

APPENDIX 8.6
AGEC Geotechnical Assessment Report

CORRIB FIELD DEVELOPMENT

PRELIMINARY GEOTECHNICAL DESIGN FOR SRAHMORE PEAT DEPOSITION SITE

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DOCUMENT APPROVAL FORM

Document title:	Preliminary Geotechnical Design for Srahmore Peat Deposition Site		
File reference Number:	382_044	Document Revision No.	2
Note: Amendments marked with line in right-hand margin			
File Reference Number	Document Revision No.	Amendment/Comment	

Task	Nominated authority	Approved (signature and date)
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TABLE OF CONTENTS

		<u>Page No.</u>
	DOCUMENT APPROVAL FORM	ii
	TABLE OF CONTENTS	iii
1	INTRODUCTION	1
2	SITE DESCRIPTION	2
3	PROPOSED WORKS	3
4	SUPERFICIAL DEPOSITS	4
	4.1 Peat	4
	4.2 Glacial Till	4
	4.3 Weathered Rock	5
5	SOLID BEDROCK GEOLOGY	6
6	GROUND INVESTIGATION	7
	6.1 Fieldwork	7
	6.2 Laboratory Testing	7
7	TOPOGRAPHIC SURVEY	8
8	GEOTECHNICAL ASSESSMENT	9
	8.1 General	9
	8.2 Factor of Safety for Earthworks Stability	9
	8.3 Stability Analysis	9
9	DESIGN PARAMETERS	10
	9.1 Peat	10
	9.2 Ex situ Peat	11
	9.3 Mineral Soil (Glacial Till)	11
10	PRELIMINARY DESIGN GROUND PROFILE	13
	10.1 General	13
	10.2 Peat Layer	13
	10.3 Mineral Soil (Glacial Till) Layer	13
11	GEOTECHNICAL DESIGN AND STABILITY RESULTS	14
	11.1 Area 6	14
	11.2 Area 5	15
	11.2.1 Access Road from R313	15

	11.2.2 Peat Transfer Area	16
12	CONSTRUCTION	17
	12.1 General	17
	12.2 Geotechnical Instrumentation	17
13	REFERENCES	18

TABLES (within text)

Table 1	Adopted Design Parameters for In Situ Peat
Table 2	Adopted Design Parameters for Ex Situ Peat
Table 3	Adopted Design Parameters for Mineral Soil
Table 4	Summary of Slope Factor of Safety in Area 6

FIGURES (at end of text)

Figure 1	Site Location
Figure 2	Site Layout Plan
Figure 3	Profile of Undrained Shear Strength (c_u) of Peat with Depth from CPT Results
Figure 4	Factor of Safety for Global Stability - Case (1)
Figure 5	Factor of Safety for Localised Stability - Case (2)

APPENDICES

Appendix A	Phase 1 Ground Investigation Results
Appendix B	Phase 2 Ground investigation Results
Appendix C	Review of Effective Stress Parameters for Peat
Appendix D	Risk Register

DRAWINGS

Drawing No. 382_001	Preliminary Design Ground Profile for Areas 5 & 6 – Section 1-1
Drawing No. 382_002	Preliminary Design Ground Profile for Areas 5 & 6 – Section 2-2
Drawing No. 382_003	Preliminary Design Ground Profile for Areas 5 & 6 – Section 3-3

1 INTRODUCTION

The Srahmore Peat Deposition Area is located about 1 km west of Bangor, County Mayo. The site is situated between the R313 and Bangor to Gweesalia roads in an area formerly used for peat harvesting by Bórd na Mona (Figure 1).

It is proposed to use the site as a deposition area for peat arisings from the excavation for the proposed gas terminal platform located at Bellanaboy, County Mayo.

Applied Ground Engineering Consultants Ltd (AGEC) was engaged in November 2003 by Shell E&P Ireland Ltd to carry out a preliminary geotechnical design of the site, which included the following.

- (1) Procurement of ground investigation data at site for design.
- (2) Interpretation of ground investigation data and selection of appropriate design parameters.
- (3) Assess and clearly demonstrate that the following elements of the proposed works have an acceptable factor of safety with respect to global and local stability in the temporary as well as permanent condition.
 - (a) Access Roads
 - (b) Deposition Areas
 - (c) Peat Transfer Area and Car park
- (4) A geotechnical risk register prepared for all activities relating to the site and the deposition activities envisaged, with the appropriate corrective and control features identified.
- (5) Observation and instrumentation requirements. The long and short-term requirements, if any, for observation and instrumentation of the site.

Details of site hydrology and drainage together with a summary of soils and geology are addressed in the main Environmental Impact Statement (TES, 2003).

2 SITE DESCRIPTION

The proposed Srahmore Peat Deposition Site (SPDS) is located to the south of the R313 (Figure 1) in an area of relatively flat to gently sloping ground. The natural ground surface at the site slopes gently from northeast to southwest with a fall about 0.2° , that is 5m fall over a distance of 1500m.

Several minor streams drain the site. These streams feed into the Munkin River to the west and the Owenmore River to the south.

The SPDS is in two parts, referred to as Area 5 and Area 6 (Figure 2). Each of these areas originally comprised natural blanket peat which has since been largely cutaway. The depth of peat cutting is some 1.5 to 2.5m.

Peat has been cutaway from Area 5 and 6 leaving a series of high- and lowfields.

- (1) Lowfields comprise areas where peat has been cut-away to near the top of the underlying mineral soil, typically a depth of 1.5 to 2.5m. In places the mineral soil can be seen exposed in the base of the low field. Lowfields are typically 120 to 150m wide and are separated by high fields.
- (2) Highfields comprise a strip of intact peat that has been left upstanding between low fields. The strip is some 15m wide, and has typically been used to facilitate vehicular and train access during peat harvesting operations.

The cutaway areas form an excavated basin within and surrounded by existing peat land. The highfields form internal divides within the cutaway areas which further compartmentalise the cutaway areas into rectangular excavated basins (Figure 2).

3 PROPOSED WORKS

Within the SPDS it is proposed to use Area 5 as a reception area for peat arriving on site. The proposed work in Area 5 will include an access road from the R313. A hardstanding for peat transfer will be constructed at the end of the access road for peat handling and car parking.

Area 6 is proposed to be used as the deposition area for peat excavated from the proposed gas terminal site at Bellanaboy. The proposed average depth of placed peat within the deposition area is given as 1.04m.

The proposed sequence of placing peat in Area 6 is given in the main Environmental Impact Statement (TES, 2003). A summary is given below.

- (1) Low ground bearing pressure (Haku) trailers will transport the peat from the reception area to highfields in Area 6 via internal haul roads constructed on existing peat.
- (2) Haku trailers will travel along internal roadways which will be constructed on highfields in Area 6 and empty the peat by tipping onto the side of the highfield.
- (3) Excavators will remove the peat from the highfield and place the peat onto the lowfield. Peat will then be bulldozed towards the centre of the lowfield to create a cambered surface with highest point in the centre sloping back toward the highfields.
- (4) The height of placed peat will generally be of the order of 1.4 to 1.8m at the highest point in the centre above the existing ground levels, with a fall towards the highfields. The edge of the placed peat will be offset from the bottom toe of each of the highfields where drainage ditches are to be constructed.

4 SUPERFICIAL DEPOSITS

The superficial deposits within the SPDS can be briefly classified into the following main types.

- (1) Peat
- (2) Glacial Till
- (3) Weathered Rock

In general terms all superficial deposit types other than peat may be referred to as mineral soils. Exposures below the base of the peat are limited to trial pits, which indicate till underlying peat. The extent of weathered rock below till is not known, as boreholes were open-holed to top of competent rock.

4.1 Peat

Blanket peat originally covered the site. Most of the peat has been removed from the lowfields, leaving typically less than 1m thickness of peat. Original peat depth was estimated as typically 3 to 4m. Locally deeper areas of peat, up to 6m adjacent to R313, were recorded.

Based on a general soil map of Ireland (An Foras Taluntais, 1980), the site is shown to be covered in low-level blanket/basin peat.

The upper about 1m of peat is generally very fibrous and possibly desiccated which results in a relatively stronger and stiffer upper layer. Peat was described using BS: 5930 (BSI, 1999) as soft slightly moist brown PEAT with occasional fragments and large pieces of bogwood. Peat appeared to lie directly on glacial till.

4.2 Glacial Till

Till, typically derived from local bedrock, underlies the peat. The thickness of till in Area 6 is estimated to vary from 6 to 14m based on the depth of superficial deposits given in borehole logs. Borehole logs do not distinguish between till and weathered rock, and it is possible that weathered rock is present in the lower part of the superficial deposits.

Based on trial pit logs, till is present at some locations as an upper cohesive deposit underlain by a granular deposit. Till was described from trial pits using BS: 5930 as follows.

- (1) Upper cohesive deposit. Described as generally firm brown sandy CLAY. Given the presence of bogwood in the peat, this suggests that prior to peat formation the site was formerly forested, and therefore a buried soil surface layer is likely present. The upper cohesive deposit possibly represents the remnants of a buried soil surface layer. This layer does not appear to be widespread.
- (2) Lower granular layer. Described as generally grey to yellow/brown clayey to slightly clayey occasionally silty gravelly fine- to medium-grained SAND with occasional to some sub-angular to sub-rounded gravels, cobbles and boulders of quartzite, schist and red sandstone. The till is layered, with occasional GRAVEL layers also recorded, though no clear stratification between trial pits was recognisable. The lower granular till layer is widespread and is more commonly found immediately below peat.

4.3 Weathered Rock

Extent and character of weathered rock is not known as borehole logs do not distinguish between till and weathered rock, and it is possible that weathered rock is present at depth. No weathered rock was identified from trial pits which were excavated to about 3m.

5 SOLID BEDROCK GEOLOGY

The bedrock geology of the area of the SPDS consists of rocks of the Dalradian Supergroup Series (GSI, 1992), which comprises essentially metamorphosed sedimentary rock. Boreholes within Area 6 show the depth to rockhead is variable and ranged from about 6 m bgl in BH3B to 14.3m bgl (BH2B).

The dominant rock type below the site is the Inver Schist Formation, which is a pelitic to semi-pelitic schist. Several sub-ordinate rock types also crop below the site along a northwest to southeast axis. These rock types are generally separated by a fault line and include marble, quartzite and psammitic schist.

Borehole records identified both psammite and quartzite bedrock. Psammite was described as moderately weak to moderately strong, narrowly banded, schistose (dipping 75°), fine- to coarse-grained micaceous to extremely micaceous PSAMMITE. In places the psammite was underlain by quartzite (BH1B) or quartzite was recorded at the top of rockhead (BH3B). Quartzite was described as strong to very strong, massive to narrowly banded (dipping 35° and 60°), fine- to medium-grained micaceous QUARTZITE.

Minor folding has been identified within the schists, with cleavage/schistosity dipping towards the northeast at between 35° and 75°.

6 GROUND INVESTIGATION

6.1 Fieldwork

Ground investigation work at the SPDS was carried out in 2 phases. Phase 1 was carried out in October/November 2003 on behalf of TES Consulting Engineers (TES) to determine the nature and extent of geological and hydrological characteristics at the site. Phase 2 was carried out in November/December 2003 on behalf of TES by AGECEC to provide further information for a geotechnical assessment of the site.

Ground investigation works were carried out by Irish Drilling Ltd (IDL) and Fugro Engineering Services Ltd.

The following ground investigation has been carried out at the SPDS.

- (1) Boreholes (7 nos.),
- (2) Trial pits (14 nos.),
- (3) In situ shear vane testing using handheld vane (7 nos.),
- (4) In situ shear vane using rig-mounted mechanical vane, (up to 40 nos.), and
- (5) Cone penetration testing (CPT) (up to 80 nos.).

The above boreholes, and some trial pits, together with permeability/pumping tests within rock were carried out in Phase 1 (Appendix A). The results of permeability/pumping tests are not included in this report.

Trial pits were carried out to a depth of typically 3m using a tracked excavator.

Hand-held shear vanes were generally carried out in trial pits by IDL using a Geonor H-60, 50.8mm diameter vane.

Cone penetration testing (CPT) was carried out by Fugro Ltd using both a 3 tonne mini crawler and 15 tonne mounted CPT rig. The rigs were also used to carry out shear vane testing using a mechanical Geonor H-10, 55mm diameter vane.

Ground investigation results for Phase 1 and 2 are given in Appendix A and B respectively.

6.2 Laboratory Testing

Phase 1 laboratory test results included particle size distribution, five-point compaction and index testing (Appendix A).

Previous experience of laboratory strength testing for peat using a range of triaxial, simple and direct simple shear (DSS) testing apparatus has shown that results can be scattered and difficult to interpret. This is due to the excessive deformations that peat undergoes and the difficulty in defining the resulting failure limit. In situ strength testing possibly provides the most realistic indication of peat strength.

7 TOPOGRAPHIC SURVEY

A topographic survey of the SPDS was carried out on behalf of TES by Bórd na Mona as part of the Phase 1 investigation. This survey has been used to generate the elevation contours used to generate the geological cross-sections (See Drawing Nos. 382_001 to 003).

Additional detailed level survey was carried out by AGECE at specific locations to supplement the topographic survey.

8 GEOTECHNICAL ASSESSMENT

8.1 General

A preliminary geotechnical design and assessment of the following elements of the SPDS has been carried out.

- (1) Global stability of the deposition area (Area 6) prior to and following peat placement,
- (2) Local stability of highfield/lowfield in deposition area (Area 6), and
- (3) Assessment of access road, peat transfer area and car park in Area 5

8.2 Factor of Safety for Earthworks Stability

The code of practice for earthworks BS 6031:1981 (BSI, 1981) provides advice on design of both temporary and permanent earthworks. It states that for a first time failure with a good standard of site investigation the design factor of safety (FoS) of should be 1.3 to 1.4.

For the purpose of peat stability a minimum FoS of 1.3 is required.

8.3 Stability Analysis

Stability analysis was carried out using slope stability computer program Talren (Terrasol, 1997) applying Bishop's rigorous method.

Both total and effective stress analyses were examined. Total stress analysis applies to short-term conditions occurring during construction and for a time following construction until construction induced pore water pressures dissipate. Undrained shear strength values, c_u are used for total stress analysis. Effective stress analysis applies to long-term conditions where construction induced excess pore water pressure has dissipated. Effective strength parameters, c' and ϕ' , are used together with assessed groundwater conditions.

9 DESIGN PARAMETERS

9.1 Peat

Undrained shear strength (c_u) of in situ peat was determined using cautious estimates of c_u . Vane results are presented in Appendix A. The following sources were used to assess c_u for peat:

- (1) In situ vane testing using both hand-held and mechanical,
- (2) In situ cone penetration testing (CPT), and
- (3) Results from neighbouring sites.

In situ vane test results are included in Appendix A. Results indicate that strength ranges typically from about $c_{u \text{ vane}}$ of 10 to 23kPa for unfactored vane results.

Vane results from several works on Irish peat have used unfactored vanes (see for example Hanrahan, 1964, Piggott et al., 1992 and AGECE, 2002). These works back-analysed failures and found that unfactored vane results provided a reasonable estimate of the operating shear strength. Furthermore several of the highfields in Area 6 are upstanding by 1.5m to 2.0m with a sub-vertical face. Back-analysis of these faces shows that a minimum $c_{u \text{ back}}$ of about 10kPa is required for stability.

CPT's were carried out across the site to establish cone resistance (q_c) and hence undrained strength ($c_{u \text{ CPT}}$) with depth in peat (Appendix B). The relationship between $c_{u \text{ CPT}}$ and q_c is based on an approximation of the bearing capacity equation (Sanglerat, 1972) which requires cone factor (N_k) to be determined.

Based on previous experience, $N_k = 15$ was adopted. Previous work (AGECE, 2002 and 2003) indicates that, whilst there is a scatter of data, this provides a reasonable cautious estimate of undrained strength of peat.

Depth profile of peat c_u with depth using CPT results is shown in Figure 3. This shows a stronger and stiffer layer within the upper 1m associated with more fibrous material overlying weaker more amorphous peat. At greater depth, the profile indicates little strength gain with depth. Inspection of exposed peat in the low field areas by AGECE estimated c_u of 10 to 15kPa.

Previous work on blanket peat in North Mayo (AGECE, 2002) determined effective strength parameters (c' and ϕ') for peat from DSS and DS tests. Results showed a lower bound $c' = 3\text{kPa}$ and $\phi' = 32^\circ$. A review of effective strength parameters for peat from Irish and international publications showed that these results are comparative to values used elsewhere (Appendix C).

Adopted design parameters for in situ peat are given in Table 1. These parameters are based on site specific results or results from neighbouring peat sites. In general, the design parameters for peat are within the range reported in the literature.

Parameter/Characteristic	Design Value	Comments
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Bulk unit weight, γ (kN/m ³)	10	-
Effective friction angle, ϕ' (degrees)	32	-
Effective cohesion, c' (kN/m ²)	3	-
Undrained shear strength	<u>Highfield</u> Upper 1m: 15kPa Peat below 1m: 5kPa <u>Lowfield</u> Upper 1m: 10kPa Peat below 1m: 5kPa	-

Table 1 Adopted Design Parameters for In Situ Peat

9.2 Ex situ Peat

The parameters for peat excavated from the gas terminal site are based on several previous site investigations (AGEC, 2002). All peat beneath the terminal is to be removed and placed at the SPDS.

Adopted design parameters for ex situ peat are given in Table 2. These parameters are based on site specific results or results from neighbouring peat sites

Parameter/Characteristic	Design Value	Comments
Bulk unit weight, γ (kN/m ³)	10	-
Effective friction angle, ϕ' (degrees)	-	Not used
Effective cohesion, c' (kPa)	-	Not used
Undrained shear strength, c_u (kPa)	2	Remoulded strength. Based on investigations results presented in AGECE (2002)
Slope inclination	>1v:10h	For long-term stability surface profile of peat to be constructed with the shallowest gradients practicable based on previous experience.

Table 2 Adopted Design Parameters for Ex Situ Peat

9.3 Mineral Soil (Glacial Till)

Mineral soil considered to be glacial till underlies the peat and has a variable thickness. Till consists of two layers, an upper cohesive layer and a lower granular layer. The upper layer is not always present and for preliminary design till is modelled as a granular layer only.

Adopted design parameters are given in Table 3.

Parameter/Characteristic	Design Value	Comments
Bulk unit weight, γ (kN/m ³)	20	-
Effective friction angle, ϕ' (degrees)	32	Assumed medium dense
Effective cohesion, c' (kPa)	0	-
Undrained shear strength, c_u (kPa)	0	-

Table 3 Adopted Design Parameters for Mineral Soil

10 PRELIMINARY DESIGN GROUND PROFILE

10.1 General

Preliminary design ground profile Area 6 is presented in Drawings Nos. 382_001 and 382_002, and preliminary design profile for Area 5 is presented in Drawing No. 382_003.

The drawings show both an exact scaled profile and a profile with an exaggerated vertical scale which highlights more clearly the geometry.

10.2 Peat Layer

Bórd na Mona undertook a peat depth survey of the Srahmore site in 1998, using a 'Hiller Borer' sampler, which is a hollow stem sampler. This sampler was pushed into the peat material and the hollow stem used to indicate depth to mineral soil.

Within Area 5, the survey indicated peat thickness varied from about 0.34m to 0.7m in the zone where it is proposed to construct the peat reception hardstand. The peat thickness along the access road from the R313 to the reception hardstand varied from 0.34m to 6m. The peat thickness being greatest immediately adjacent to the R313, where no peat extraction has been undertaken.

With respect to Area 6, the Hiller Borer survey indicates that between 0.1m and 2.16m of peat overlies the mineral subsoil in the lowfields.

10.3 Mineral Soil (Glacial Till) Layer

Mineral soil underlies the peat. The top surface of the mineral soil is variable with ground investigation results indicating a depth varying between about 3 and 6m. The thickness of mineral soil is estimated as between 6 and 14 m bgl.

11 GEOTECHNICAL DESIGN AND STABILITY RESULTS

11.1 Area 6

Peat is to be placed within the lowfields of Area 6. Stability of lowfields during and following placement of peat has been assessed for the following cases.

- (1) Global stability of the deposition area (Area 6) prior to and following peat placement.
- (2) Local stability of highfield/lowfield in deposition area (Area 6).

Stability results are presented in Table 4 and Figures 4 and 5. A surcharge of 10 kPa is assumed to represent construction traffic for Case (2).

Case	Minimum Factor of Safety				Comments
	Total Stress Analysis		Effective Stress Analysis		
	Existing	Filled	Existing	Filled	
(1)	5.76	>20	3.21	>20	See Figure 4
(2)	1.39	4	1.37	1.46	See Figure 5

Table 4 Summary of Slope Factor of Safety in Area 6

For Case (1) the FoS is high, as would be expected given the geometry of the area. The minimum FoS of 3.21 is prior to filling for global failure along perimeter of deposition (Figure 4a and b). This is greater than the required minimum of 1.3.

Where peat is placed within Area 6, global stability analyses were carried out assuming potential translational failure below deposition area. Stability along Section 2-2 (Drawing No. 382_002) was examined together with stability along the lowfield to the south of Section 1-1 (Drawing No. 382_001). The calculated FoS is greater than 20 (Figure 4c to h). The high FoS indicates that such a failure mode is inapplicable.

Case (2) examined local stability within Area 6. The minimum FoS of 1.37 for local stability was found for potential side-slope failure of highfield (Figure 5a and b). Where a surcharge load is placed up to the edge of the highfield the FoS reduces to less than 1.3 within about 2m of the edge of the highfield. Siting of concentrated loads close to the edge of the highfield, may result in localised side slope failure of highfield, and is to be avoided.

Local stability of placed peat in the western end of the lowfield was examined. This shows a minimum FoS of 1.46 (Figure 5d) and assumes failure surface passes through intact peat below placed peat. Some minor slippage of placed peat may occur from the face of the peat until such time as plant cover can be established on the placed peat surface.

Further analyses examined potential failure of placed peat between highfields (Figure 5e and f). This shows minimum FoS of 11.62.

11.2 Area 5

Within Area 5 it is proposed to construct an access road from the R313 to a hardstanding area for peat transfer. The hardstanding will be used for transferring peat received from the Bellanaboy site on to onto specialist low ground bearing machinery for transport to deposition in Area 6.

A geotechnical assessment of access road and peat transfer area was carried out.

11.2.1 Access Road from R313

The peat thickness along the access road from the R313 to the reception hardstand varies from 0.34m to 6m based on Bórd na Mona's peat depth survey. The peat thickness is greatest immediately adjacent to the R313, where no peat extraction took place (Drawing No. 382_003).

Where peat is to remain below the access road, then estimated settlements up to 1m would be expected. This settlement is likely to be differential varying with applied loading and thickness of peat.

