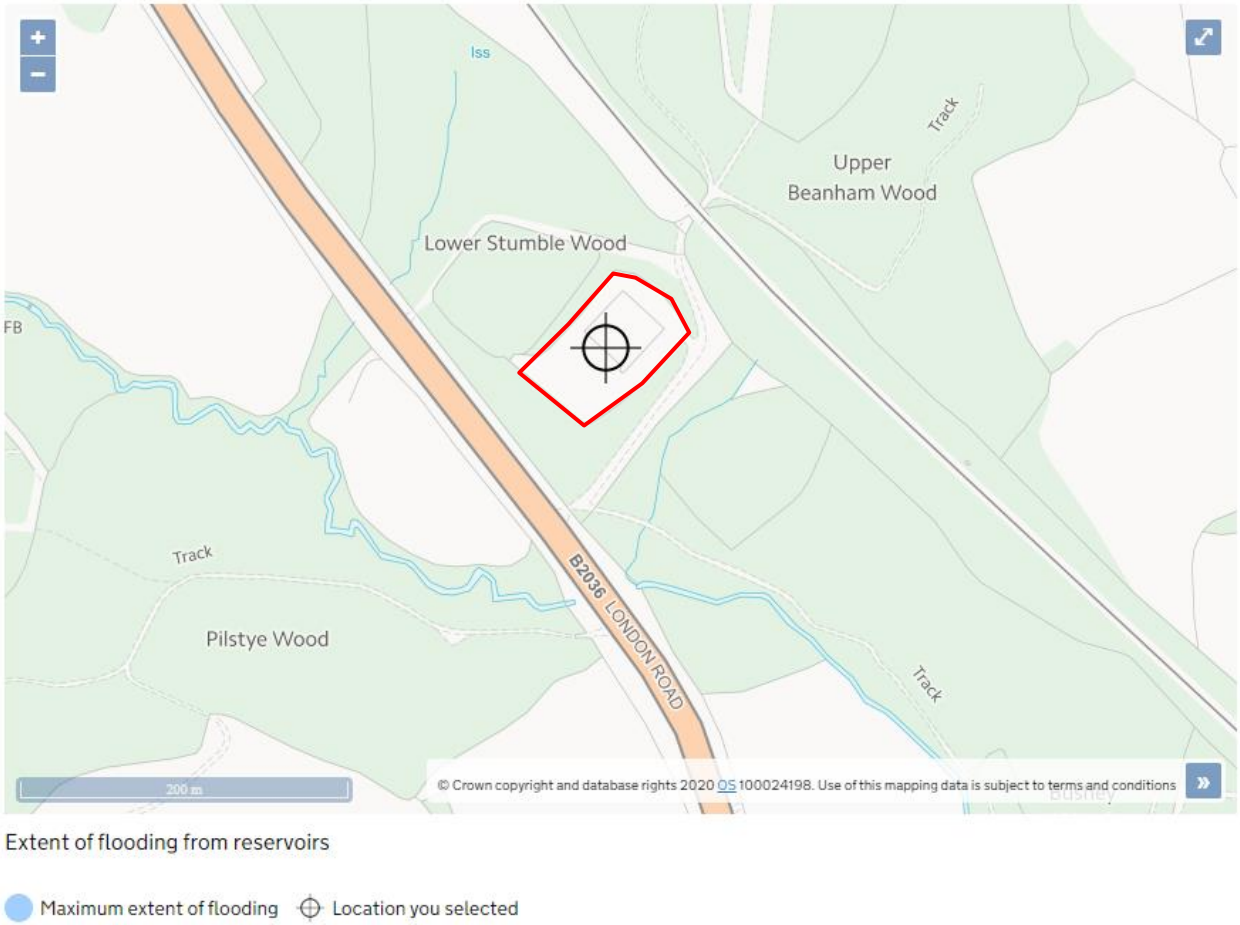
There are no existing public sewers within the site's boundaries. The sewer flood risk for this area can be considered **negligible** since the site incorporates a private surface water network (described in Section 5).

4.6 Flooding from Reservoirs

The EA's online reservoir flood risk map (**Figure 4**) provides a worst-case scenario of the maximum extent of flooding that would occur in the event that a reservoir were to fail and release the water it holds. The map indicates that the site is located outside a reservoir breach zone.

[2] RSK Environment Ltd (2020), Hydrogeological Risk Assessment: Lower Stumble Exploration Site, London Road, Balcombe, West Sussex, RH17 6JH, 11467-01(01)

Figure 4: Risk of flooding from reservoirs



Generally, reservoir flooding is extremely unlikely. There has been no loss of life in the UK from reservoir flooding since 1925, but since then reservoir safety legislation has been introduced to ensure reservoirs are maintained.

Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to control the effects of climate change. Increased rainfall has the potential to increase base flow, but this should be minimal. It is unlikely that there will be a substantial change to the risk of flooding for this site. Given the ability to manage reservoirs over time flood risk from this source is considered to be **low**.

4.7 Canals

There are no Canal & River Trust assets within the vicinity of the site.

4.8 Blockage of artificial drainage systems

There is a possibility that flooding may result due to culverts and/or sewers being blocked by debris or structural failure. This can cause water to backup and result in localised flooding, as well as placing areas with lower ground levels at risk.

The site has a private surface water drainage system installed to regulate surface water runoff both during an operational phase and when inactive. The primary function is the ensure that all surface water runoff and water used in borehole operations are contained on-site and removed by separate means, ensuring that no offsite runoff occurs during operation. It is considered unlikely that this system will surcharge and therefore the risk of flooding from artificial drainage is considered **low**.

5 SURFACE WATER DRAINAGE CONTROLS

5.1 Drainage Control Features

As part of the previous planning application (Ref WDCC/071/19) the sites primary drainage control feature was an impermeable membrane designed to accommodate a 1 in 100yr + 30% allowance for climate change rainfall event (in accordance with RSK document P661913 produced in 2018 in order to discharge the relevant planning condition relating to drainage and Appended to this FRA as **Appendix D**). The impermeable membrane and surrounding perimeter bund ensures that no surface water runoff from the main operation area (boreholes and pad area) is discharged to the surrounding water environment or to the ground. All surface water falling on the impermeable membrane is retained on site prior to recycling or removal from the site, and as such does not require an offsite discharge rate.

Runoff water is attenuated in an underground storage cellar. The cellar is cleared by a suction tanker to extract all collected water without the need for infiltration or watercourse outfall. A “sump-pump” is installed in the sites southern corner to pump all liquids out of the bunded area and into a tanker.

A final surface water control is a series of ACO French Drains installed within the pad area. This has a built-in oil interceptor to treat any contaminants, while a 150mm butterfly valve is in place to prevent discharge from the site. The valve is accessible from a manhole cover situated adjacent to the oil interceptor. The valve will be shut during the operational phase of work.

The remainder of the site compound will continue to infiltrate into the underlying strata, albeit at a reduced rate due to the compacted stone laid to facilitate vehicle movements and site activity. In periods when the site is not operational, surface water from the site will flow from the perimeter French drain via a trickle flow to a neighbouring unnamed watercourse approximately 60m to the southeast of the site.

The Design Philosophy Statement for the Fully Engineered Impermeable Subbase[1] notes the objective of the fully engineered impermeable subbase is to provide full hydraulic containment of the wellsite platform, preventing contaminated surface water and/or pollutants from entering the ground. Subject to obtaining the relevant surface water discharge permits from the Environment Agency, it also provides the ability to discharge ‘clean’ run-off water, although, for the purpose of EWT, it is proposed that the interceptor is isolated and all surface water removed from site via road tanker to an Environment Agency permitted water treatment works. For clarity, the pipework connecting the perimeter containment ditch to the interceptor needs to be included in the fully engineered impermeable subbase, thus future proofing the containment system, negating the need to modify the system at a later date (if the site continues to operate, subject to future consents).

The Design Philosophy Drawings proposed for the site and the associated drainage are included in Appendix 2 of the Design Philosophy Statement for the Fully Engineered Impermeable Subbase Report (ZG-AE-BAL-EWT-DPS-01) produced by Zeatland Group (2019).

5.2 Water Quality Control Features

Angus Energy will need to comply with all applicable legislation, industry guidelines and, as far as practicable, accepted best practice in environmental management in order to ensure that contaminants do not leave the site.

The impermeable membrane installed around the main pad also acts as the principle contamination control. A perimeter constructed from used railway sleepers has been established along with a geotextile membrane laid on top of the stone surface area within the bund. A HDPE membrane has been laid on top of the geotextile area and fixed down by sleepers.

The operational phases fuel tank will be double skinned in line with the Oil Storage Regulations. Any chemicals will be stored in containers supported by drip trays. Any oils, diesels, chemicals in use shall also be stored on drip trays.

The concrete pad area has ACO drains flowing into the cellar forming a sealed impermeable area. The surface water from the pad will be directed into the cellar and be disposed of off-site via a suction tanker to a waste water treatment works. The enclosing bund prevents any contaminated runoff from leaving the site via runoff, while the oil interceptor and restricted valve controls in the surrounding ACO drains prevent contamination from escaping during non-operational periods.

As part of standard operations, a Site Health, Safety & Environment Advisor will need to inspect the butterfly valve on a daily basis during drilling and well testing. No discharges are to be allowed from the oil interceptor at any time. There will be no discharge to local watercourses from the pad area and no silting will arise as a result of the on-site exploratory operations.

6 PREDICTED EFFECTS

6.1 Flood Risk

Given the location of the site within Flood Zone 1 and the absence of significant external overland flow routes through the site, no further mitigation measures to control runoff from outside the site are required. The site remains outside of any active fluvial flood zones and no modifications are proposed to extent the site into them.

The proposed reactivation is there expected to have **negligible** effects on and from fluvial flooding from the surrounding watercourses in the short, medium, and long term.

Due to the underlying sandstone geology groundwater flooding is not considered to pose any risk to site. The proposed reactivation is there expected to have **negligible** effects on groundwater in the short, medium, and long term.

Since the site is not in proximity to any other artificial water features (sewers or reservoirs) and no new extensions are proposed to the sites systems sites risk is not expected to change as a result of the sites reactivation.

6.2 Drainage

Any internally generated surface runoff is attenuated by the onsite system described in Section 5.1. This will ensure that any surface water generated by and used in the drilling operations will be contained onsite and removed as necessary. Since the process does not result in any uncontrolled runoff the effects on any external features outside the sites bund is considered **negligible**.

The remaining area of the site compound (the non-concrete pad) will continue to infiltrate into the underlying soils supported by the enclosing ACO French drain and oil interceptor systems. Under non-operational conditions this drain discharges via a trickle flow to the watercourse. During the operational phase, the butterfly valve will be shut, and any excess water tankered offsite after collation via the "sump pump". This setup will ensure that there is a **negligible** impact on the surrounding hydrology during the operational phase. The trickle discharge to the watercourse during non-operation is maintained by the perimeter drain, also ensuring a **negligible** impact on the receiving watercourse in the long term.

The proposals outlined as part of the Design Philosophy Statement notes that until such time that relevant surface water discharge consents are sought from the Environment Agency, surface water from the site will be discharged in the manner determined as part of the previous planning application. Surface water will be stored on site and tankered off as required to a permitted treatment works.

7 CONCLUSIONS AND RECOMMENDATIONS

This FRA complies with the NPPF and Planning Practice Guidance and demonstrates that the flood risk from all sources has been considered in the proposed development.

The existing surface and water quality control features ensure that any effects on flood risk, hydrology and drainage are considered to be **minor** to **negligible**.

Flood risk is not enhanced because any runoff is contained onsite and no increase in impermeable area is proposed so no modifications to the system are required.

The single surface water outfall from the site will be shut down during operations and all surface drainage will be removed by alternative means. Any effects from operations or any potential incidents on site will also be minor, and controllable due to the proposed mitigation measures and control features onsite.

We trust the above is useful, but should you require any additional information, please do not hesitate to contact the undersigned.

Yours faithfully,

Kristian Jackson
Senior Hydrologist, RSK LDE Ltd
Author

Matthew Cheeseman
Associate Director, RSK LDE Ltd
Technical Reviewer

APPENDICES

Appendix A: Service Constraints
Appendix B: Proposed Site Plan
Appendix C: Ground Investigation
Appendix D: Site Surface Water Drainage Calculation Details (RSK Report 661913 dated August 2018)

APPENDIX A

Service Constraints

1. This report and the Drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Angus Energy (the "client") in accordance with the terms of a contract between RSK and the "client" dated June 2020. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable Civil Engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK’s understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between

the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt,

unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.

APPENDIX B

Proposed Site Plan

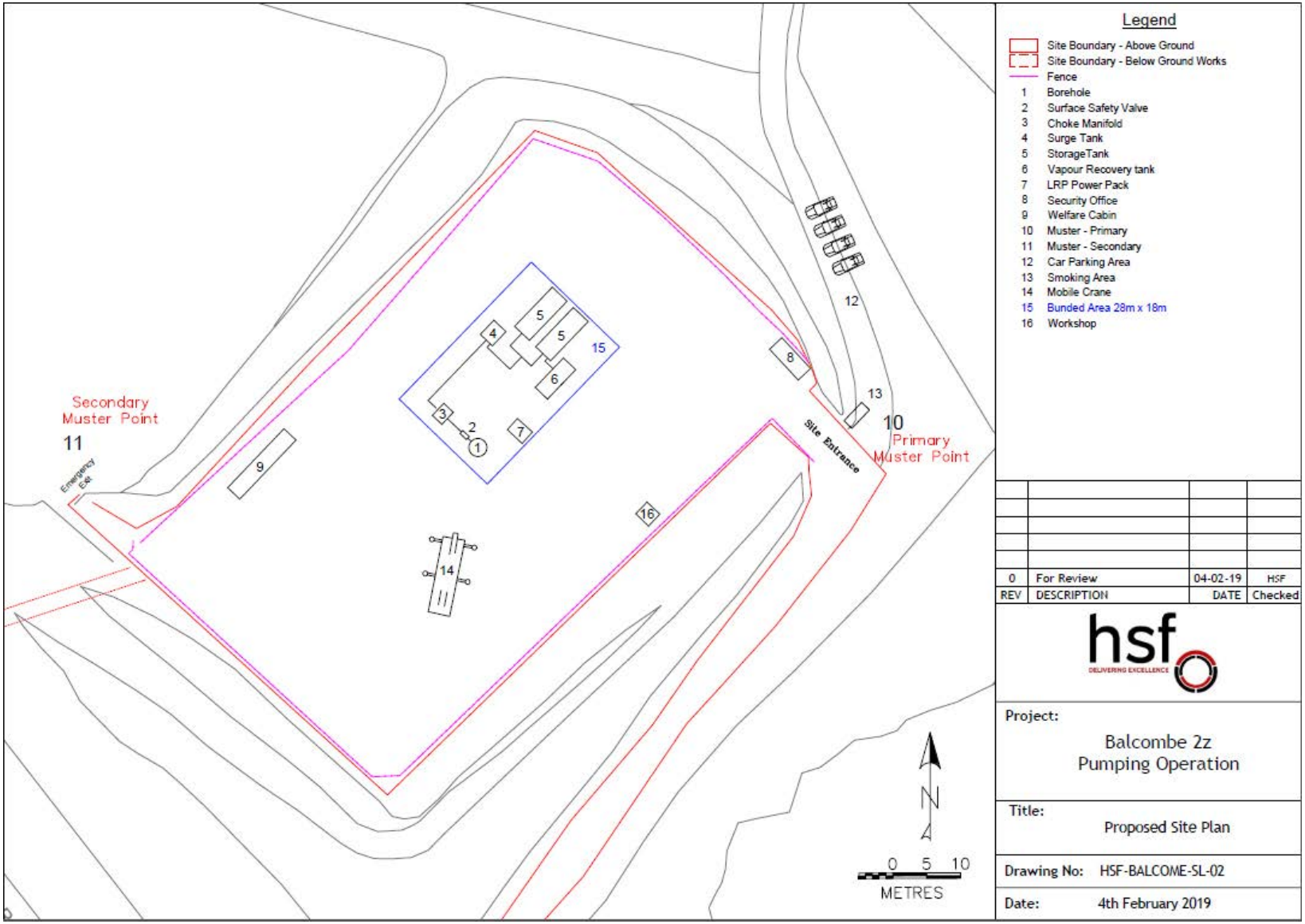


Fig. 3 – Indicative site layout for the proposed operation

APPENDIX C

Ground Investigation

Trendrevel Services Limited

FOX (OWMBY) LIMITED

BALCOMBE RIG SITE
BALCOMBE
SOUTH CRAWLEY

GROUND INVESTIGATION
T10/053gi

Ground Investigation

October 2010

T10/053gi

The Old Court House, 20 Simpson Road, Fenny Stratford, Milton Keynes. MK2 2DD

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FOX (OWMBY) LIMITED

BALCOMBE RIG SITE
BALCOMBE
SOUTH CRAWLEY

GROUND INVESTIGATION

T10/053gi
OCTOBER 2010

Trendrevel Services Limited
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20 Simpson Road
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On behalf of : Fox (Owmby) Limited

Caenby Hall
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FOX (OWMBY) LIMITED

BALCOMBE RIG SITE
BALCOMBE
SOUTH CRAWLEY

GROUND INVESTIGATION

T10/053gi
OCTOBER 2010

CONTENTS

APPENDICES

1	**Site Location Plan** **Aerial Photograph**
2	**Site Photographs**
3	**Site Plan – CPT Location Plan** **Fugro Engineering Services Limited Static Cone Penetration Tests Report no. CPT101161**

1.0 INTRODUCTION

Acting upon instructions received from Fox (Owmby) Limited, the Client, on 30th September 2010, a Ground Investigation has been performed in connection with determining the ground bearing capacity in relation to the installation of an on-shore drilling rig at Balcombe Rig Site, Balcombe, South Crawley.

The site works were performed to provide bearing capacity of the natural and overlying fill stratum prior to the use of a 100 tonne Demag AC crane with five axles and ten 1600 x R25 tyres.

This report presents the factual data from the investigation.

The site is situated in an open area of land, which is believed to have recently been in use for the production of crushed aggregate. Access to the site is via a gated entrance off of the B2036 in Balcombe.

The proposed site is approximately rectangular in shape and generally level.

2.0 SITE LOCATION

The address of the site is:

Balcombe Rig Site
Balcombe
South Crawley

The National Grid Reference for the site is approximately **N 531022, E 129238**

A Site Location Plan is presented in Appendix 1.

3.0 SUMMARY OF WORKS

Static Cone Penetration Tests (CPT's) were performed in sixteen locations as part of an approximate grid pattern within the rectangular site area for the drilling rig. The area is believed to have been backfilled in a relatively uncontrolled manner after being used in the production of crushed aggregate similar to MOT grade material. Testing was performed, in order to delineate both horizontally and vertically, the shear parameters of the underlying soil strata. The CPT tests were carried out by Fugro Engineering Services Limited using a 20 tonne 6x6 wheel drive Cone Penetrometer Truck Unit.

Multiple tests were performed in locations that were believed to be a former mud pit and an interceptor location. Two tests were also completed in an area where the overlying crushed aggregate had been excavated and reinstated in layers of 250mm compacted with a smooth drum vibrating roller with no less than 8 passes per layer.

The location of each of the CPT's performed is shown on diagram 'Site Plan – CPT Location Plan', which is presented in Appendix 3.

Photographs taken during the site works are presented in Appendix 2.

4.0 GEOLOGY

Information obtained from the British Geological Survey on-line geology viewer shows the site may be underlain by Ardingly Sandstone, comprising sandstone. No superficial geology has been noted in the area.

5.0 SUB-SOIL CHARACTERISTICS

From contemporary anecdotal trial pit evidence the immediate underlying geology is indicated to be a firm light yellow brown sandy CLAY underlying between 100mm and 550mm unregulated crushed aggregate (MADE GROUND).

6.0 CONE PENETRATION TESTING

Static Cone Penetration Tests (CPT's) were carried out in sixteen locations within the rectangular site area for the proposed construction of an on-shore drilling rig. The site was overlain with varying depths of indiscriminately crushed aggregate.

The CPT tests were carried out by Fugro Engineering Services Limited using a 20 tonne 6x6 wheel drive Cone Penetrometer Truck Unit.

A copy of the report on the CPT's prepared by Fugro Engineering Services Limited, reference CPT101161 is presented in Appendix 3.

The results have been interpreted to include an estimated soil type derived by data obtained from the cone end resistance and friction ratio data. The results also include an estimation of undrained shear strength "S_u" calculated from the cone resistance data. This is presented as an upper and lower bound shear strength based on an Nk value of 15 and 20 respectively. The estimated undrained shear strength values for the cohesive soils, presented in Appendix C of the report, show the measured cone resistance (q_c), these value's give an envelope of equivalent 'Nk' values which have been used to determine the estimated shear strength values.

The following equation has been used in order to ascertain the estimated undrained shear strength shown on the graphs presented in Appendix C:

$$Su = q_c / N'_k$$

Where: Su = Undrained Shear Strength
q_c = Minimum cone end resistance
N'_k = Bearing capacity factor

The following table shows the depth of the lower bound 'Nk' value envelope becoming *'STIFF'* estimated in each of the CPT locations. These results disregard any small band falling back behind the *'STIFF'* constituency line.

CPT Location	Depth to 'STIFF' Consistency - m	CPT Location	Depth to 'STIFF' Consistency - m
CPT1	3.30	CPT8	0.40
CPT2	2.40	CPT9	0.50
CPT3	1.00	CPT11	0.30
CPT4	2.30	CPT12	0.40
CPT5	1.40	CPT15	3.50
CPT6	0.50	CPT16	2.20
CPT7	0.50		

CPT locations CPT10, CPT10a, CPT10b and CPT16 were completed in an area believed to be a former mud pit; they were advanced in order to find potential 'Soft' areas. The series of CPT locations designated by the number "10" failed to penetrate further than 1.00m below existing ground level (BEGL); this is generally believed to be due to the potential presence of coarse grained, cobble sized crushed aggregate, which resulted in test refusal.

The location of CPT15 was positioned in order to assess the ground conditions in the underlying stratum where it was thought a former interceptor had been removed, it was considered necessary as there were no details of the restoration process. The results from this CPT test show that instead of the relatively steady increase in ground bearing pressure generally found in other locations, CPT15 increased in strength significantly from 5.00m BEGL, this strengthens the anecdotal evidence of the former interceptor and potentially indiscriminately compacted fill.

CPT16 was completed closer to the edge of the site after external anecdotal evidence suggested that the potential mud pit may have been located closer to the site boundary. The results of CPT16, however, did not show any inconsistencies when compared to the other test locations in the adjacent areas.

Two CPT tests were completed in a test pit comprising on-site crushed aggregate material, the pit was backfilled in layers not exceeding 250mm compacted using a smooth drum vibrating roller by no less than 8 passes per layer.

The two test locations showed the material as 'Loose' becoming 'Dense' and 'Medium Dense' becoming 'Very Dense' with a density peak in both locations at approximately 0.50m.

7.0 ENGINEERING EVALUATION

7.1 Introduction

The sub-soil characteristics are outlined in detail in section 6 above, and are generally thought to represent the material expected to be found across the proposed development area.

7.2 Design Considerations for Crane Pad Area

It is understood from data provided by the crane operator that in use under load, the crane applies a maximum load of 4,720 Lbs/ft^2 through a bearing pad measuring 1.2m x 2.4m, this equates to 225 kN/m^2.

The estimated equivalent shear strength in the underlying material varied across the site, the '*Soft' to 'Firm'* material was generally located near the southwest boundary. The underlying stratum in the northern half of the site is generally of a '*Stiff' to 'Very Stiff'* consistency.

The potential former interceptor which was denoted by the location of CPT15 indicated '*Very Soft'* to *'Firm'* CLAY from ground level to approximately 5.0m BEGL where it significantly increases in strength, this is indicative of uncontrolled fill being placed within the top 5m.

8.0 CERTIFICATION

This report is produced for the sole use of the Client, and no responsibility of any kind, whether for negligence or otherwise, can be accepted for any Third Party who may rely upon it.

The conclusions and recommendations given in this report are based on our understanding of the future plans for the site. If, however, the site is developed for a varying use, then a different interpretation might be appropriate.

The report has been prepared following the guidelines and principles established in the British Standards. It necessarily relies on the co-operation of other organisations and the free availability of information and total access.

No responsibility can, therefore, be accepted for conditions arising from information that was not available to the investigating team as a result of information being withheld or access being denied.

The scope of this Ground Investigation was discussed and agreed with the Client. No responsibility is accepted for conditions not encountered, which are outside of the agreed scope of work.

This report may suggest an opinion on a possible configuration of strata or conditions between exploratory points and below the maximum depth of investigation. However, this is for guidance only and no liability can be accepted for its accuracy.

It should be noted that this report is based solely on the CPT's performed. During the works and following general site clearance, should the sub-soil conditions in other areas of the site appear to be inconsistent with those found in the areas tested then this geotechnical appraisal may need to be reviewed.

Prepared By:	Reviewed Authorised By
Christopher J Larkin BSc FGS IAEG **Geo-environmental Engineer**	**John R Holt IEng MICE FGS** **Managing Director**

Fox (Owmby) Limited	1
Electronic Copy	1
TSL Archive	1

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TRENDREVEL SERVICES LIMITED

GENERAL NOTES

1. Any assessments made in this report are based on the ground conditions as revealed by field observation, together with the results of any field or laboratory testing undertaken and where appropriate, other relevant data that may have been obtained about the site, including previous site investigation reports. There may be special conditions appertaining to the site, however which have not been revealed by the investigation and which, therefore, have not been taken into account in this report. Any assessments made in this report may be subject to amendment considering additional information becoming available.

2. Where data supplied by the Client, including that from previous site investigations, have been used, it has been assumed that the information is correct. No responsibility can be accepted by Trendrevel Services Limited for inaccuracies within the data supplied.

3. While the report may express an opinion on: possible strata configurations between or beyond fieldwork locations; or the possible presence of features based on either, visual, verbal or published evidence, this is for guidance only and no liability can be accepted for the accuracy of such an opinion.

4. Comments on the groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. It should be noted, however, that groundwater levels might vary due to seasonal or other effects.

5. The copyright of this report, plans and documents prepared by Trendrevel Services Limited is owned by them and no part of any such report, plan or document may be reproduced, published or adapted without their written consent. Complete copies of this report may, however be made and distributed by the Client as an expedient in dealing with matters relating to its commission.

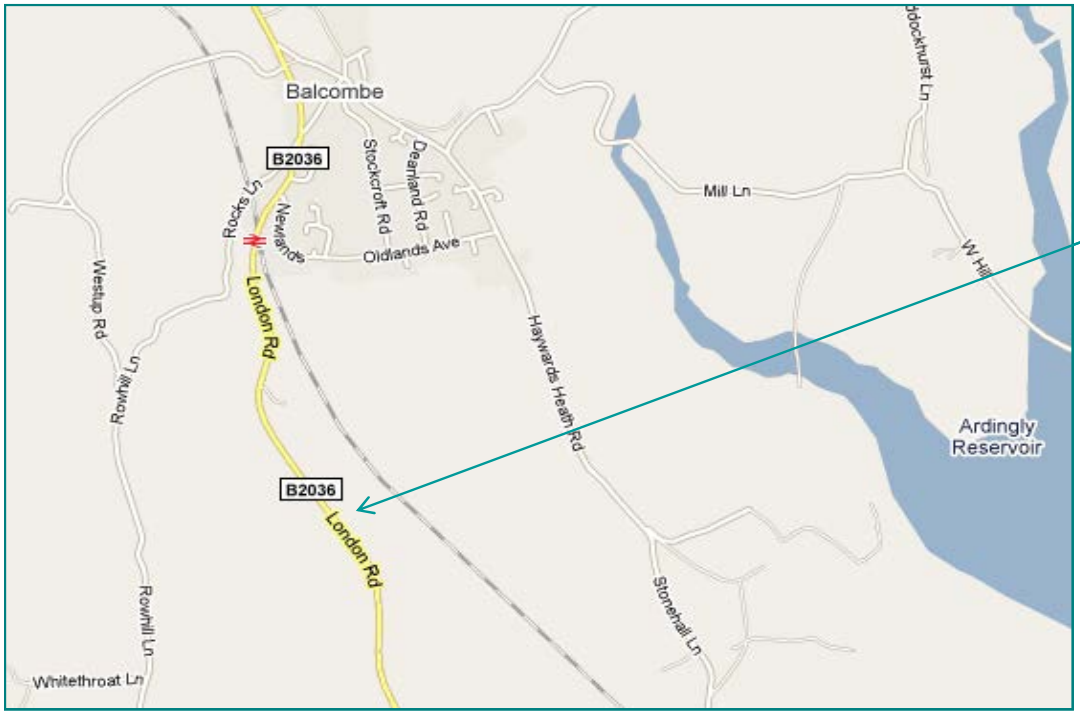
6. This report is prepared and written in the context of the proposals stated in the introduction to this report and it should not be used in a differing context. Furthermore, new information, improved practices and changes in legislation may require an alteration to the report in whole or in part after its submission. Therefore, with any changes in circumstances, or after one year from the date of the report, the report should be referred to Trendrevel Services Limited for re-assessment (and, if necessary, for an estimate for the cost of such).

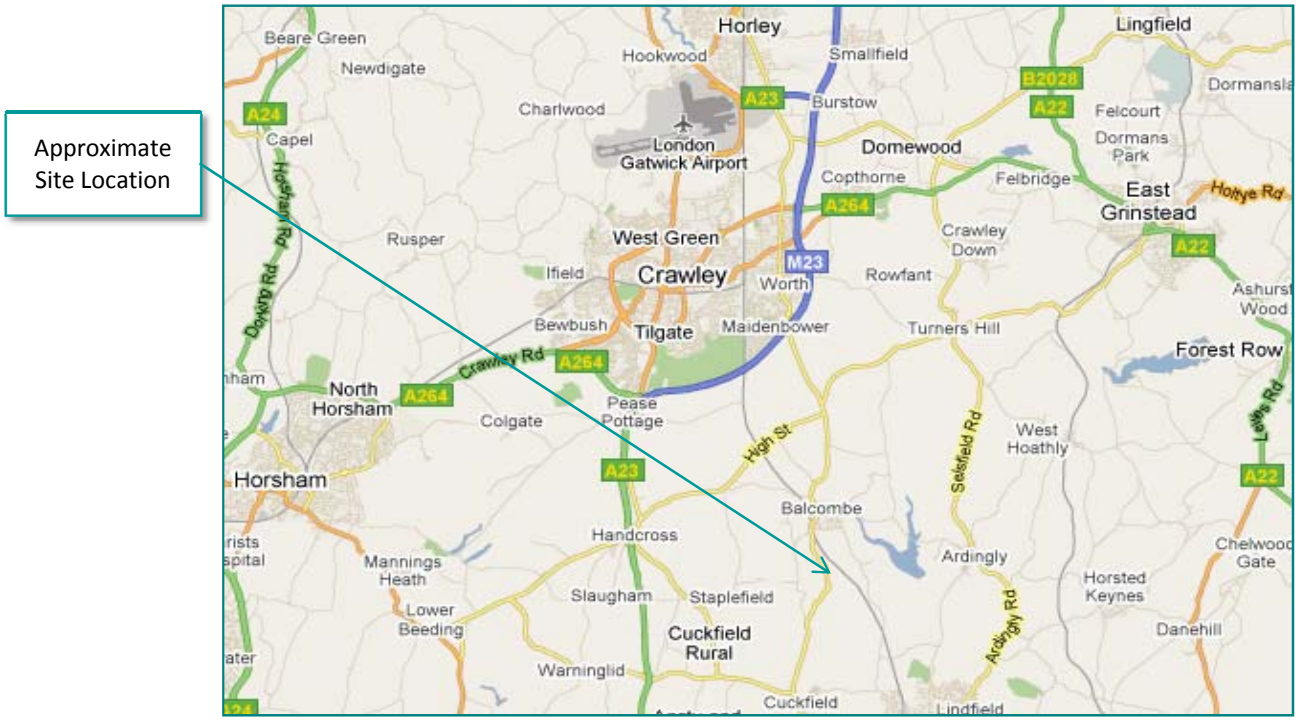
7. The report is provided for the sole use by the Client and is confidential to him/her and his/her professional advisors. No responsibility whatsoever for the contents of this report will be accepted to any other person other than the Client.

APPENDIX 1

Site Location Plan
Aerial Photograph

SITE LOCATION PLAN





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Client:	Fox (Owmby) Limited
Project No:	T10/053
Project:	Balcombe Rig Site Balcombe, South Crawley
Date:	October 2010

Aerial Photograph

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Project No:	T10/053
Project Title:	Balcombe Rig Site, Balcombe South Crawley

APPENDIX 2

Site Photographs

Photograph Location 1 — Fugro Engineering Services
4th October 2010

Photograph Location 2 — Site Entrance
4th October 2010

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Project Title:	Balcombe Rig Site Balcombe South Crawley
Date:	October2010

Photograph Location 3 — View south across site
4th October 2010

Photograph Location 4 — View west across site
4th October 2010

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Date:	October2010

Photograph Location 5 — Centre pin in foreground, view west
4th October 2010

Photograph Location 6 — CPT test location 9
4th October 2010

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Date:	October2010

Photograph Location 7 — Trial fill trench
4th October 2010

Photograph Location 8 — Crushed fill
4th October 2010

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Project No:	T10/053
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Photograph Location 9 — Trial trench along south-eastern boundary
4th October 2010

Photograph Location 10 — Underlying CLAY stratum
4th October 2010

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Date:	October2010

Photograph Location 11 — Trial trench along south-eastern boundary
4th October 2010

Photograph Location 12 — View of former mud-bed area and site entrance
4th October 2010

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Project Title:	Balcombe Rig Site Balcombe South Crawley
Date:	October2010

Photograph Location 13 — Trial fill trench
4th October 2010

Photograph Location 14 — Trial fill trench
4th October 2010

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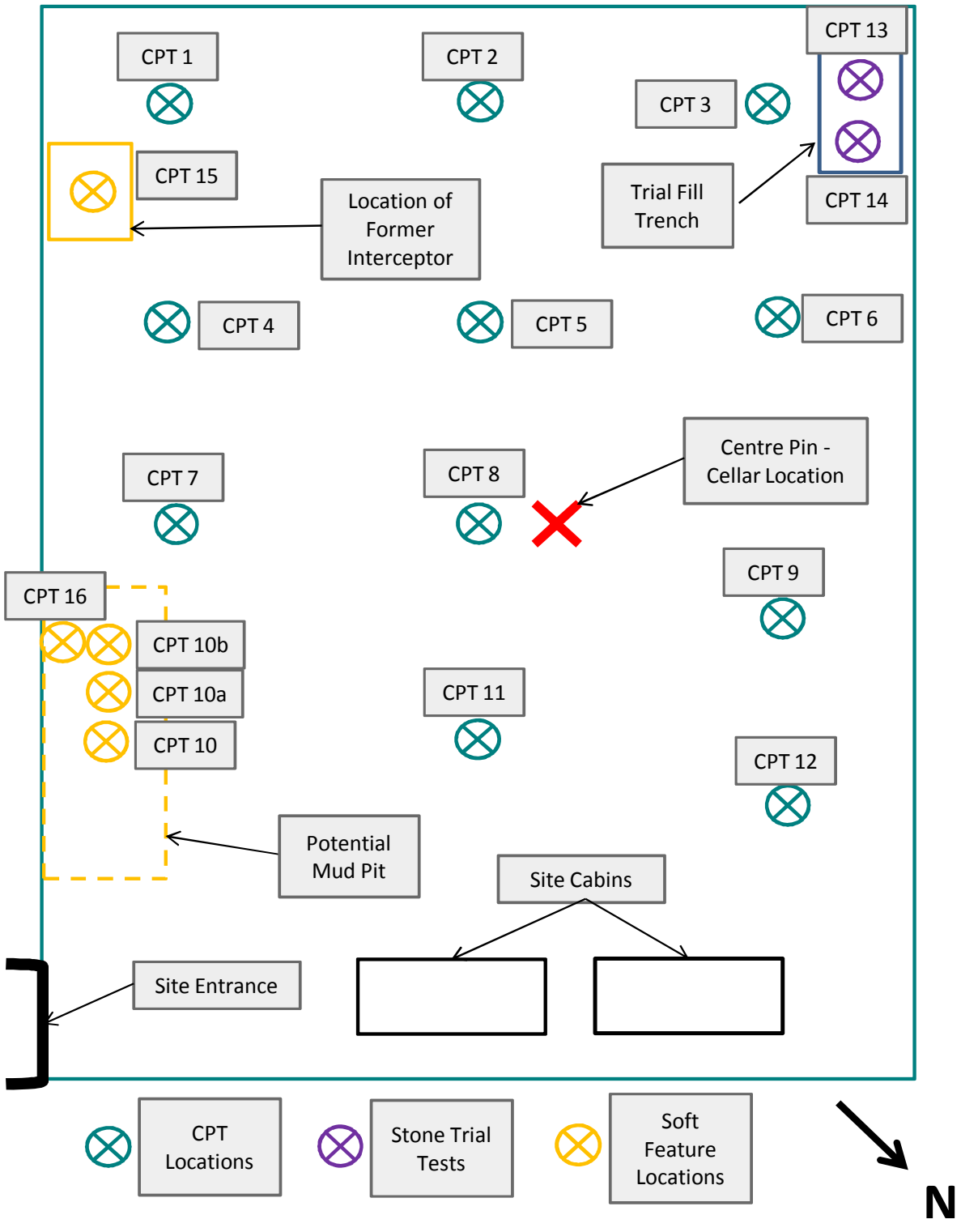
Project No:	T10/053
Project Title:	Balcombe Rig Site Balcombe South Crawley
Date:	October2010

APPENDIX 3

Site Plan – CPT Location Plan
Fugro Engineering Services Limited Static Cone Penetration Tests Report no. CPT101161

Site Plan - CPT Location Plan



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	South Crawley

Checked: CJL
Approved: JRH
Date: Oct 2010

TRENDREVEL SERVICES LTD

BALCOMBE RIG SITE, SOUTH CRAWLEY

STATIC CONE PENETRATION TESTS
SOILS INVESTIGATION

CONTRACT NO : CPT101161

CONFIDENTIAL

TRENDREVEL SERVICES LTD

BALCOMBE RIG SITE, SOUTH CRAWLEY

STATIC CONE PENETRATION TESTS
SOILS INVESTIGATION

CONTRACT NO : CPT101161

CLIENT : TRENDREVEL SERVICES LTD

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REPORT ISSUE STATUS

2.0	19/10/2010	Final Factual Report	PJS		AKW	
1.0	11/10/2010	Draft Factual Report	PJS			
Issue	**Date**	**Description**	**Prepared**	**Checked**	**Approved (Printed)**	**Approved (Signature)**

Fugro Engineering Services Limited
Fugro House, Hithercroft Road
Hithercroft Industrial Estate
Wallingford
Oxon, OX10 9RB

1. INTRODUCTION

At the request of Trendrevel Services Ltd (the Client), a soils investigation was carried out at a site in South Crawley, approximate national grid reference TQ 307 295. The investigation consisted of carrying out electric Static Cone Penetration Tests (CPTs) in order to provide information on the soil conditions. A factual report was requested together with an interpretation of the estimated soil type.

This work was carried out in accordance with the client's order no T2031 dated 1st October 2010.

2. FIELDWORK

2.1 GENERAL

The fieldwork was carried out on 4th October 2010. A total of 19 CPTs were made using hydraulic penetrometer equipment at 16 locations set out by the Client's representative on site.

2.2 METHOD OF TESTING

The static cone penetration tests were made using twenty tonne capacity hydraulic penetrometer equipment mounted in a heavy truck ballasted to provide a reaction weight of about eighteen tonnes. A 15cm square 7.5 tonne capacity electric cone was used for each of the tests. During each test, measurements of local side friction were made, in addition to cone end resistance. All tests were terminated at a depth instructed on site or when the maximum available safe thrust capacity of the equipment was reached.

The results of all tests carried out are presented in Appendix B and show the records of cone end resistance, local side friction and friction ratio. A list of tests performed is presented on the contents sheet of Appendix B. Test numbers followed by a letter indicate completely new tests at the same location.

The cone penetrometer load cells are regularly calibrated against load transducers which are themselves calibrated by an independent authority. The cone calibration certificates for the cones used at this site are presented in Appendix A.

The CPTs presented in this report were performed using a mobile unit which has been accredited as a site laboratory by the United Kingdom Accreditation Service as testing laboratory No. 0925. The relevant UKAS schedule is presented in Appendix A.

2.3 OPERATION

The cone end resistance and local side friction are registered by a load cell in the cone and transmitted by an umbilical cable through hollow push rods to a laptop computer.

During the test, the computer displays immediate and continuous records on its screen of cone end resistance, local side friction and friction ratio, and these are plotted out after the test. The data is recorded on magnetic media at 2 cm depth intervals and this facility provides for automatic computer-controlled processing and plotting of cone end resistance, local side friction and friction ratio. The rate of penetration is kept constant at approximately 2 cm per second.

3. INTERPRETATION OF ESTIMATED SOIL TYPE

On each of the attached cone test graphs presented in Appendix B, the estimated soil type has been plotted alongside. The descriptions are based on the data obtained from the cone end resistance and friction ratio data, together with experience gained in similar soils elsewhere. It should be noted that the descriptions can be enhanced if there is borehole information from the site. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Extensive research has indicated that the ratio of local side friction to cone end resistance ("Friction Ratio") assists in identifying the soil type. The ratio can vary greatly depending on whether the soil is cohesive or granular.

The results of a combined study of tests (Sanglerat, 1972[i] Schmertmann, 1969[ii]) have been produced in graphical form by the latter author and a modified form of this graph as it applies to British soils is shown on the attached data sheet entitled "Interpretation of Static Cone Penetration Tests" (Erwig, 1988[iii]). This chart relates the soil type as a function of the cone end resistance and friction ratio. In addition, general notes on the interpretation of Static Cone Penetration Tests are also given. Additional information to assist in the interpretation of static electric cone penetration test results is documented by Meigh (1987[iv]) and Lunne et al. (1997[v]).

3.1 INTERPRETATION OF UNDRAINED SHEAR STRENGTH FROM CPTs

In fine-grained cohesive soils (clays) the cone resistance is often related to the undrained shear strength by a relationship of the form:

$$s_u = q_c/N_k$$

where :

s_u is the inferred undrained shear strength (kPa)

q_c is the measured cone resistance (kPa)

N_k is an empirical factor relating cone resistance to undrained shear strength

Experience has shown that an N_k factor in the range 15 to 20 may normally be used to give an initial estimate of shear strength. These factors have therefore been used to infer the estimates of undrained shear strength that are in Appendix C.

4. SERVICE CONSTRAINTS

The "Service Constraints" in Appendix A outline the limitations of this report, in terms of a range of considerations including, but not limited to, its purpose, its scope, the data on which it is based, its use by third Parties, possible future changes in design procedures and possible changes in the conditions at the site with time. The Appendix represents a clear exposition of the constraints which apply to all reports issued by Fugro Engineering Services Limited. It should be noted that the Service Constraints do not in any way supersede the terms and conditions of the contract between Fugro Engineering Services Limited and the Client.

REFERENCES

[i] Sanglerat, G. (1972). "The penetrometer and soil exploration." Elsevier Publishing Company. Amsterdam, 2nd Edition, 1979.

[ii] Schmertmann, J.H. (1969) "Dutch friction-cone penetration exploration of research area at Field 5, Eglin Air Force Base, Florida." US Army Waterways Experimental Station, Vicksburg, Contract Report S-69-4, 1969.

[iii] Erwig, H. (1988). Contribution to discussion on Soil Type Interpretation. Proc. Conf. on Penetration Testing in the U.K., I.C.E. Birmingham University, 1988, p.p 261-263.

[iv] Meigh, A.C. (1987). "Cone Penetration testing. Methods and Interpretation." CIRIA Ground Engineering Report. In situ testing.

[v] Lunne, T., Robertson, P. K. and Powell, J. J. M. (1997) "Cone Penetration testing in Geotechnical Practice" Blackie.

APPENDIX A General Site and Calibration Data

General Site Location Plan

Test Report Data

Data Sheet - "Interpretation of Static Cone Penetration Tests"

Data Sheet – "Heavy Truck Mounted Penetrometer"

UKAS Testing Schedule

Cone Calibration Certificate

Performance Summary Sheet

AGS Format “ASCII” Disk (included in master copy of report only)

Service Constraints

Approximate Site Location

GENERAL SITE LOCATION PLAN

CONE PENETRATION TESTING
TEST REPORT DATA

This sheet contains data which does not appear on the test certificate but is required to satisfy the test reporting requirements laid down in BS1377:Part 9:1990 for Cone Penetration Tests.

The tests have been performed by Fugro Engineering Services Limited, Fugro House, Hithercroft Road, Wallingford, Oxfordshire, OX10 9RB
(UKAS accreditation held for cone, cone and friction and piezocone tests -Laboratory 0925)

Project/Certificate No.: CPT101161 **Issue Date: 19th October 2010**

Client: Trendrevel Services Ltd
Client Address: The Old Court House
20 Simpson Road
Fenny Stratford
Milton Keynes
MK2 2DD

CPT unit No.: GB7 **Operator: NF/SA**
Total number of CPT results appended to this sheet - single certificate: 19
double certificates: 0
Test identification numbers: See Appendix B

Type of cone(s) used: ~~Cone only~~/Cone and friction/~~Piezocone/Other(please specify)~~

Cone capacity: 75kN **Measuring system used:** Electrical
Physical condition of cone: Within specification

Position of HDPE filter for piezocone: ~~face/shoulder~~/not applicable
Range over which friction reducer/reduced diameter rods used: Not used
Notes on any unusual events / sounds / vibrations: None

Depth of ground water in hole or depth of hole collapse after test: Not available
Details of any backfilling carried out: None

Other factors which may have affected the test results: None

(Copies of the calibration certificates for the cones used in the tests covered by this data sheet are attached. All Fugro cones provide an overall accuracy after estimation of uncertainty that exceeds the accuracy levels required by BS1377:Part 9:1990)

Fugro Engineering Services Limited

INTERPRETATION OF STATIC CONE PENETRATION TESTS

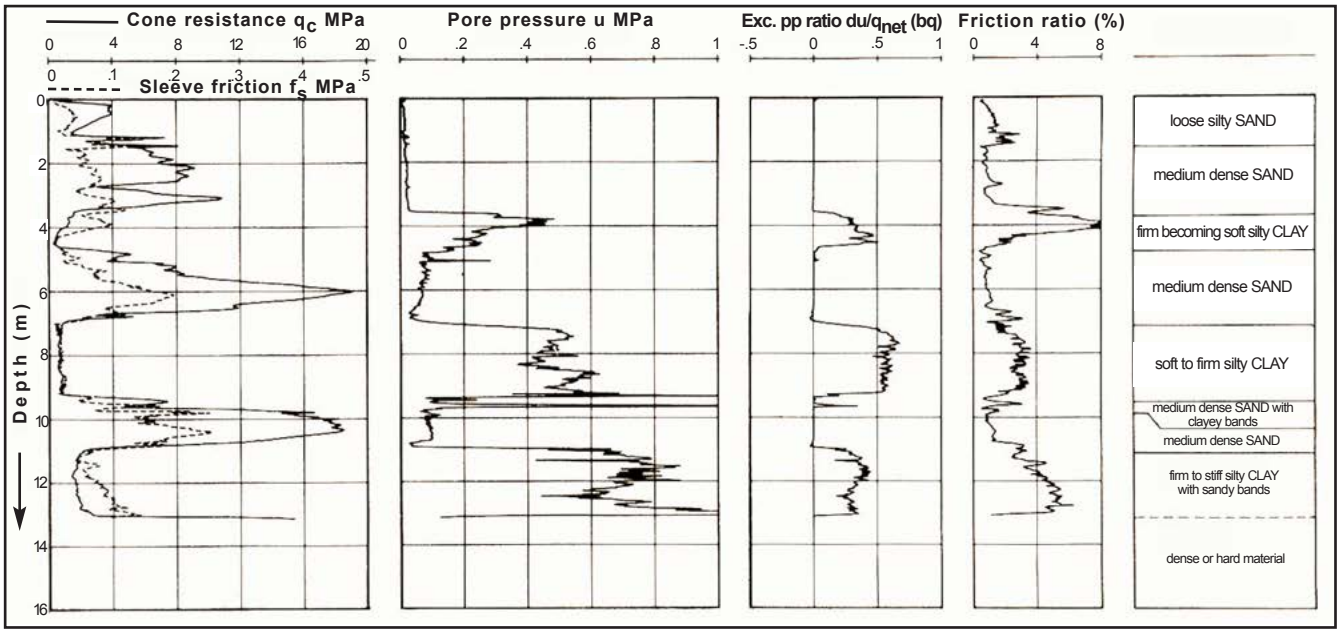

Figure 1 - Typical Cone Test Graph with Estimated Soil Type

INTERPRETATION OF STATIC CONE PENETRATION TESTS BY USE OF THE FRICTION RATIO

Extensive research has indicated that the ratio of local side friction to cone end resistance ("friction ratio") assists in identifying the soil type. The results of various research studies (Meigh 1987) have been produced in graphical form and a modified version for British soils is presented in Figure 2, where the soil type is given as a function of cone end resistance and friction ratio.

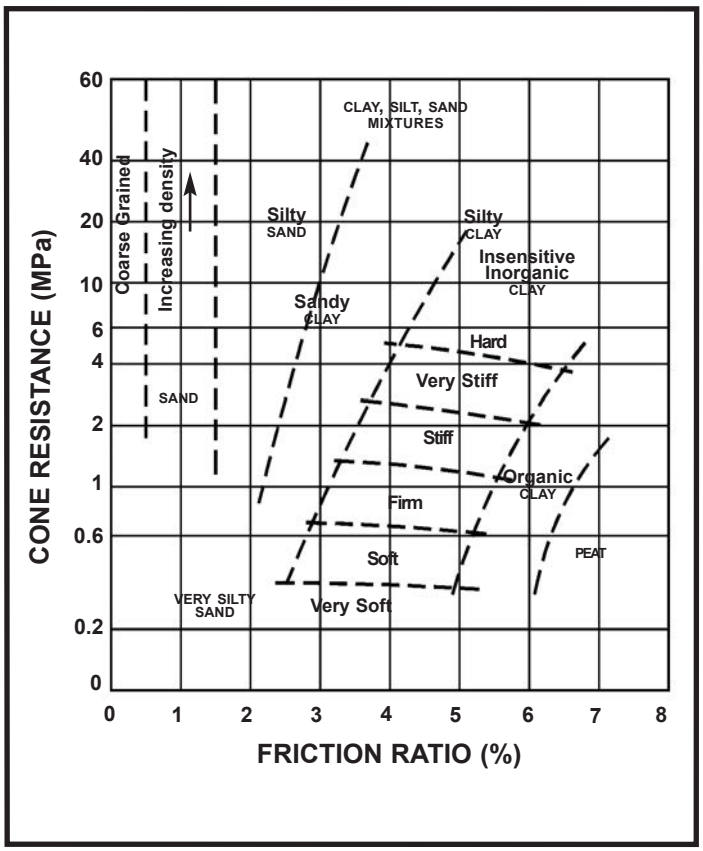

Figure 2 - Guide for Estimating Soil Type

THE USE OF PORE PRESSURE READINGS

The additional measurement of pore pressure with the piezocone assists in identifying the soil types.

Variations in pore pressure reflect changes in stratification that cannot always be determined with q_c or f_s. For instance, in Figure 1, changes in pore pressure response in the clay layers indicate the permeable seams or lenses that can greatly influence the drainage characteristics of the stratum.

Furthermore, the excess pore pressure ratio could give an indication of the stress history of the soil.

The Fugro Group is an international organisation with around seven thousand staff in over fifty countries.
Our major disciplines are Geotechnics, Environmental Services and Survey.

GRANULAR SOILS

Correlation of q_c and D_r and Ø

Table 1, below provides a guide for the relation between cone end resistance and the angle of internal friction in fine sand.

It should be noted that the guide table applies to unaged, uncemented sands up to about 10 to 15 metres depth.

A more recent correlation between q_c and D_r is presented in Figure 3, which takes account account of the effect of the effective stress (Lunne and Christophersen, 1983).

COHESIVE SOILS

Bearing capacity theory indicates that, in simple terms for Ø =0, the cone resistance q_c should be related to over-burden pressure P_o and the undrained shear strength S_u in the following way (Sanglerat et al 1972):

$$q_c = S_u N_k + P_o \qquad (1)$$

where N_k is a bearing capacity factor or "cone factor". However, in some circumstances, Fugro use a modified expression in which the effect of over-burden pressure is included in the cone factor.

$$q_c = S_u N'_k + P_o \qquad (2)$$

To use either equation, the cone factor must be determined empirically, or be known from correlations based on previous investigations in the same clay. The value of the cone factor depends on the stress-strain properties of the clay and is frequently found to lie in the range 15 to 20, although it should be noted that values outside this range have been observed.