Bearing failure of the road has been assessed. This indicates that where peat is left below the road, the road foundation requires a biaxial geotextile, such as Tensar SS30/40 or similar, laid within a suitable granular fill. Whilst this may reduce the potential for bearing failure and limit localised differential settlement, the total predicted settlement is likely to disrupt the running surface.

Preliminary design options are as follows.

- (1) Peat should be removed from below the road where it is proposed to construct a metalled road surface. Where there is significant depth of peat then excavations need to be fully supported. Partial removal of peat may be a viable option where it can be shown that significant settlement and bearing failure do not adversely affect the road. Alternatively stabilising peat in situ is an option, see below
- (2) Where there is a significant depth of peat, modification of peat in situ can be carried out using for example vibro-compacted concrete columns, stone columns, in situ mixing of peat with cement and lime.
- (3) Where no metalled road surface is required then peat can be left in place. Road construction would then consist of a suitable granular fill reinforced with a biaxial geogrid, such as Tensar SS30/40 or similar. This construction would require periodic re-levelling and grading to maintain an acceptable running surface.

11.2.2 Peat Transfer Area

Trial pit (TP2) was excavated in the area of the proposed hardstanding for the peat transfer area (Drawing No. 382_003). The depth of peat encountered was 0.65m underlain by mineral soil. These ground conditions do not represent any great difficulty with respect the proposed construction.

Where peat is to remain below the hardstanding, then settlements of the order of about 200mm would be expected. This settlement is likely to be differential varying with applied loading and thickness of peat.

Preliminary design options are as follows.

- (1) Peat should be removed from below the hardstanding where it is proposed to construct a metallised surface to the hardstanding.
- (2) Where no surface to the hardstanding is proposed then a suitable granular fill reinforced with a biaxial geogrid, such as Tensar SS30/40 or similar, would suffice. This construction would require periodic re-levelling and grading of hardstanding surface.

12 CONSTRUCTION

12.1 General

An assessment of geotechnical hazard and associated risk for the proposed construction is presented in Appendix D. The risk assessment identified no significant risks with respect to major failure or instability associated with the proposed works.

All geotechnical hazards were classified as trivial risk. Of the 6 likely geotechnical hazards identified for the works (see Table in Appendix D), 5 of these hazards affect the site work only and have no impact beyond the site boundary. The highest risk is associated with possible settlement and bearing failure of the access road from the R313. Where this road is constructed on peat then monitoring of road performance is required. Disruption of this road would have a high impact on the works.

12.2 Geotechnical Instrumentation

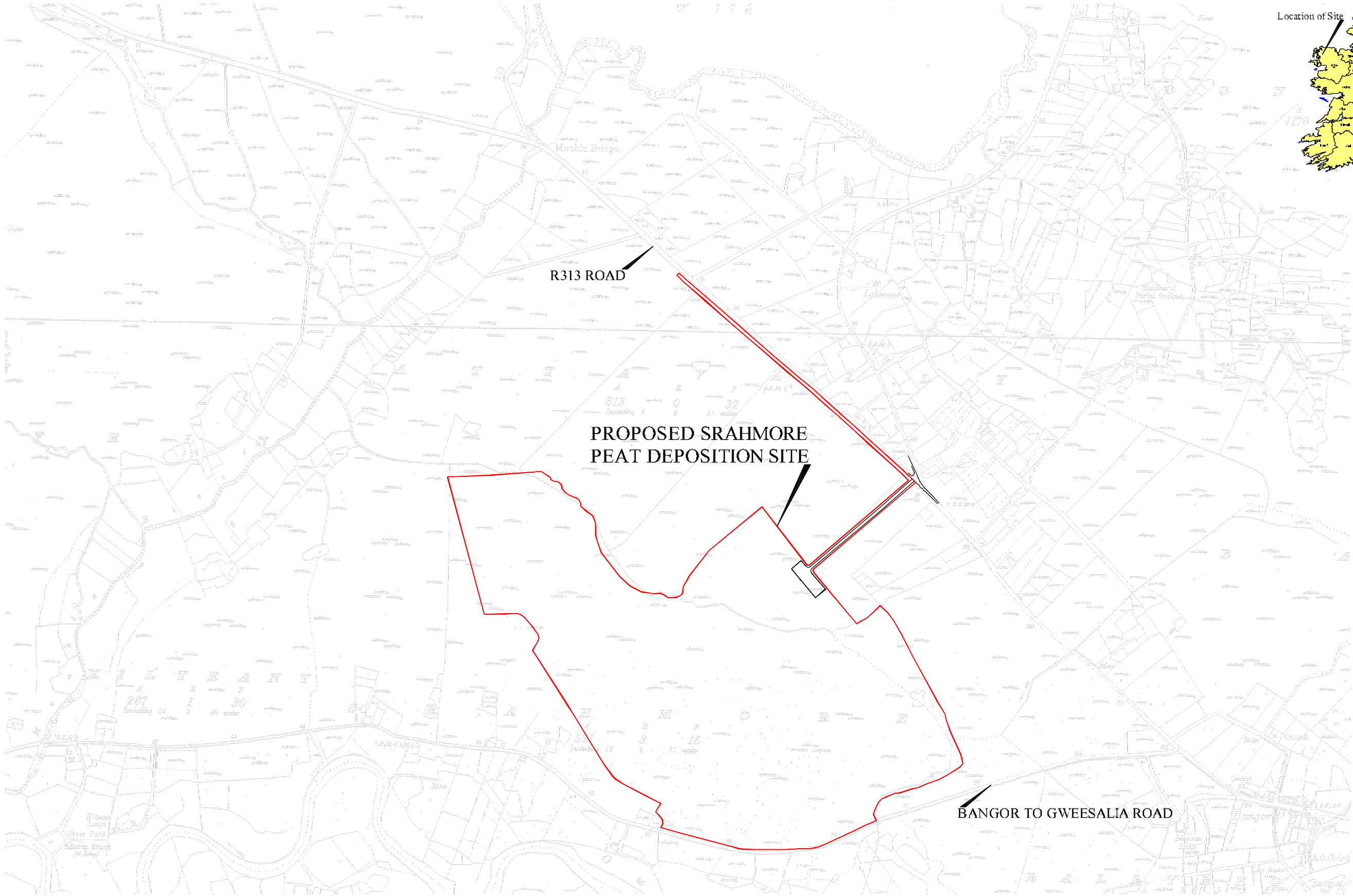
Geotechnical instrumentation is required to monitor key performance criteria and validate the design. Instrumentation is usually required to monitor horizontal and vertical displacement of the ground or construction access road embankments.

Given the low geotechnical risk associated with the proposed works, at the preliminary stage no requirement for geotechnical monitoring is envisaged.

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FIGURES



Notes:	
Scale: 1:12500	Checked: P.J.
Date: 09/12/03	Revision: A
Drawn: P.O.R.	Based on: 382_018

Client



Job:

Preliminary Geotechnical Design for
Srahmore Peat Deposition Site

Figure 1

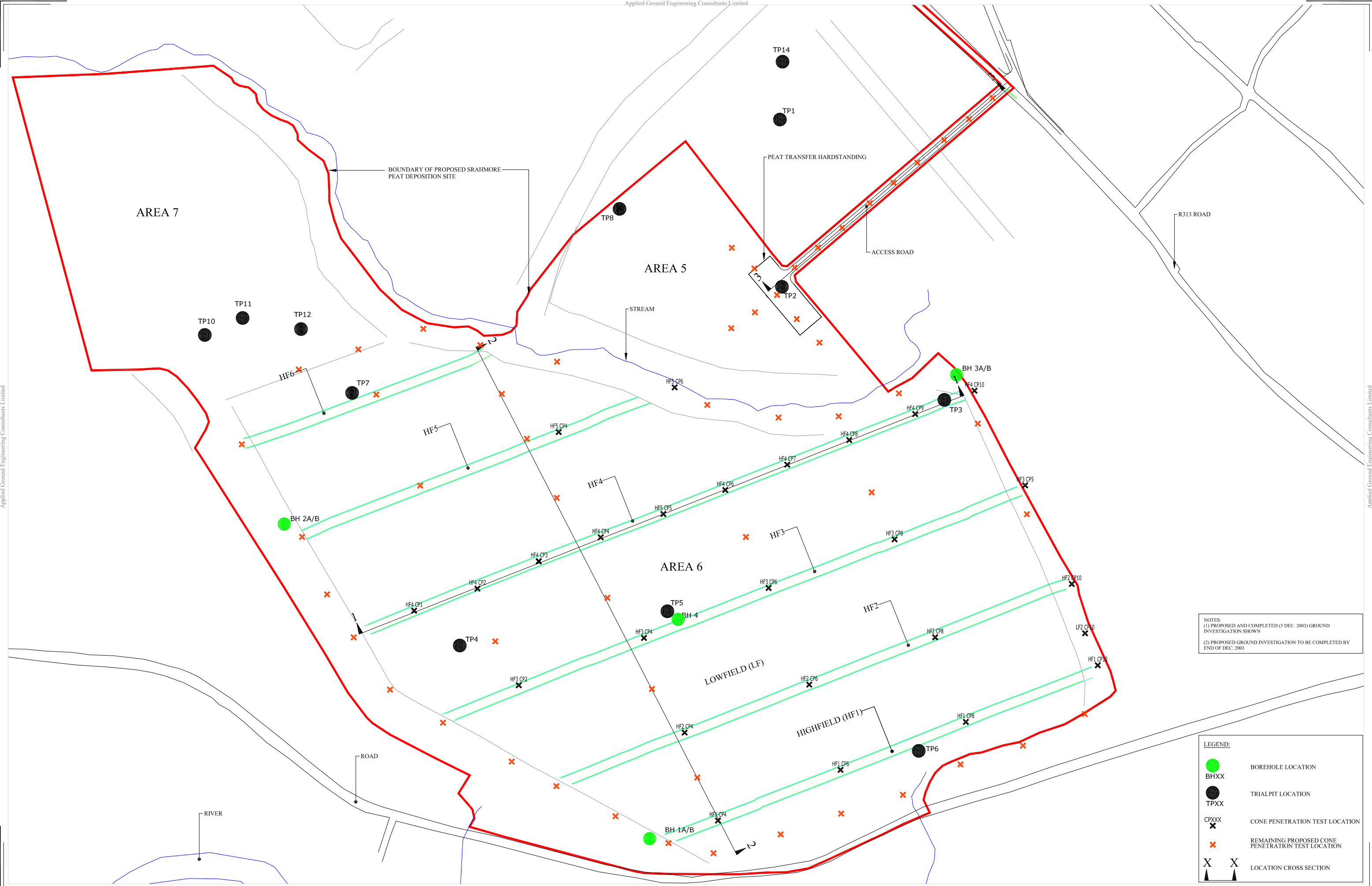
Title:
Site Location

AGEC Ltd
5 Kilcarrig Street
Baginbown
Carlow
Ireland



Tel: +353 503 23800
Fax: +353 503 23793

www.agcc.ie
info@agcc.ie



NOTES:
(1) PROPOSED AND COMPLETED (5 DEC. 2003) GROUND INVESTIGATION SHOWN
(2) PROPOSED GROUND INVESTIGATION TO BE COMPLETED BY END OF DEC. 2003

LEGEND:

- BOREHOLE LOCATION
- TRIALPIT LOCATION
- CONE PENETRATION TEST LOCATION
- REMAINING PROPOSED CONE PENETRATION TEST LOCATION
- LOCATION CROSS SECTION

Further notes:

Notes:

Scale: 1:2500 (A1)
Date: 09/12/03
Drawn: P.O.R.

Checked: P.J.
Revision: A
Based on: 382_03,018

Client:



Job:

Preliminary Geotechnical Design for Srahmore Peat Deposition Site

Figure 2

Site Layout Plan

AGEC Ltd
5 Kilcarrig Street
Bagenalstown
Carlow
Ireland
Tel: 353-503-23800
Fax: 353-503-23793



www.agec.ie
info@agec.ie

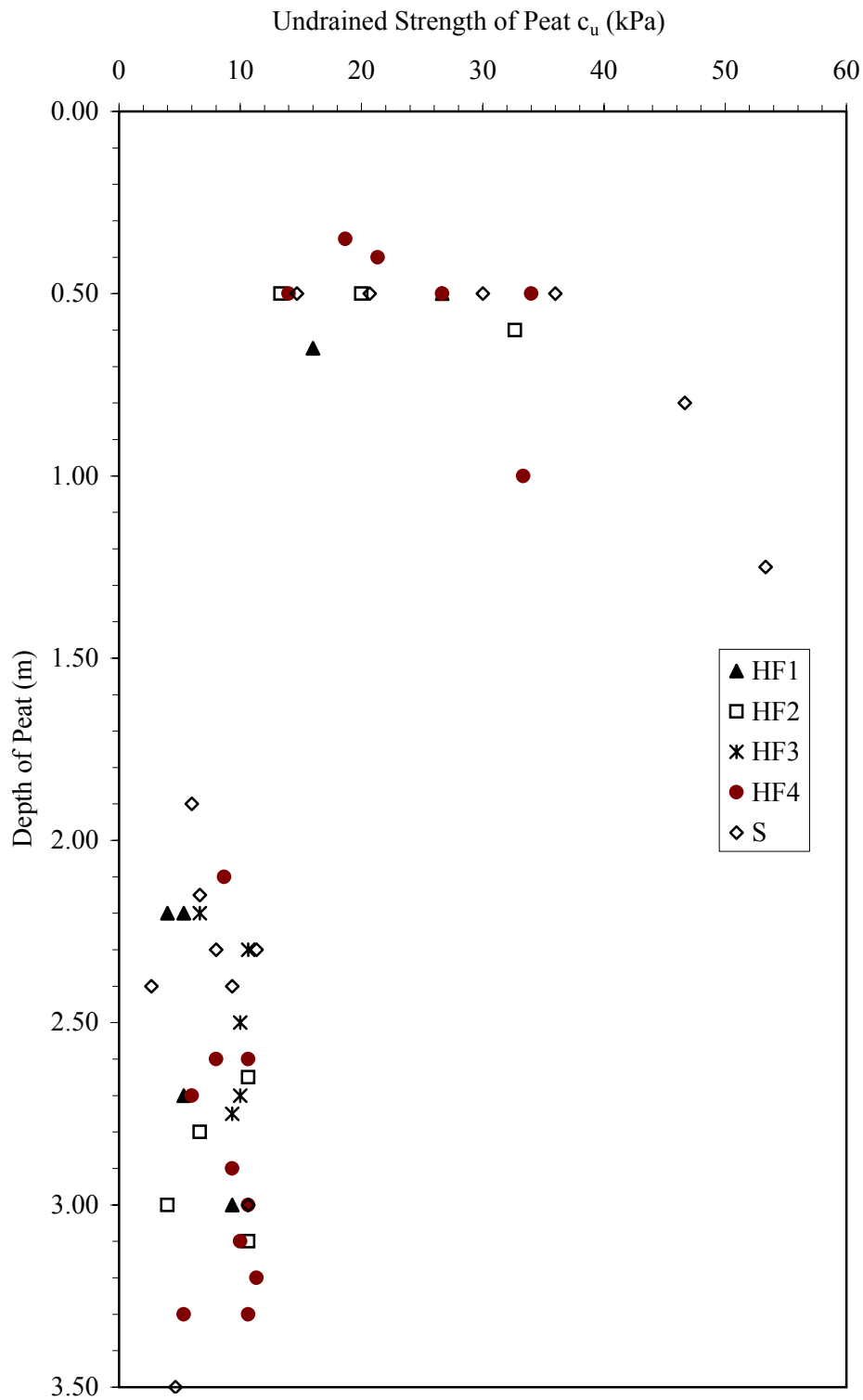
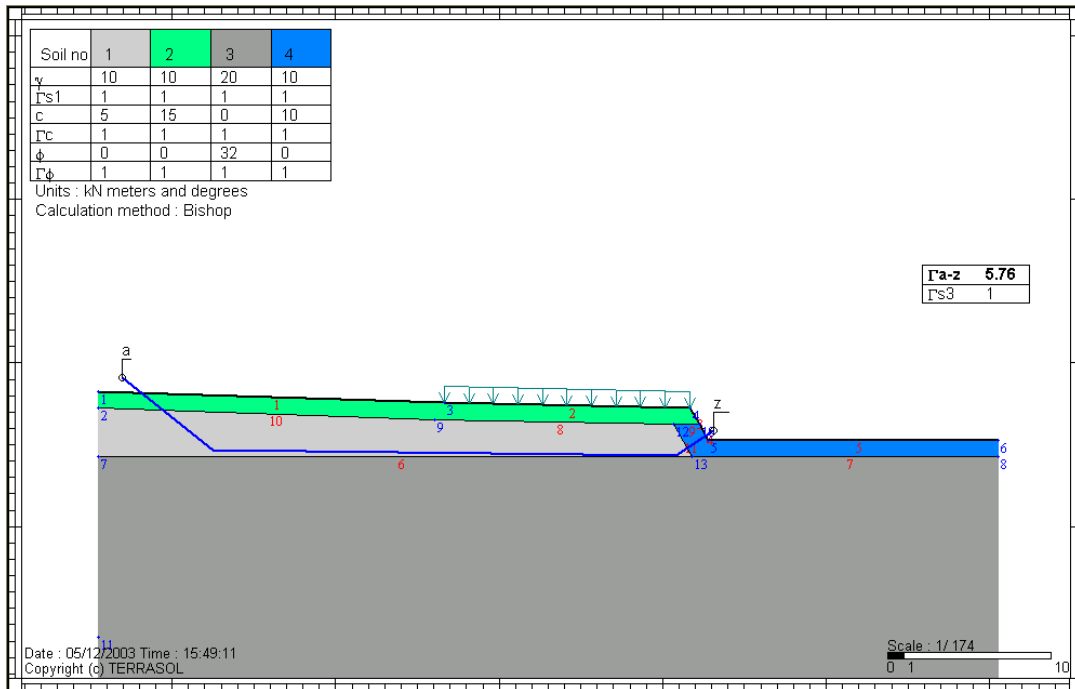


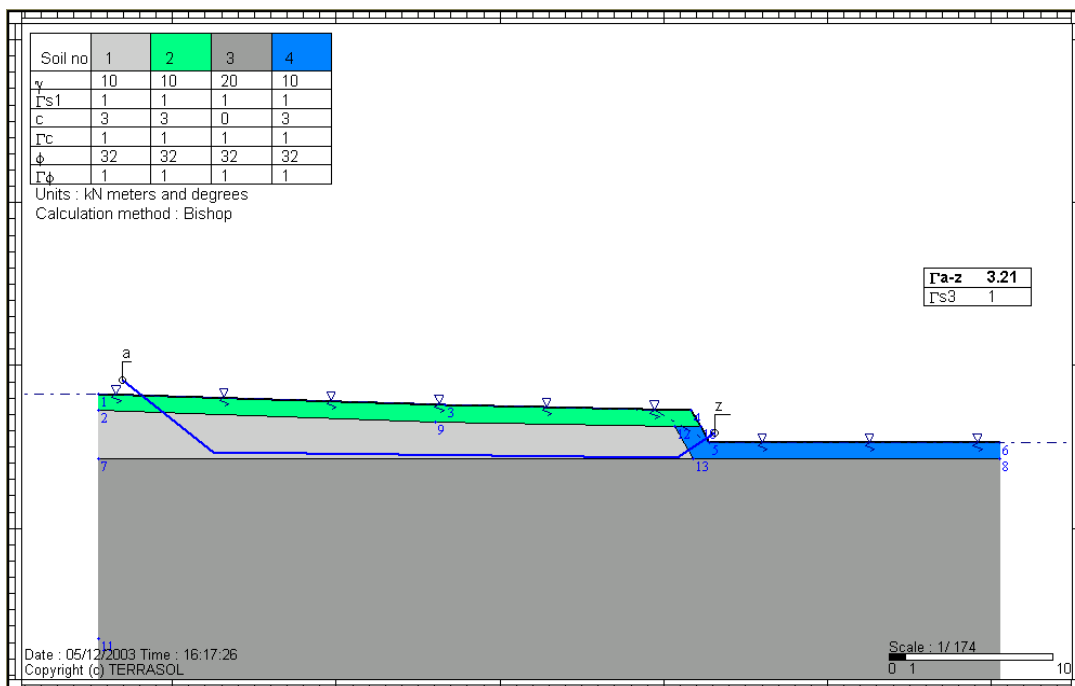
Figure 3 Profile of Undrained Shear Strength (c_u) of Peat with Depth from CPT Results

Notes

- (1) Results are for highfield (HF) and southern (S) perimeter areas
- (2) CPT converted to $c_{u\text{CPT}}$ using $N_k = 15$
- (3) Results based on 30 CPT locations throughout the site

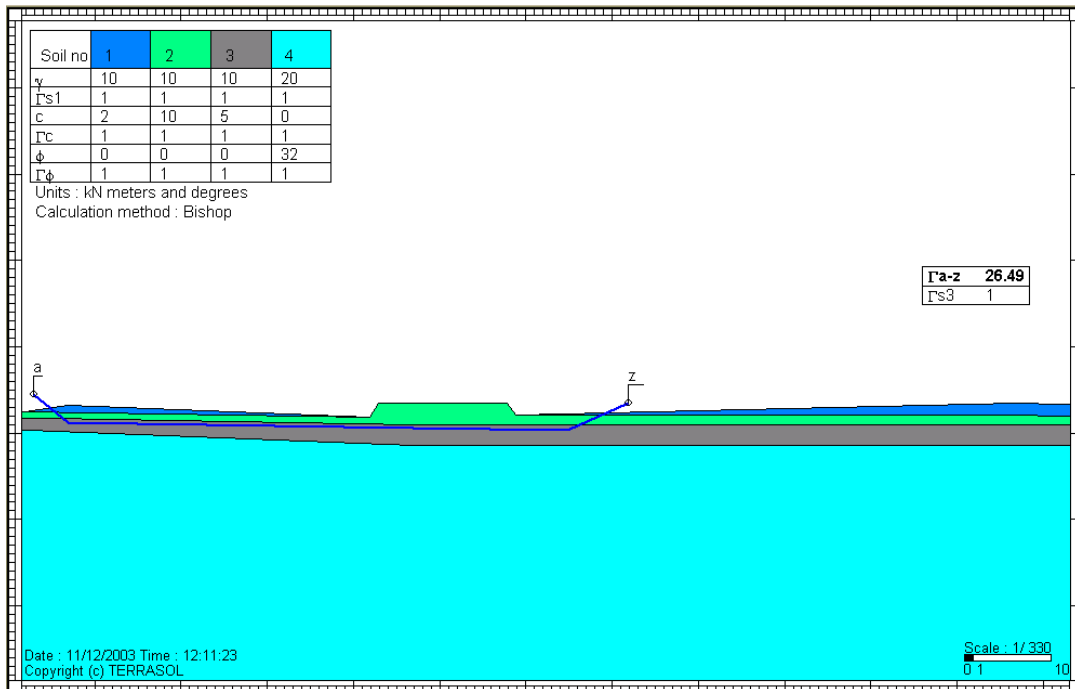


(a) Showing global stability of perimeter assuming translational slide for total stress (undrained) analysis

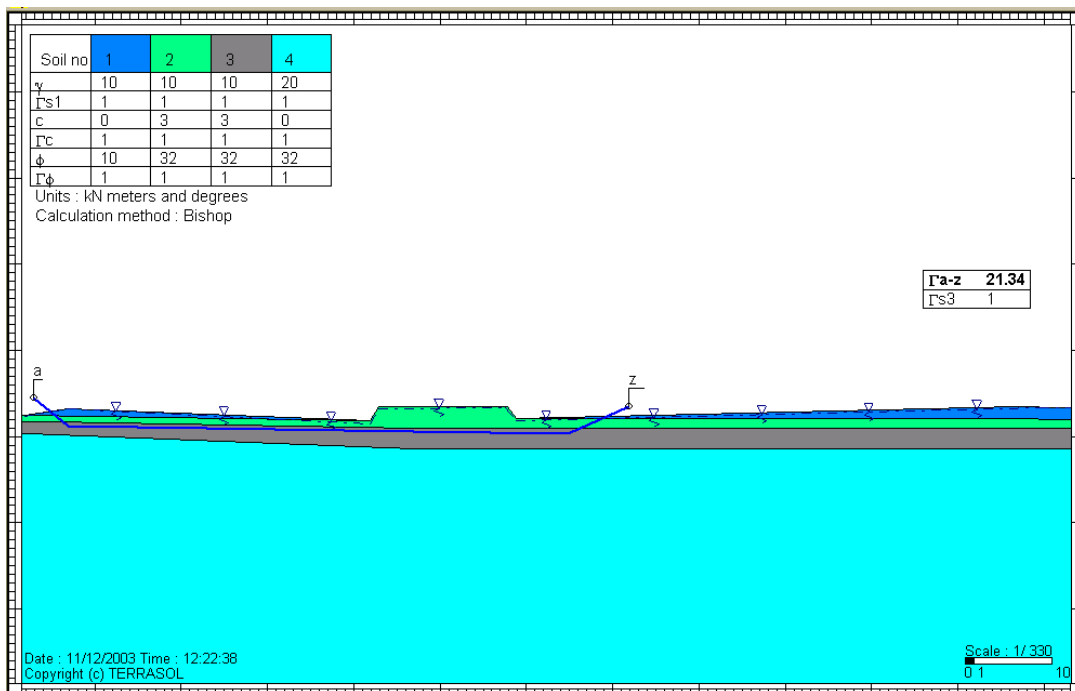


(b) Showing global stability of perimeter assuming translational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 4 Factor of Safety for Global Stability - Case (1) Cont.