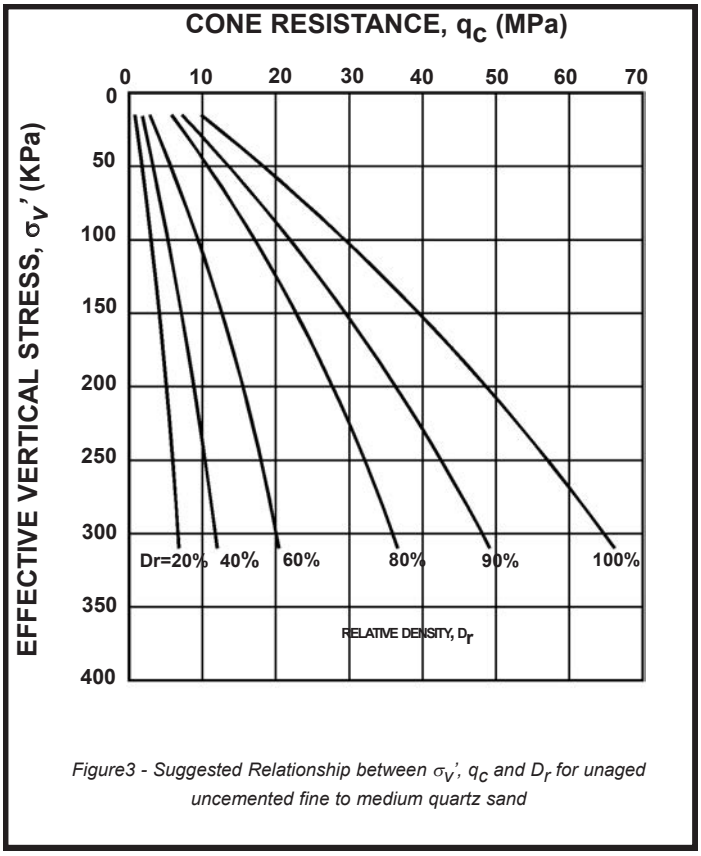

Figure3 - Suggested Relationship between σ_v', q_c and D_r for unaged uncemented fine to medium quartz sand

CORRELATION OF q_c WITH SPT-'N' VALUE

Many comparative studies have been carried out by various researchers and it is known that the particle size distribution has an important influence on the correlation.

It is generally accepted that the conversion factors given below may be used. (ESOPT1, 1982 and Meigh, 1987). In the following q_c is in MPa.

Soil Description	q_c / N
Silts, sandy silts and slightly cohesive silt-sand mixtures	0.2 -0.3
Fine to medium sands and slightly silty sands sand mixtures	0.4 - 0.5
Coarse sands and sands with some gravel	0.6 - 1.0
Sandy gravels and gravel	1.1 - 1.8

The SPT N-value can be influenced by many factors such as the quality of the equipment, the performance of the test, the depth of test and the groundwater (CIRIA News, No4, 1986; BRE Report 1979). "For foundation design purposes, direct use of the more repeatable CPT results is preferred to conversion to SPT.

Table 1 - Correlation of Cone resistance and angle of internal friction

Cone Resistance (q_c) (MPa)	Compaction of Fine Sand	SPT (N)	Relative Density Dr(%)	Angle of Internal Friction (degrees)
<2	very loose	<4	<20	<30
2-4	loose	4-10	20-40	30-35
4-12	medium dense	10-30	40-60	35-40
12-20	dense	30-50	60-80	40-45
>20	very dense	>50	80-100	>45

Ref: Interpretation of Static Cone Penetration Tests

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Fugro Engineering Services Limited
Heavy Truck Mounted Penetrometer

The Fugro Static Cone Penetration Test System provides a quick, efficient and reliable method of soil exploration. The penetrometers are mounted on rugged, six wheel drive, all terrain trucks which provide a reaction force of 20 tonnes from their own weight. In suitable conditions the reaction force available can be increased to 23 tonnes by using supplementary ballast.

Technical data

Dimensions of Equipment

Length	7.9m
Width	2.5m
Height	3.6m when travelling
	4.9m when operating

Thrust Capacity
20 tonnes (own weight)

Rate of Penetration

Average	2cm per second
Range	1.8-2.2cm per second

Maximum Penetration
Depends on soil conditions, but 40m of rods normally available.

Performance Rates
Typically 140 to 160m during one working day, depending on access.

Penetrometer description

The cone (See Figure 1) is pushed into the ground by the hydraulic jacking system onboard the truck at a rate of 2 cm/sec. Strain gauges within the cone provide a means of measuring cone tip resistance and sleeve friction.

Electrical signals are transmitted via an umbilical cable passing through the hollow push rods to a computer controlled logging system inside the truck. Measurements are recorded every 2cm of penetration. The combination of cone resistance and friction ratio (i.e. friction/cone resistance) provides data from which the soil type can be characterised.

The cone resistance may be used to estimate undrained shear strength in clay and friction angle in sand. Testing can also be performed with a piezocone which, in addition to measuring tip resistance and sleeve friction, measures porewater pressure during penetration. Pore-water pressure measurements significantly improve the reliability of interpretation, and provide additional data regarding the in-situ nature of the soil.

The maximum depth of penetration achievable depends on the soil conditions encountered, but generally cone tests have to be terminated in soils which have in-situ conditions equivalent to those corresponding to an SPT value of between 40 and 70.

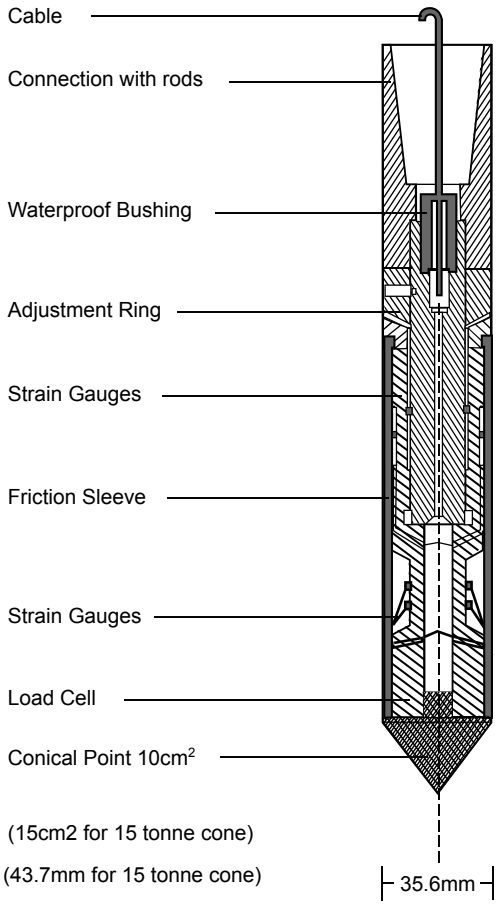
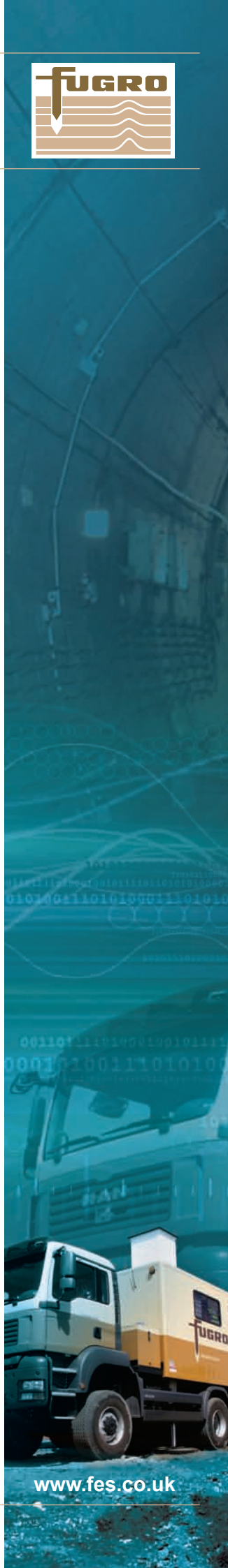


Fig 1. Cross Section of Friction Cone.



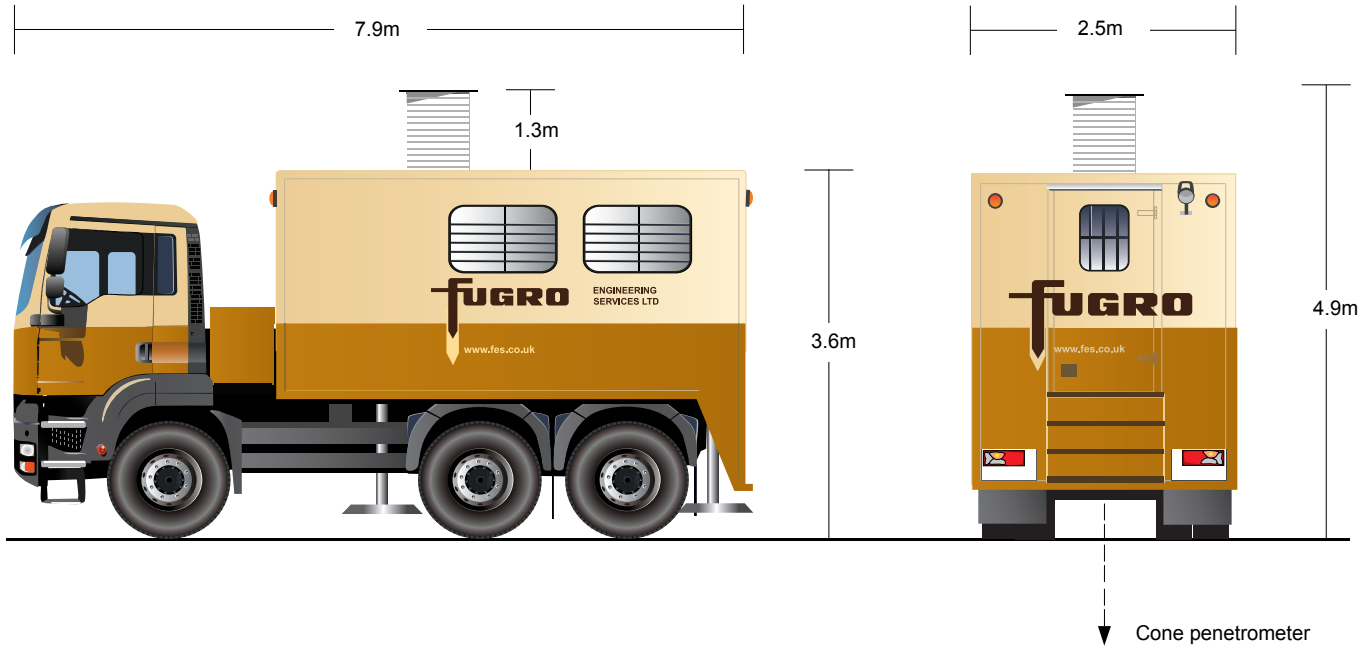
Fugro Engineering Services Limited

Options

In addition to friction cone and piezocone penetration testing, the penetrometer equipment may also be used to carry out other in situ tests and take undisturbed samples, i.e.:

– Seismic cone testing
– Penetration vane tests
– Discrete/contiguous undisturbed samples in support stocking and plastic liners (Mostap system)
– Cone pressuremeter tests to measure undrained shear strength, shear modulus and in situ horizontal stress.

DIMENSIONS OF GB17 HEAVY TRUCK MOUNTED PENETROMETER



The Fugro Group is an international organisation with around thirteen thousand staff in over fifty countries. Our major disciplines are Geotechnics, Environmental Services and Survey.

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CPT - Heavy Truck Mounted Penetrometer.
Details of services and specifications may change without notice.

1483 0925

Schedule of Accreditation

issued by

United Kingdom Accreditation Service

21 - 47 High Street, Feltham, Middlesex, TW13 4UN, UK

0925

Accredited to ISO/IEC 17025:2005

Fugro Engineering Services Limited

Issue No: 007 **Issue date:** 5 Jun 2009

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Testing performed by the Organisation at the locations specified below

Locations covered by the organisation and their relevant activities

Site activities performed away from the locations listed above:

Location details	Activity	Location code
Ground Investigation Sites	Cone penetration testing including UXO detection	B

0925

Accredited to
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Schedule of Accreditation

issued by

United Kingdom Accreditation Service

21 - 47 High Street, Feltham, Middlesex, TW13 4UN, UK

Fugro Engineering Services Limited

Issue No: 007 **Issue date:** 05 June 2009

Testing performed by the Organisation at the locations specified

DETAIL OF ACCREDITATION

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
SOILS for civil engineering purposes	Penetration resistance using the fixed 60° cone and friction sleeve (static cone penetration test CPT)	BS 1377:Part 9:1990 and Eurocode 7 Geotechnical Design Clause 4.3 Continuous measurement using a penetrometer tip with electrical sensors for cone and sleeve resistance and inclination	B
	Penetration resistance using the fixed 60° cone and friction sleeve (static cone penetration test CPT)	BS 1377:Part 9:1990 and Eurocode 7 Geotechnical Design Clause 4.3 Continuous measurement using a penetrometer tip with electrical sensors for cone and sleeve resistance, inclination and piezometric pressure	B
	UXO detection for clearance of site investigations and piling using a tri-axial magnetometer	Cone Penetration Testing Procedures Manual. Continuous measurement using a magnetometer housed in a penetrometer with electrical sensors for cone and sleeve resistance, inclination and piezometric pressure.	B
END			

CALIBRATION CERTIFICATE

APPLICANT	FESLtd UK	Certificate number	FC100915	Page 1 of 1
SUBMITTED	**A Cone Penetrometer**	Manufacturer	Fugro Engineers B.V.	
Device type	CONE, A15F7,5CKE2HA/B		Serial number	1701-1875

The device contains an electronic data sheet which contains, amongst others, the characteristics of all the sensors inside the device. The data acquisition system calculates the measured value from these known characteristics. All calibration results are conform the values specified below.

Force calibration

Calibration reference : 548 FRE.002
Procedure : FEBV.CAL.PRO.003 KALIBRATIE KRACHT
Title of channel(s) : Cone and Cone+Fric.
Max. load 150 kN

Range	Calibration range From	to	Sensitivity Deviation	Zero load output
1	0	75 kN	< 0.5 %	< 1.5 kN
Calibration uncertainty			0.3 %	0.008 kN

Pressure test :

Deviation from specified Alpha factor at 2.5 MPa	< 5 %

Cone quality control values :

Max. deviation from reference	< 1 %
Max. Tip to Sleeve friction Crosstalk	< 1 %

Calibration of the DUAL axis slope sensors

Calibration reference :
Procedure:FEBV.CAL.PRO.006 KALIBRATIE HELLING
Title of channel : Slope x, Slope y

Range	Calibration range From		Sensitivity Deviation	Zero load output
1	-10 deg	10 deg	< 3 %	< 0.5 deg
Calibration uncertainty			1 %	0.5 deg

Typical values for this type of device

Cone diameter (mm)	43.7			Alpha factor	0.58
Cone area (square cm)	15	Sleeve length (mm)	144.7	Cone - Sleeve distance (mm)	14.4
Sleeve diameter (mm)	43.9	Sleeve area (square cm)	200		

TRACEABILITY The measurements have been executed using standards for which the traceability to primary and/or (inter)national standards has been demonstrated .

Calibrated by: Boer, Kimmo de

Calibration date: 27/07/2010

Calibrate before: 27/01/2011

Approved by : Sinjorgo, Gerry

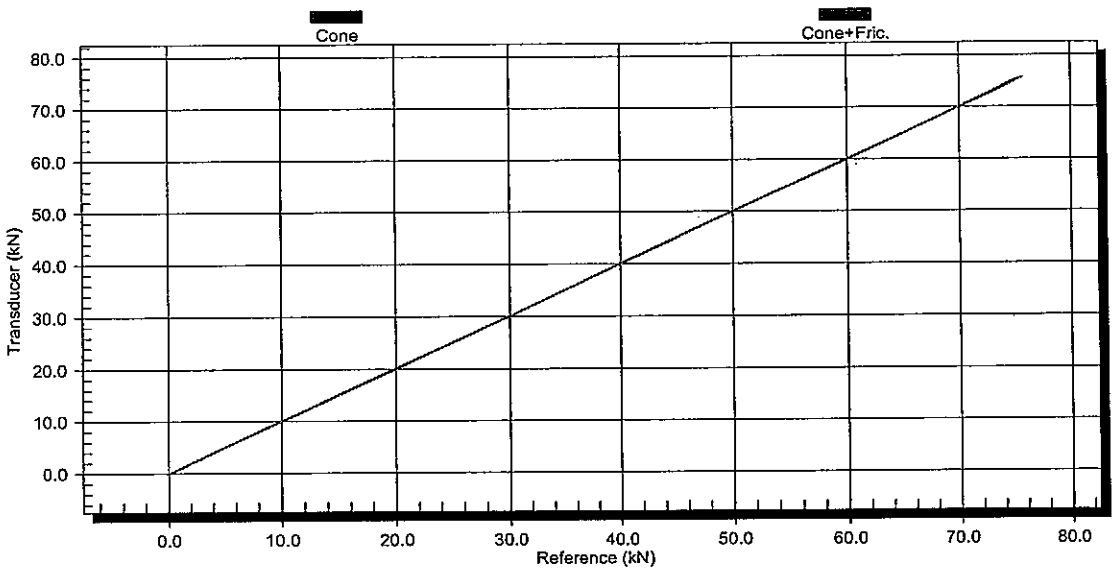
Approval date: 27/07/2010

FUGRO ENGINEERS B.V. * Veurse Achterweg 10 - 2264 SG Leidschendam *

Template : 75CKE2HA 002A Updated : 4/05/2010 2:45:00 PM

FORCE CALIBRATION FORM

F7.5CKE2HA/B 1701-1875
X-Y PLOT



Certificate Nr :	FC100915
Device :	F7.5CKE2HA/B 1701-1875
Date :	27 July 2010
Time :	15:28:09
******* Channels *******	######## RESULTS #########
Channel name ----------	**Cone**
Sensitivity Error	0.06 %
Zero Load Error	-0.014 kN
Transducer - Ref	0.35 %
Noise p-p	0.003 kN
Channel2 Name	**Cone+Fric.**
Sensitivity Error	0.07 %
Zero Load Error	-0.018 kN
Transducer - Ref	0.36 %
Noise p-p	0.000 kN
Tip-Sleeve Interaction	4.3 kPa
Tip-Sleeve Interaction %	0.85 %
Versions Script / Dll:	**5.36 22-03-10 / 3.69 11-11-2008**
Node type	**7001**
Electronics Serial number	**1432**
Working hours	**40**

FUGRO ENGINEERS B.V. * Veurse Achterweg 10 - 2264 SG Leidschendam *

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

FRICTION SET UPS	19	PIEZO SET UPS	0	Dissip. Hours	0.0
Friction metres	136.44	Piezo metres	0.00	Metres Standpipe	0.0
				Metres Casing	0.0

TEST INFORMATION					CONE DATA								SAMPLING					
TESTNAME	DEPTH (m)	CONE #	DATE	DAYSHEET CHECK	STAND PIPE (m)	CASING (m)	DISSIPATION (MINS)	10 cm² AREA	15 cm² AREA	PEIZO CONE	SEISMIC	CPM	MOSTAP 0-10	MOSTAP 10-20	MOSTAP 20-30	VEHICLE #	OPERATOR	REMARKS
CPT1	9.97	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT2	10.00	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT3	10.00	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT4	10.68	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT5	9.98	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT6	9.99	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT7	10.01	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT8	0.34	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT8A	9.99	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT9	10.00	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT10	1.09	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT10A	0.76	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT10B	0.61	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT11	9.96	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT12	9.99	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT13	1.87	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT14	1.20	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT15	9.98	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	
CPT16	10.02	F7.5CKE2HA/B 1701-1875	04-Oct-2010	Y					X							GB7	NF/SA	

SERVICE CONSTRAINTS

1. This report and the assessment carried out in connection with the report (together the "Services") were compiled and carried out by Fugro Engineering Services Limited ("FES") for Trendrevel Services Ltd (the "Client") in accordance with the terms of a contract between FES and the Client dated 1st October 2010. The Services were performed by FES with the skill and care ordinarily exercised by a reasonable geotechnical specialist at the time the Services were performed. Further, and in particular, the Services were performed by FES taking into account the limits of the scope of works required by the Client, the time scale involved and the resources, including financial and manpower resources, agreed between FES and the Client.

2. Other than that expressly contained in paragraph 1 above, FES provides no other representation or warranty whether express or implied, in relation to the Services.

3. The Services were performed by FES exclusively for the purposes of the Client. FES is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, FES does not authorise, consent or condone any party other than the Client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and FES disclaims any liability to such party. Any such party would be well advised to seek independent advice from a competent geotechnical specialist and / or lawyer.

4. It is FES's understanding that this report is to be used for the purpose described in Section 1 - "Introduction" of this report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, and/or should the Client's proposed development or use of the site change (including in particular any change in any design and/or specification relating to the proposed use or development of the site), this report may no longer be valid or appropriate and any further use of or reliance upon the report in those circumstances by the Client without FES's review and advice shall be at the Client's sole and own risk. Should FES be requested, and FES agree, to review the report after the date hereof, FES shall be entitled to additional payment at the then existing rates or such other terms as may be agreed between FES and the Client.

5. The passage of time may result in changes (whether man-made or otherwise) in site conditions and changes in regulatory or other legal provisions, technology, methods of analysis, or economic conditions which could render the report inaccurate or unreliable. The information, recommendations and conclusions contained in this report should not be relied upon if any such changes have taken place or after a period of 2 years from the date of this report or such other period as maybe expressly stated in the report, without the written agreement of FES. In the absence of such written agreement of

FES, reliance on the report after any such changes have occurred or after the period of 2 years has expired shall be at the Client's own and sole risk. Should FES agree to review the report after the period of 2 years has expired, FES shall be entitled to additional payment at the then existing rates or such other terms as may be agreed between FES and the Client.

6. The observations, recommendations and conclusions in this report are based solely upon the Services which were provided pursuant to the contract between the Client and FES. FES has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the Client and FES. FES is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services.

7. Where the Services have involved FES's interpretation and/or other use of any information (including documentation or materials, analysis, recommendations and conclusions) provided by third parties (including independent testing and/or information services or laboratories) or the Client and upon which FES was reasonably entitled to rely or involved FES's observations of existing physical conditions of any site involved in the Services, then the Services clearly are limited by the accuracy of such information and the observations which were reasonably possible of the said site. Unless otherwise stated, FES was not authorised and did not attempt to independently verify the accuracy or completeness of such information, received from the Client or third parties during the performance of the Services. FES is not liable for any inaccuracies (including any incompleteness) in the said information, the discovery of which inaccuracies required the doing of any act including the gathering of any information which it was not reasonably possible for FES to do including the doing of any independent investigation of the information provided to FES save as otherwise provided in the terms of the contract between the Client and FES.

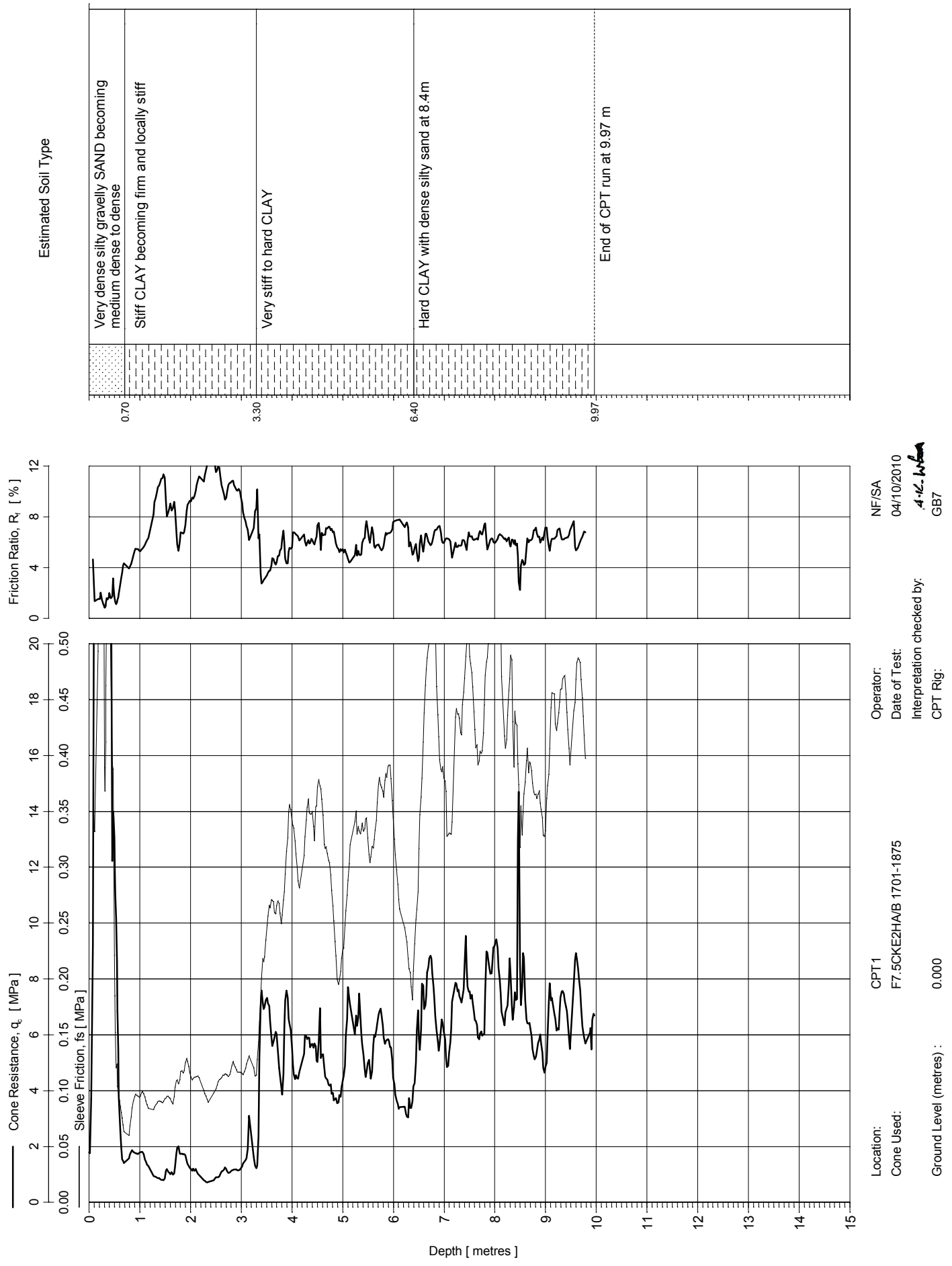
8. The soil and ground conditions information provided in the Services are based solely on evaluations of soil and ground condition samples and in-situ tests at determined sample test locations and elevations. That information cannot be extrapolated to any area or elevation outside those locations and elevations unless specifically so stated in the report. In the light of the information available to FES, the soil and ground conditions information are considered appropriate for use in relation to the geotechnical design and installation aspects of the structures addressed in the report, but they may not be appropriate for the design of other structures.

APPENDIX B Cone Penetration Test Results

Cone Penetration Graphs

CPT1, CPT2, CPT3, CPT4, CPT5, CPT6, CPT7, CPT8, CPT8A, CPT9, CPT10, CPT10A, CPT10B, CPT11, CPT12, CPT13, CPT14, CPT15 & CPT16

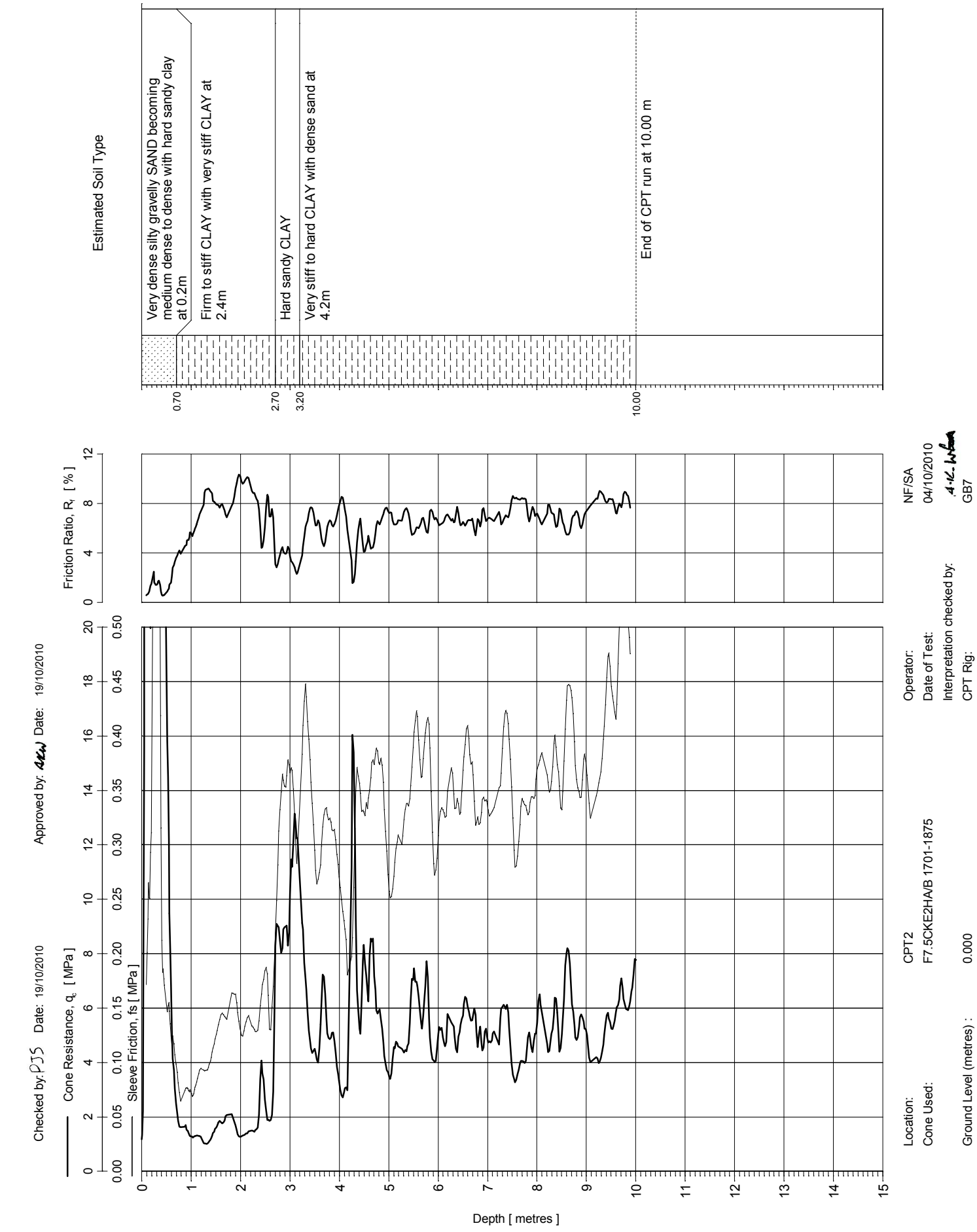
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT1

Contract No:CPT101161

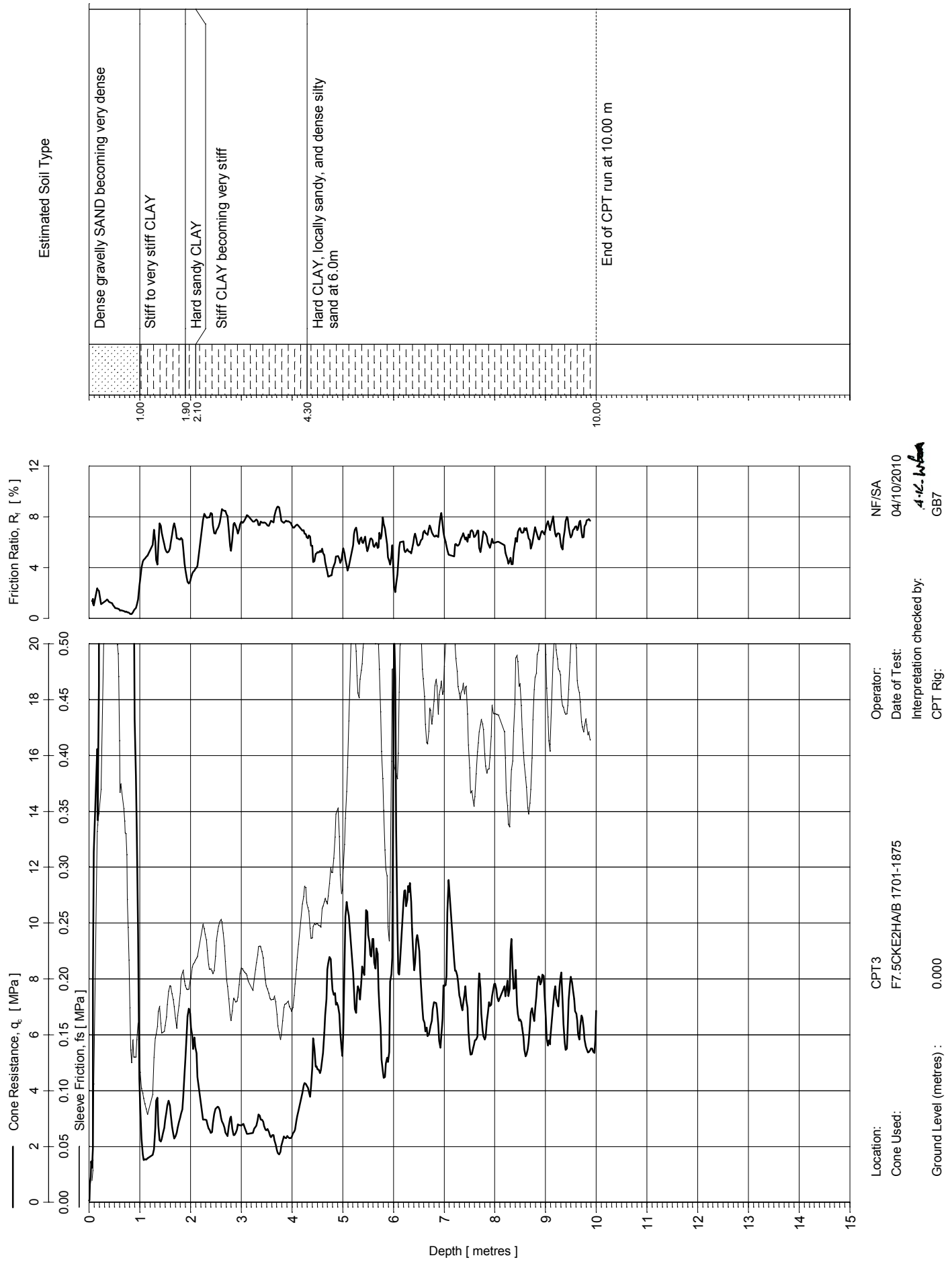
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT2

Contract No:CPT101161

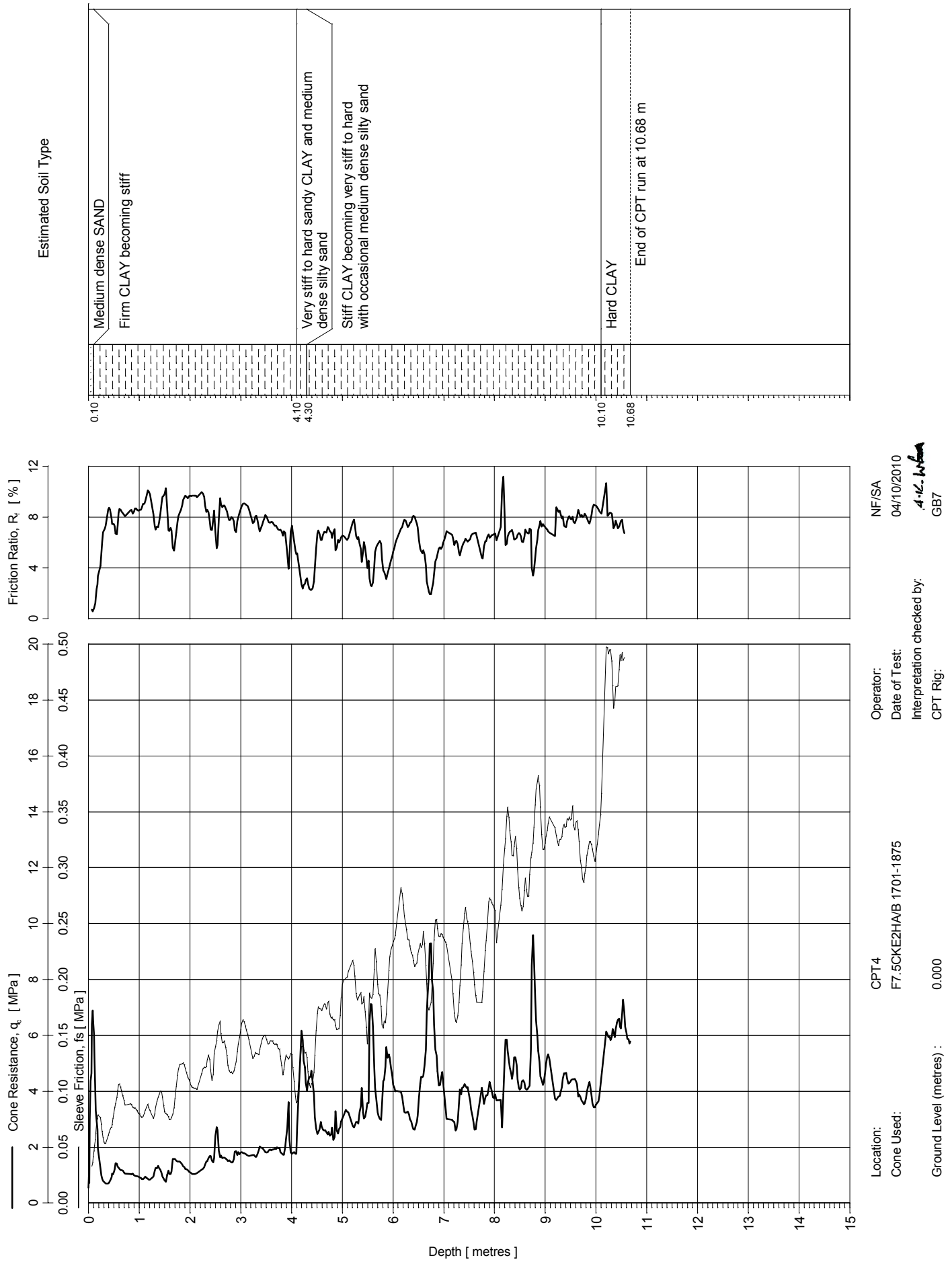
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT3

Contract No:CPT101161

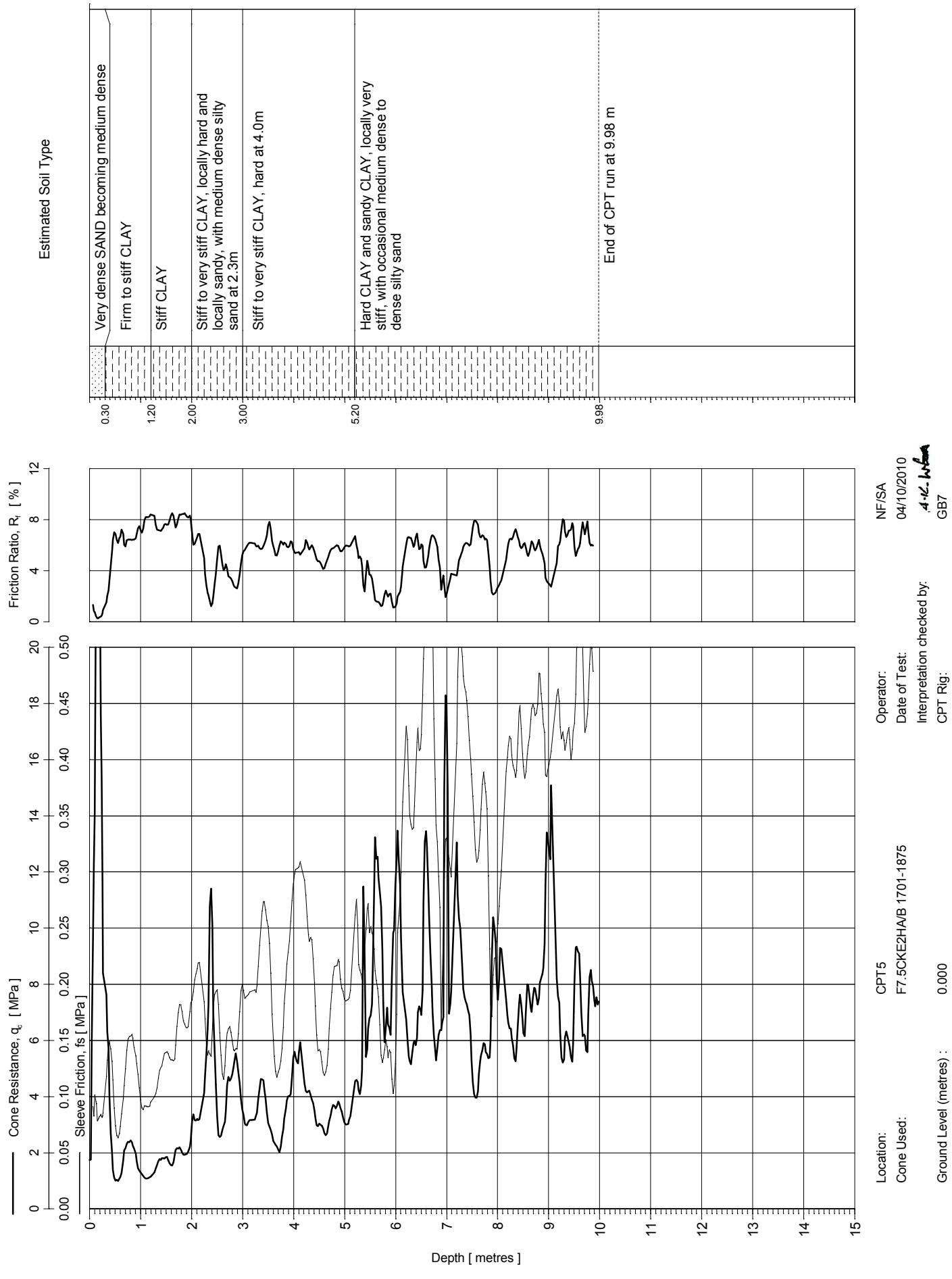
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT4

Contract No:CPT101161

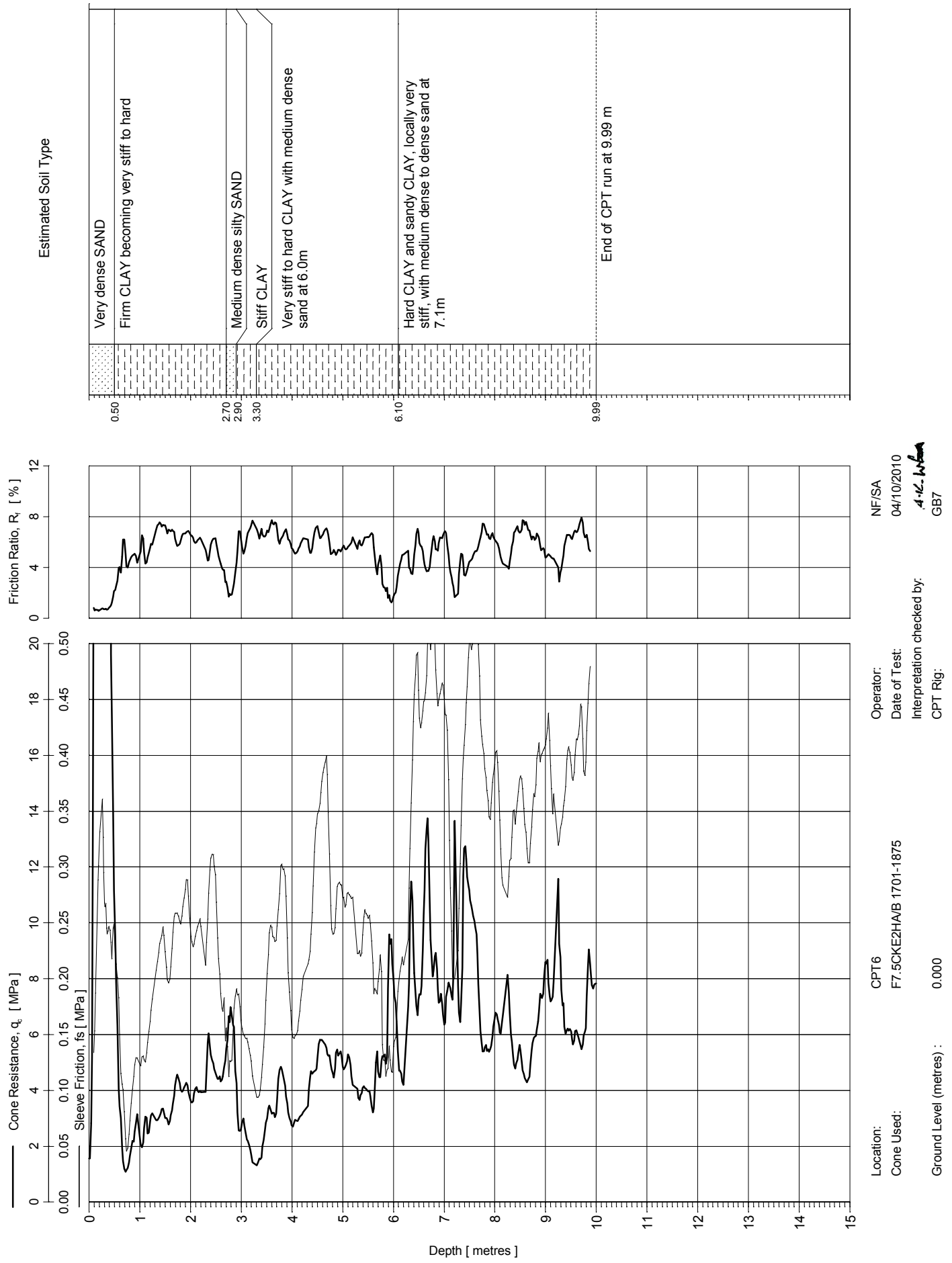
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT5

Contract No:CPT101161

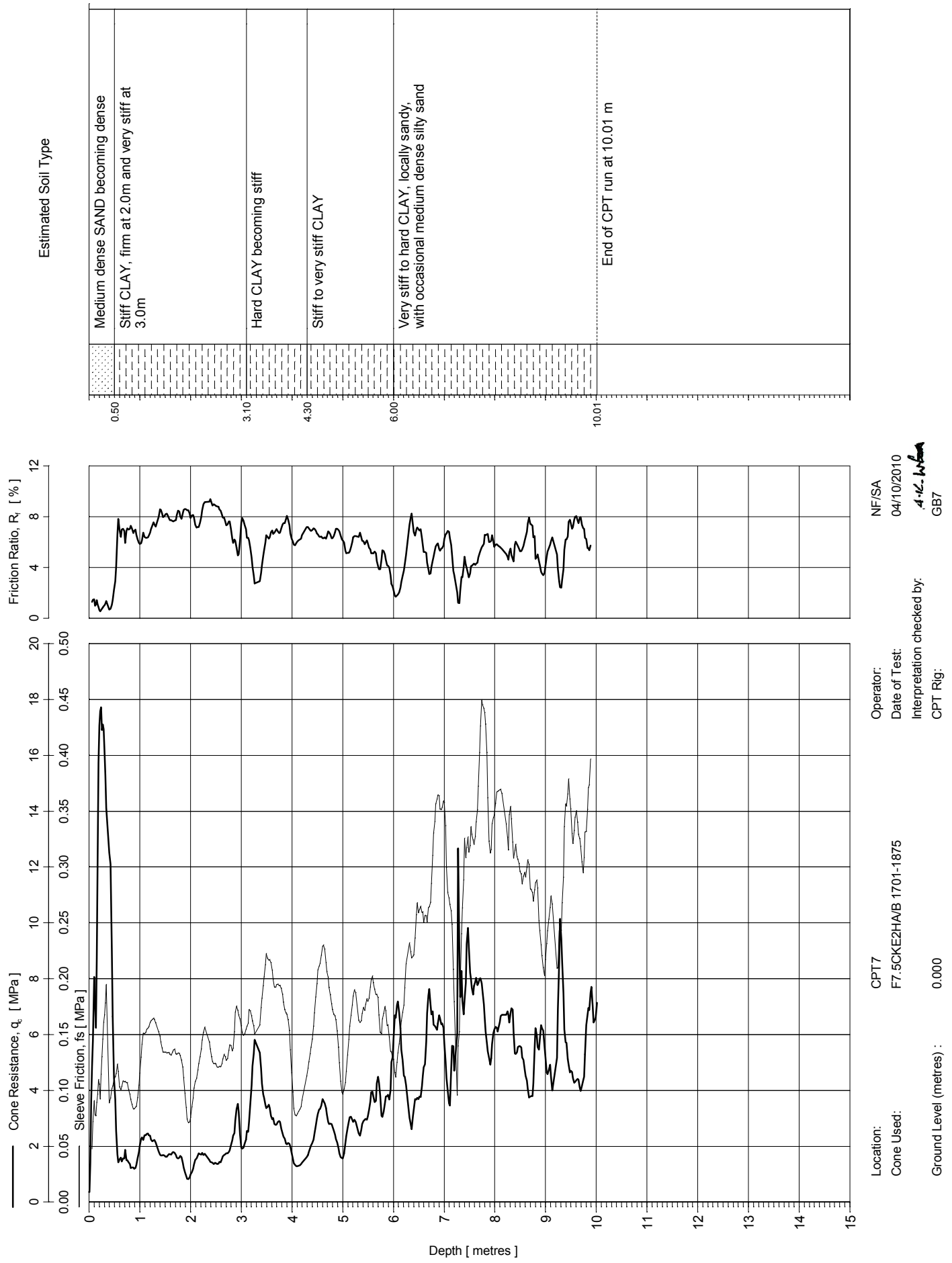
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT6

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



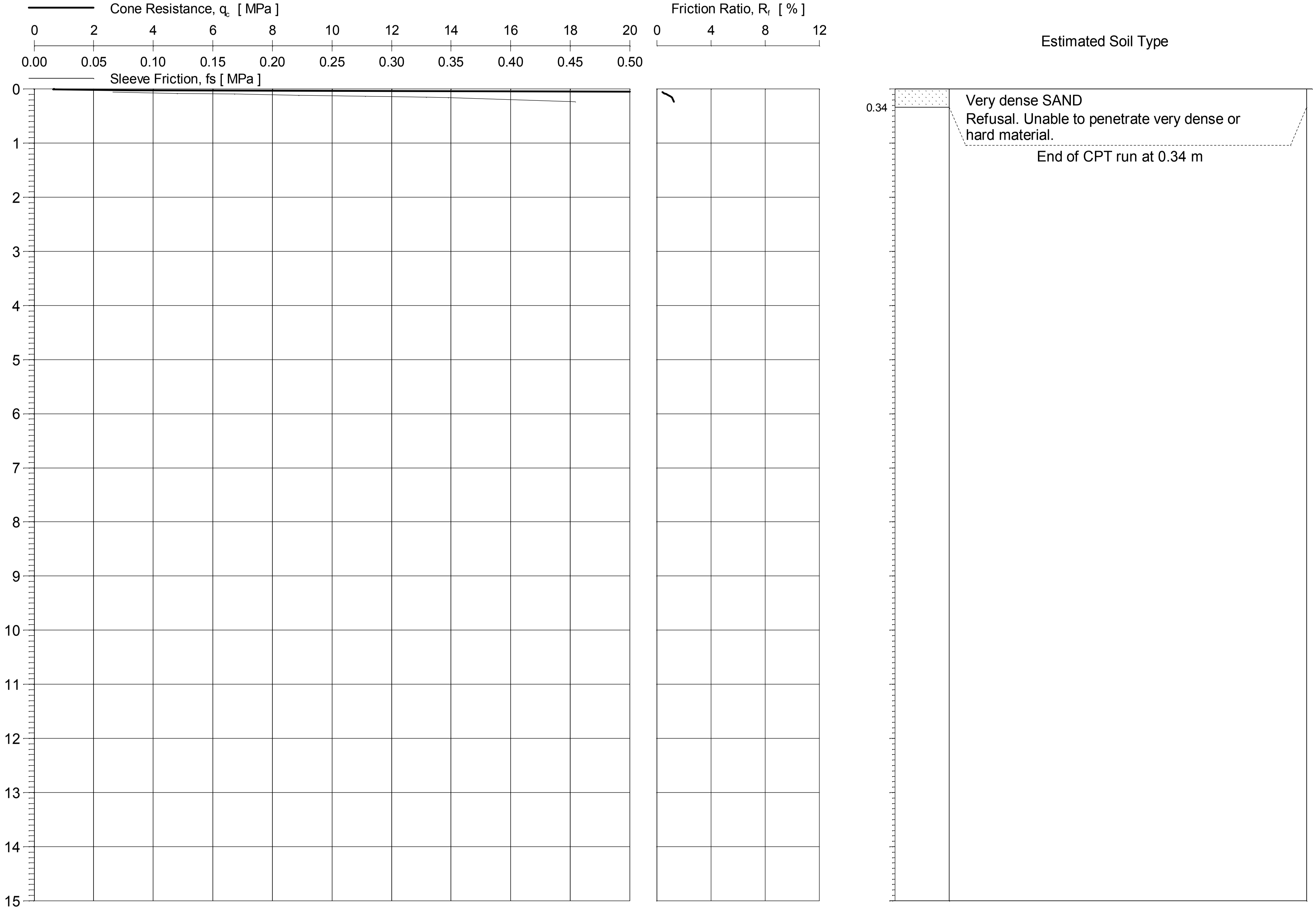
STATIC CONE PENETRATION TEST CPT7

Contract No:CPT101161

STATIC CONE PENETRATION TEST CPT8

Contract No:CPT101161

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010

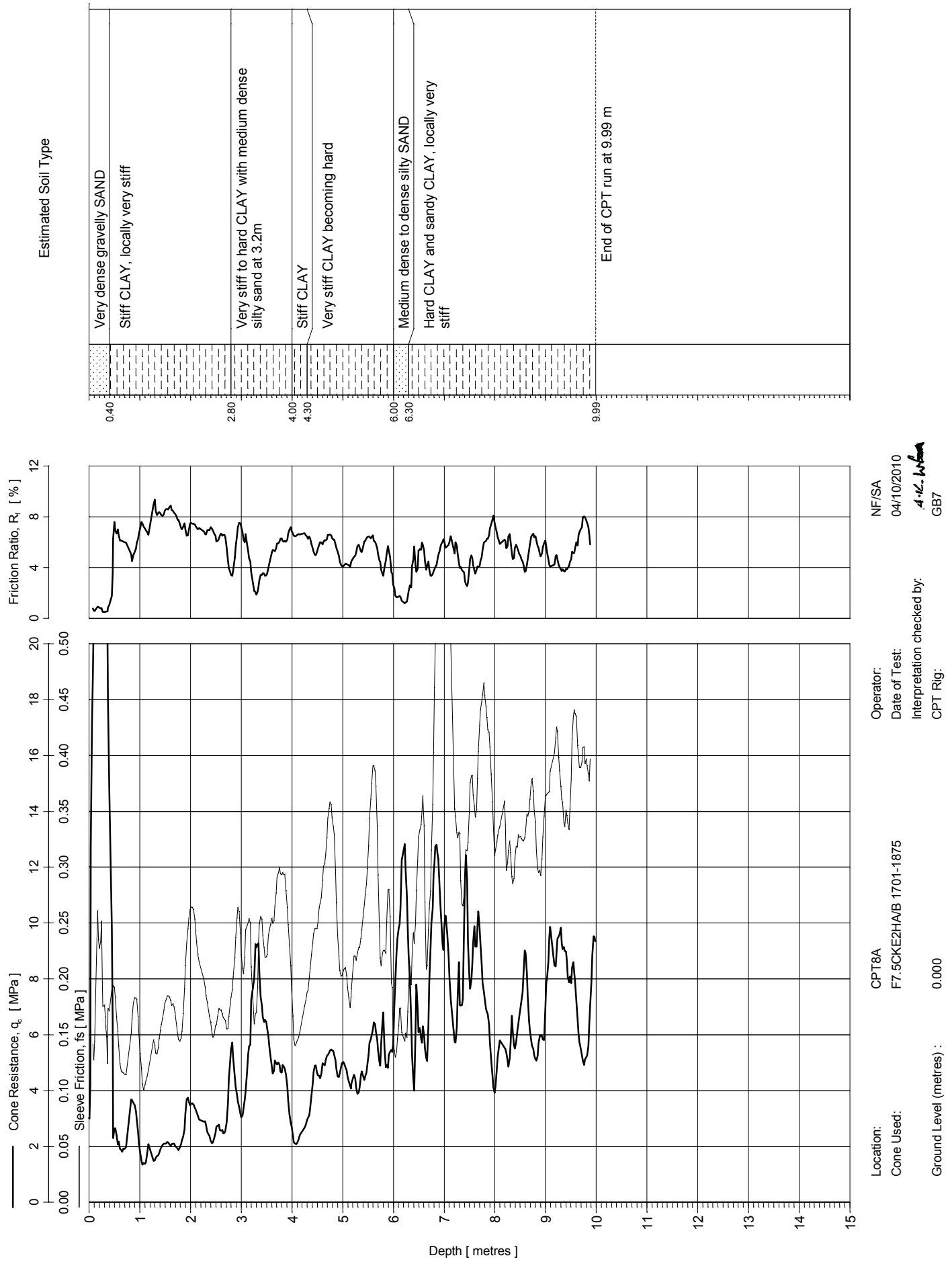


Location:	CPT8	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K.W.
Ground Level (metres) :	0.000	CPT Rig:	GB7