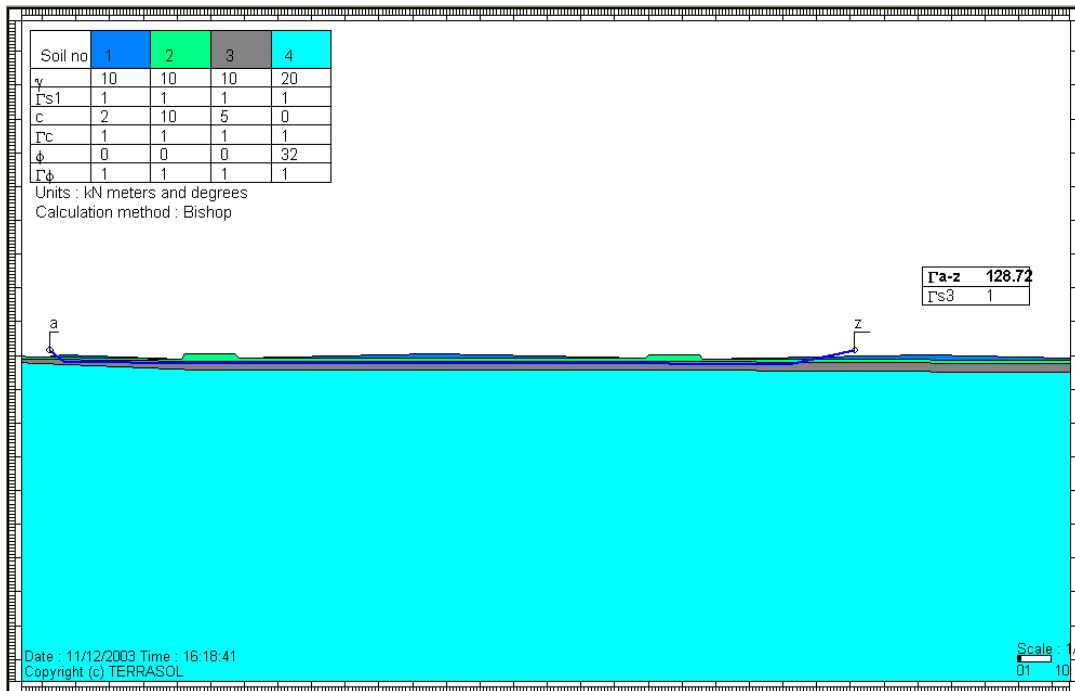


(c) Example of global stability of under highfield along Section 2-2 following peat placement assuming translational slide for total stress (undrained) analysis

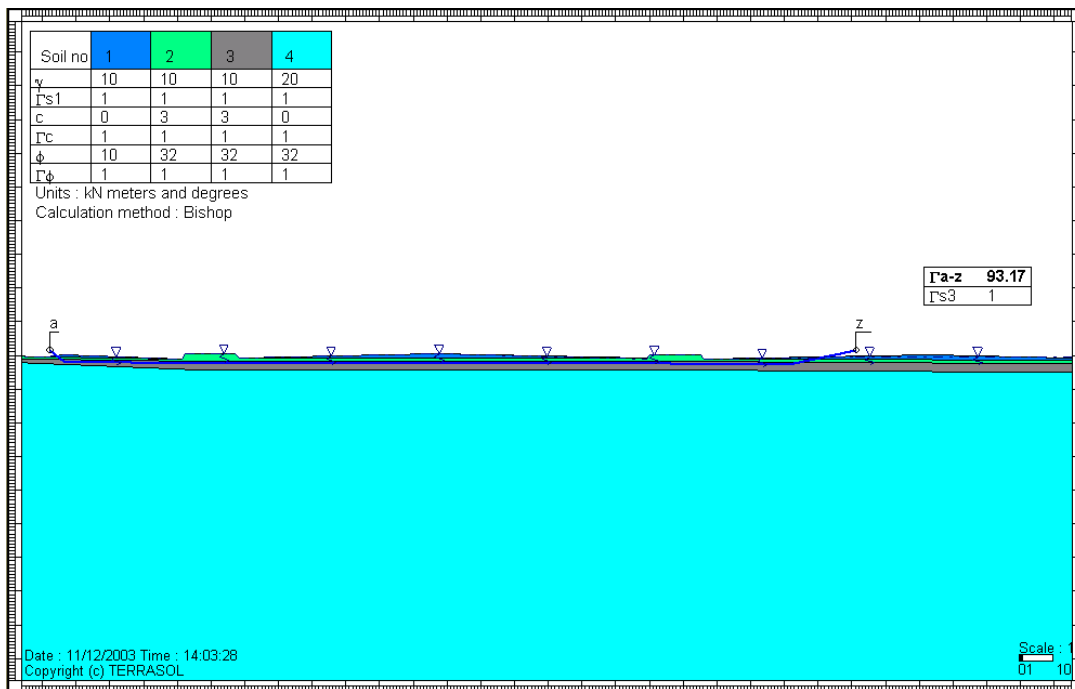


(d) Example of global stability of under highfield along Section 2-2 following peat placement assuming translational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 4 Factor of Safety for Global Stability - Case (1) Cont.

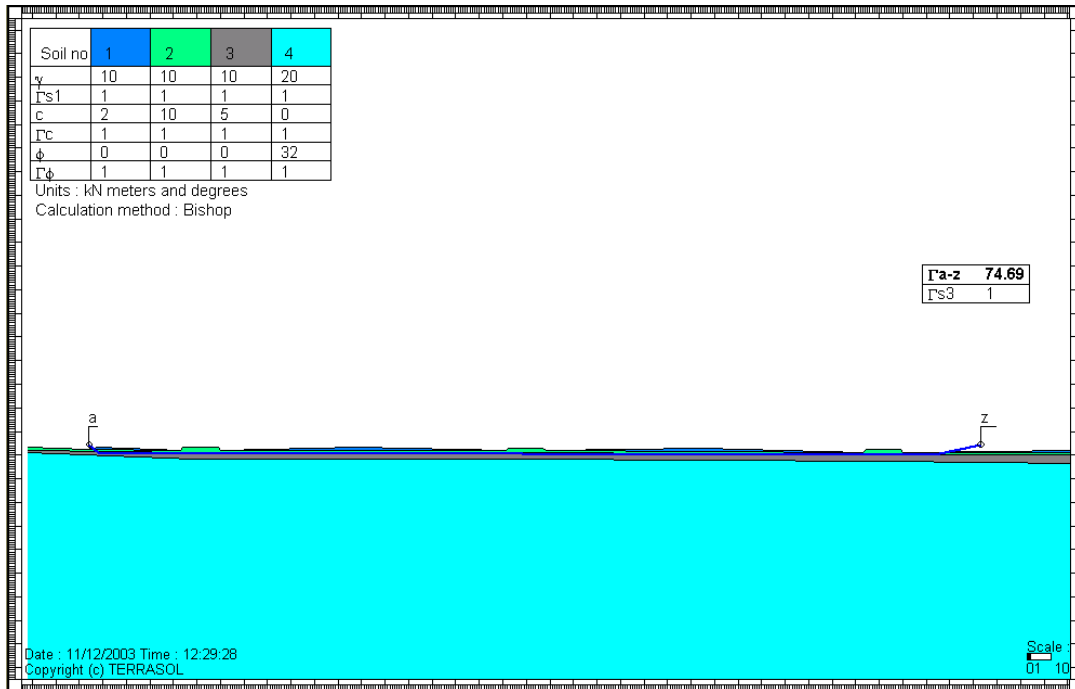


(e) Example of global stability under 2 highfields along Section 2-2 following peat placement assuming translational slide for total stress (undrained) analysis

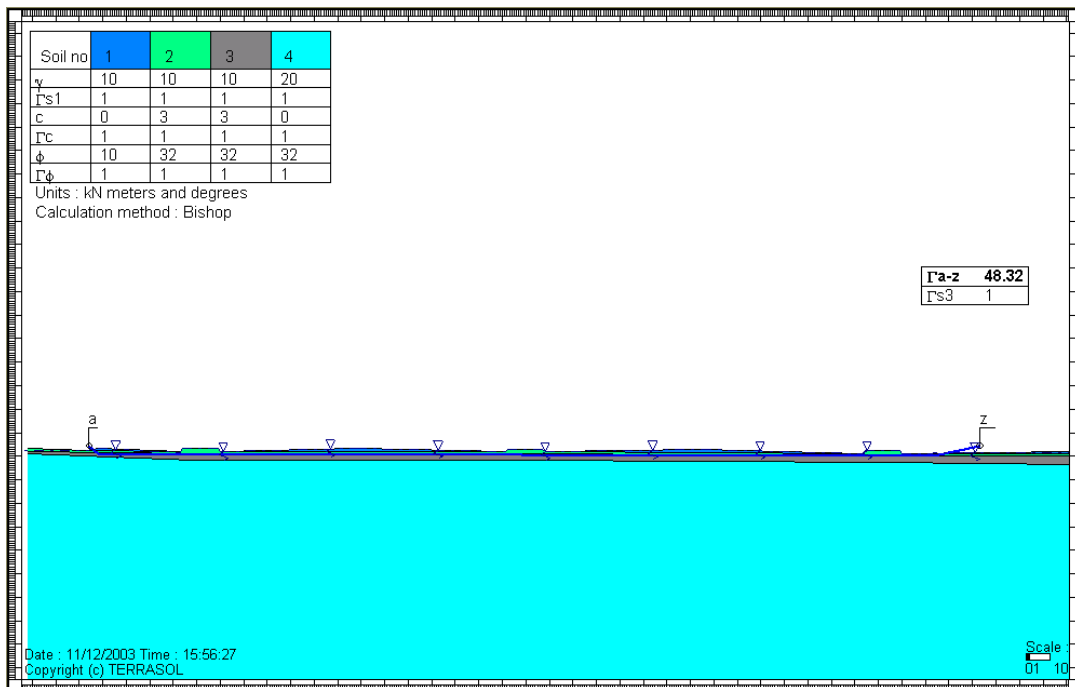


(f) Example of global stability under 2 highfields along Section 2-2 following peat placement assuming translational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 4 Factor of Safety for Global Stability - Case (1) Cont.

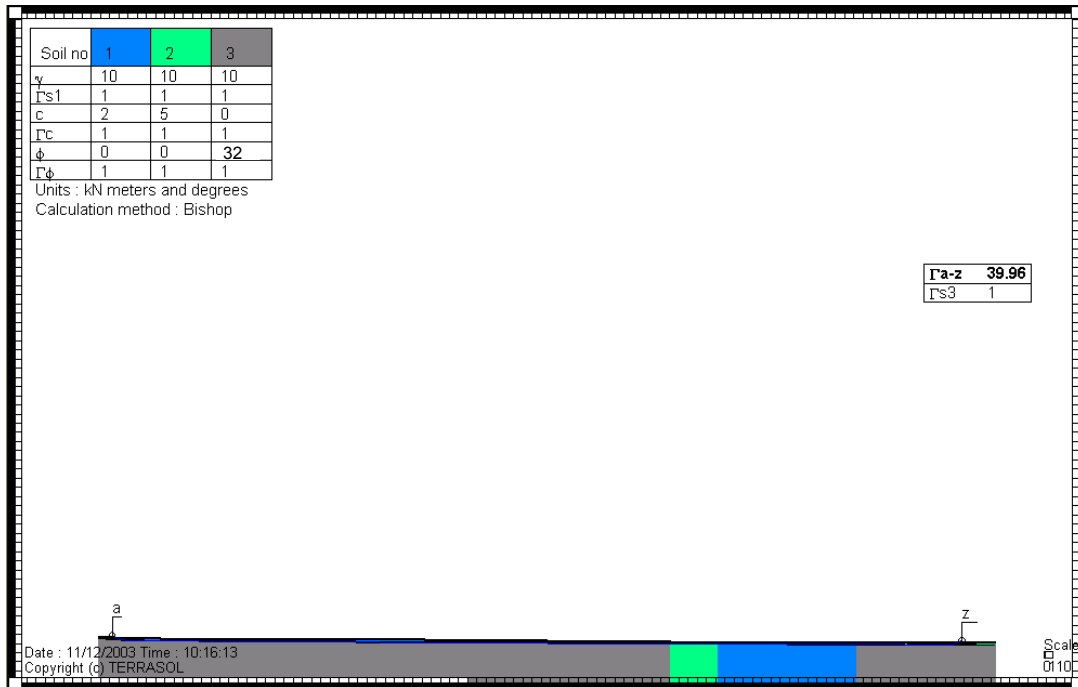


(g) Example of global stability under 3 highfields along Section 2-2 following peat placement assuming translational slide for total stress (undrained) analysis

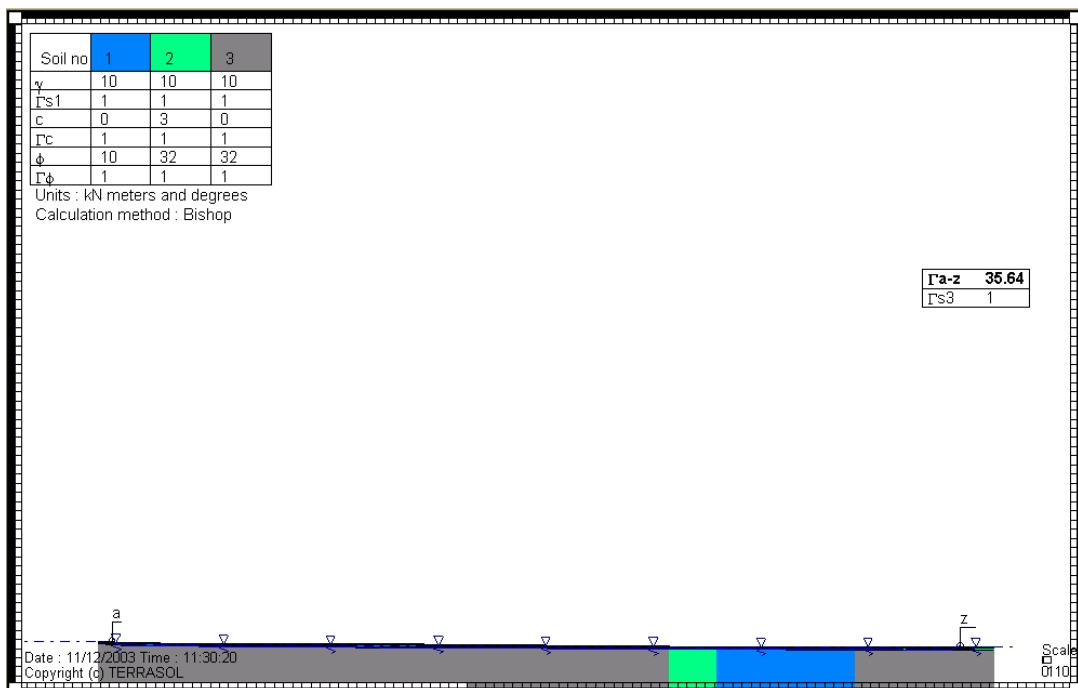


(h) Example of global stability under 3 highfields along Section 2-2 following peat placement assuming translational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 4 Factor of Safety for Global Stability - Case (1) Cont.

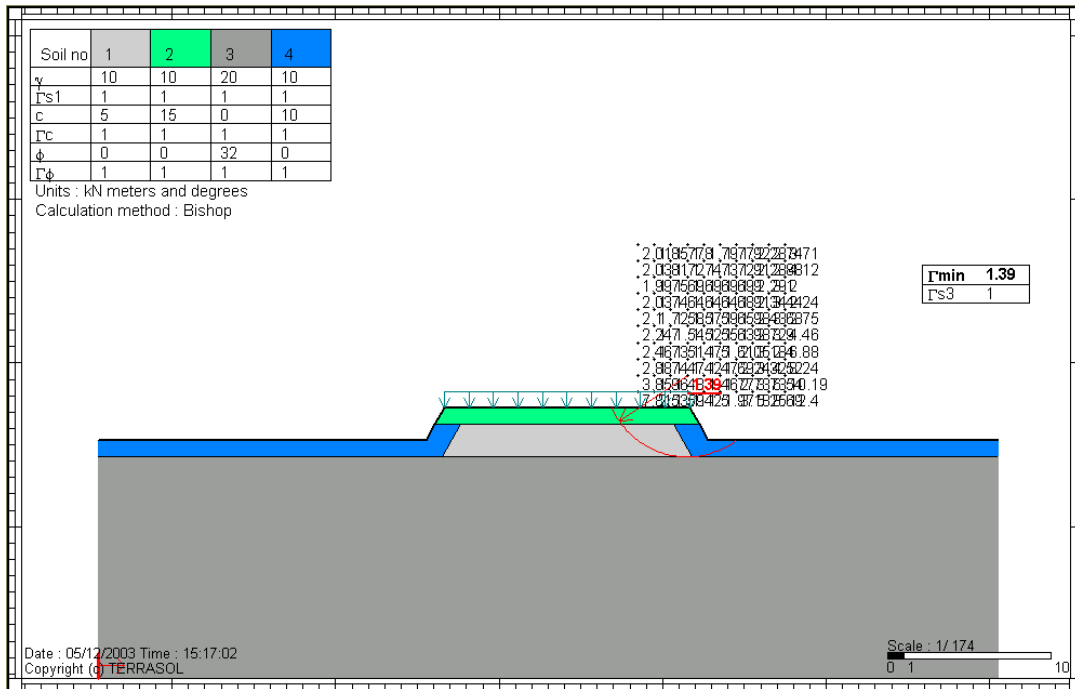


(i) Example of global stability under lowfield to south of Section 1-1 following peat placement assuming translational slide for total stress (undrained) analysis

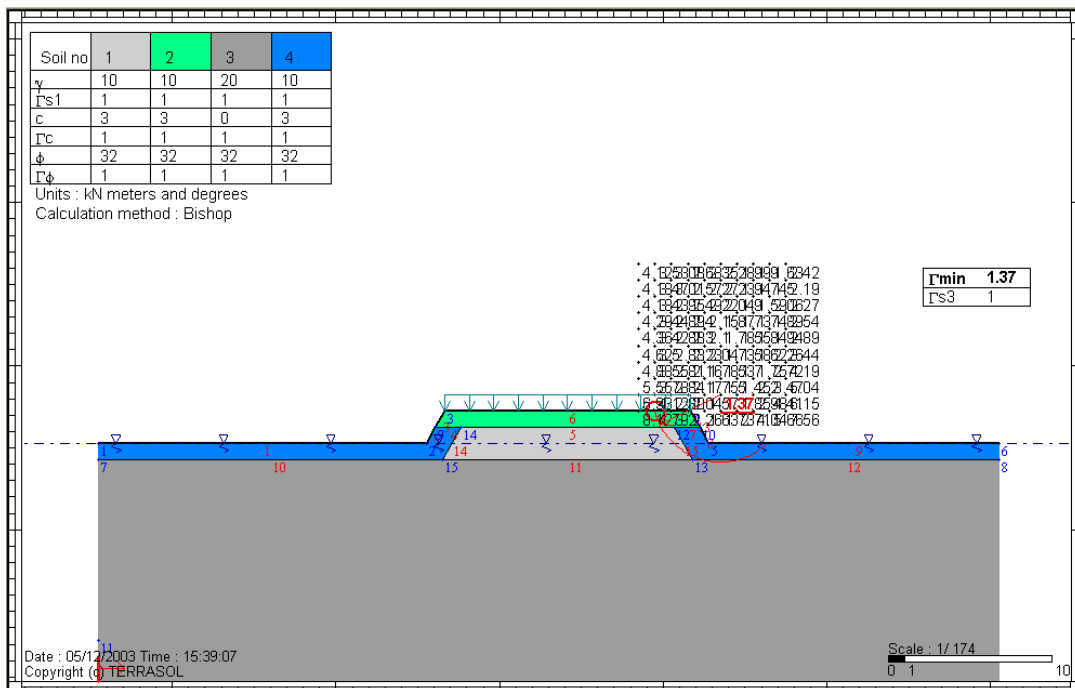


(j) Example of global stability under lowfield to south of Section 1-1 following peat placement assuming translational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 4 Factor of Safety for Global Stability - Case (1)