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

FUGRO

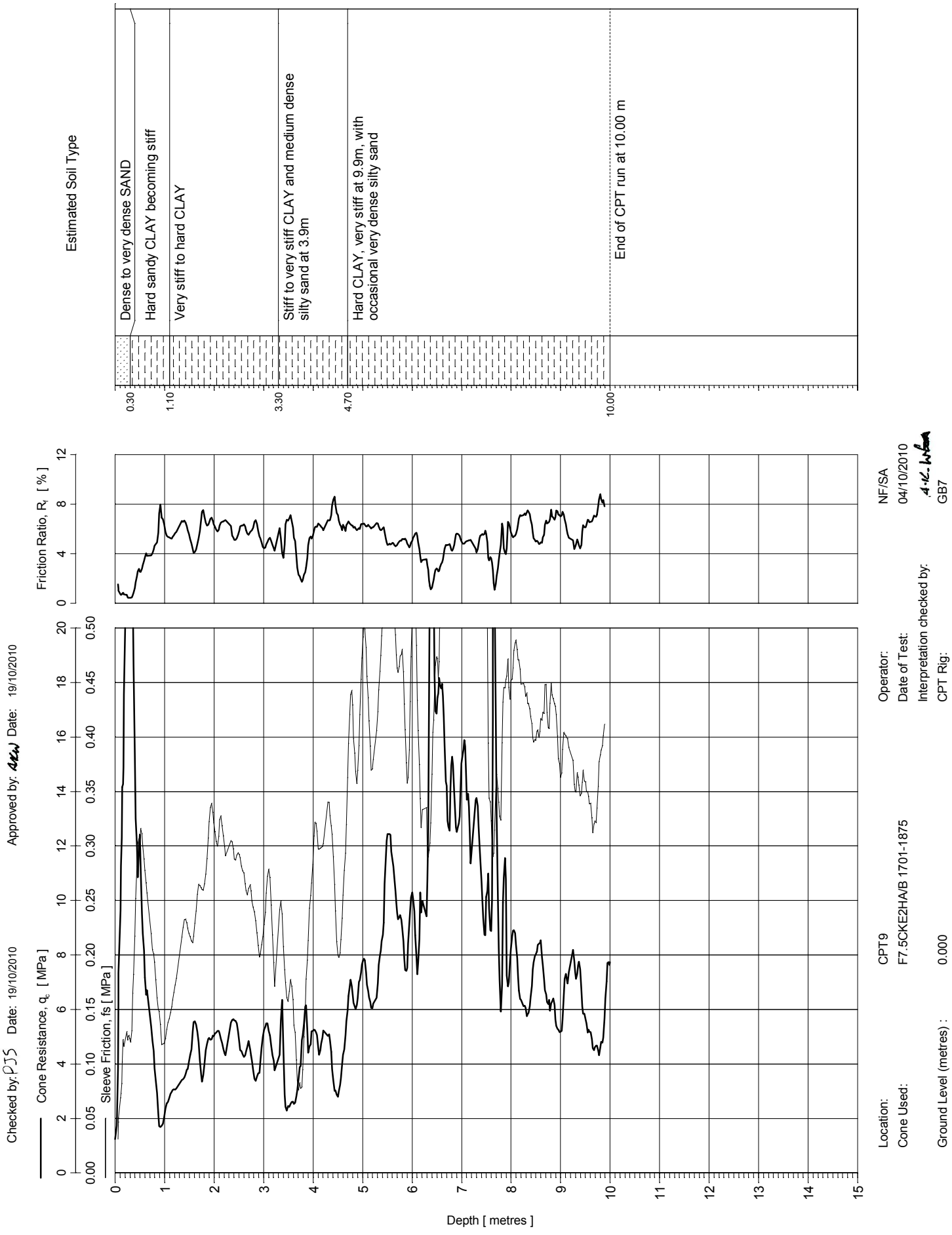
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT8A

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



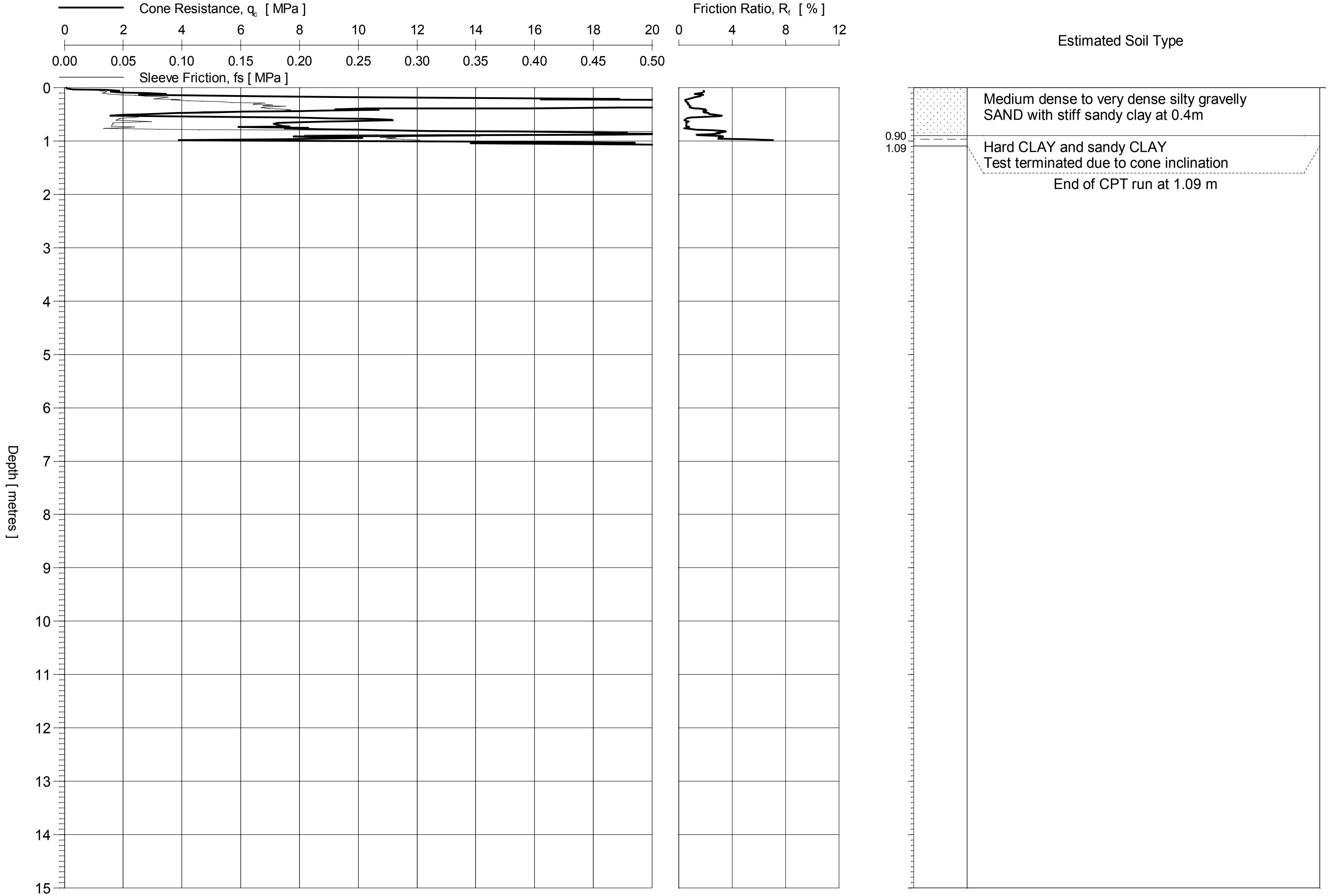
STATIC CONE PENETRATION TEST CPT9

Contract No:CPT101161

STATIC CONE PENETRATION TEST CPT10

Contract No:CPT101161

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010

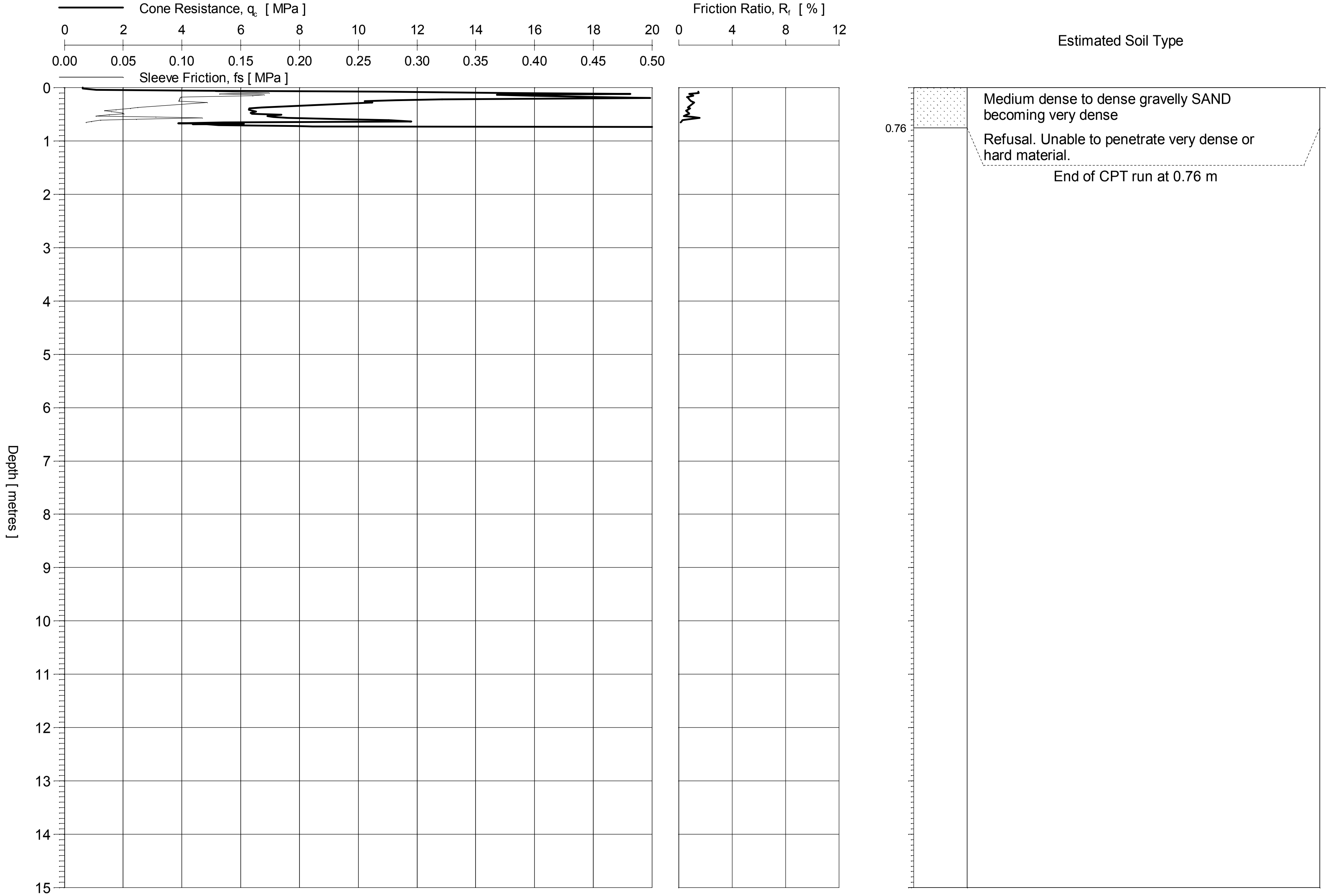


Location:	CPT10	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K. W.
Ground Level (metres) :	0.000	CPT Rig:	GB7

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

STATIC CONE PENETRATION TEST CPT10A

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010



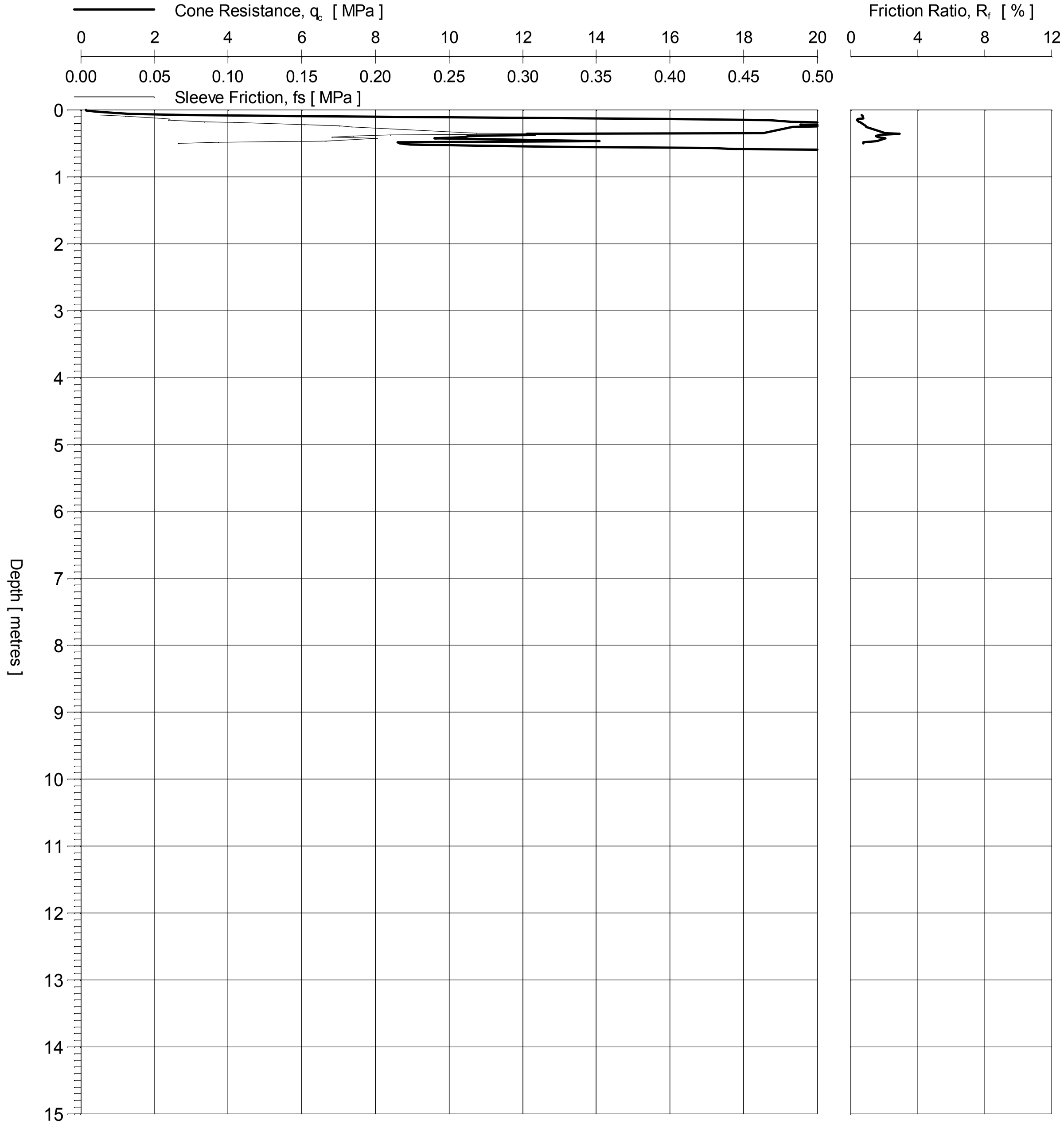
Location:	CPT10A	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K. Wilson
Ground Level (metres) :	0.000	CPT Rig:	GB7

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

FUGRO

STATIC CONE PENETRATION TEST CPT10B

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010



Estimated Soil Type

0.61

Medium dense to dense silty gravelly SAND becoming very dense
Refusal. Unable to penetrate very dense or hard material.

End of CPT run at 0.61 m

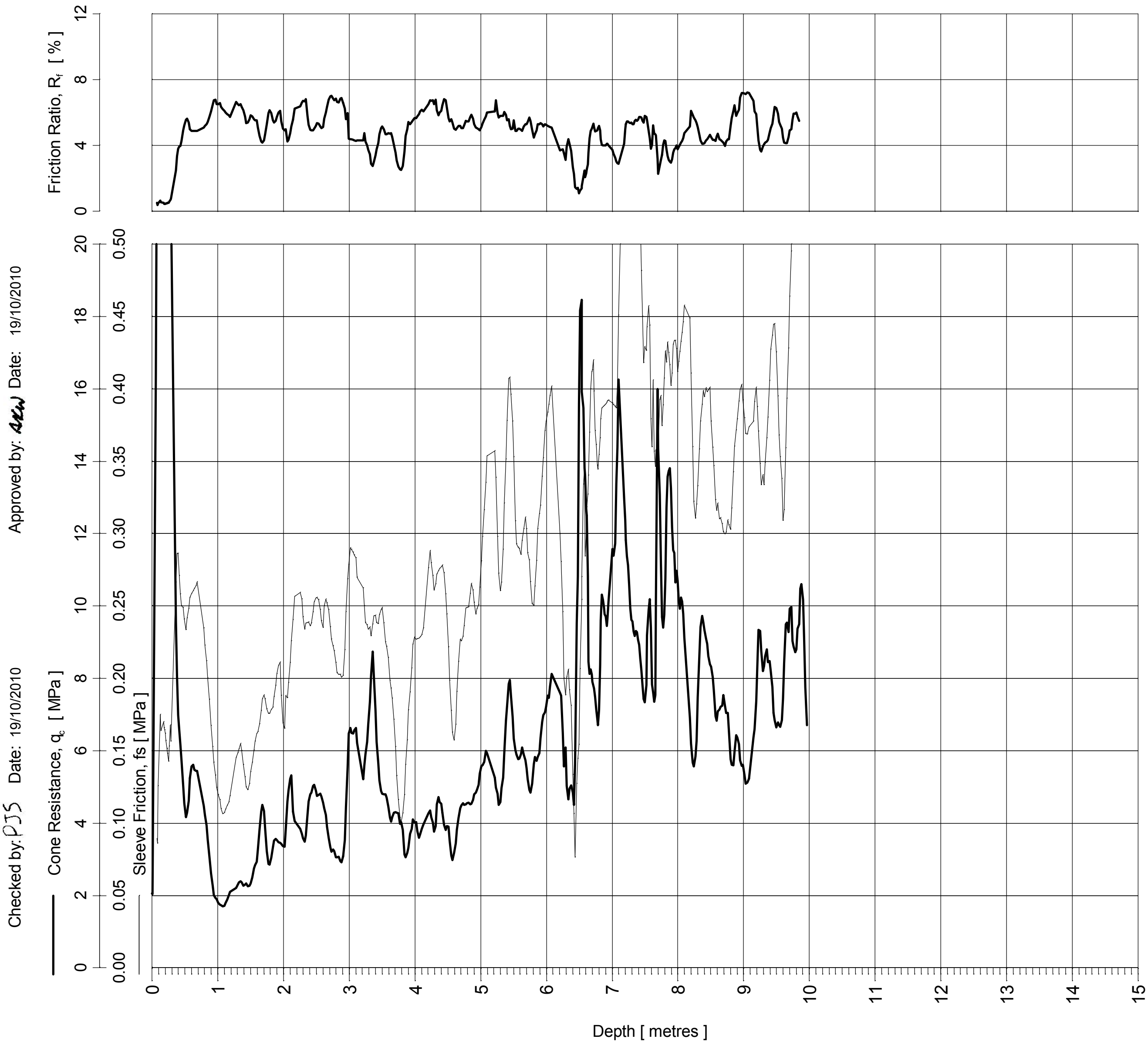
Location:	CPT10B	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K.W
Ground Level (metres) :	0.000	CPT Rig:	GB7

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

FUGRO

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

Depth (m)	Estimated Soil Type
0.30	Very dense SAND
1.60	Very stiff to hard CLAY becoming stiff
3.00	Very stiff to hard CLAY
3.30	Hard CLAY and sandy CLAY
4.90	Very stiff CLAY, locally sandy
6.70	Hard CLAY, locally very stiff, with dense sand at 6.5m
9.96	Hard CLAY and sandy CLAY
	End of CPT run at 9.96 m



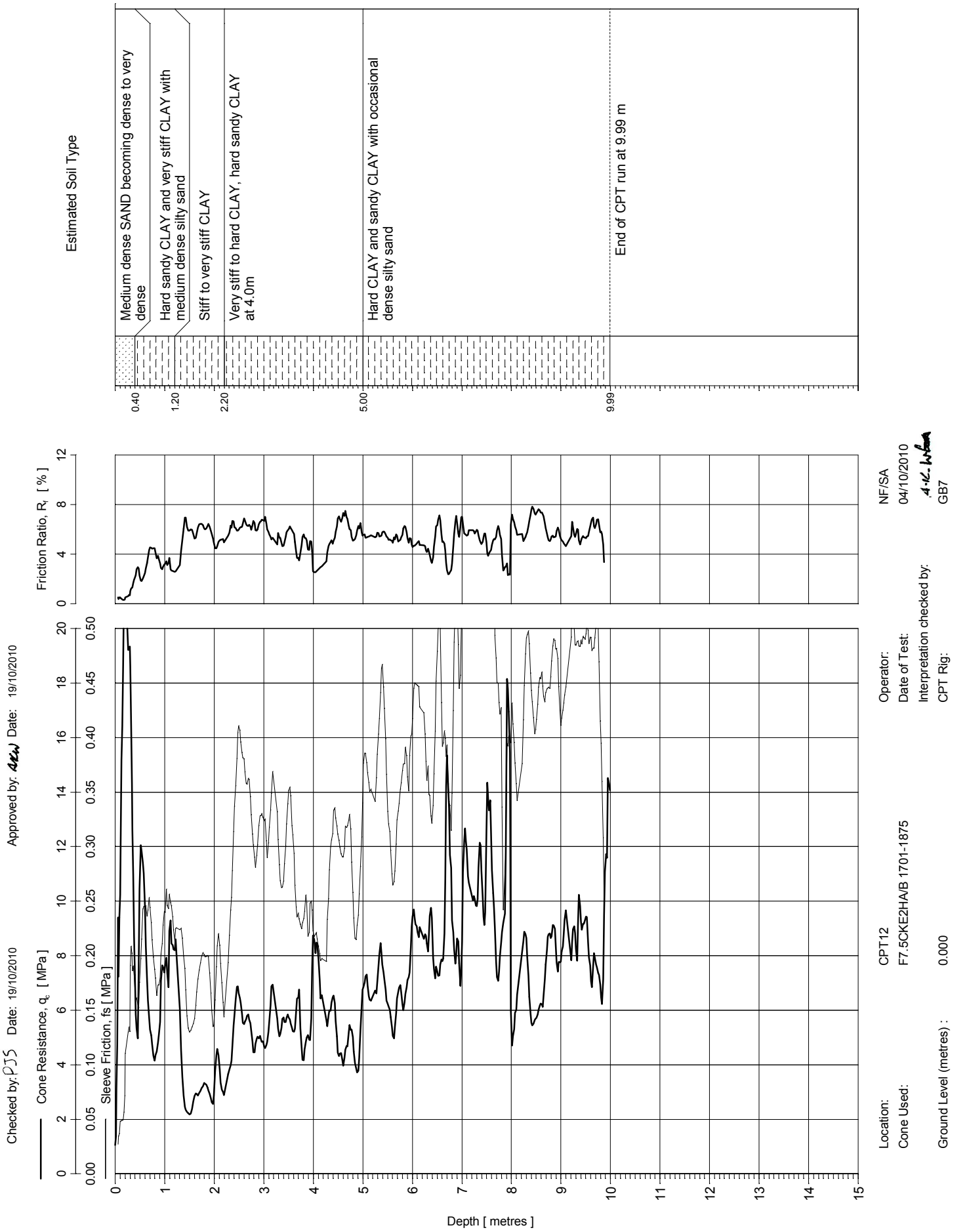
Location: CPT11
Cone Used: F7.5CKE2HA/B 1701-1875
Ground Level (metres) : 0.000