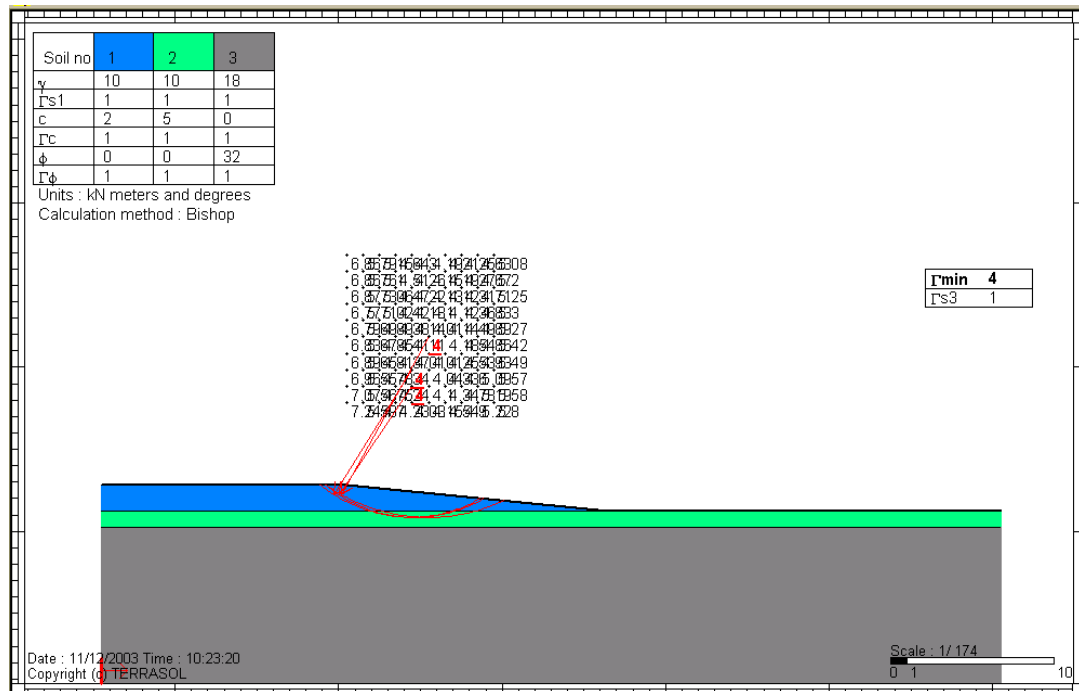


(a) Showing locally stability of highfield for total stress (undrained) analysis

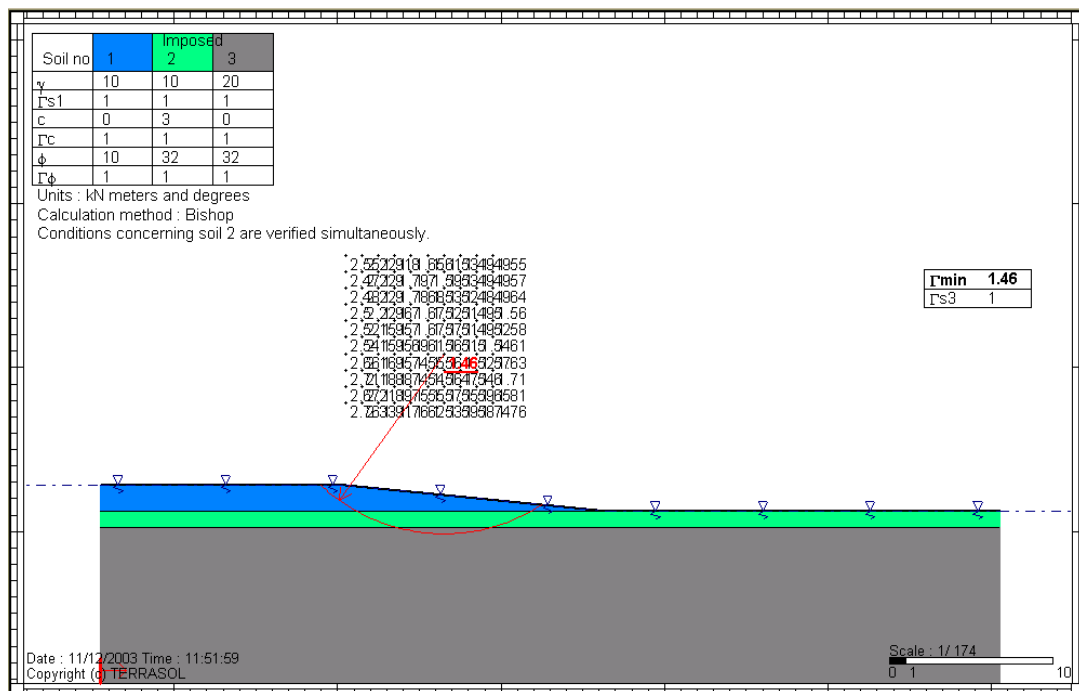


(b) Showing locally stability of highfield for effective stress (drained) analysis

Figure 5 Factor of Safety for Localised Stability - Case (2) Cont.

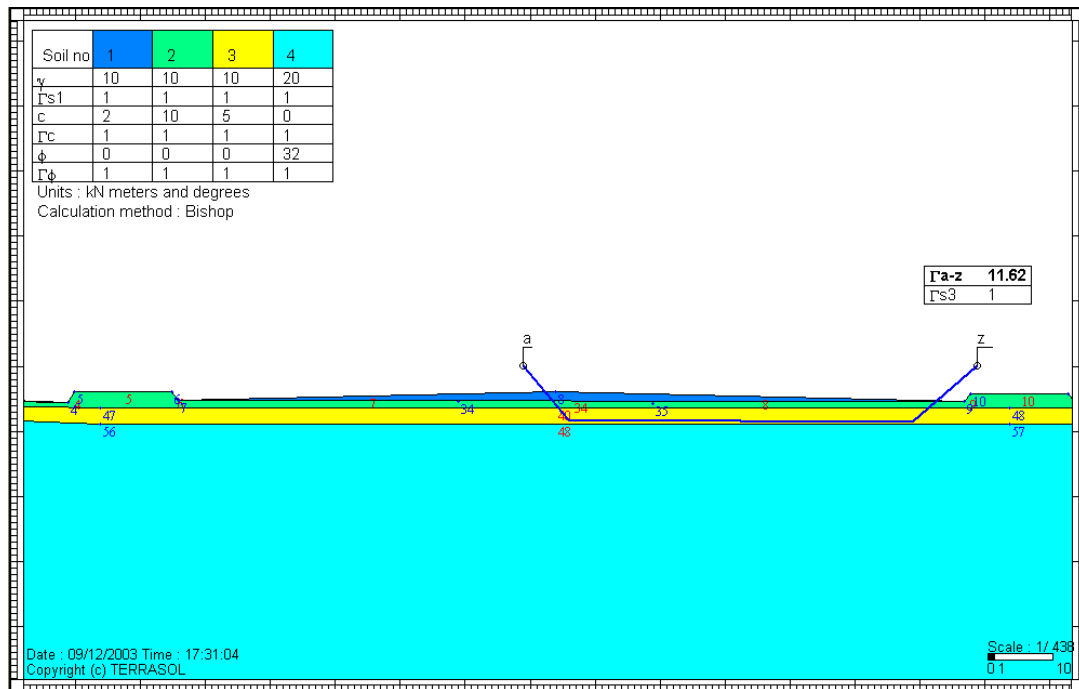


(c) Example of stability of placed peat at western end of lowfield assuming rotational slide for total stress (undrained) analysis.

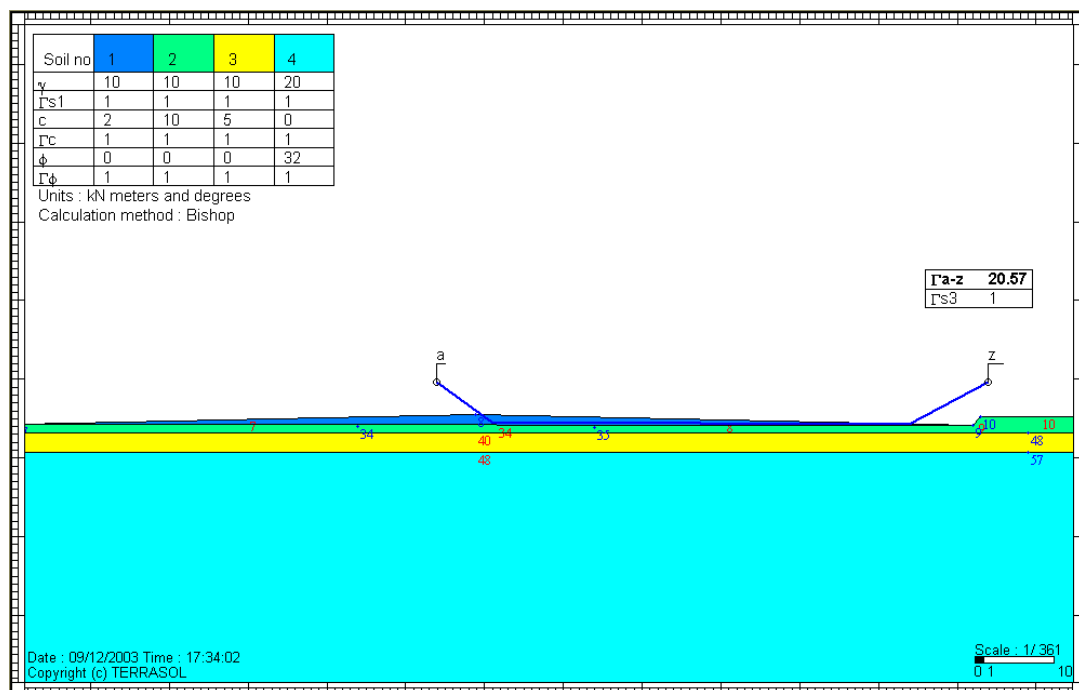


(d) Example of stability of placed peat at western end of lowfield assuming rotational slide for drained loading condition. Groundwater assumed at peat surface.

Figure 5 Factor of Safety for Localised Stability - Case (2) Cont.



- (e) Example of stability of underlying intact peat below placed peat between highfields assuming translational slide for total stress (undrained) analysis.



- (f) Example of stability within placed peat between highfields assuming translational slide for total stress (undrained) analysis.

Figure 5 Factor of Safety for Localised Stability - Case (2)

DRAWINGS

Legend:

HF2

Location of Highfield 2

CPXXX

Static Cone Penetration Location, depth to bottom of peat shown by line.

BHXXX

Location of borehole with descriptions

OH. no recovery 5.8

PT 2.0

SA 1.5

GR 2.4

Open hole to 5.8 mbgl

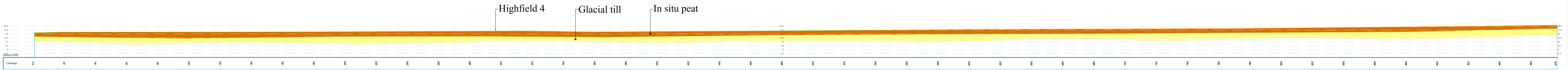
Peat to 5.8 mbgl

Sand to 5.8 mbgl

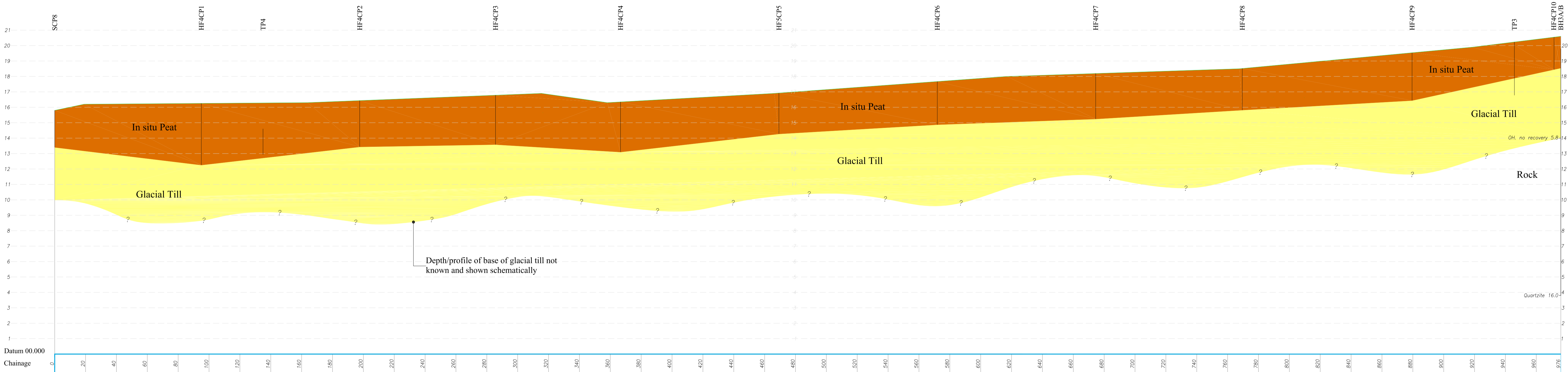
Gravel to 5.8 mbgl

TPXXX

Location of trialpit, depth reached shown by line.



Section 1-1
Hor. Scale: 1:1250
Ver. Scale: 1:1250



Section 1-1 with vertical scale exaggerated by 10

Hor. Scale: 1:1250
Ver. Scale: 1:125

Further notes:

Notes:

Client:

Job:

Drg. No. - 382_001

AGEC Ltd
5 Kilcarrig Street
Bagenalstown
Carlow
Ireland



www.agec.ie
info@agec.ie

Scale: See Above	Checked: P.J.
Date: 10/12/03	Revision: A
Drawn: P.O.R.	Based on: 382_03,018



Preliminary Geotechnical Design for
Srahmore Peat Deposition Site

Title:
Preliminary Design Ground Profile
for Areas 5 & 6
Section 1-1

Tel: 353-503-23800
Fax: 353-503-23793

Legend:

HF2

Location of Highfield 2

CPXXX

Static Cone Penetration Location, depth to bottom of peat shown by line.

BHXXX

Location of borehole with descriptions

-OH. no recovery 5.8

-PT 2.0

-SA 1.5

-GR 2.4

Open hole to 5.8 mbgl

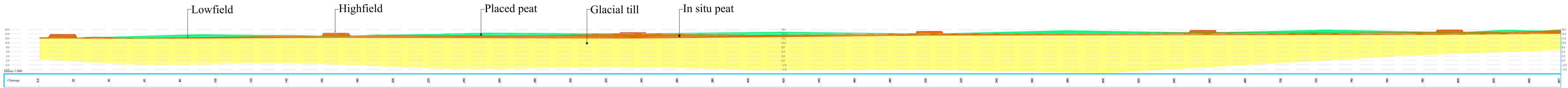
Peat to 5.8 mbgl

Sand to 5.8 mbgl

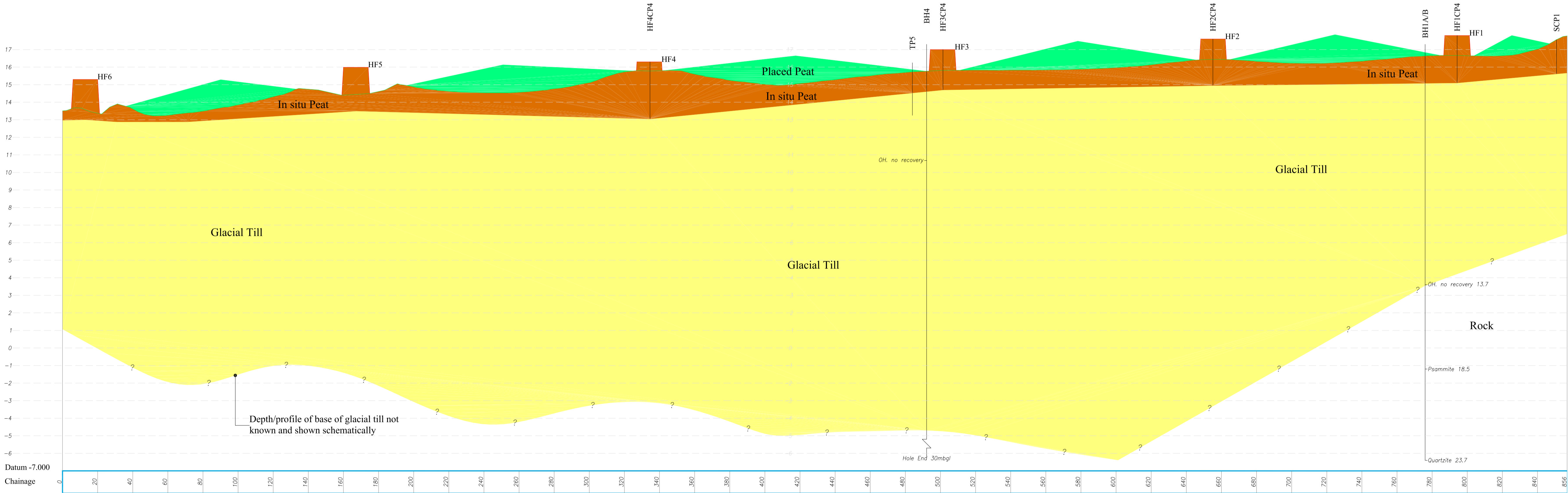
Gravel to 5.8 mbgl

TPXXX

Location of trialpit, depth reached shown by line.



Section 2-2
Hor. Scale: 1:1250
Ver. Scale: 1:1250



Section 2-2 with vertical scale exaggerated by 10
Hor. Scale: 1:1250
Ver. Scale: 1:125

Further notes:

Notes:	
Scale: See Above	Checked: P.J.
Date: 10/12/03	Revision: A
Drawn: P.O.R.	Based on: 382_03,018

Client:

Job:
Preliminary Geotechnical Design for
Srahmore Peat Deposition Site

Drg. No. - 382_002
Title:
Preliminary Design Ground Profile
for Areas 5 & 6
Section 2-2

AGEC Ltd
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info@agec.ie

Legend:

HF2

Location of Highfield 2

CPXXX

Static Cone Penetration Location, depth to bottom of peat shown by line.

BHXXX

Location of borehole with descriptions

OH, no recovery 5.8

Open hole to 5.8 mbgl

PT 2.0

Peat to 5.8 mbgl

SA 1.5

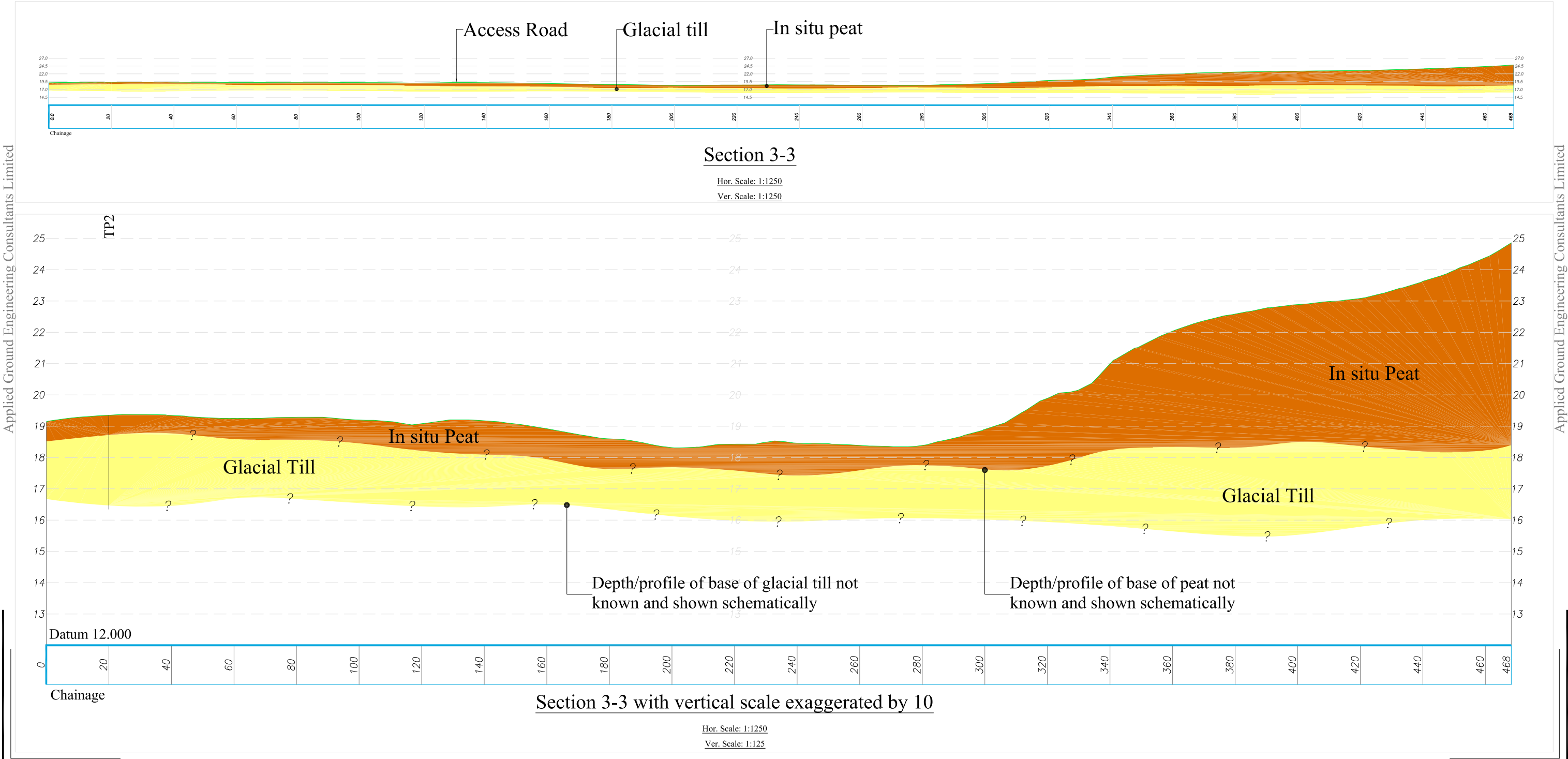
Sand to 5.8 mbgl



GR 2.4

Gravel to 5.8 mbgl

TPXXX

Location of trialpit, depth reached shown by line.



Notes:		<div>Client:</div> <div></div>	<div>Job:</div> <div>Preliminary Geotechnical Design for Srahmore Peat Deposition Site</div>	Drg. No. - 382_003		<div>AGEC Ltd</div> <div>5 Kilcarrig Street</div> <div>Bagenalstown</div> <div>Carlow</div> <div>Ireland</div> <div>Tel: +353 503 23800</div> <div>Fax: +353 503 23793</div> <div></div> <div>www.agec.ie</div> <div>info@agec.ie</div>	
				Title:			
				Preliminary Design Ground Profile for Areas 5 & 6			
				Section 3-3			
Scale: See Above	Checked: P.J.						
Date: 10/12/03	Revision: A						
Drawn: P.O.R.	Based on: 382_018						

APPENDIX A PHASE 1 GROUND INVESTIGATION RESULTS

FIELDWORK

TES

CONSULTING ENGINEERS

Second Floor, Unit 4B/5
Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG

Borehole BH1A

Sheet No. 1 of 1

Client: Bord na Mona/Shell E&P		Site: Srahmore, Bangor-Erris, Co. Mayo.		Job No.: 1169		Scale: 1:50			
Grid Reference Easting: E084463 Northing: N323049		Elevation (mOD): 17.56m Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 13.5m		Date Started: 22/10/03 Date Completed: 22/10/03		Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: P.K.			
Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples Type Ref. No.		BH Tests Type & Ref.	Completion Details Lining: Backfill:	
GL									
0.55	PEAT							50MM uPVC CASING	CEMENT
	Fine grained SAND, with clay/silt matrix, medium light grey to greenish grey.		15.09	▼				50MM uPVC SCREEN	BENT ONITE
12.5									
13.5	SAND with fragments of Schist and Quartzite. Light grey to light greenish grey.								
	END OF BOREHOLE							END OF CASING	
18									

Remarks:

TES**CONSULTING ENGINEERS**

Second Floor, Unit 4B/5
Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG

Borehole BH1B

Sheet No. 2 of 2

Client: Bord na Mona/Shell E&P	Site: Srahmore, Bangor-Erris, County Mayo.	Job No.: 1169	Scale: 1:50
-----------------------------------	---	------------------	----------------

Grid Reference Easting: 084463 Northing: 323049	Elevation (mOD): 17.254 Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 23.7m	Date Started: 23/10/03 Date Completed: 24/10/03	Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: PK
---	---	--	--

Depth m	Description of Strata	Legend	OD Level m	Water Inflows	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
18m 18.5	As above						Packet Test Ref.: BH1B Test section: 15.5-23.7m bgl	50mm uPVC Screen	3-7mm Pea Gravel
23.7	Strong to very strong, faintly narrowly banded, (dipping 60 degrees), white to very pale grey, fine to medium grained, micaceous QUARTZITE, fresh to slightly weathered. Mica occurs as strong orientated flakes, producing previously described narrow banding. Discontinuities: Closely to medium spaced, generally banding parallel (but also steeply dipping in at least 2 other orientations), generally planar, slightly rough surfaced, tight and clean.								
	END OF BOREHOLE								

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Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG**Borehole BH2A****Sheet No. 1 of 1**

Client: Bord na Mona/Shell E&P Site: Srahmore, Bangor-Erris, Co. Mayo. Job No.: 1169 Scale: 1:50

Grid Reference Easting: E083092 Northing: N323519 Elevation (mOD): 17.20m Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 6.1m Date Started: 28/10/03 Date Completed: 28/10/03 Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: P.K.

Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
GL									
0.55	PEAT								CEMENT
12.3	Fine grained SAND, with clay/silt matrix, medium light grey to greenish grey.		14.10	▼				50MM UPVC CASING	BENTONITE
14.0	SAND with fragments of eroded Quartzite, Sandstone and Schist. grey.							50MM UPVC SCREEN	3-7mm Pea Gravel
18	END OF BOREHOLE								

Remarks:

CONSULTING ENGINEERS

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Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410**

BOREHOLE LOG

Borehole BH2B

Sheet No. 1 of 2

Client: Bord na Mona/Shell E&P

Site:
Srahmore, Bangor-Erris, County Mayo.

Job No.:
1169

Scale:
1:50

Grid Reference
Easting: 083092
Northing: 323519

Elevation (mOD): 17.17m
Borehole Diameter (Subsoil): 65mm
Borehole Diameter (Rock): 65mm
Borehole Depth (m): 23.5m

Date Started: 27/10/03
Date Completed: 27/10/03

Drill Contractor: Irish Drilling Ltd.
Drill Method: Coring
Logged by: PK

Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples		BH Tests	Completion Details	
					Type	Ref. No.	Type & Ref.	Lining:	Backfill:
GL									
0.55	PEAT								
12.0	Fine grained SAND with clay/silt matrix. Medium light grey to greenish grey.		14.09	▼				50mm uPVC CASING	BENTONITE
14.3	SAND with fragments/cobbles of eroded Quartzite, Sandstone and Schist.								
18	Moderately weak to moderately strong thinly bedded/schistose (dipping 30-45 degrees), greenish grey (changing to brown below 21.4m), fine to medium grained micaceous PSAMMITE, moderately weathered. Occasional very thin (<20mm) highly weathered zones. Discontinuities: Very closely spaced, schistosity parallel, generally planar smooth to slightly rough, thick to moderately open, strongly discoloured and clay/rock material filled.								

Remarks: moderately open.

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Blanchardstown
Dublin 15
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BOREHOLE LOG**Borehole BH2B****Sheet No. 2 of 2**

Client: Bord na Mona/Shell E&P	Site: Srahmore, Bangor-Erris, County Mayo.	Job No.: 1169	Scale: 1:50
--	--	-------------------------	-----------------------

Grid Reference Easting: 083092 Northing: 323519	Elevation (mOD): 17.17m Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 23.5	Date Started: 27/10/03 Date Completed: 27/10/03	Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: PK
--	--	--	---

Depth m	Description of Strata	Legend	OD Level m	Water Inflows	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
18m	As above						Packet Test Ref.: BH2B Test section: 15.75-23.5m	50mm uPVC Screen	3-7mm Pea Gravel
23.5	END OF BOREHOLE								

CONSULTING ENGINEERS

**Second Floor, Unit 4B/5
Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410**

Borehole BH3A

Sheet No. 1 of 1

Client: Bord na Mona/Shell E&P	Site: Srahmore, Bangor-Erris, Co. Mayo.	Job No.: 1169	Scale: 1:50
--	---	-------------------------	-----------------------

Grid Reference	Elevation (mOD): 20.29m	Date Started: 28/10/03	Drill Contractor: Irish Drilling Ltd.
Easting: E084908	Borehole Diameter (Subsoil): 65mm	Date Completed: 28/10/03	Drill Method: Coring
Northing: N323745	Borehole Diameter (Rock): 65mm		Logged by: P.K.
	Borehole Depth (m): 12.5m		

Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
GL									
1.55	PEAT		18.52	▼				50MM uPVC CASING	CEMENT BENT ONITE
5.5	Fine grained SAND, with clay/silt matrix, medium light grey to greenish grey.							50MM uPVC SCREEN	3-7mm Pea Gravel
	END OF BOREHOLE							END OF CASING	

Remarks:

TES**CONSULTING ENGINEERS**

Second Floor, Unit 4B/5
 Blanchardstown Corporate Park
 Blanchardstown
 Dublin 15
 TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG**Borehole BH3B****Sheet No. 1 of 2**

Client: Bord na Mona/Shell E&P	Site: Srahmore, Bangor-Erris, County Mayo.	Job No.: 1169	Scale: 1:50
--	--	-------------------------	-----------------------

Grid Reference Easting: 084908 Northing: 323745	Elevation (mOD): 20.26m Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 16m	Date Started: 29/10/03 Date Completed: 29/10/03	Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: PK
--	---	--	---

Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
GL									
1.55	PEAT								
6.0	Fine grained SAND with clay/silt matrix. Medium light grey to greenish grey.		18.02	▼				50mm uPVC CASING	BENTONITE
16	Strong to very strong, massive but locally narrowly banded (dipping 35 degrees), grey to yellowish grey, fine grained micaceous QUARTZITE, fresh to slightly weathered. Mica locally occurring as close to very closely spaced bands/laminae dipping circa 35 degrees. Discontinuities: Between non-intact zones, fractures are closely to very closely spaced, bedding parallel, (dipping about 35 degrees), generally sub-planar, smooth to slightly rough, generally clean.						Packet Test Ref.: BH3B Test section: 11.75-16.0m	50mm uPVC SCREEN	3-7mm Pea Gravel
	END OF BOREHOLE								

Remarks:

CONSULTING ENGINEERS

**Second Floor, Unit 4B/5
Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410**

Borehole BH3B

Sheet No. 2 of 2

Client: Bord na Mona/Shell E&P

Site:
Srahmore, Bangor-Erris, County Mayo.

Job No.:
1169

Scale:
1:50

Grid Reference
Easting: 084908
Northing: 323745

Elevation (mOD):	20.26m
Borehole Diameter (Subsoil):	65mm
Borehole Diameter (Rock):	65mm
Borehole Depth (m):	23.5

Date Started: 27/10/03
Date Completed: 27/10/03

Drill Contractor: Glovers SI Ltd.
Drill Method: Air Rotary
Logged by: KM (TES)

[illegible]

TES

CONSULTING ENGINEERS

Second Floor, Unit 4B/5
Blanchardstown Corporate Park
Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG

Borehole BH4

Sheet No. 1 of 2

Client: Bord na Mona/Shell E&P Site: Srahmore, Bangor-Erris, County Mayo. Job No.: 1169 Scale: 1:50

Grid Reference Easting: 084489 Northing: 323373 Elevation (mOD): 17.22 Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 30m Date Started: 01/11/03 Date Completed: 01/11/03 Drill Contractor: Irish Drilling Ltd. Drill Method: Coring Logged by: PK

Depth m	Description of Strata	Legend	OD Level m	Static Water Level 4/11/03	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
GL									
3.1	PEAT		14.81	▼					
18	Fine grained SAND with clay/silt matrix. Medium light grey to greenish grey.							50mm uPVC CASING	BENTONITE
								50mm uPVC SCREEN	3-7mm Pea Gravel

Remarks:

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Blanchardstown
Dublin 15
TEL: (01) 8030401 FAX: (01) 8030410

BOREHOLE LOG**Borehole BH4****Sheet No. 2 of 2**

Client: Bord na Mona/Shell E&P	Site: Srahmore, Bangor-Erris, County Mayo.	Job No.: 1169	Scale: 1:50
--	--	-------------------------	-----------------------

Grid Reference Easting: 084489 Northing: 323373	Elevation (mOD): 17.22m Borehole Diameter (Subsoil): 65mm Borehole Diameter (Rock): 65mm Borehole Depth (m): 30m	Date Started: 01/11/03 Date Completed: 01/11/03	Drill Contractor: Glovers SI Ltd. Drill Method: Air Rotary Logged by: PK
--	---	--	---

Depth m	Description of Strata	Legend	OD Level m	Water Inflows	Samples		BH Tests Type & Ref.	Completion Details	
					Type	Ref. No.		Lining:	Backfill:
18m	As above							50mm uPVC Screen	3-7mm Pea Gravel
30	END OF BOREHOLE								

TES CONSULTING ENGINEERS		Second Floor, Unit 4B/5 Blanchardstown Corporate Park Blanchardstown Dublin 15				TRIAL PIT LOG		
						Trial Pit No. 1		
						Sheet No. 1 of 1		
Excavator Type: HITACHI		Date: 23/10/03		Client: Bord na Mona/Shell E&P				
Grid Reference: E084643, N324121		Elevation (mOD):		Site: Srahmore, Bangor-Erris, Co. Mayo.				
Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0	PEAT Soft, medium light brown to medium brown, occasional fragments of bog wood, slightly moist.							
				Vane Test	TP1			
2.4	Yellowish brown to light yellowish brown gravelly, clayey SAND, with some angular subangular cobbles of schist at base.							
				Disturbed Sample	TP1			
3.0	END OF TRIAL PIT							
Logged by: P.K.		Job No.: 1169		Remarks: 1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing. 2. No significant groundwater inflow recorded during excavation. 3. Excavation terminated at 3m due to obstruction/compaction of subsoil.				
Scale: 1:25		Rev.:						

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TRIAL PIT LOG

Trial Pit No. 2

Sheet No. 1 of 1

Excavator Type:	Date: 23/10/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E084646, N323870	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
----------------------------------	------------------	---

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0	PEAT Soft, medium dark brown to dark brown, occasional fragments of bog wood.							
0.65				Vane Test	TP2			
3.0	Medium light grey to light greenish grey, gravelly, clayey slightly micaceous SAND. The Gravels are platy, angular to subangular Quartzites.							
				Disturbed Sample	TP2			
END OF TRIAL PIT								

Logged by: P.K.	Job No.: 1169	Remarks: 1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing. 2. No significant groundwater inflow recorded during excavation.
Scale: 1:25	Rev.:	

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TRIAL PIT LOG

Trial Pit No. 3

Sheet No. 1 of 1

Excavator Type:		Date: 23/10/03		Client: Bord na Mona/Shell E&P				
Grid Reference: E084890, N323700		Elevation (mOD):		Site: Srahmore, Bangor-Erris, Co. Mayo.				
Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
1.8	PEAT Soft, medium brown to light brown, fragments of bog wood and rootlets, slightly moist.			Vane Test	TP3			
3.45	Greenish grey to light greenish grey to light grey SAND, with some angular to subangular gravels and cobbles of schist.			Disturbed Sample	TP3			
	END OF TRIAL PIT							
Logged by: P.K.		Job No.: 1169		Remarks: 1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing. 2. Slight to moderate groundwater inflow recorded at 2.5m during excavation. 3. Excavation terminated due to obstruction/compaction of subsoil at 3.45m.				
Scale: 1:25		Rev.:						

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TRIAL PIT LOG

Trial Pit No. 4

Sheet No. 1 of 1

Excavator Type:	Date: 23/10/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E084164, N323332	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
----------------------------------	------------------	---

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
1.1	PEAT Soft to very soft, medium brown to medium dark brown, with fragments of bog wood and rootlets, moist.			Vane Test	TP4			
1.4	Medium greenish grey to grey, clayey, fine grained SAND with occasional subrounded to rounded gravel and cobbles.			Disturbed Sample	TP4			
1.65	Medium grey to light brownish grey GRAVEL with some sub-rounded to subangular cobbles.							
	END OF TRIAL PIT							

Logged by: P.K.	Job No.: 1169	Remarks: 1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing. 2. Excavations terminated at 1.65m bgl due to unstable ground and pit wall collapse caused by water inflow.
Scale: 1:25	Rev.:	

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TRIAL PIT LOG

Trial Pit No. 5

Sheet No. 1 of 1

Excavator Type:	Date: 23/10/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E084474, N323382	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
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Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0	PEAT Soft, medium dark brown fragments of bog wood and rootlets, moist.							
0.9				Vane Test	TP5			
3.0	Yellowish brown to greyish brown, gravelly, cobbly SILT/ SAND. The gravels are subangular to subrounded.							
				Disturbed Sample	TP5			
	END OF TRIAL PIT							

Logged by: P.K.	Job No.: 1169	Remarks: 1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing. 2. Slight to moderate groundwater inflow at 2.5m bgl.
Scale: 1:25	Rev.:	

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TRIAL PIT LOG

Trial Pit No. 6

Sheet No. 1 of 1

Excavator Type:

Date:

23/10/03

Client:

Bord na Mona/Shell E&P

Grid Reference:

E084852, N323176

Elevation (mOD):

Site:

Srahmore, Bangor-Erris, Co. Mayo.

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.95	PEAT Soft, dark brown to brownish black, fragments of bog wood, moist.			Vane Test	TP6			
1.9	Light yellowish brown clayey, fine grained SAND with occasional gravels that are subrounded to rounded							
2.5	Medium brown to dark brown subangular to subrounded GRAVELS, with some Cobbles.			Disturbed Sample	TP6			
	END OF TRIAL PIT							

Logged by:

P.K.

Job No.:

1169

Remarks:

1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing.
 2. No significant groundwater inflows noted during excavation.

Scale:

1:25

Rev.:

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TRIAL PIT LOG

Trial Pit No. 7

Sheet No. 1 of 1

Excavator Type:

Date:

23/10/03

Client:

Bord na Mona/Shell E&P

Grid Reference:

E084001, N323713

Elevation (mOD):

Site:

Srahmore, Bangor-Erris, Co. Mayo.

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.85	PEAT Soft, dark brown to brownish black, fragments of bog wood, moist. Occurance of more recent plant material and heather.			Vane Test	TP7			
2.5	Light yellowish brown to light yellowish grey clayey SAND with occasional gravels that are subrounded to rounded. Gravel content increases with depth and becomes angular at base.			Disturbed Sample	TP7			
	END OF TRIAL PIT							

Logged by:

P.K.

Job No.:

1169

Remarks:

1. Shear vane test undertaken on peat, disturbed soil sample obtained for Particle Size Distribution testing.
2. No significant groundwater inflows noted during excavation.

Scale:

1:25

Rev.:

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TRIAL PIT LOG

Trial Pit No. 8

Sheet No. 1 of 1

Excavator Type:	Date: 23/10/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E084402, N323988	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
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Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.2	Medium dark, soft PEAT							
	Medium light grey to greenish grey, gravelly, cobbly SILT/SAND. The gravels are subangular to subrounded and occasionally well rounded Quartzites, with occasional Red Sandstones and Slate.							
2.6	END OF TRIAL PIT							

Logged by: P.K.	Job No.: 1169	Remarks:
Scale: 1:25	Rev.:	

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Dublin 15

TRIAL PIT LOG

Trial Pit No. 9

Sheet No. 1 of 1

Excavator Type:

Date:

23/10/03

Client:

Bord na Mona/Shell E&P

Grid Reference:

E084402, N323988

Elevation (mOD):

Site:

Srahmore, Bangor-Erris, Co. Mayo.

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.4	Medium dark, soft PEAT							
2.5	Medium light grey to greenish grey, gravelly, cobbly SILT/SAND. The gravels are subangular subrounded and occasionally well rounded Quarzites, with occasional Red Sandstone and Slate.							
	END OF TRIAL PIT							

Logged by:

P.K.

Job No.:

1169

Remarks:

Scale:

1:25

Rev.:

TES CONSULTING ENGINEERS		Second Floor, Unit 4B/5 Blanchardstown Corporate Park Blanchardstown Dublin 15		TRIAL PIT LOG				
				Trial Pit No. 10				
				Sheet No. 1 of 1				
Excavator Type:		Date: 18/11/03		Client: Bord na Mona/Shell E&P				
Grid Reference: E083780, N323797		Elevation (mOD):		Site: Srahmore, Bangor-Erris, Co. Mayo.				
Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.1	Dark brown, peaty GRAVEL, with many cobbles and boulders. Gravels subangular to subrounded							
	Quartzite, Schist, Slate and Red Sandstone							
0.7	Medium brown, clayey, gravelly, fine grained SAND. Gravels are subangular to subrounded							
	Medium grey to greenish grey to light brownish grey, clayey, gravelly, fine to medium grained SAND, with occasional subangular to subrounded cobbles.			Bulk Sample	TP10			
1.45								
	Medium light grey, sandy, slightly clayey, subangular GRAVEL, with occasional angular, subangular and subrounded cobbles and boulders of Quartzite, Schist and Red Sandstone.							
3.2								
	END OF TRIAL PIT							
Logged by: P.K.		Job No.: 1169		Remarks: 1. Surface water running into pit excavation because of heavy rain				
Scale: 1:25		Rev.:						

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Dublin 15

TRIAL PIT LOG

Trial Pit No. 11

Sheet No. 1 of 1

Excavator Type:	Date: 18/11/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E083837, N323823	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
----------------------------------	------------------	---

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0	Medium brown, sandy, slightly clayey, peaty GRAVEL, with some cobbles. Gravel is subangular to angular Quartzite, with occasional Schist and Sandstone							
0.2								
3.0	Light brown to yellowish grey, slightly clayey, gravelly, fine SAND. Subangular gravels of Quartzite and occasional angular boulders of banded Gneiss			Bulk Sample	TP11			
3.0	END OF TRIAL PIT							

Logged by: P.K.	Job No.: 1169	Remarks: 1. No water Inflows to pit, dry.
Scale: 1:25	Rev.:	

TES CONSULTING ENGINEERS		Second Floor, Unit 4B/5 Blanchardstown Corporate Park Blanchardstown Dublin 15		TRIAL PIT LOG				
				Trial Pit No. 12				
				Sheet No. 1 of 1				
Excavator Type:		Date: 18/11/03		Client: Bord na Mona/Shell E&P				
Grid Reference: E083925, N323806		Elevation (mOD):		Site: Srahmore, Bangor-Erris, Co. Mayo.				
Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.3	Medium brown, slightly clayey fine grained SAND, with thin layers of peat on top							
3.0	Medium light grey, gravelly, slightly clayey, slightly micaceous SAND with some subangular cobbles and occasional subangular boulders. Gravels are subangular to subrounded Quartzite. Medium grey to medium light grey gravelly, fine grained SAND with some cobbles and some blocky boulders of Gneiss. Gravels are subrounded and occasionally well rounded			Bulk Sample	TP12A			
				Bulk Sample	TP12B			
	END OF TRIAL PIT							
Logged by: P.K.		Job No.: 1169		Remarks: 1. Increase in moisture content at 3m bgl.				
Scale: 1:25		Rev.:						

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TRIAL PIT LOG

Trial Pit No. 13

Sheet No. 1 of 1

Excavator Type:	Date: 18/11/03	Client: Bord na Mona/Shell E&P
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Grid Reference: E084417, N324002	Elevation (mOD):	Site: Srahmore, Bangor-Erris, Co. Mayo.
----------------------------------	------------------	---

Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0	Medium dark brown to brownish black, soft PEAT, with angular and subrounded gravels and boulders of Quartzite and Schist							
0.25								
0.75	Medium dark brown to medium brown, Firm CLAY							
3.2	Light grey to medium light grey and light greyish brown, gravelly, silty, fine grained SAND with occasional subangular to subrounded blocky boulders of Gneiss. Gravels are subangular to subrounded, occasionally well rounded, composed of Quartzite Schist, Red Sandstone and Slate.			Bulk Sample	TP13A			
				Bulk Sample	TP13B			
	END OF TRIAL PIT							

Logged by: P.K.	Job No.: 1169	Remarks:
Scale: 1:25	Rev.:	

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 Dublin 15

TRIAL PIT LOG

Trial Pit No. 14

Sheet No. 1 of 1

Excavator Type:		Date: 18/11/03		Client: Bord na Mona/Shell E&P				
Grid Reference: E084647, N324207		Elevation (mOD):		Site: Srahmore, Bangor-Erris, Co. Mayo.				
Depth m	Description of Strata	Legend	OD Level m	Samples		Water Inflows	Pit Completion	
				Type	Ref. No.		Lining:	Backfill:
0.0								
0.75	Medium brown, gravelly, slightly clayey, fine grained SAND, with some angular cobbles and boulders of Quartzite. Gravels are subangular to angular.							
2.0	Light grey to light yellowish grey, gravelly, cobbley, slightly clayey SAND with some angular boulders of Gneiss. Gravels are subangular to subrounded Quartzite and Red Sandstone.							
				Bulk Sample	TP14A			
3.5	Medium grey, gravelly, slightly clayey, slightly micaceous SAND with some subangular to subrounded cobbles of Quartzite. Gravels are subangular to subrounded Quartzite.							
				Bulk Sample	TP14B			
	END OF TRIAL PIT							
Logged by: P.K.		Job No.: 1169		Remarks: 1. Increase in moisture content at 1.5m bgl.				
Scale: 1:25		Rev.:						

TEST RESULTS

IRISH DRILLING LTD. Loughrea Co. Galway Tel: (091) 841274 Fax: (091) 847687	Contract: Peat Deposit Site at Bangor Erris		
	Date: Eng.:	23.10.'03 DJ	

In-situ Shear Vane

Trial Pit	Depth m	Co-ordinates	Undrained Shear strength Uncorrected kN/m ²	Undrained Shear strength *Corrected (based on plasticity) kN/m ²
1	1.5	84643, 24121	12	6
2	0.5	84646, 23870	12	6
3	1.0	84890, 23700	23	12
4	0.9	84164, 23332	10	5
5	0.7	84474, 23382	10	5
6	0.6	84852, 23173	19	9.5
7	0.8	84001, 23713	14	7

* Correction factor based on Bjerrum's (1972,1973) correction factor for field vane strength as a function of Plasticity Index

IRISH DRILLING LTD.