Operator: NF/SA
Date of Test: 04/10/2010
Interpretation checked by:
CPT Rig: GB7

STATIC CONE PENETRATION TEST CPT11

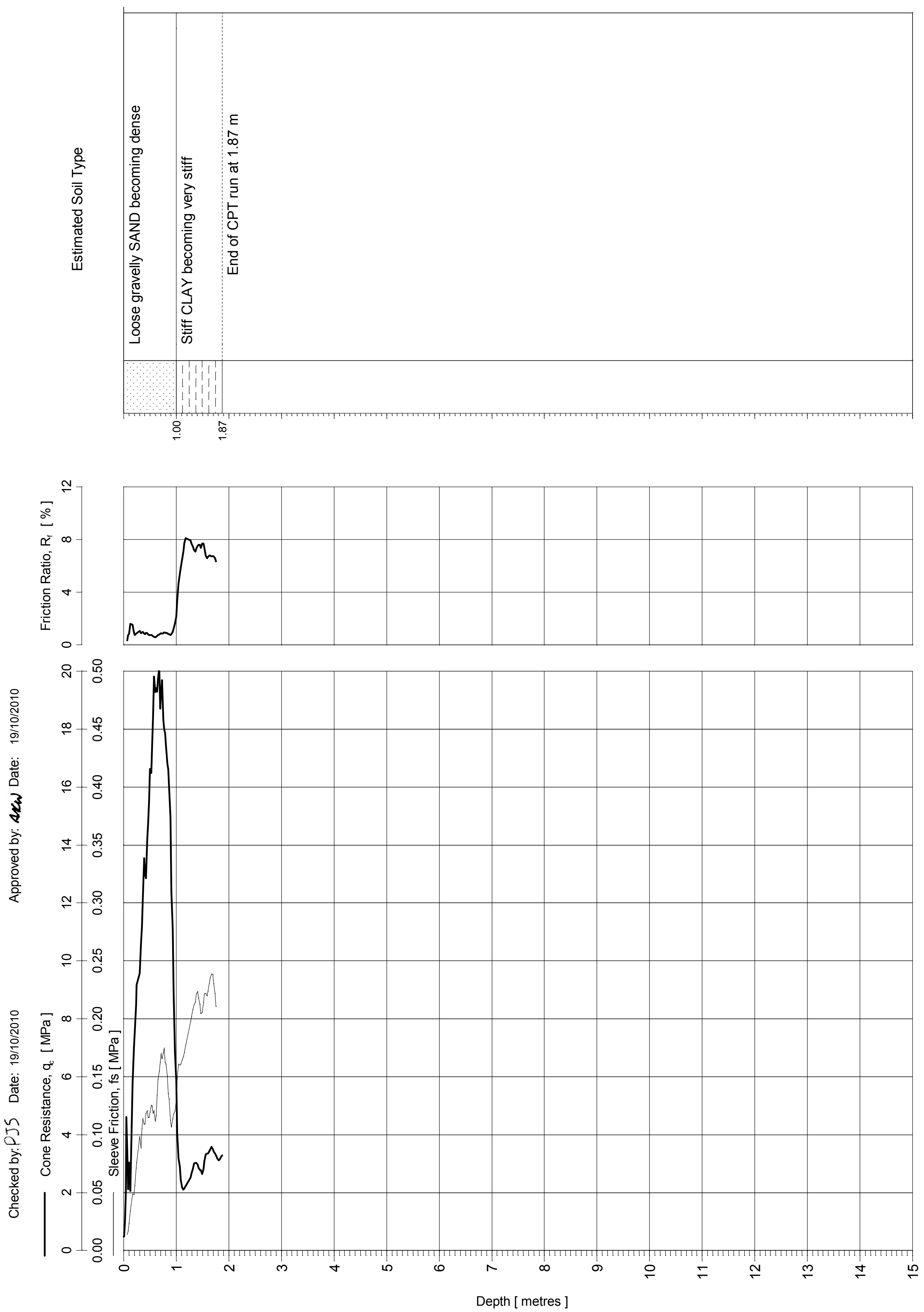
Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT12

Contract No:CPT101161

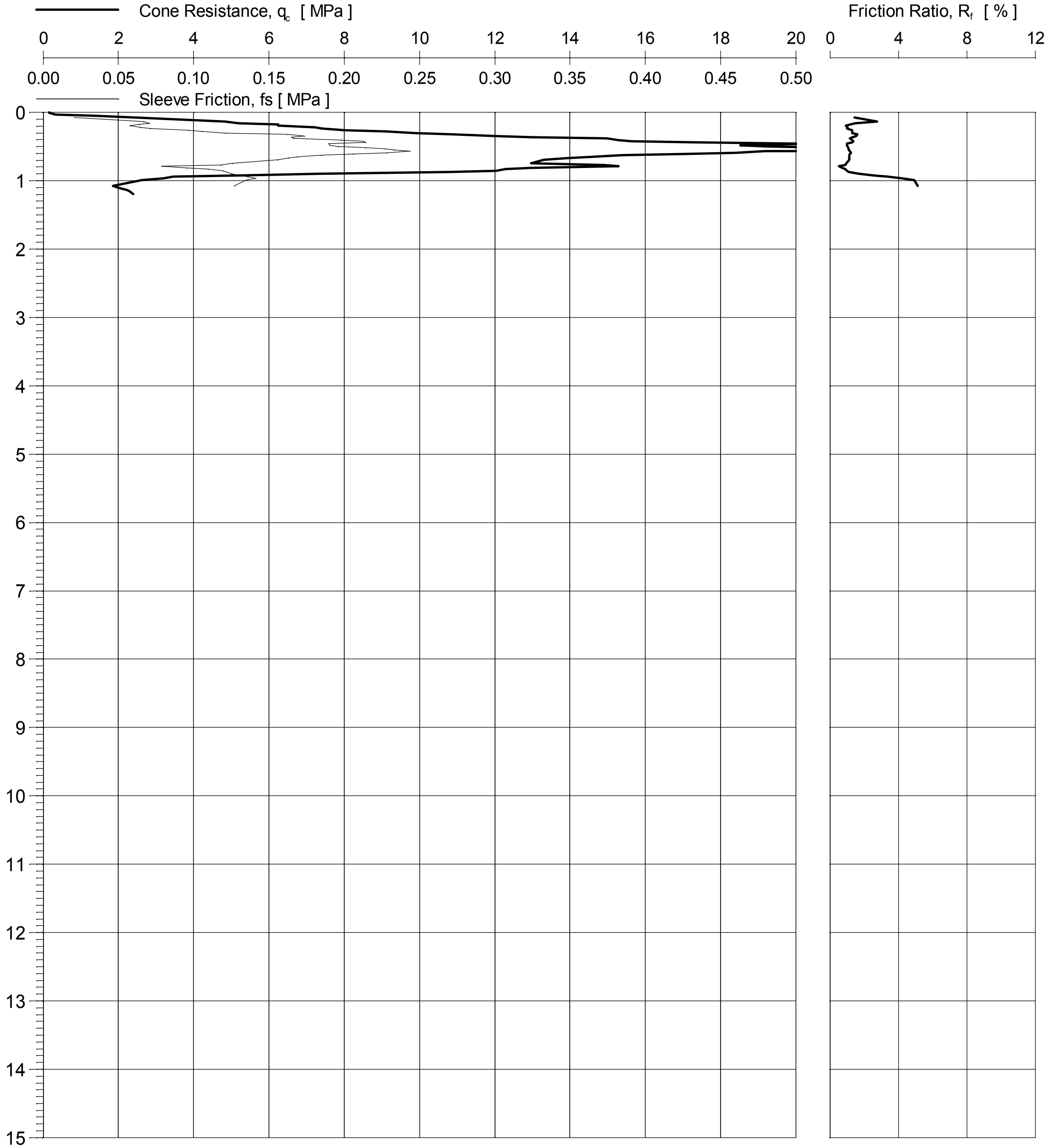


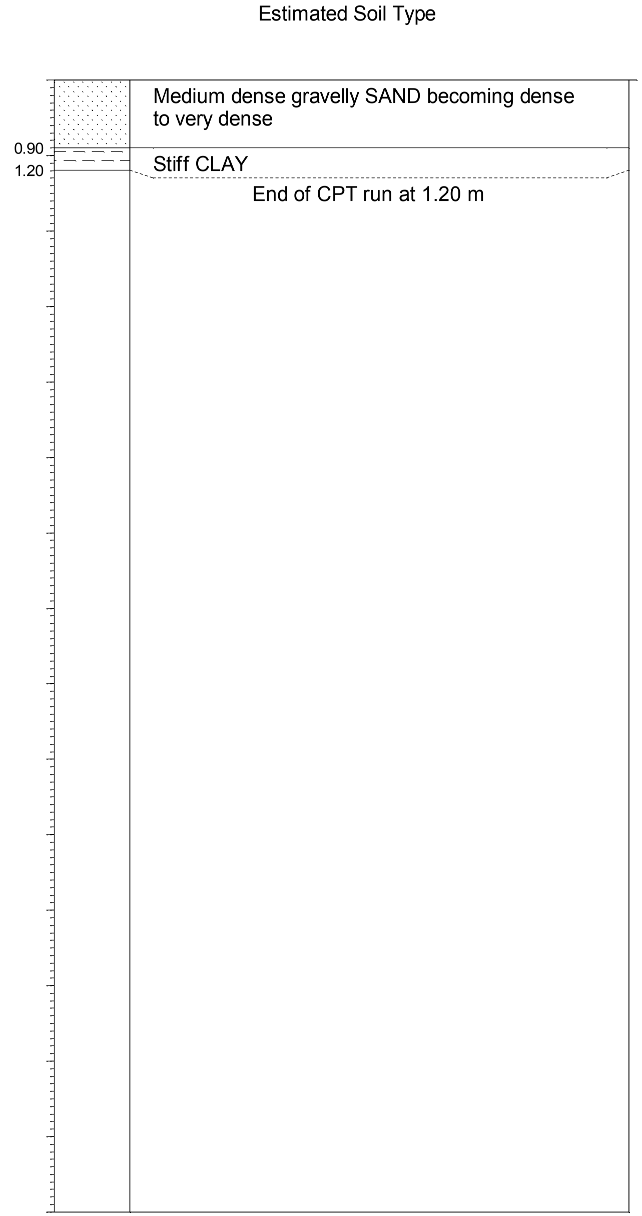
Location:	CPT13	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K. W[signature]
Ground Level (metres) :	0.000	CPT Rig:	GB7

STATIC CONE PENETRATION TEST CPT13

STATIC CONE PENETRATION TEST CPT14

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010

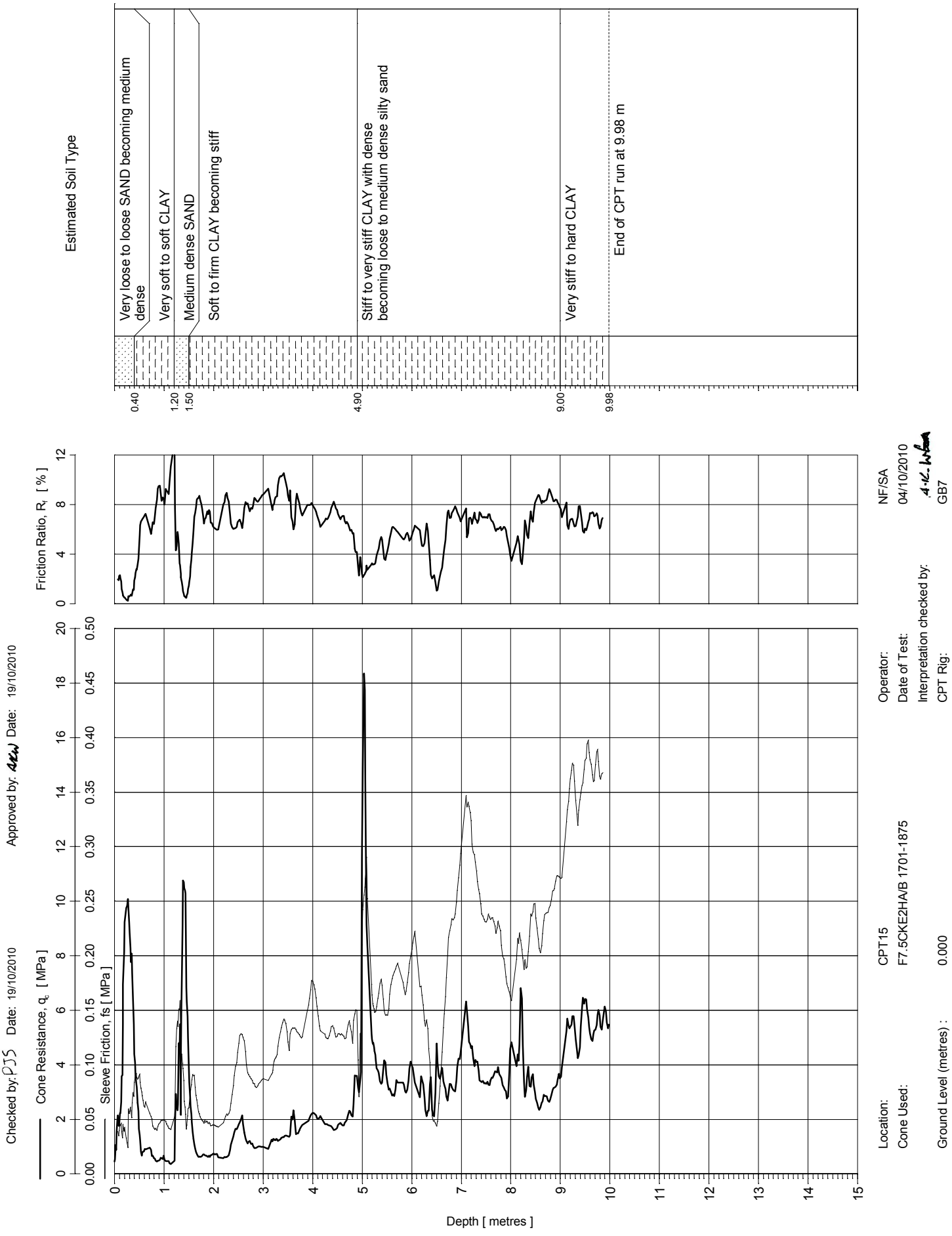




Location:	CPT14	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K. Wilson
Ground Level (metres) :	0.000	CPT Rig:	GB7

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT15

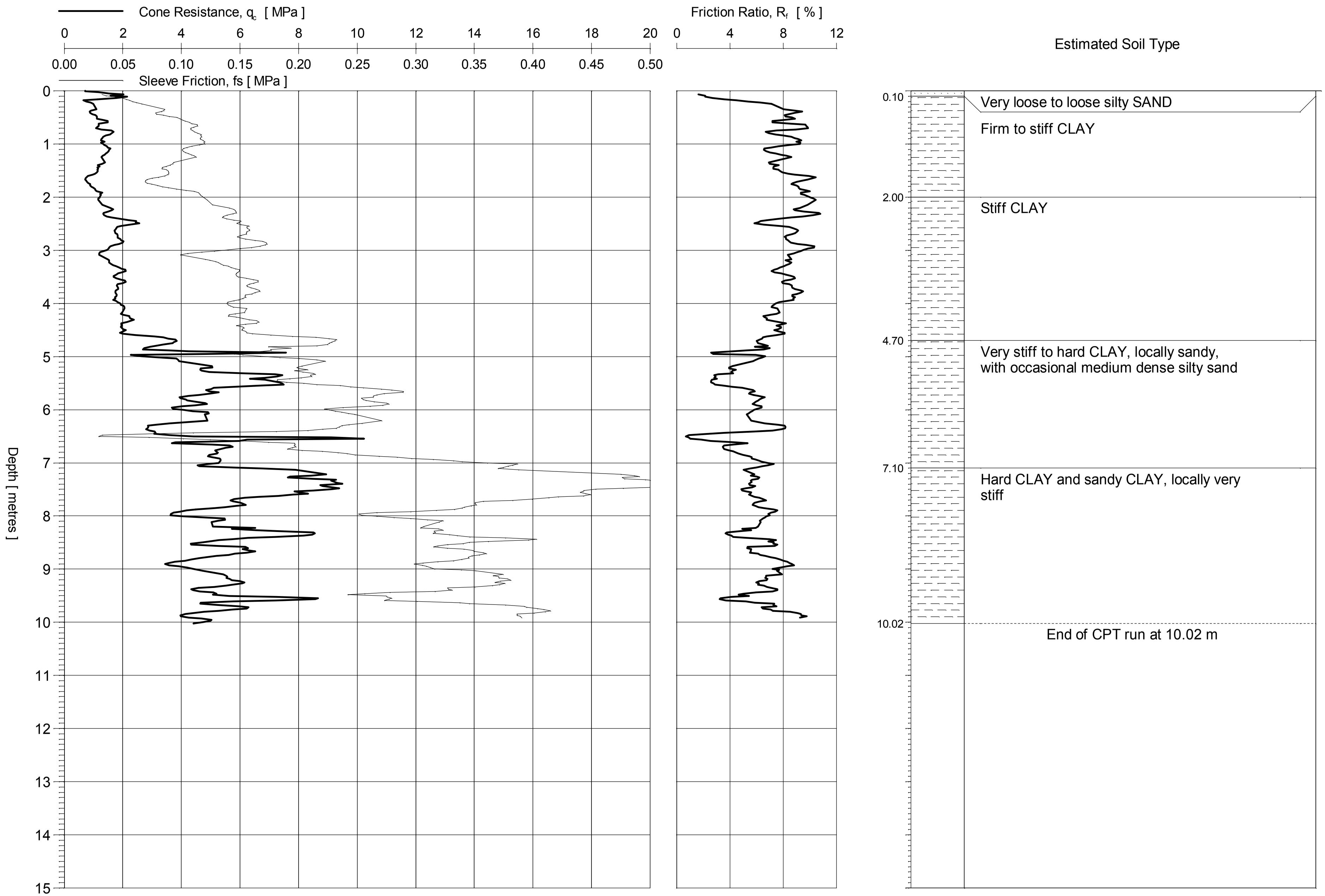
Contract No:CPT101161

STATIC CONE PENETRATION TEST CPT16

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

Checked by: PJS Date: 19/10/2010 Approved by: AKW Date: 19/10/2010



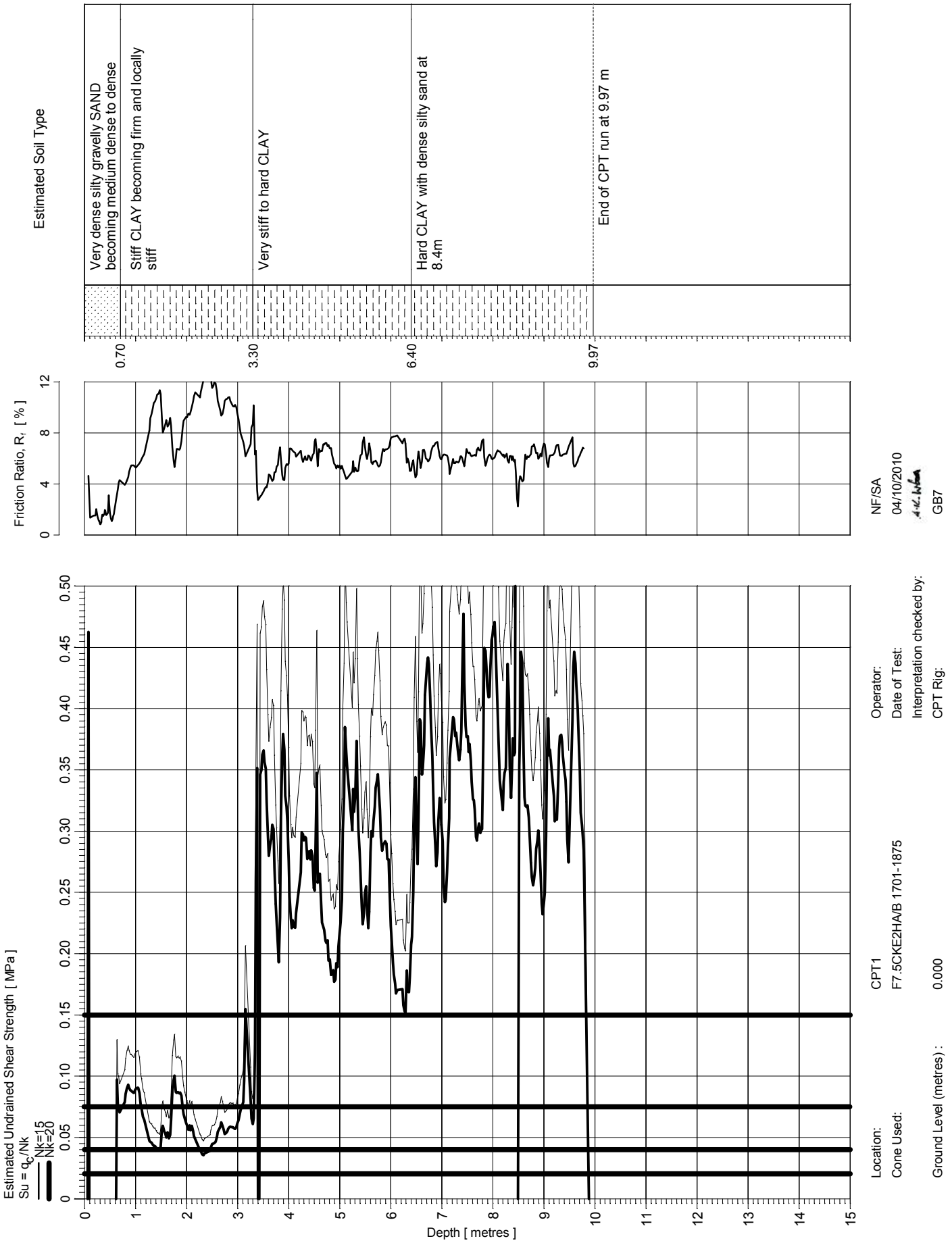
Location:	CPT16	Operator:	NF/SA
Cone Used:	F7.5CKE2HA/B 1701-1875	Date of Test:	04/10/2010
		Interpretation checked by:	A.K.W.
Ground Level (metres) :	0.000	CPT Rig:	GB7

APPENDIX C Estimated Undrained Shear Strength Profiles

Estimated Undrained Shear Strength Graphs

CPT1, CPT2, CPT3, CPT4, CPT5, CPT6, CPT7, CPT8A, CPT9, CPT11, CPT12, CPT15 & CPT16

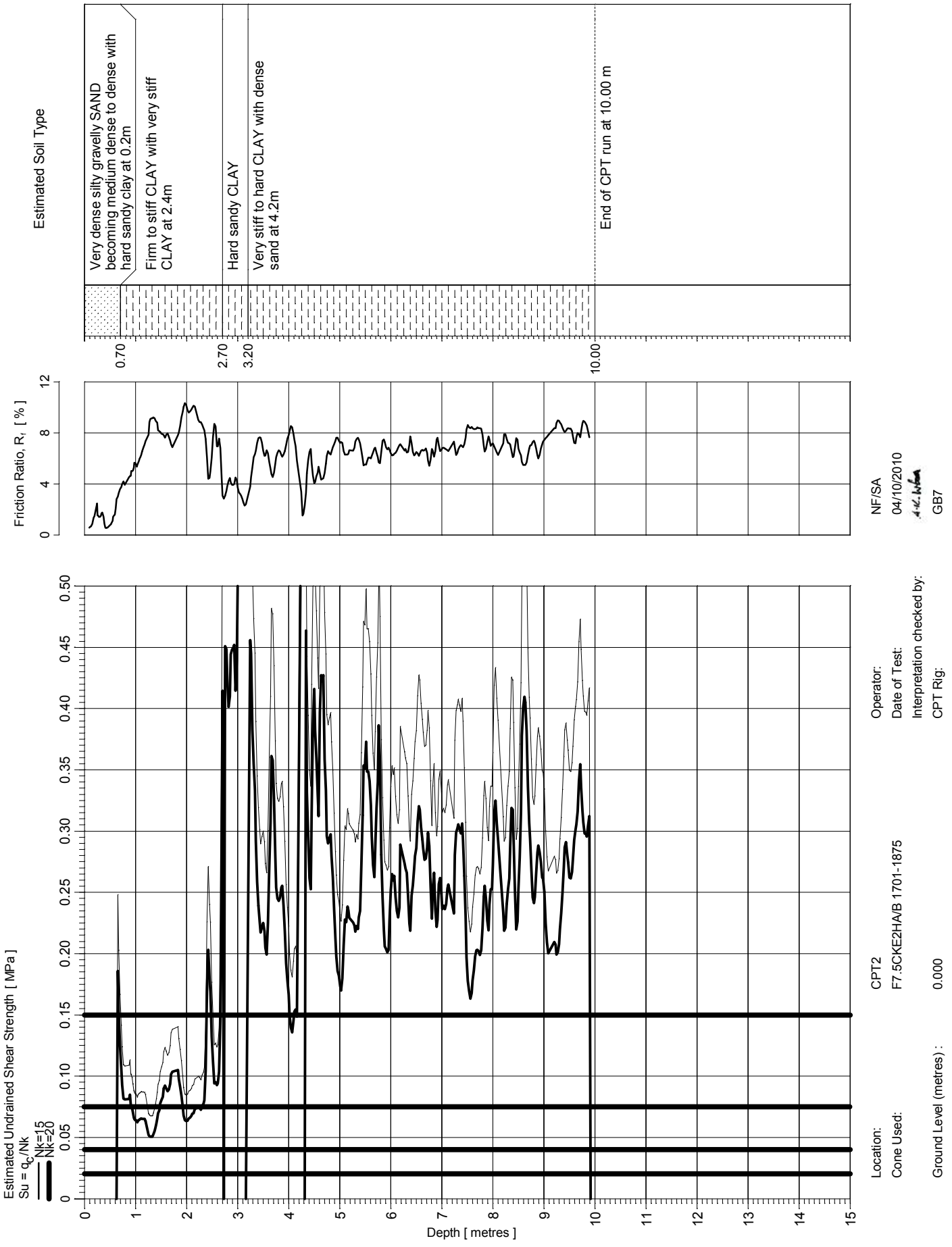
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT1