Loughrea Co. Galway.

Contract: Peat deposit site at Bangor Erris

Client: Enterprise Oil

Engineer: TES

Date: 20/11/2003

Tested By: DD Checked: DJ

Tel: (091)841274 Fax: (091) 847687

Summary of Soil Classification Tests
BS1377: Part 2: 1990

Borehole/ Triplpit	Type	Depth m	Bulk Density Mg/m3	Moisture Content %	Particle Density Mg/m3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% passing 425 micron %	Description of fraction passing 425 micron sieve.
TP 1		1.0		840						
		2.0		877.8						
		3.0		20.8			Non plastic		93	
TP 2		0.5		448.1						
		1.5		14			Non plastic		94	
		2.5		14.3						
TP 3		1.0		343.6						
		2.5		23.8			Non plastic		95	
		3.5		23.7						

[illegible]

PROJECT: Bangor Erris		Project No: 1169		PARTICLE SIZE DISTRIBUTION	
CLIENT: Irish Drilling		Reference: 0415			
Borehole No.	TP1	Sample No.	Depth 3.00 m		

The graph shows a particle size distribution curve. The y-axis is 'Percentage passing' from 0.0 to 100.0. The x-axis is 'Particle size mm' on a log scale with major ticks at 0.0001, 0.0010, 0.0100, 0.1000, 1.0000, 10.0000, and 100.0000. The curve is a step function: it is at 100% for particle sizes up to 0.075 mm, then drops to 0% at 0.075 mm, and remains at 0% for all larger particle sizes up to 4.75 mm.

Particle Size (mm)	Percentage Passing (%)
0.075	100.0
0.075	0.0
4.75	0.0

CLAY	SILT			SAND			GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	

Visual Description: Pale grey silty SAND with little gravel

K4 SOILS LABORATORY

PROJECT: Bangor Erris

CLIENT: Irish Drilling

Project No: 1169

Reference: 0415

PARTICLE SIZE DISTRIBUTION

Borehole No. TP2

Sample No.

Depth 2.50 m

Percentage passing

Particle size (mm)	Percentage passing (%)
0.075	100
0.15	98
0.3	95
0.6	90
1.18	85
2.5	75
5.0	65
10.0	55
20.0	45
40.0	35
75.0	25

Particle size mm

CLAY

FINE

MEDIUM

COARSE

SILT

FINE

MEDIUM

COARSE

SAND

FINE

MEDIUM

COARSE

GRAVEL

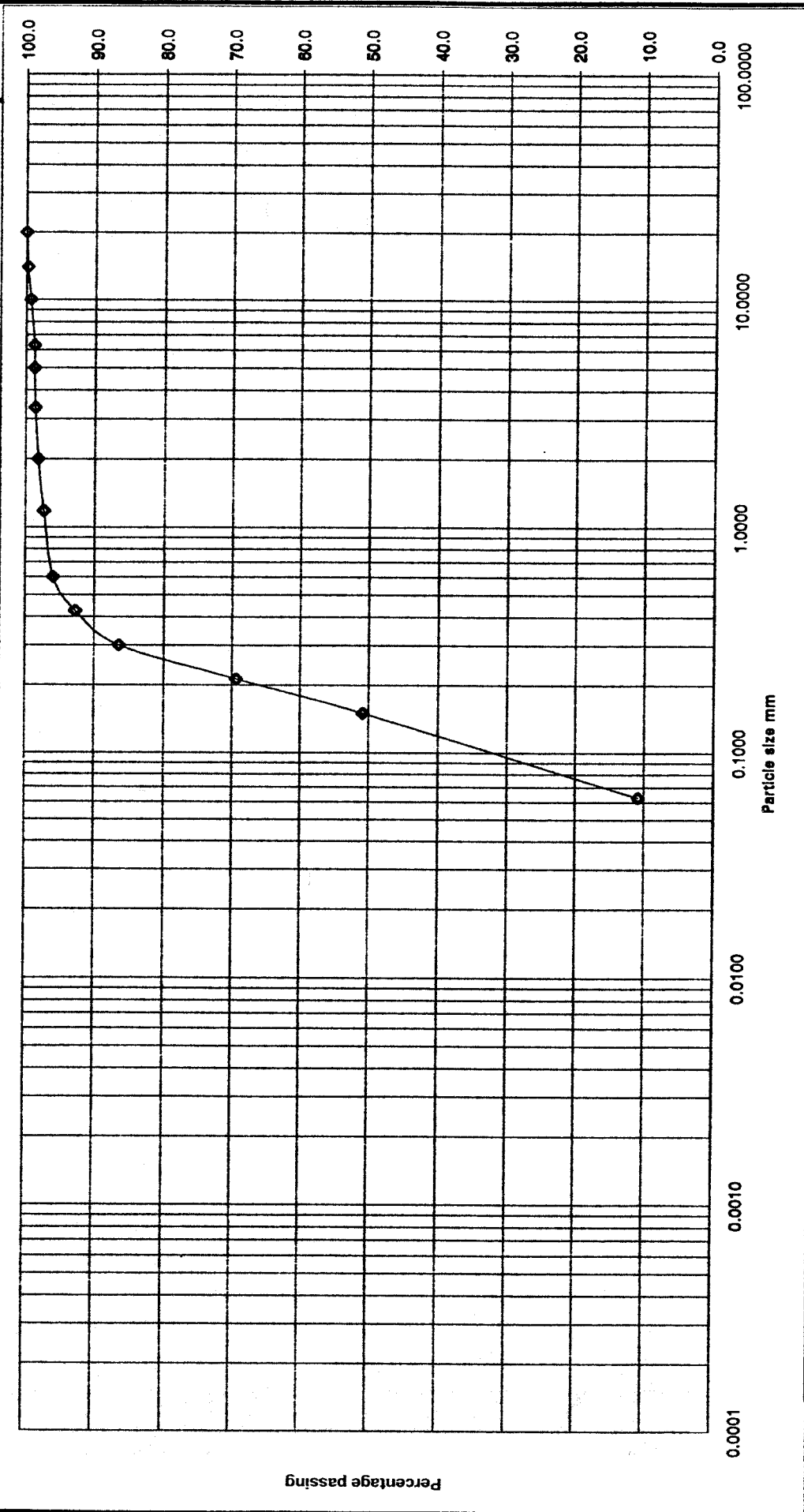
COBBLES

Visual Description: Grey silty SAND with a little gravel

K4 SOILS LABORATORY

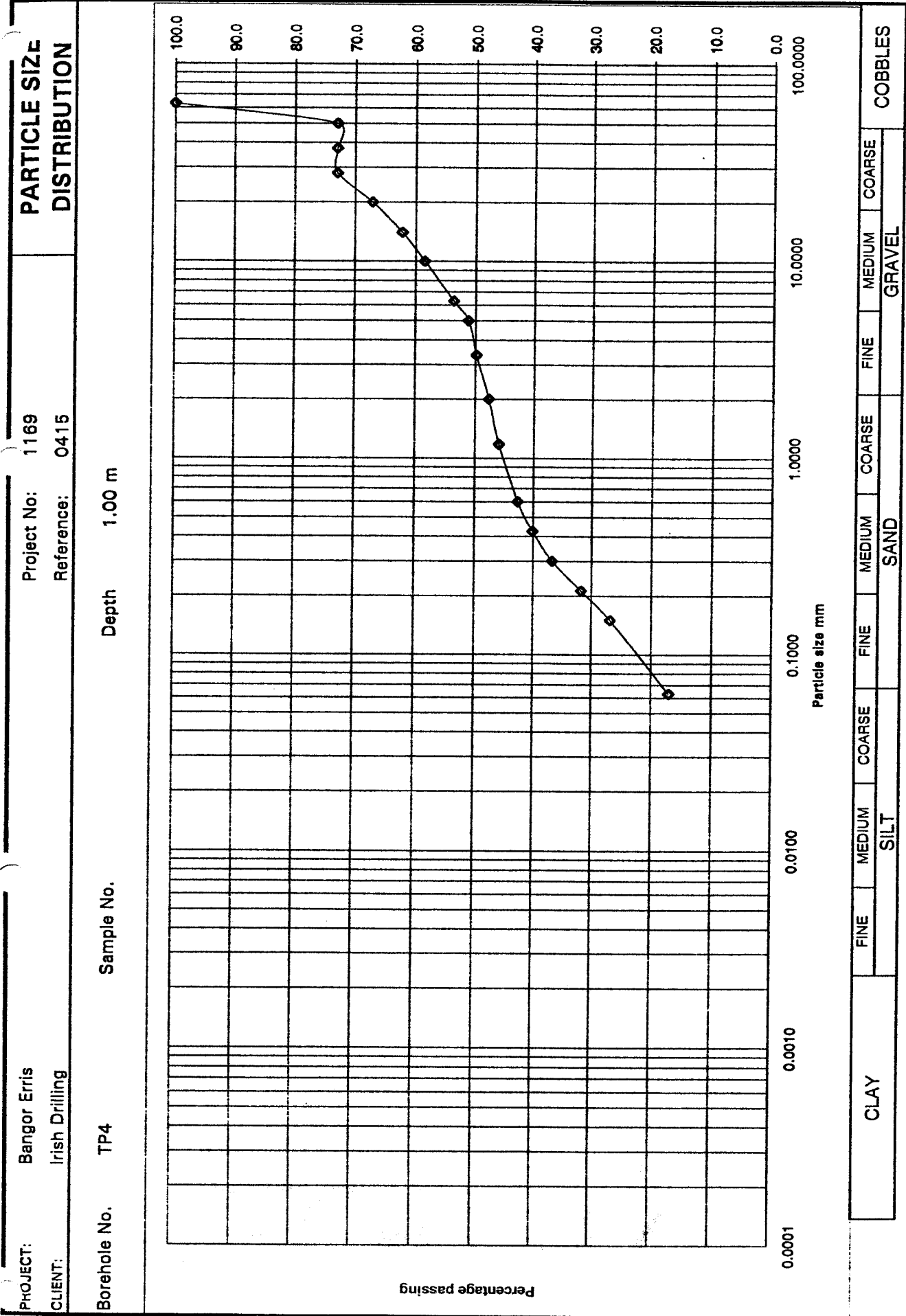
PROJECT: Bangor Erris	Project No: 1169	PARTICLE SIZE DISTRIBUTION
CLIENT: Irish Drilling	Reference: 0415	

Borehole No. TP3	Sample No.	Depth 2.50 m
------------------	------------	--------------



CLAY	SILT		SAND		GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	

Visual Description: Pale grey SAND with a trace of gravel



Visual Description: Grey silty SAND and GRAVEL

PROJECT: Bangor Erris

CLIENT: Irish Drilling

Project No: 1169

Reference: 0415

PARTICLE SIZE DISTRIBUTION

Borehole No. TP5

Sample No.

Depth 1.50 m

Percentage passing

100.0

90.0

80.0

70.0

60.0

50.0

40.0

30.0

20.0

10.0

0.0

100.0000

10.0000

1.0000

0.1000

0.0100

0.0010

0.0001

Particle size mm

Particle Size (mm)	Percentage Passing (%)
0.075	100.0
0.15	75.0
0.3	55.0
0.6	40.0
1.18	20.0
2.0	10.0

CLAY

FINE

MEDIUM

COARSE

FINE

MEDIUM

COARSE

FINE

MEDIUM

COARSE

SILT

GRAVEL

COBBLES

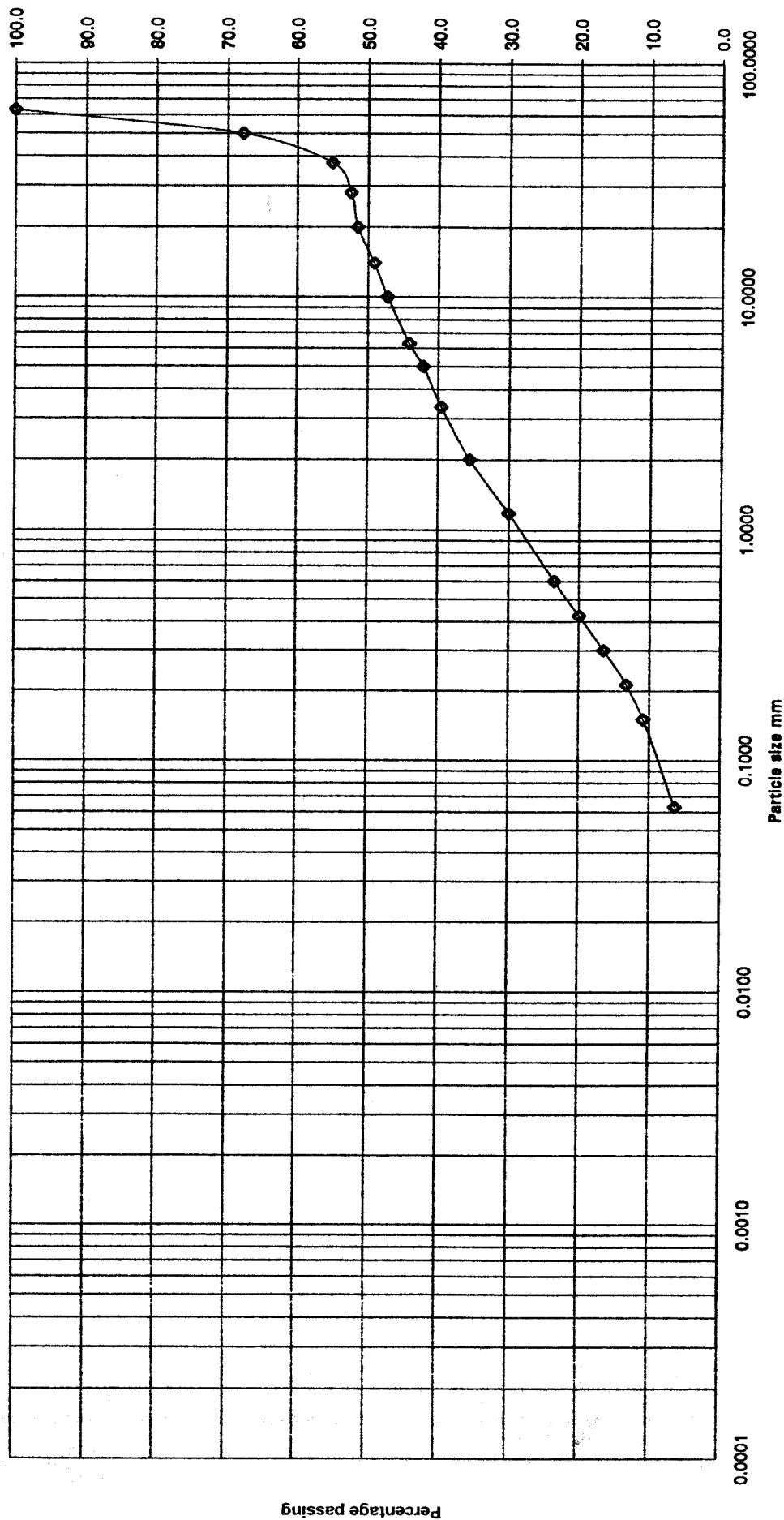
Visual Description: Grey silty sandy GRAVEL with occasional cobbles

Project No: 1169
Reference: 0415

PARTICLE SIZE DISTRIBUTION

Borehole No.	TP6	Sample No.
1		
2		
3		
4		
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100		

Depth 2.50 m



CLAY

FINE	MEDIUM
SILT	

MEDIUM SAND

COARSE

MEDIUM GRAVEL

COBBLES

Visual Description: Grey sandy GRAVEL

K4 SOILS LABORATORY

Compaction/CBR/Moisture content test

2.5kg rammer

BS1377:1990; Part 4, Clause 3.4, 7

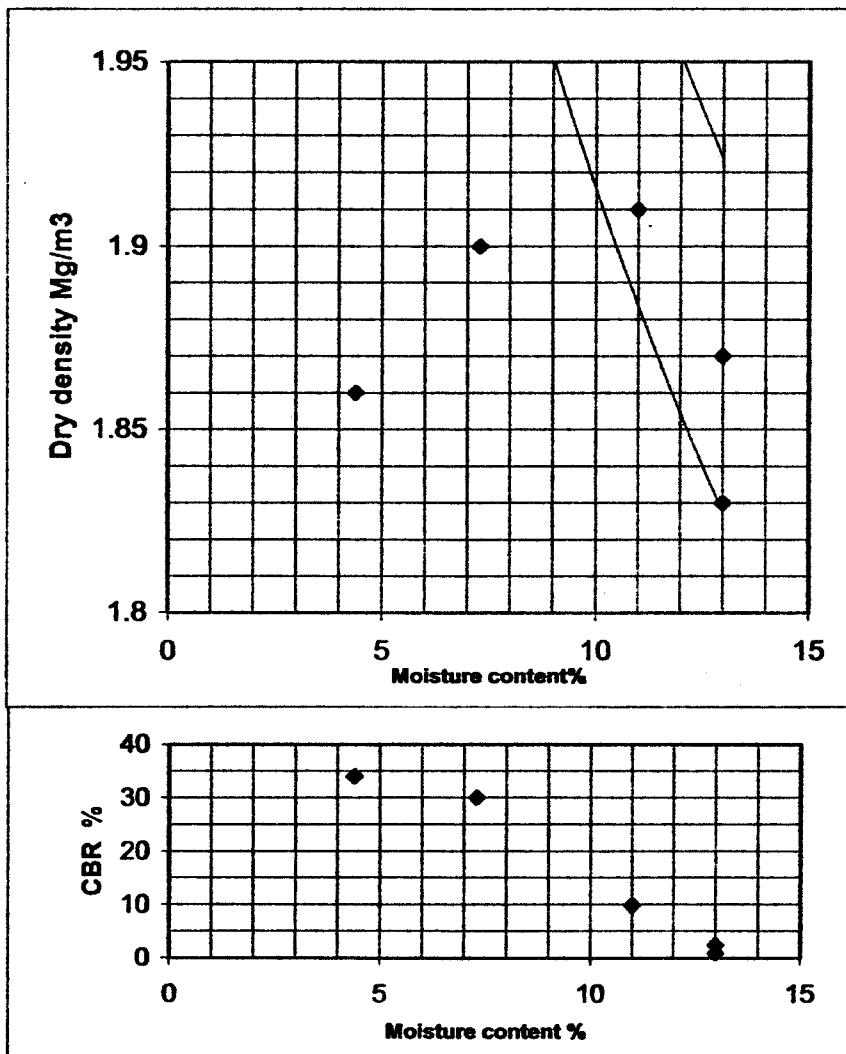
IRISH DRILLING LTD. Loughrea, Co. Galway	Contract: Peat Deposit Site at Bangor Erris (1169) Client: Enterprise oil Engineer: TES Date: 20/11/2003 Tested: DD Chckd: DJ	Location: TP 2 Depth: 1.5 m
--	---	--

Description: Grey slightly clayey fine to medium SAND.

Moisture Content %	Dry Density Mg/m ³
4.4	1.86
7.3	1.9
11	1.91
13	1.83
13	1.87

moisture content %	CBR %
4.4	34
7.3	30
11	9.8
13	2.4
13	0.9

Gs assumed: 2.55



RESULTS:

Maximum dry density: 1.91 Mg/m³

Optimum moisture content: 11.00 %

Natural moisture content * : 13.00 %

Retained on 20mm Sieve: %

Natural moisture content **: %

* refers to bulk sample before removal of coarse particles

** refers to sample after removal of coarse particles

Compaction/CBR/Moisture content test

2.5kg rammer

BS1377:1990; Part 4, Clause 3.4, 7

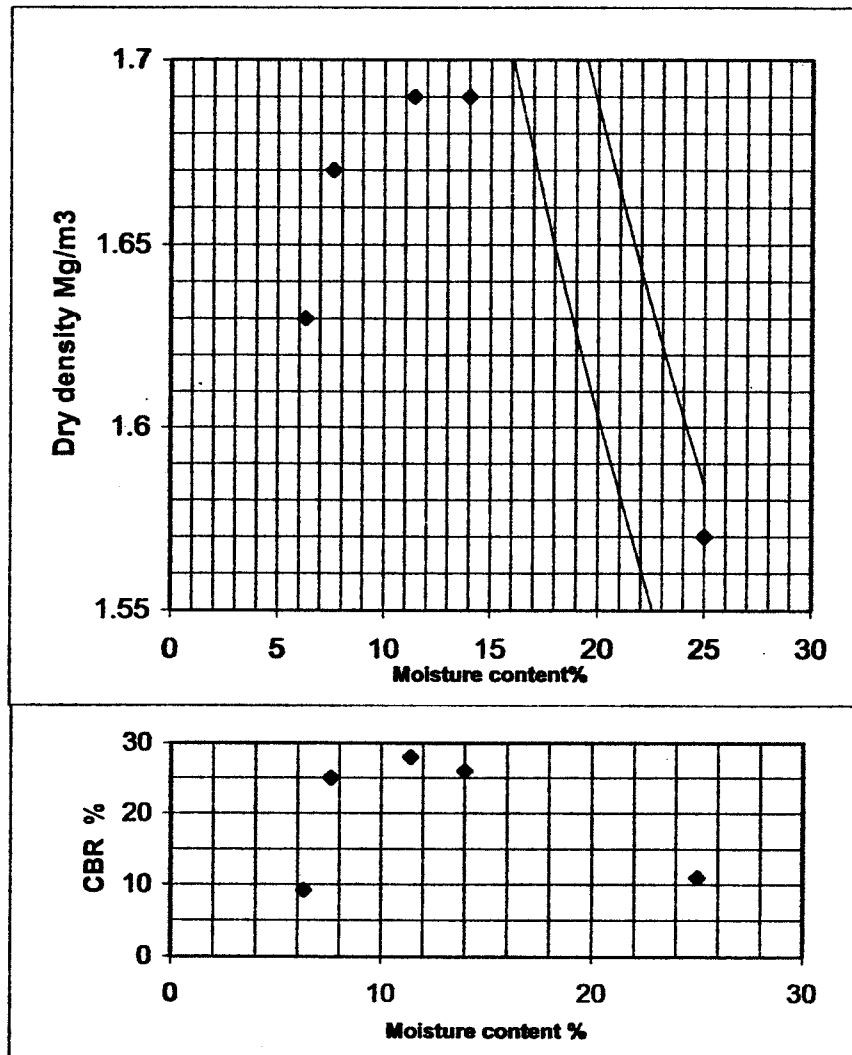
IRISH DRILLING LTD. Loughrea, Co. Galway	Contract: Peat Deposit Site at Bangor Erris (1169) Client: Enterprise oil Engineer: TES Date: 20/11/2003 Tested: DD Chckd: DJ	Location: TP 3 Depth: 2.5 m
--	---	--

Description: Dark grey-green SAND with occasional peat pockets.

Moisture Content %	Dry Density Mg/m ³
6.3	1.63
7.6	1.67
11.4	1.69
14	1.69
25	1.57

moisture content %	CBR %
6.3	9.2
7.6	25
11.4	28
14	26
25	11

Gs assumed: 2.55



RESULTS:

Maximum dry density: 1.69 Mg/m³
 Optimum moisture content: 11.50 %
 Natural moisture content *: 25.00 %
 Retained on 20mm Sieve: %
 Natural moisture content **: %

* refers to bulk sample before removal of coarse particles

** refers to sample after removal of coarse particles

Compaction/CBR/Moisture content test

2.5kg rammer

BS1377:1990; Part 4, Clause 3.4, 7

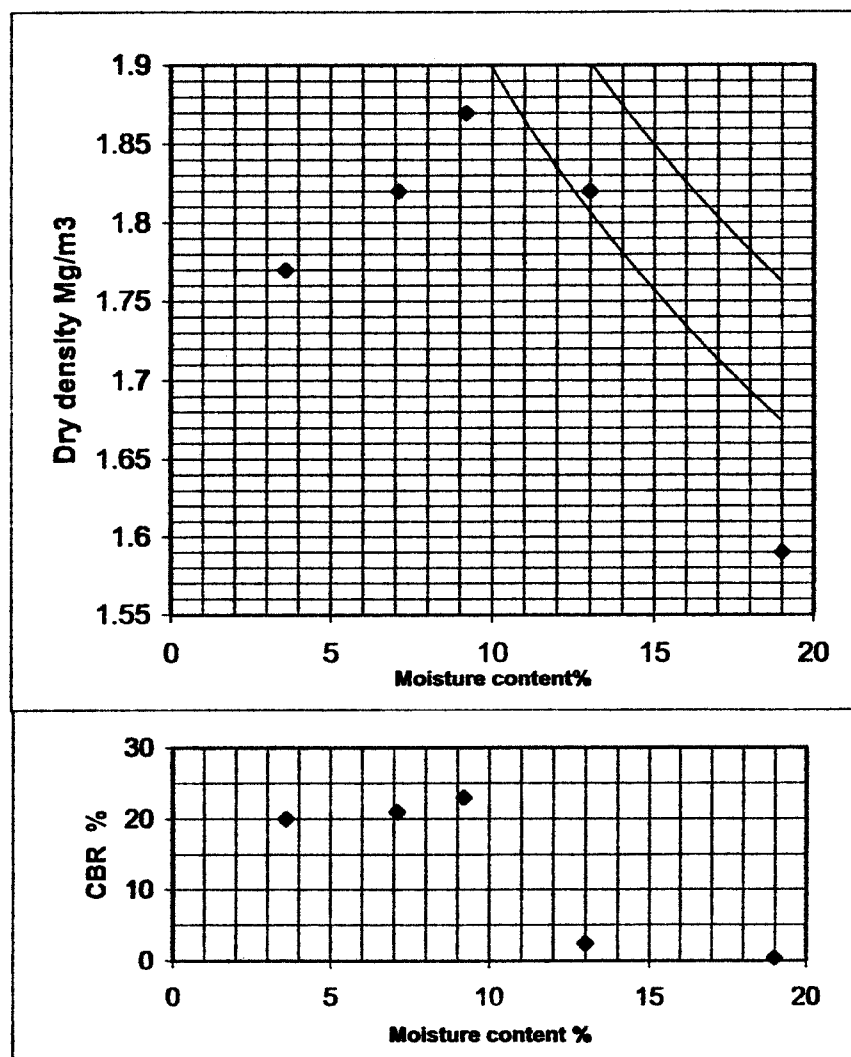
IRISH DRILLING LTD. Loughrea, Co. Galway	Contract: Peat Deposit Site at Bangor Erris (1169) Client: Enterprise oil Engineer: TES Date: 20/11/2003 Tested: DD Chckd: DJ	Location: TP 5 Depth: 1.5 m
--	---	--

Description: Dark grey very sandy CLAY with fine, medium to coarse gravel.

Moisture Content %	Dry Density Mg/m ³
3.6	1.77
7.1	1.82
9.2	1.87
13	1.82
19	1.59

moisture content %	CBR %
3.6	20
7.1	21
9.2	23
13	2.4
19	0.36

Gs assumed: 2.55



RESULTS:

Maximum dry density: 1.87 Mg/m³
 Optimum moisture content: 9.20 %
 Natural moisture content *: 19.00 %
 Retained on 20mm Sieve: %
 Natural moisture content **: %

* refers to bulk sample before removal of coarse particles

** refers to sample after removal of coarse particles

Compaction/CBR/Moisture content test

2.5kg rammer

BS1377:1990; Part 4, Clause 3.4, 7

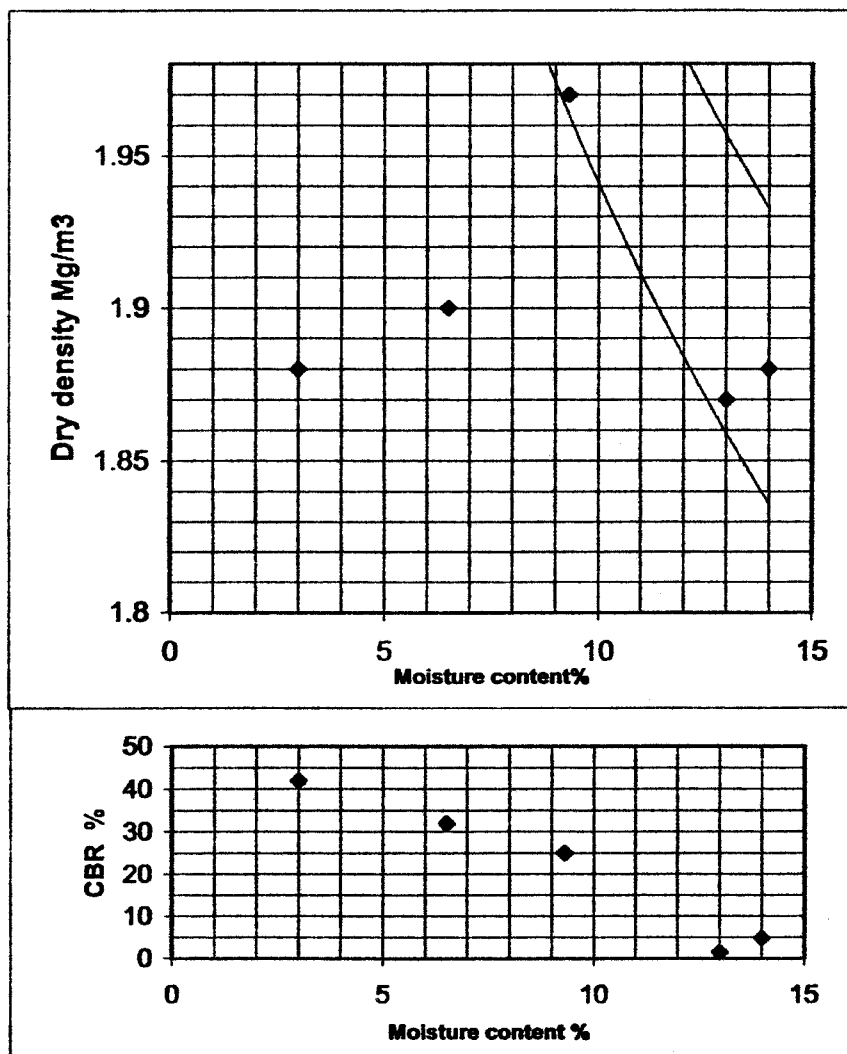
IRISH DRILLING LTD. Loughrea, Co. Galway	Contract: Peat Deposit Site at Bangor Erris (1169) Client: Enterprise oil Engineer: TES Date: 20/11/2003 Tested: DD Chckd: DJ	Location: TP 6 Depth: 1.5 m
--	---	--

Description: Grey SAND with a little gravel.

Moisture Content %	Dry Density Mg/m ³
3	1.88
6.5	1.9
9.3	1.97
13	1.87
14	1.88

moisture content %	CBR %
3	42
6.5	32
9.3	25
13	1.4
14	4.79

Gs assumed: 2.60



RESULTS:

Maximum dry density: 1.97 Mg/m³
 Optimum moisture content: 9.30 %
 Natural moisture content *: 14.00 %
 Retained on 20mm Sieve: %
 Natural moisture content **: %

* refers to bulk sample before removal of coarse particles

** refers to sample after removal of coarse particles

Compaction/CBR/Moisture content test

2.5kg rammer

BS1377:1990; Part 4, Clause 3.4, 7

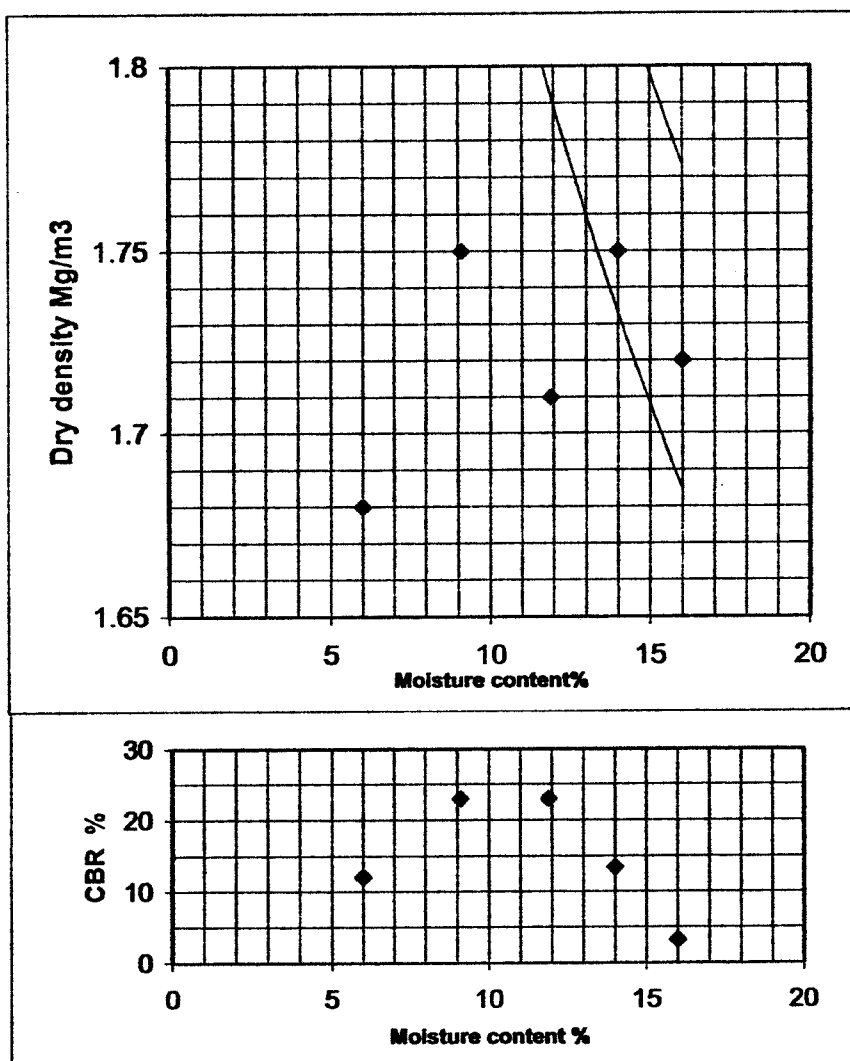
IRISH DRILLING LTD. Loughrea, Co. Galway	Contract: Peat Deposit Site at Bangor Erris (1169)	Location: TP 7
	Client: Enterprise oil	
	Engineer: TES	
	Date: 20/11/2003	Depth: 2.5 m
	Tested: DD Chckd: DJ	

Description: Grey SAND with a little gravel.

Moisture Content %	Dry Density Mg/m ³
6	1.68
9.1	1.75
11.9	1.71
14	1.75
16	1.72

moisture content %	CBR %
6	12
9.1	23
11.9	23
14	13.4
16	3.2

Gs assumed: 2.45



RESULTS:

Maximum dry density: 1.97 Mg/m³

Optimum moisture content: 9.30 %

Natural moisture content * : 14.00 %

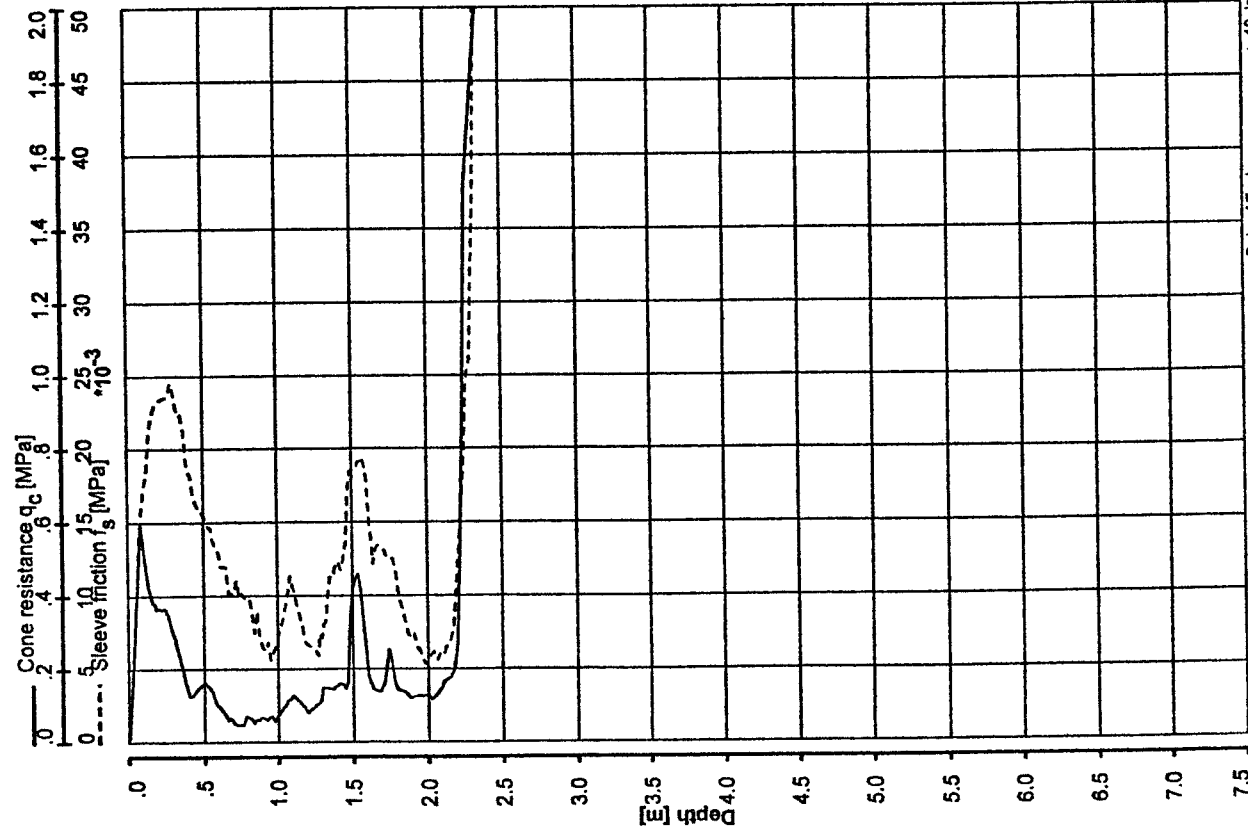
Retained on 20mm Sieve: %

Natural moisture content **: %

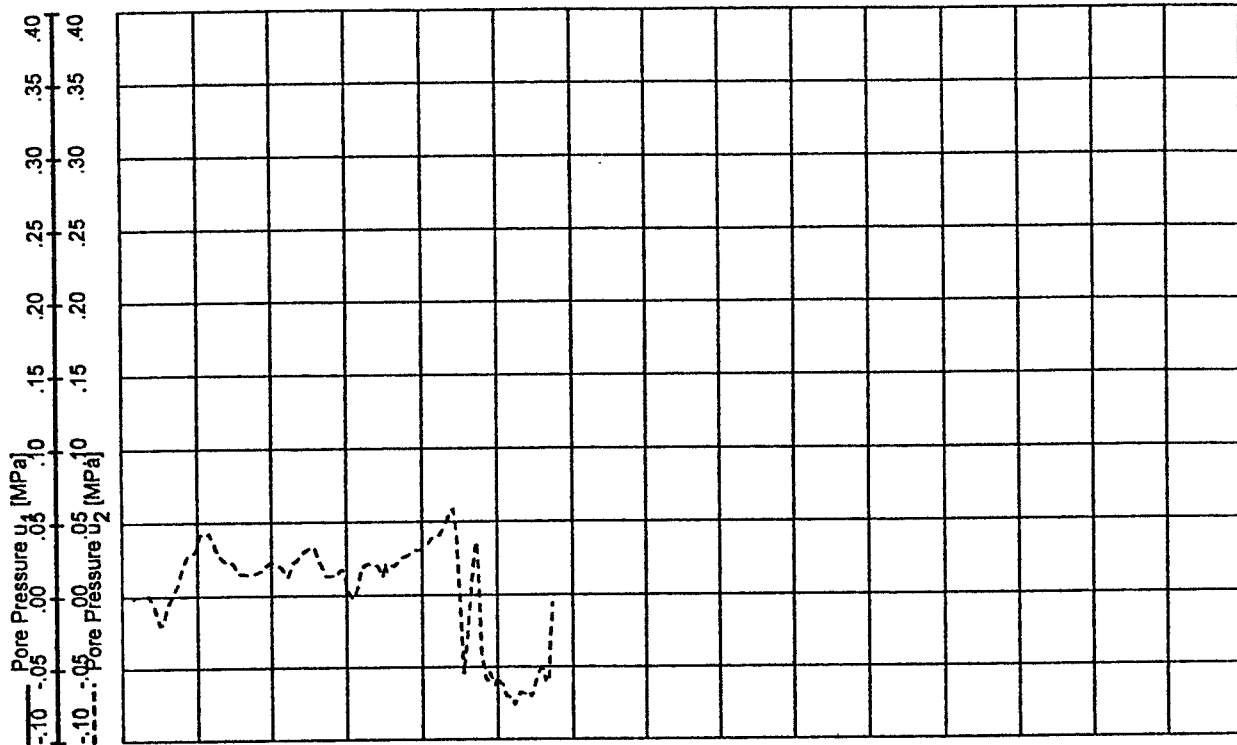
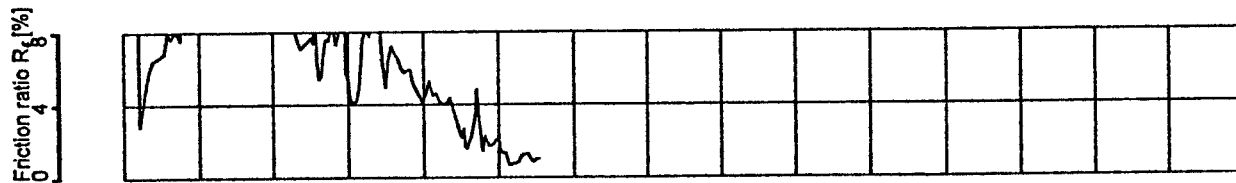
* refers to bulk sample before removal of coarse particles

** refers to sample after removal of coarse particles

APPENDIX B PHASE 2 GROUND INVESTIGATION RESULTS



11
15
15

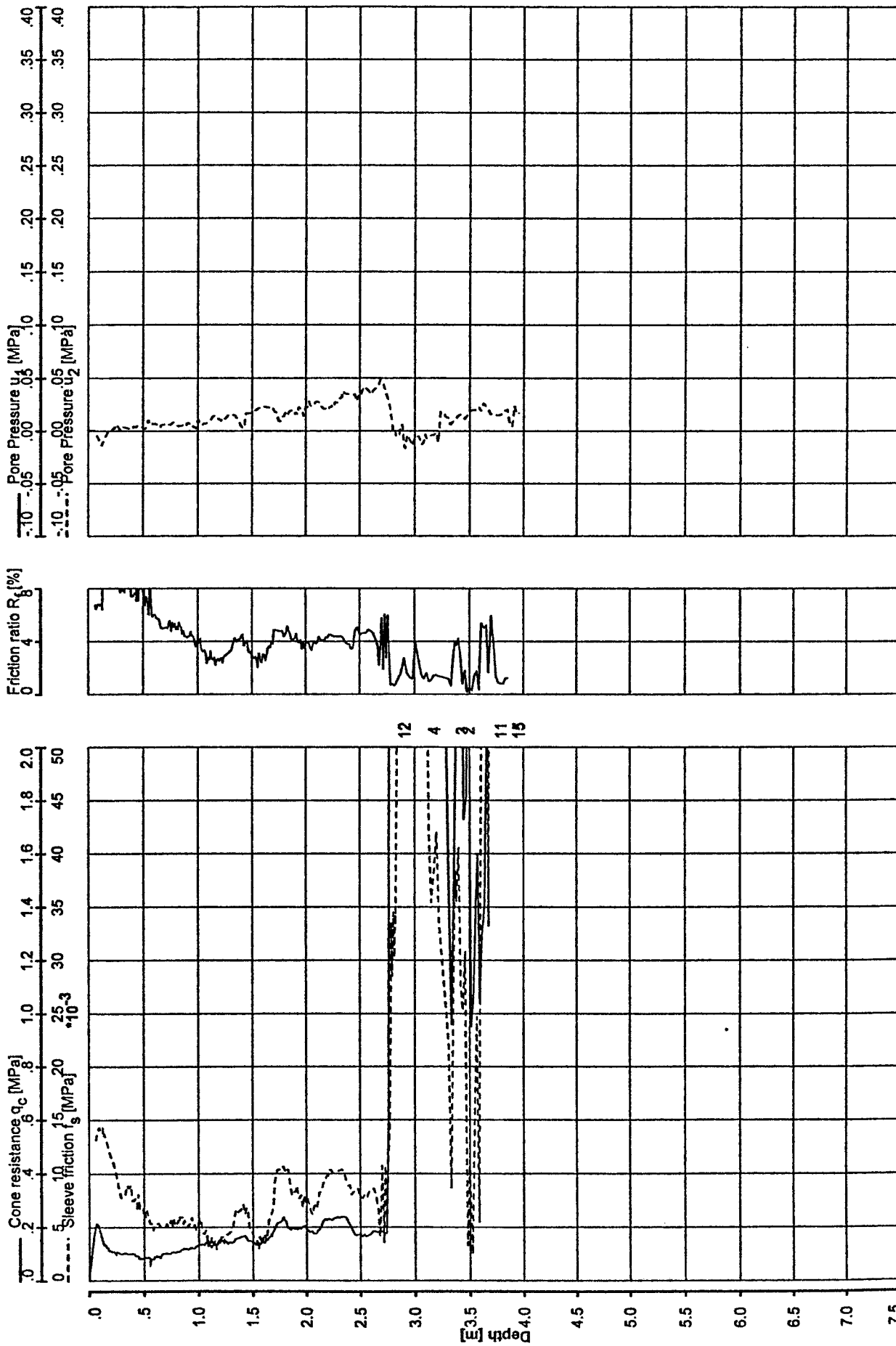


Location : HF1 CP10 Date of Test : 16-Jan-1990
 Coordinates : Date of Plot : 02-Dec-2003
 Ground Level [m] : File name : Hf1cp10.000
 Cone used : F7.5SKEW-V 1515 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST HF1 CP10
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