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

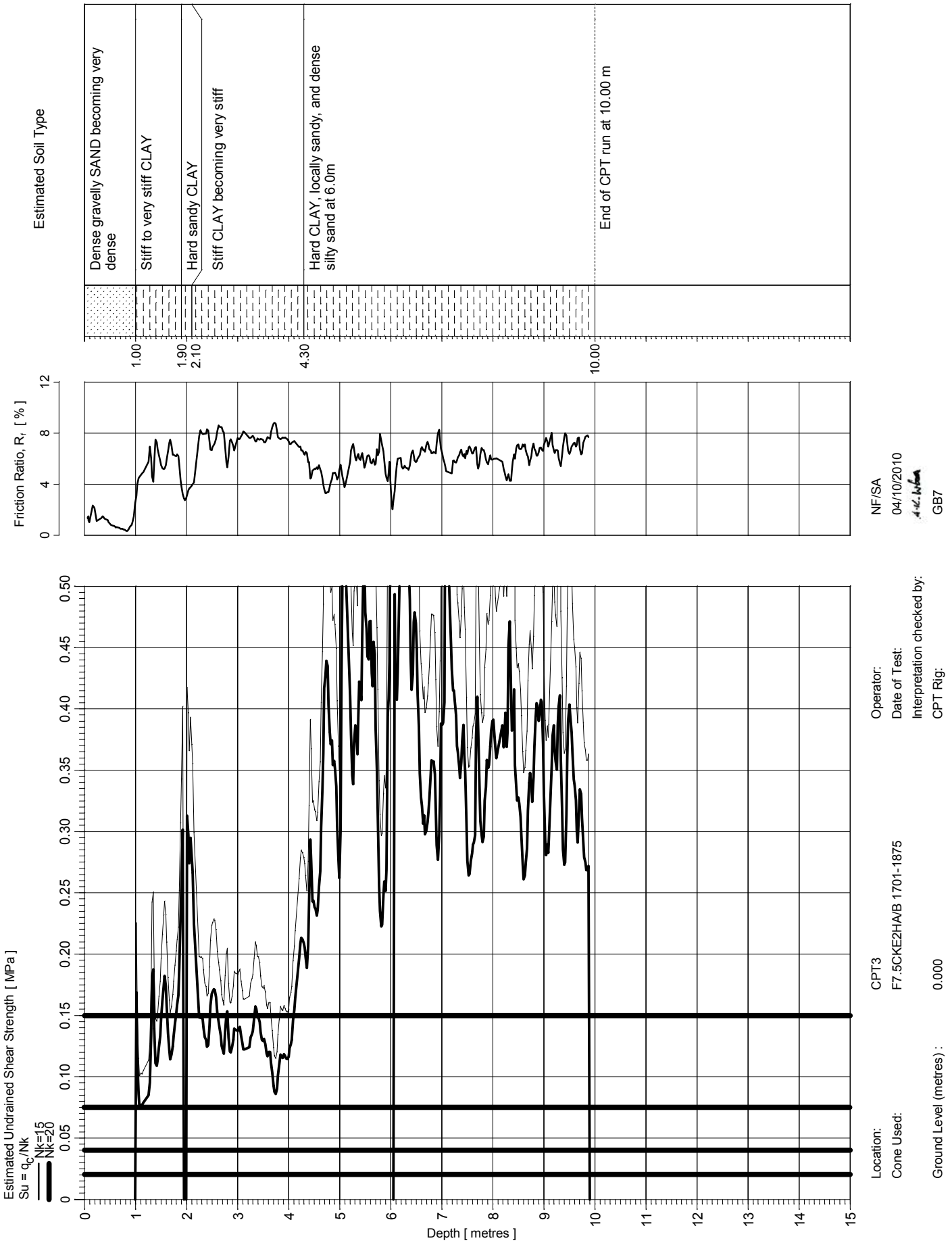


Checked by PJS Date: 19/10/2010 Approved by Date: 19/10/2010

STATIC CONE PENETRATION TEST CPT2

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



Checked by PJS Date: 19/10/2010 Approved by: Date: 19/10/2010

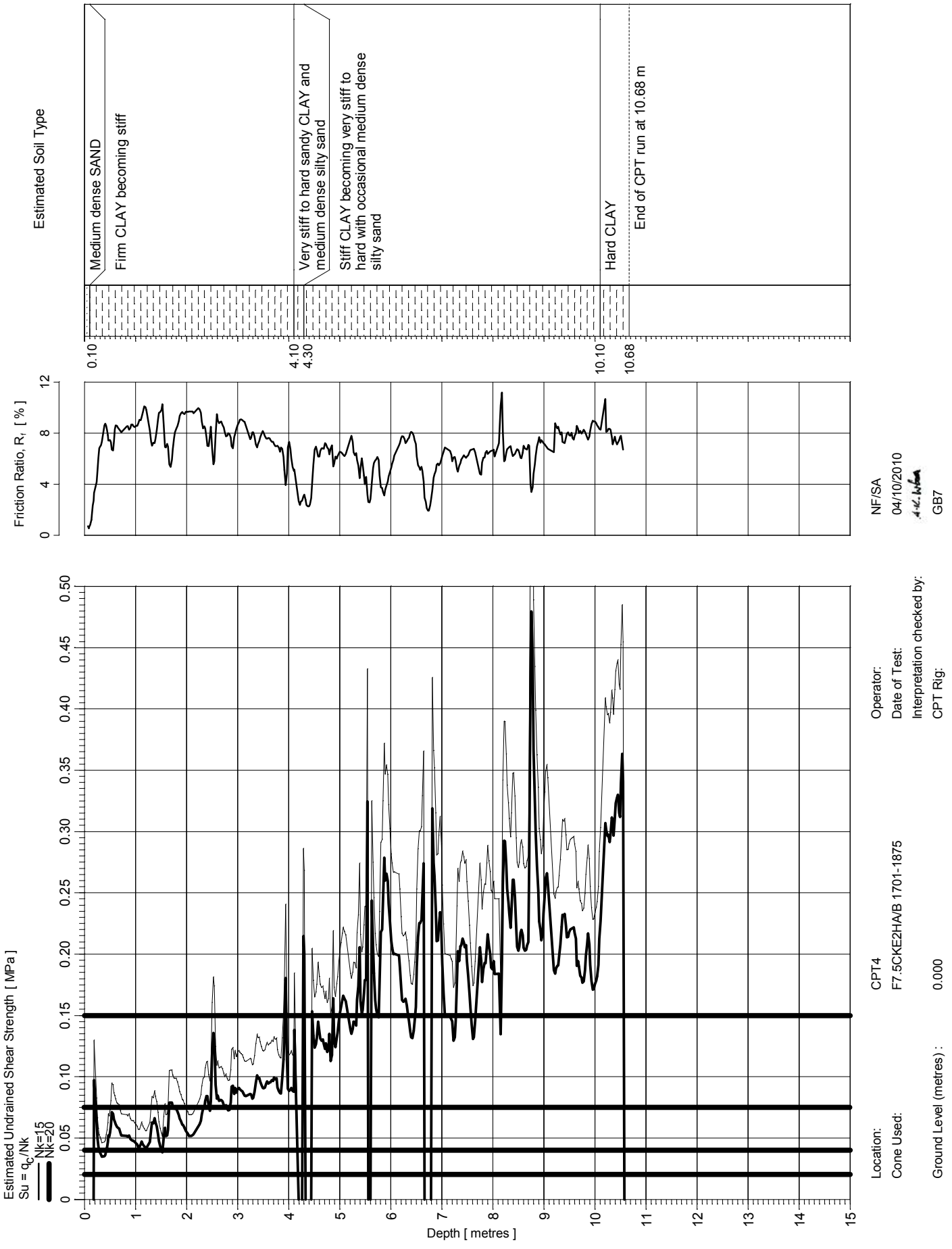
Operator: NF/SA
Date of Test: 04/10/2010
Interpretation checked by:
CPT Rig: GB7

Location: CPT3
Cone Used: F7.5CKE2HA/B 1701-1875
Ground Level (metres) : 0.000

STATIC CONE PENETRATION TEST CPT3

Contract No:CPT101161

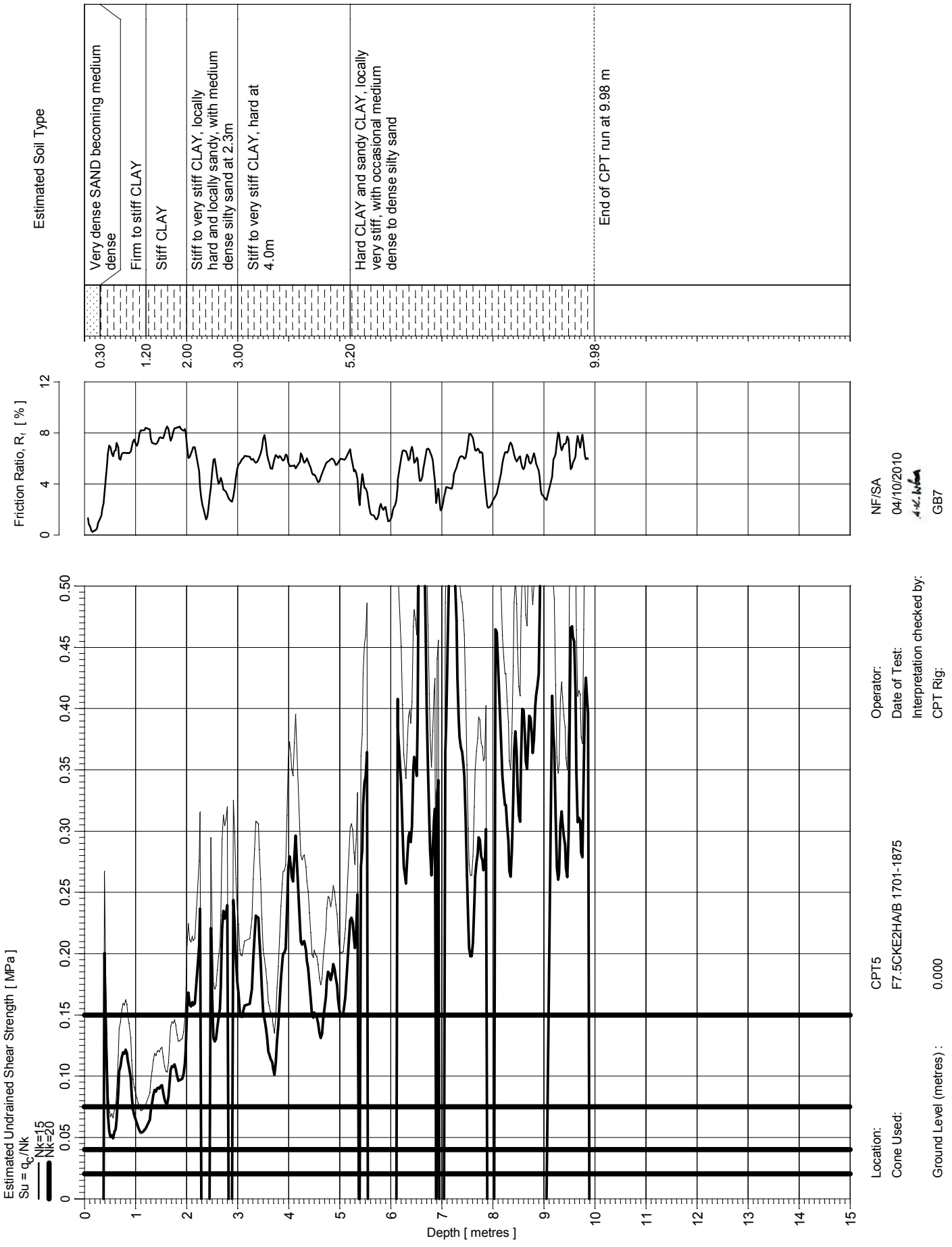
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT4

Contract No:CPT101161

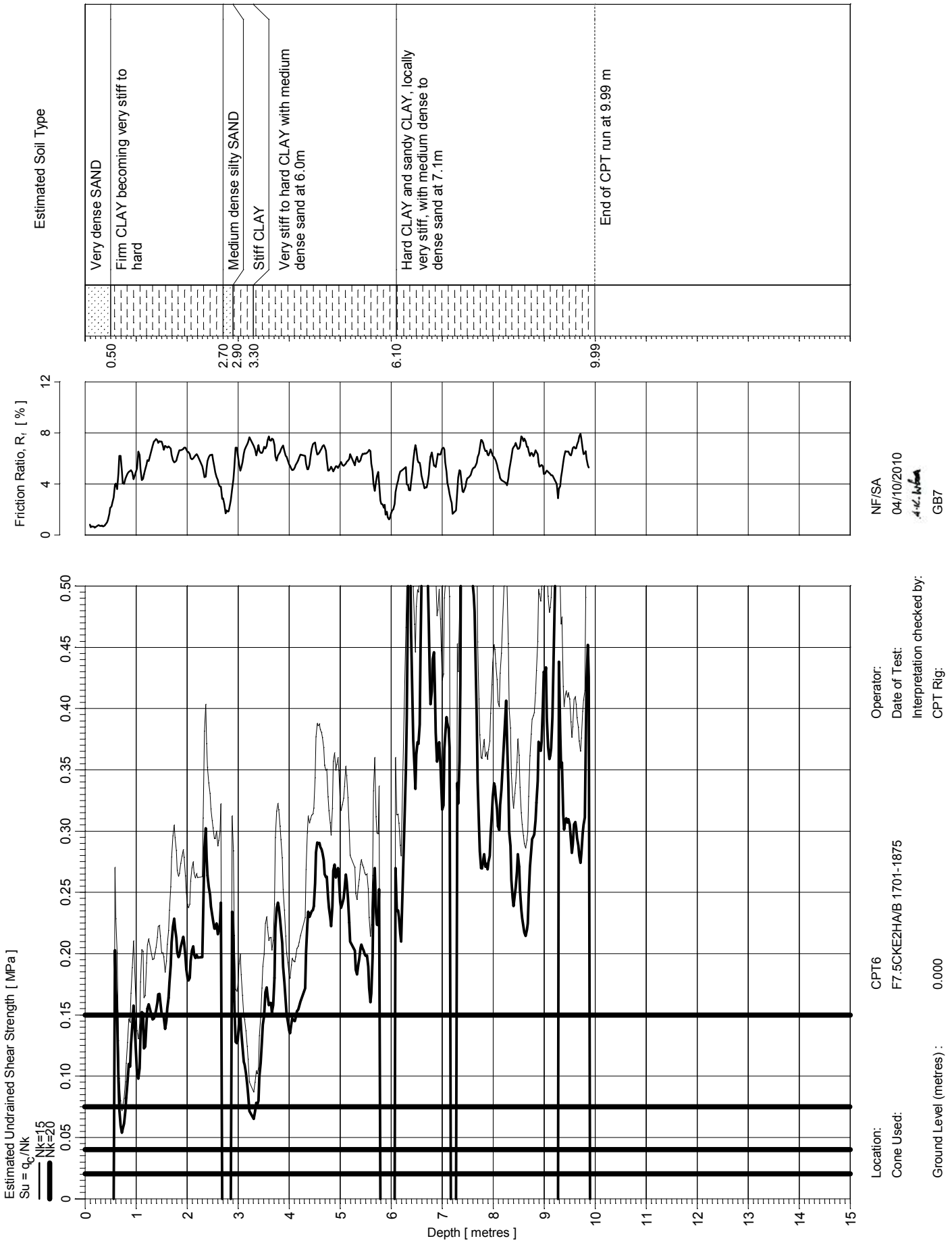
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT5

Contract No:CPT101161

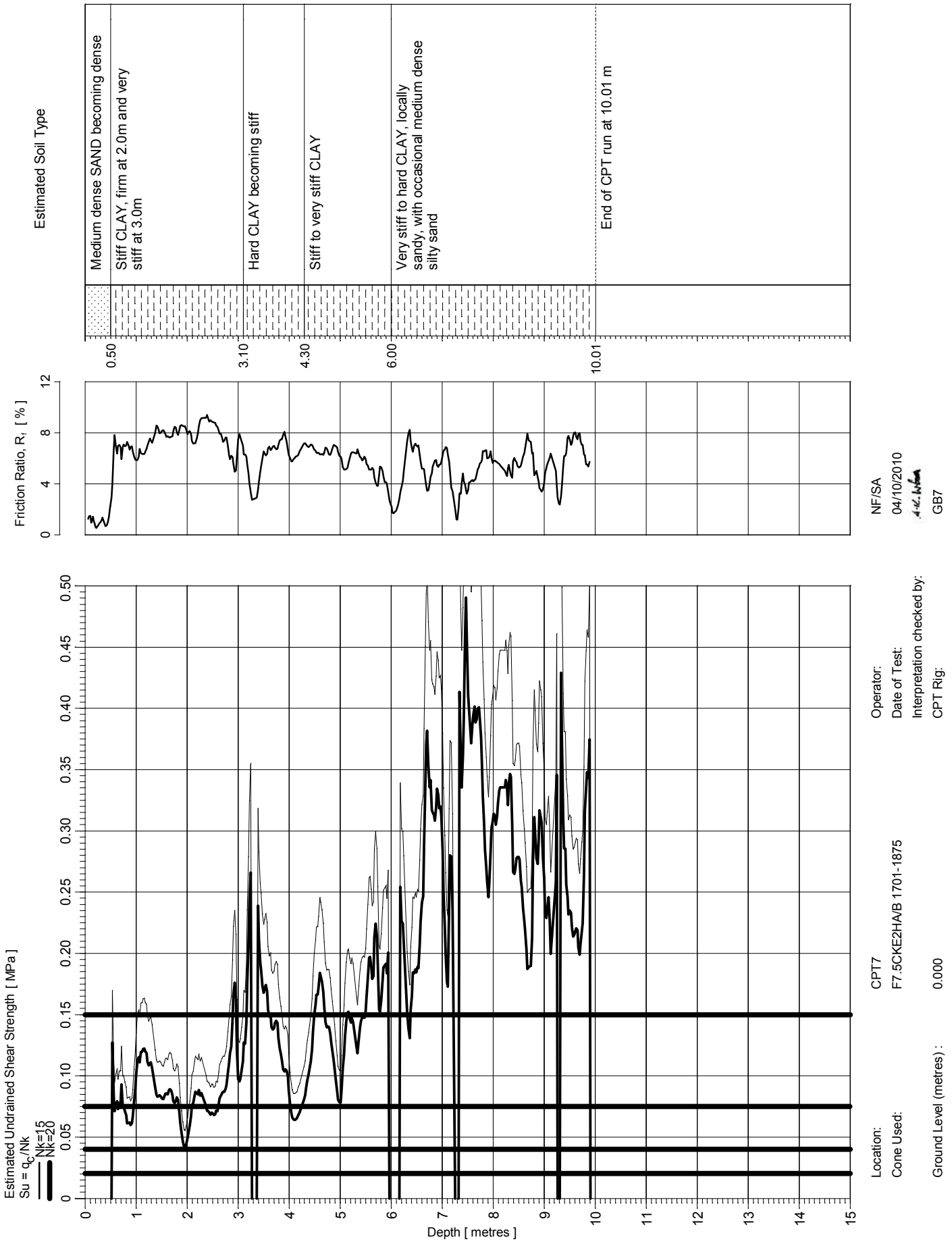
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT6

Contract No:CPT101161

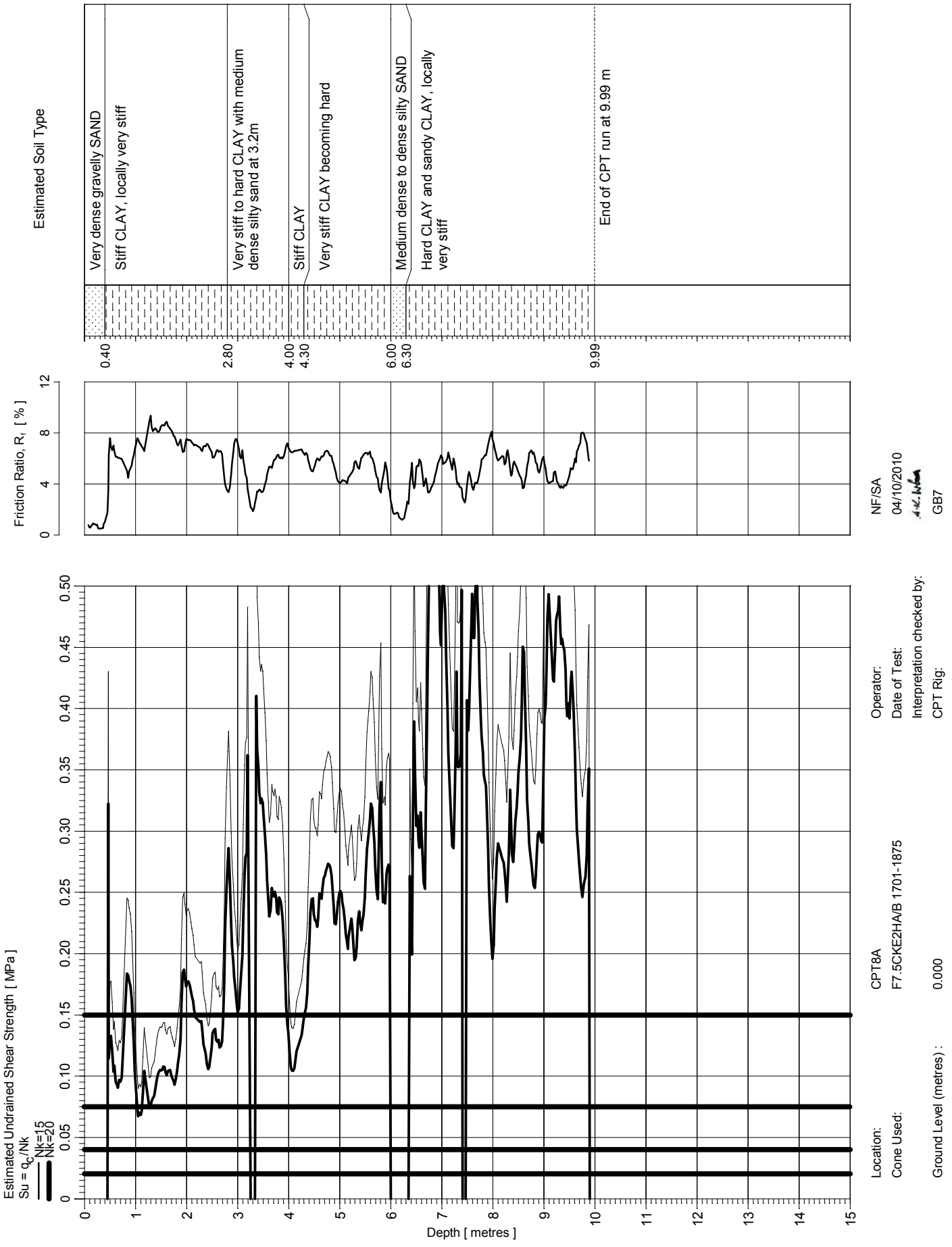
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT7

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



Checked by PJS Date: 19/10/2010 Approved by: Date: 19/10/2010

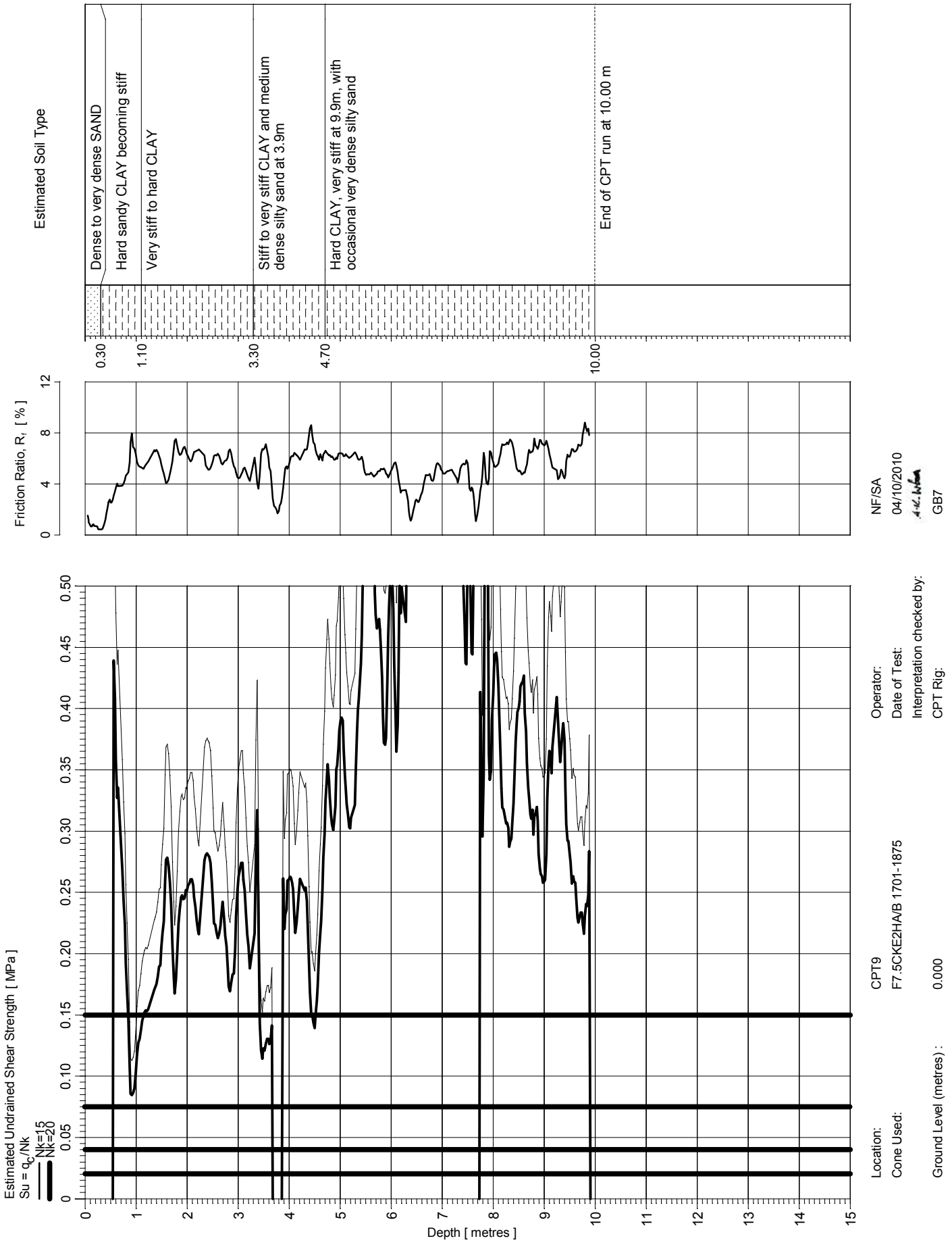
Location: CPT8A
Cone Used: F7.5CKE2HA/B 1701-1875
Ground Level (metres) : 0.000

Operator: NF/SA
Date of Test: 04/10/2010
Interpretation checked by:
CPT Rig: GB7

STATIC CONE PENETRATION TEST CPT8A

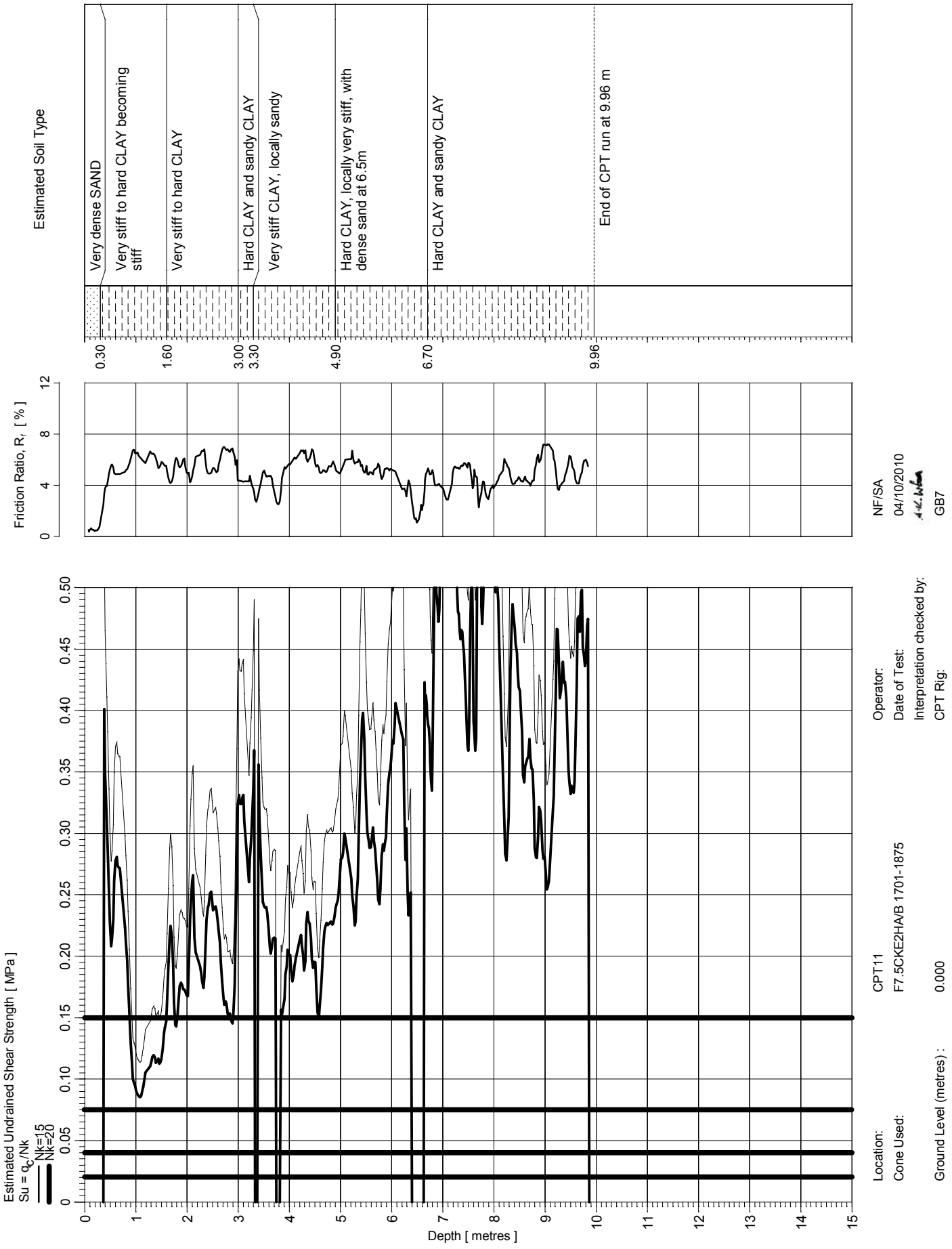
Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

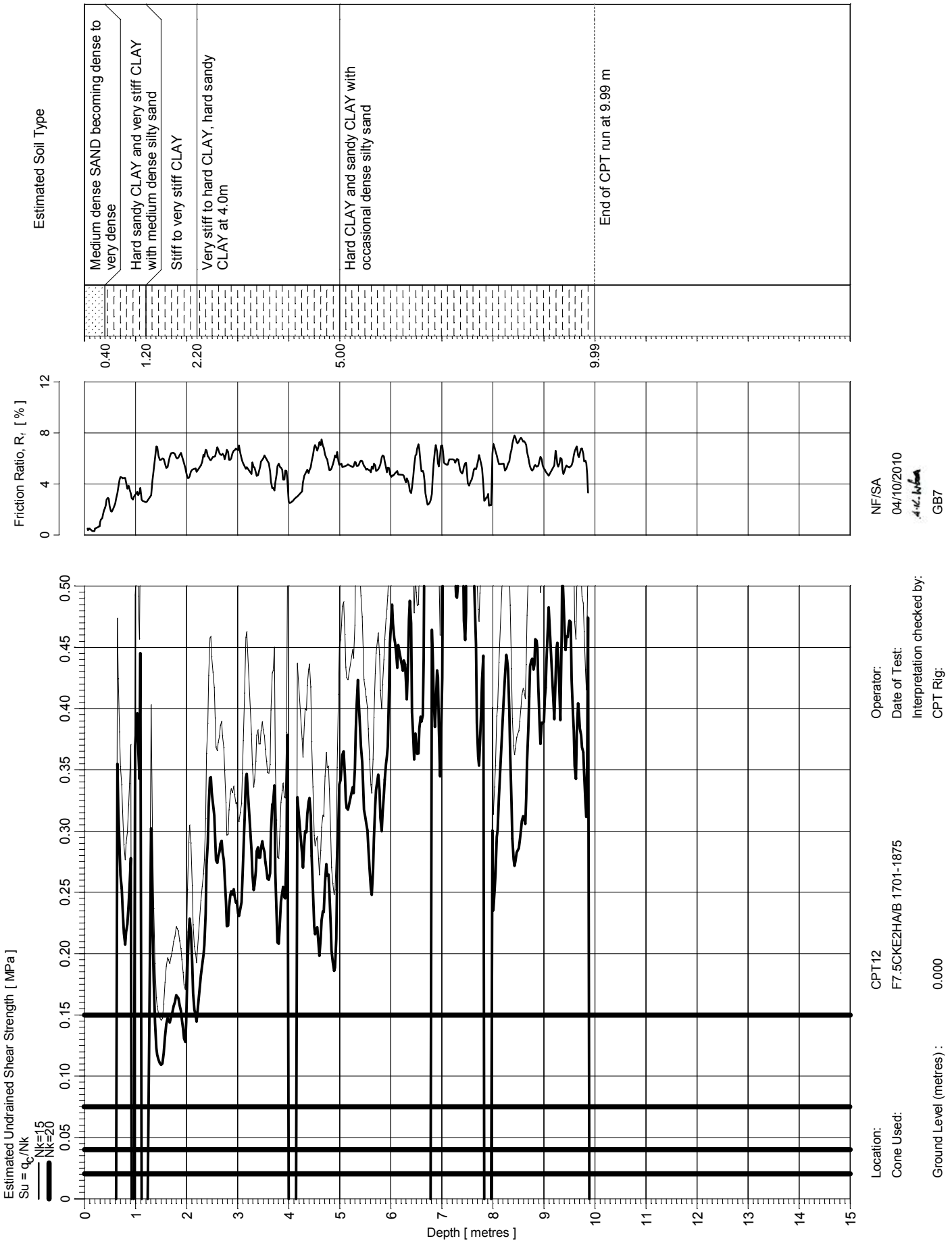


STATIC CONE PENETRATION TEST CPT9

Contract No:CPT101161


Estimated Soil Type
Very dense SAND
Very stiff to hard CLAY becoming stiff
Very stiff to hard CLAY
Hard CLAY and sandy CLAY
Very stiff CLAY, locally sandy
Hard CLAY, locally very stiff, with dense sand at 6.5m
Hard CLAY and sandy CLAY
End of CPT run at 9.96 m
0.30
1.60
3.00
3.30
4.90
6.70
9.96
Friction Ratio, R_f [%]
0
4
8
12
Estimated Undrained Shear Strength [MPa]
Su = q_c/Nk
Nk=15
Nk=20
0
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Depth [metres]
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Location: CPT11
Cone Used: F7.5CKE2HA/B 1701-1875
Ground Level (metres) : 0.000
Operator: NF/SA
Date of Test: 04/10/2010
Interpretation checked by:
CPT Rig: GB7
Checked by PJS Date: 19/10/2010
Approved by Date: 19/10/2010

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY

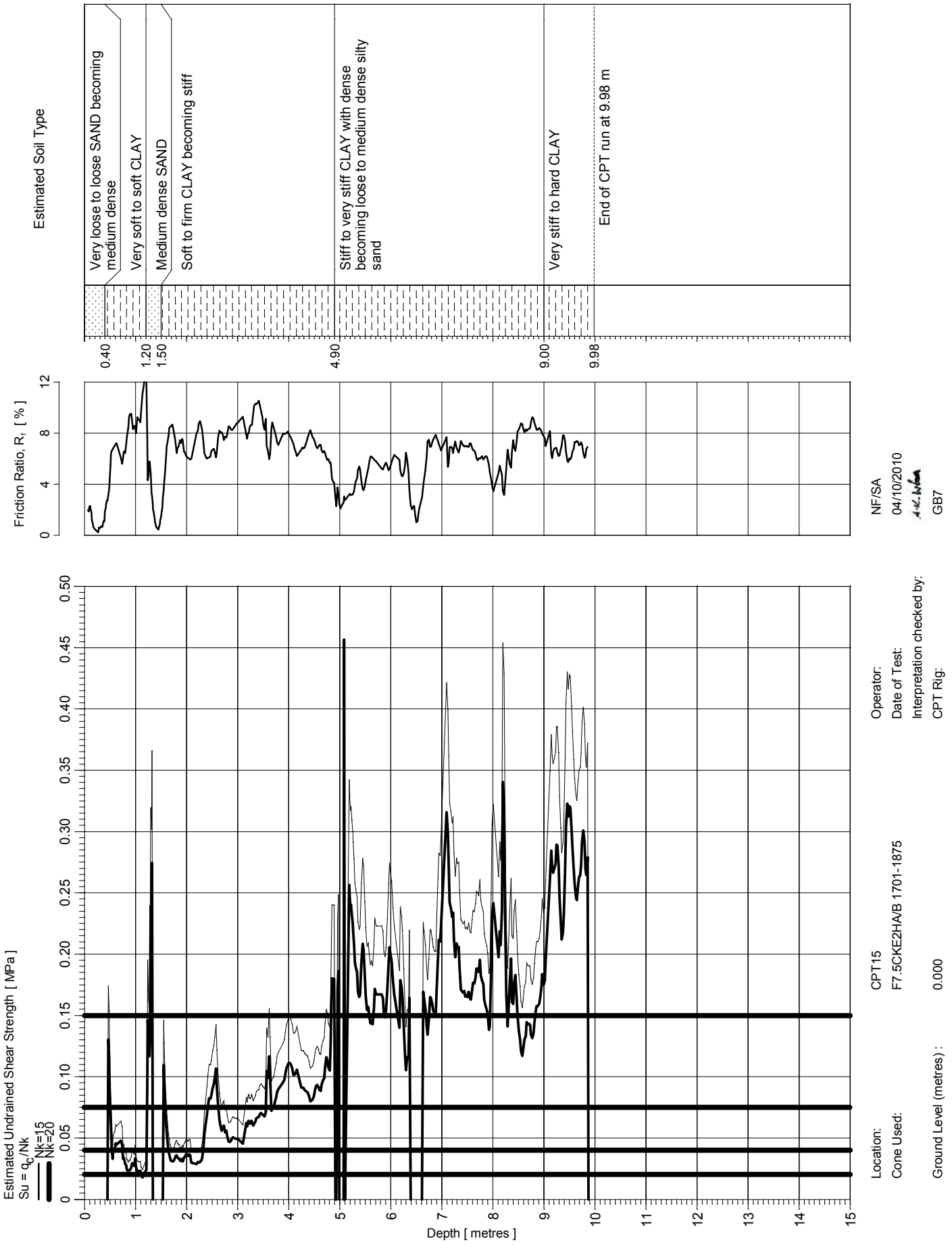


Checked by PJS Date: 19/10/2010 Approved by Date: 19/10/2010

STATIC CONE PENETRATION TEST CPT12

Contract No:CPT101161

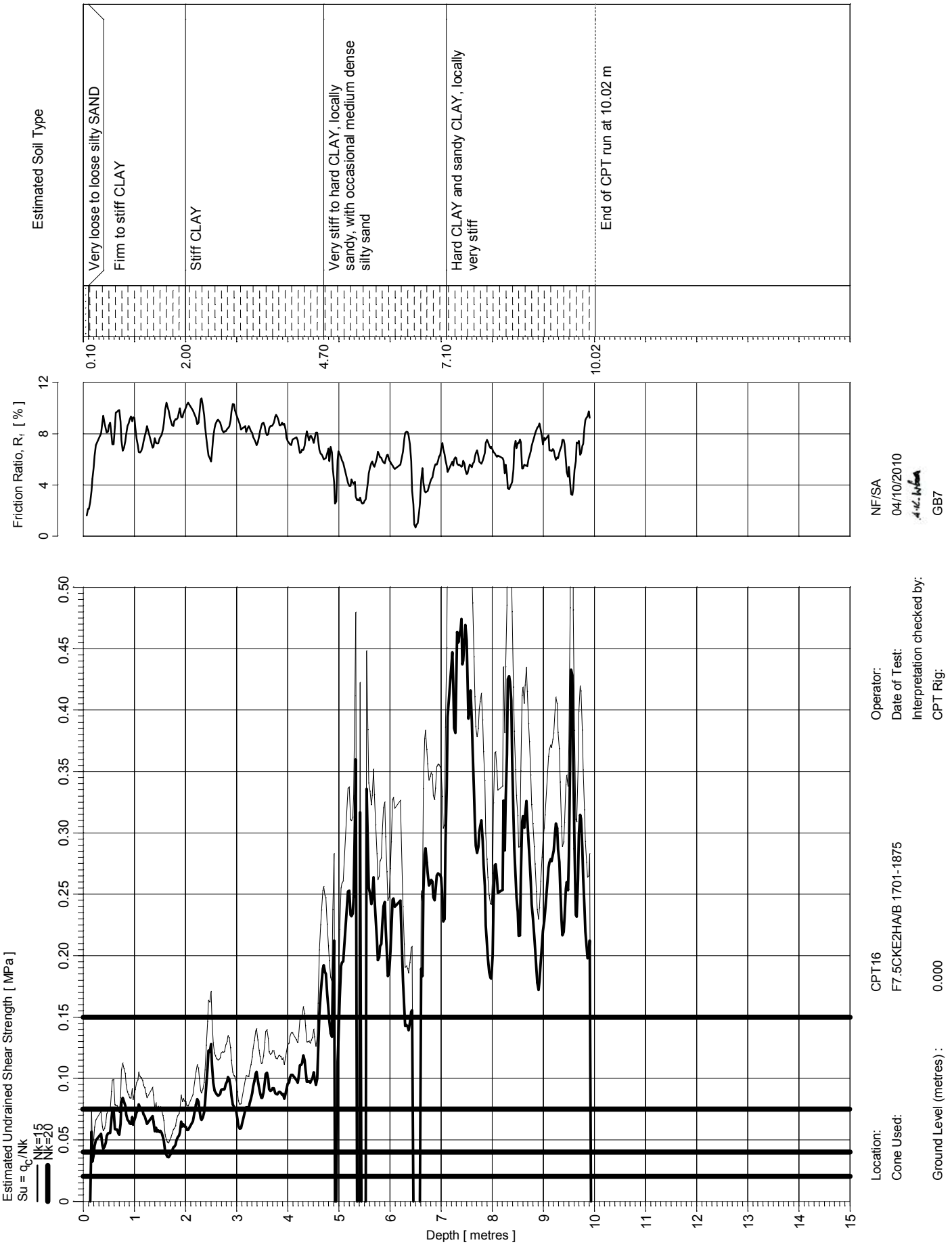
TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



STATIC CONE PENETRATION TEST CPT15

Contract No:CPT101161

TRENDREVEL SERVICES LTD
BALCOMBE RIG SITE, SOUTH CRAWLEY



Checked by PJS Date: 19/10/2010 Approved by Date: 19/10/2010

Operator: NF/SA
Date of Test: 04/10/2010
Interpretation checked by:
CPT Rig: GB7

Location: CPT16
Cone Used: F7.5CKE2HA/B 1701-1875
Ground Level (metres) : 0.000

STATIC CONE PENETRATION TEST CPT16

Contract No:CPT101161

APPENDIX D

Site Surface Water Drainage Calculations

Angus Energy Plc

Balcombe 2z Hydrocarbon Well Testing

Planning Permission Ref: WSCC/040/17/BA

Discharge of Planning Condition 8

P661913

AUGUST 2018

RSK GENERAL NOTES

Project No.: P661913

Title: Balcombe 2z Hydrocarbon Well Testing: Discharge of Planning Conditions 8

Client: Angus Energy Plc

Date: 10th August 2018

Office: Helsby

Status: Rev06

Author	David Johnson	**Technical reviewer**	Wendy Hogben
Signature		Signature	
Date:	10/08/2018	Date:	10/08/2018

Project manager	David Johnson
Signature	
Date:	10/08/2018

CONTENTS

1 INTRODUCTION

Angus Energy Plc is seeking to discharge a number of planning conditions in relation to the exploration and appraisal of the existing hydrocarbon lateral borehole at Lower Stumble Hydrocarbon Exploration Site, London Road, Balcombe, Haywards Heath, West Sussex, RH17 6JH.

Planning permission for the works (Ref: WSCC/040/17/BA) was received from West Sussex County Council on 27th October 2017.

This report provides information to discharge Planning Condition 8: Surface Water Drainage Scheme.

Table 1-1: Planning Condition to be Discharged

Planning Condition Number	Planning Condition
8	Development shall not begin until a scheme of surface water drainage has been submitted to and approved in writing by the Minerals Planning Authority. Details shall include: • Design for 1:100 year return period. • Inclusion of 30% peak run-off and 20% additional volume for climate change. • Infiltration rates and groundwater levels shall be determined by site investigation and/or testing during the winter period • Inclusion of a suitable freeboard above the seasonal high groundwater table (minimum 1m unless otherwise agreed by the Minerals Planning Authority's engineers). • Consideration of overland flows (pluvial impact). • Evidence of agreement with the Local Water Authority. • Assessment of pollution control measures. The approved scheme shall thereafter be implemented in full and maintained throughout the duration of the development.

This document has been prepared by RSK Environment Ltd on behalf of Angus Energy Plc.

2 CONDITION 8: SURFACE WATER DRAINAGE SCHEME

2.1 Action to Discharge Condition

An assessment of flood risk and drainage was undertaken as part of the 2017 planning application (WSCC/040/17/BA), which also referenced previously submitted documentation in support of the 2013 planning application (WSCC/063/13/BA). A new surface water drainage scheme has been now been developed for the project.

2.1.1 Site Drainage

ANGS are committed to continuous improvement of environmental performance and management and the prevention of pollution from activities they undertake. The ANGS management team alongside a number of consultants inspected the Balcombe well site and the existing containment infrastructure and have made an informed decision to install new containment infrastructure prior to the well test operation. ANGS will comply with all applicable legislation, industry guidelines and, as far as practicable, accepted best practice in environmental management.

An impermeable membrane will be installed measuring approximately 62.5 x 40m. A perimeter bund (height 300mm) from used railway sleepers (2 x railway sleepers at 150mm height) will be laid and protective geotextile 300g/m^2 shall be laid on top of the stone surface area within the bund.

A fully welded 1.0mm textured HDPE membrane will be laid on top of the geotextile area and fixed to the top of sleepers. The HDPE membrane is textured to prevent slippage. A further 300g/m^2 protective geotextile over HDPE area has been fixed to the perimeter sleepers.

An access ramp in/out of the area in timber/stone will be installed. To protect the HDPE membrane further, 100mm thick rig mats (5m x 1m) will be provided to the entire area excluding 3m x 3m for the cellar.

The fuel tank will be double skinned (secondary containment) in line with the Oil Storage Regulations. Chemicals are stored in containers containing drip trays. Any oils, diesels, chemicals in use shall be stored on drip trays.

The concrete slab has Aco drains flowing into the cellar forming a sealed impermeable area. The surface water from the pad will be directed into the cellar and be disposed of off-site via a suction tanker to a waste water treatment works.

Surface water and water used in the well test operation on the 15m x 14m pad will be contained within the site and removed as necessary by tanker ensuring no offsite discharges from this area.

The impermeable membrane will be designed to accommodate the 1 in 100 year rainfall event, plus a 30% increase in rainfall resulting from climate change.

Based on the surface area of the impermeable membrane (62.5m x 40m), an increase in impermeable area at the site of 2, 500m^2 is anticipated. The impermeable membrane

and perimeter bund ensures that no surface water runoff from the pad area is discharged to the surrounding water environment or to the ground.

The volume surface water from the impermeable membrane will be attenuated in storage tanks, with freeboard provided through the incorporation of the perimeter bund. To enable the storage of the surface water runoff from the site during a 1 in 100 year (plus 30% climate change event), perimeter bunds of a nominal height of 300mm should be installed. The total capacity of the bunded area in line with the above is 750m^3.

Based on the specifications noted above, a maximum attenuated storage capacity of 475m^3 is to be provided in storage tanks, sufficiently accommodating the 1 in 100 year plus climate change volume of 466m^3. (based on a CV of 1.0 as requested by West Sussex Council) The remaining capacity in the bunded area as noted above, provides a measure of freeboard for further events.

The above calculations assumes that all surface water falling during a 1 in 100 year event (including a climate change factor) on the impermeable membrane is retained on site prior to recycling or removal from the site via suction tanker, and as such does not have a discharge rate attributed to the area.

Calculations to support the drainage strategy are included in Appendix 1.

The remainder of the site compound (measuring approximately 90m x 55m) will continue to infiltrate into the underlying strata, albeit at a reduced rate due to the compacted stone laid to facilitate vehicle movements and site activity. Infiltration rates will be confirmed though on site investigation.

A French drain runs along the site compound perimeter. An oil interceptor has been built into the drainage system along with a sump. A 150mm butterfly valve system is in place to prevent discharge from the site. The valve is accessible from a manhole cover situated adjacent to the oil interceptor. The valve will be shut during the operational phase of work and any excess water tankered offsite.

Whilst the site is not operational the overflow outlet pipe from the perimeter French drain discharges via a trickle flow to the watercourse approximately 60m to the southeast of the site.

The Site HSE Advisor will visually inspect the butterfly valve on a daily basis during drilling and well testing. No discharges are allowed from the oil interceptor at any time.

There will be no discharge to local watercourses from the pad area and no silting will arise as a result of the on-site exploratory operations.

2.1.2 Flood Risk

2.1.2.1 Fluvial Flood Risk

The site of the pad and the access track from London Road are located within the Environment Agency (EA) Flood Zone 1. This is the low risk flood zone considered to have a less than 1 in 1000 year (i.e. a probability of less than 0.1%) chance of flooding from rivers or streams.

2.1.2.2 Surface Water (Pluvial) Flood Risk

According to Environment Agency data, the majority of the site is shown to be at a very low risk from surface water flooding. Two isolated areas of 'low' and 'low to medium' risk are shown adjacent to the southeast and southwest site boundary respectively.

The site is located within an area considered by the Strategic Flood Risk Assessment (SFRA) prepared by West Sussex County Council to have a low to medium risk of flooding from surface water flows.

2.1.2.3 Groundwater Flood Risk

The site is located within an area that is considered to be potentially at medium risk of flooding from groundwater flooding according to Flood Map G of the SFRA prepared by West Sussex County Council (2010). However, given the underlying geology, and as the site is on ground that is locally elevated above the valley floor and outside of the fluvial floodplain (considered indicative of potentially worst case groundwater flooding potential), it is concluded to be at low risk from this source of flooding.

2.1.2.4 Conclusion

Given the site setting within the local topography of the surrounding land, the site is not considered to be at risk from surface water (overland flow) flooding and therefore no site-specific flood risk mitigation measures are recommended.

2.1.3 Summary

It is considered that the above information provides sufficient reassurance that the proposed surface water drainage installation at the site is appropriate and sufficient, and that further design and assessment is not required.

APPENDIX 1: MICRODRAINAGE CALCULATIONS

Summary of Results for 100 year Return Period (+30%)

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
15 min Summer	98.160	0.160	75.2	O K
30 min Summer	98.217	0.217	101.9	O K
60 min Summer	98.280	0.280	131.7	O K
120 min Summer	98.349	0.349	163.8	O K
180 min Summer	98.389	0.389	183.0	O K
240 min Summer	98.419	0.419	196.8	O K
360 min Summer	98.464	0.464	218.2	O K
480 min Summer	98.499	0.499	234.3	O K
600 min Summer	98.526	0.526	247.4	O K
720 min Summer	98.550	0.550	258.5	O K
960 min Summer	98.589	0.589	276.8	O K
1440 min Summer	98.647	0.647	304.1	O K
2160 min Summer	98.709	0.709	333.3	O K
2880 min Summer	98.756	0.756	355.1	O K
4320 min Summer	98.825	0.825	387.6	O K
5760 min Summer	98.878	0.878	412.5	O K
7200 min Summer	98.922	0.922	433.2	O K
8640 min Summer	98.959	0.959	450.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	120.318	27
30 min Summer	81.509	42
60 min Summer	52.662	72
120 min Summer	32.767	132
180 min Summer	24.403	192
240 min Summer	19.681	252
360 min Summer	14.546	372
480 min Summer	11.717	492
600 min Summer	9.898	612
720 min Summer	8.618	732
960 min Summer	6.920	972
1440 min Summer	5.068	1452
2160 min Summer	3.703	2172
2880 min Summer	2.959	2892
4320 min Summer	2.154	4332
5760 min Summer	1.719	5776
7200 min Summer	1.444	7216
8640 min Summer	1.252	8656

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Volume (m³)	Status
10080 min Summer	98.992	0.992	466.5	O K
15 min Winter	98.160	0.160	75.2	O K
30 min Winter	98.217	0.217	101.9	O K
60 min Winter	98.280	0.280	131.7	O K
120 min Winter	98.349	0.349	163.8	O K
180 min Winter	98.389	0.389	183.0	O K
240 min Winter	98.419	0.419	196.8	O K
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8640 min Winter	98.959	0.959	450.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
10080 min Summer	1.111	10096
15 min Winter	120.318	27
30 min Winter	81.509	42
60 min Winter	52.662	72
120 min Winter	32.767	132
180 min Winter	24.403	192
240 min Winter	19.681	252
360 min Winter	14.546	372
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10080 min Winter	1.111	10096

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.333	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.250

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.083	4-8	0.083	8-12	0.083

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	470.0	1.000	470.0	1.001	0.0