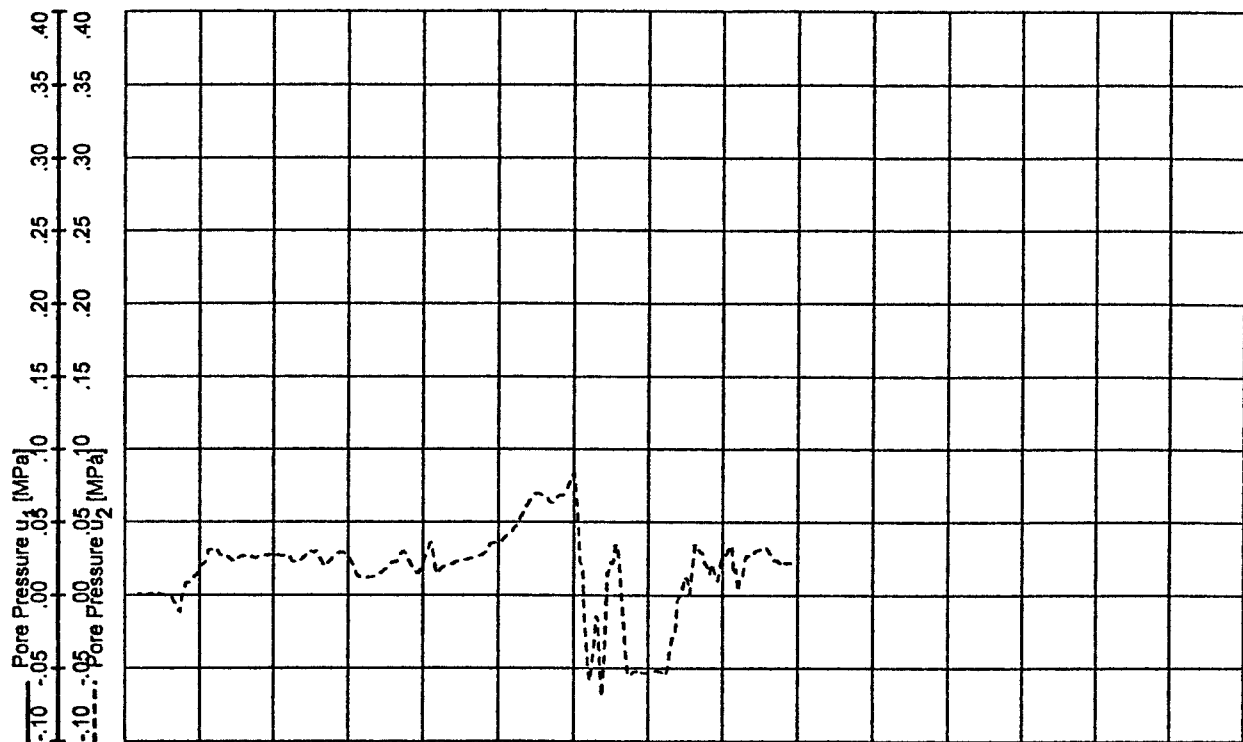
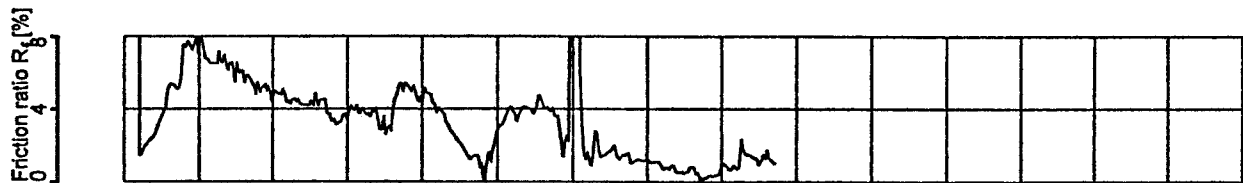
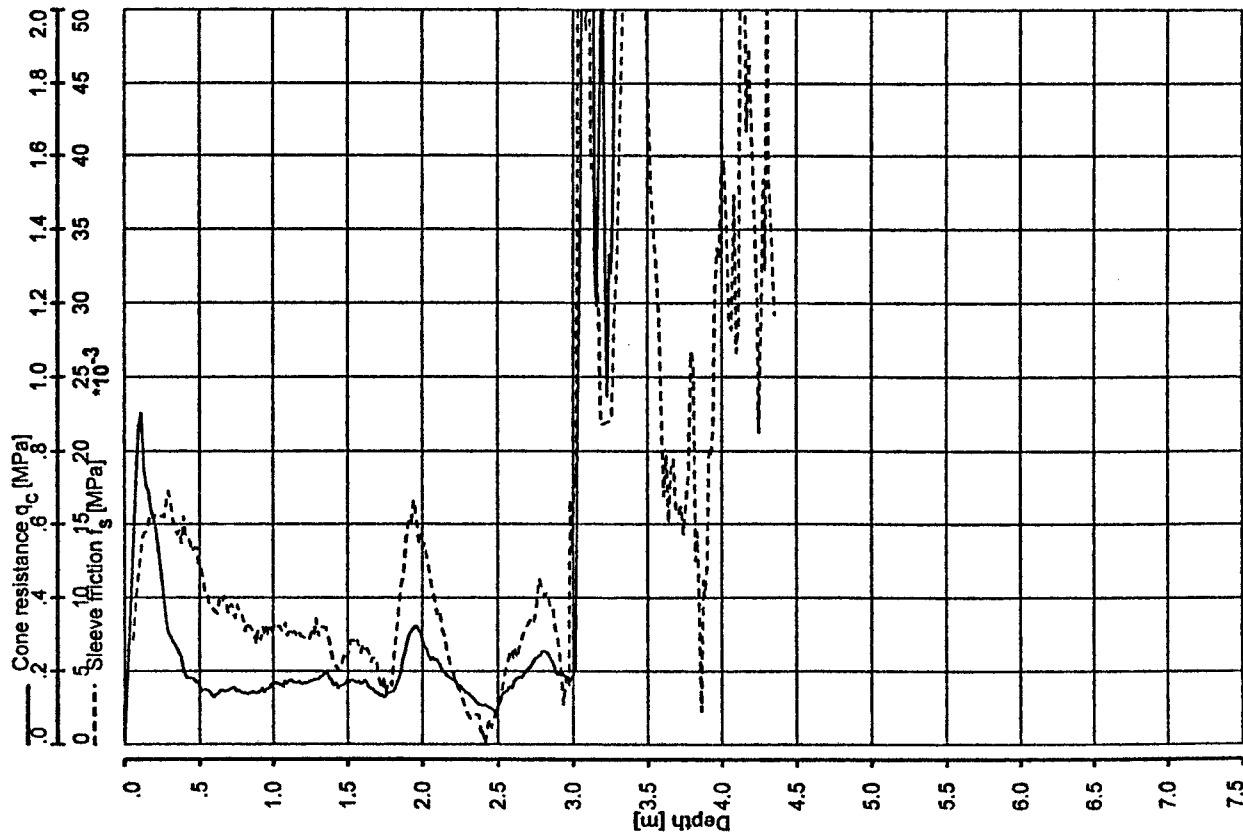


STATIC CONE PENETRATION TEST
EASINGTON LANFALL PIPELINE
STATOIL

Location : HF1 CP4
Coordinates :
Ground Level [m] :
Cone used : F7.5CKEW₂V 1515
Date of Test : 17-Jan-1990
Date of Plot : 02-Dec-2003
File name : HF1cp4.000
Interpretation Checked by : ...

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

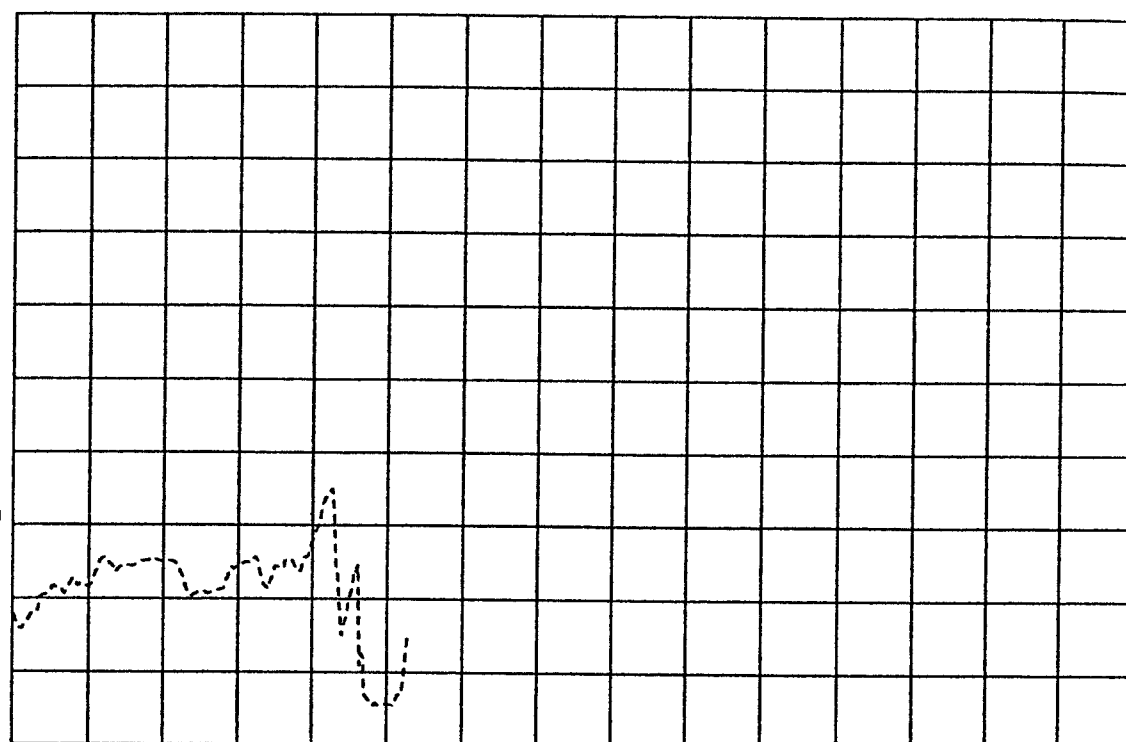
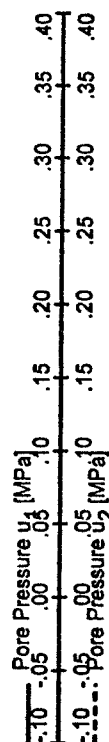
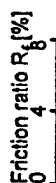
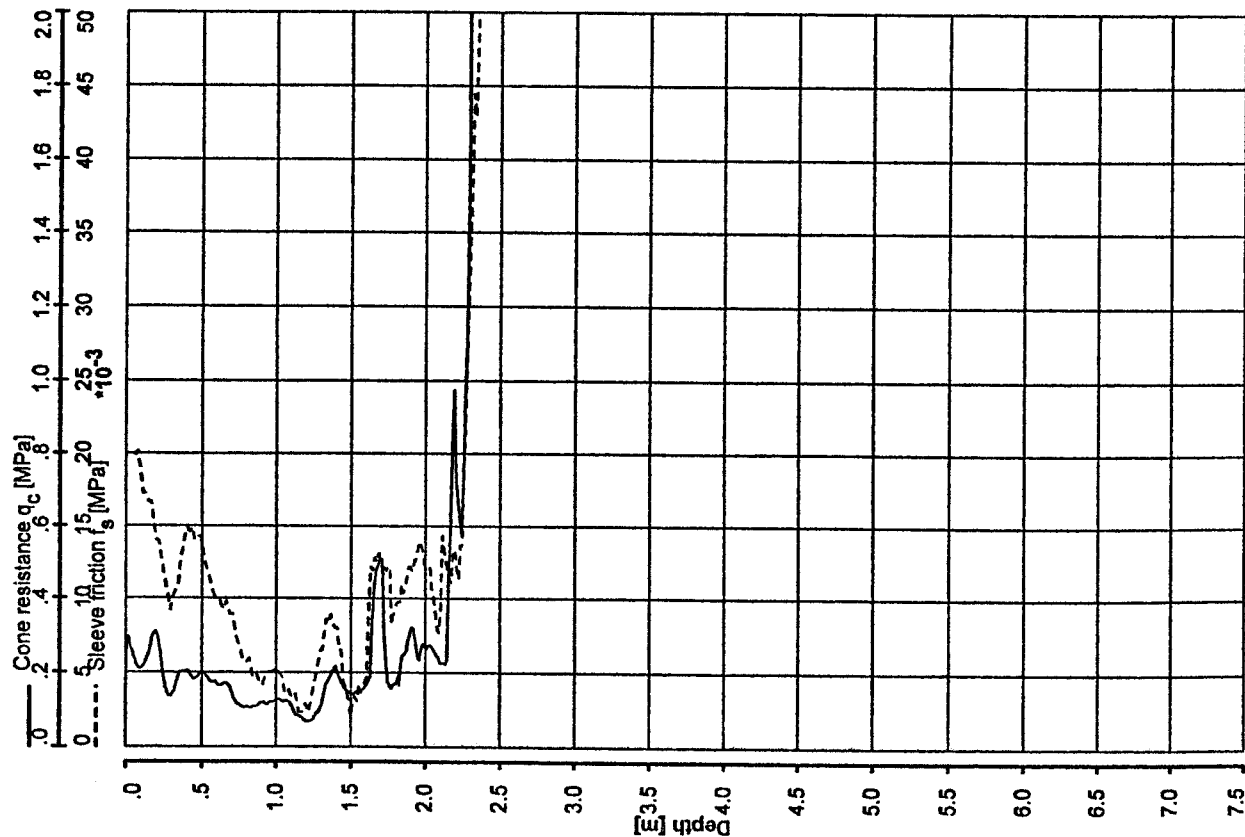


Location : HF1 CP6
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW-V 1515
 Date of Test : 17-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF1cp6.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



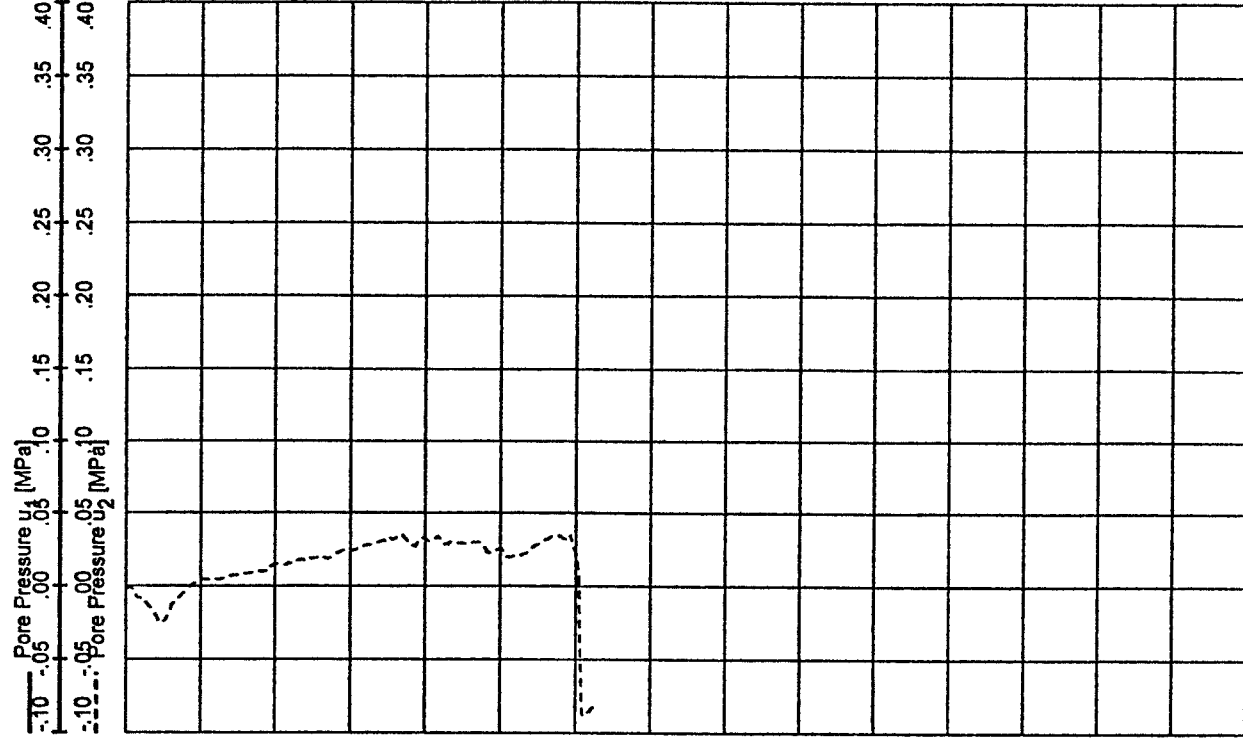
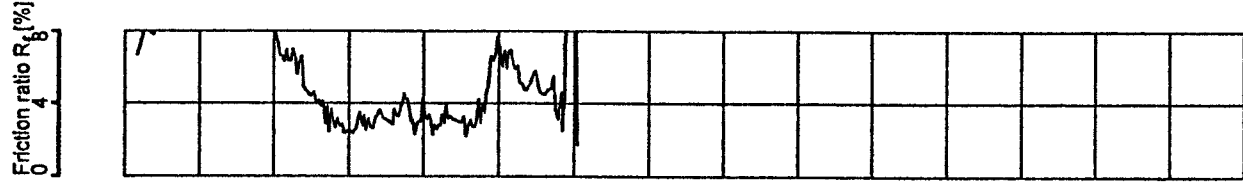
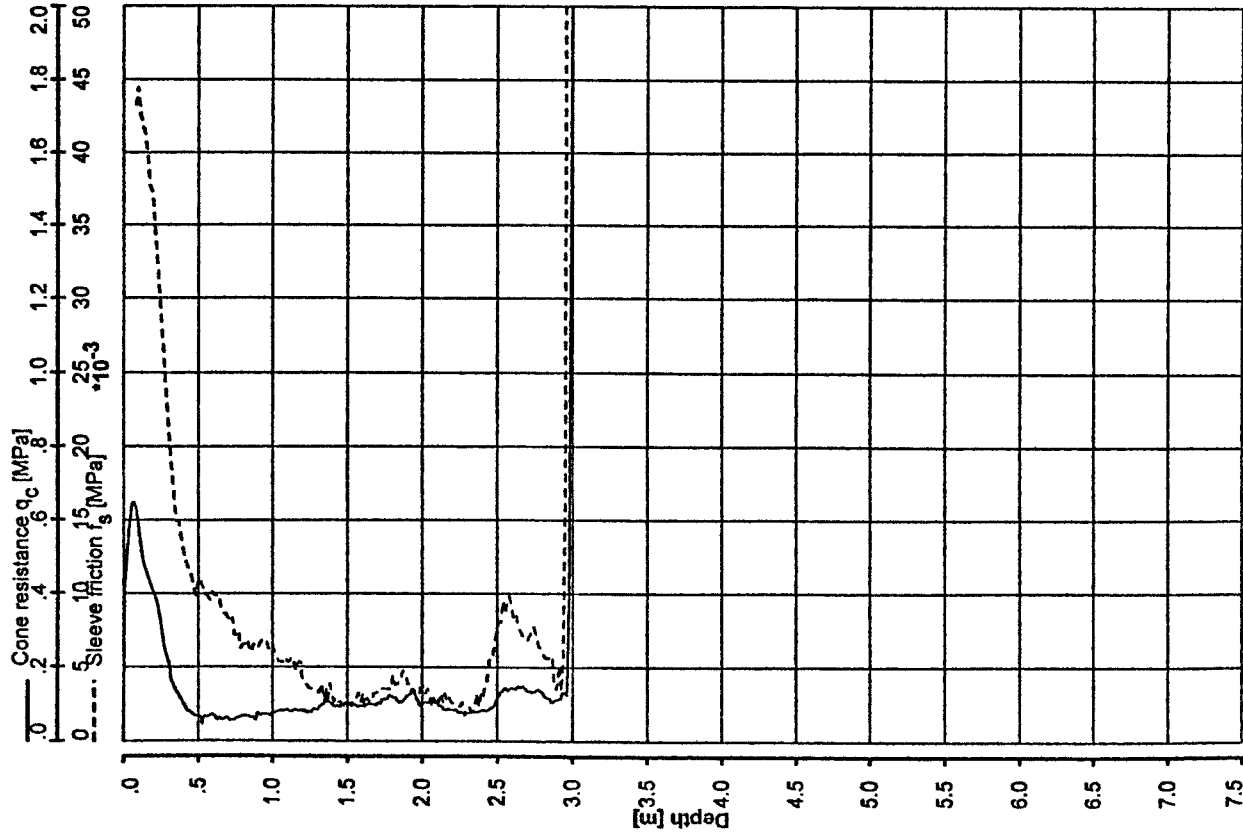
Location : HF1 CP8
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW₂N 1515
 Date of Test : 17-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF1cp8.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

HF1 CP8

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



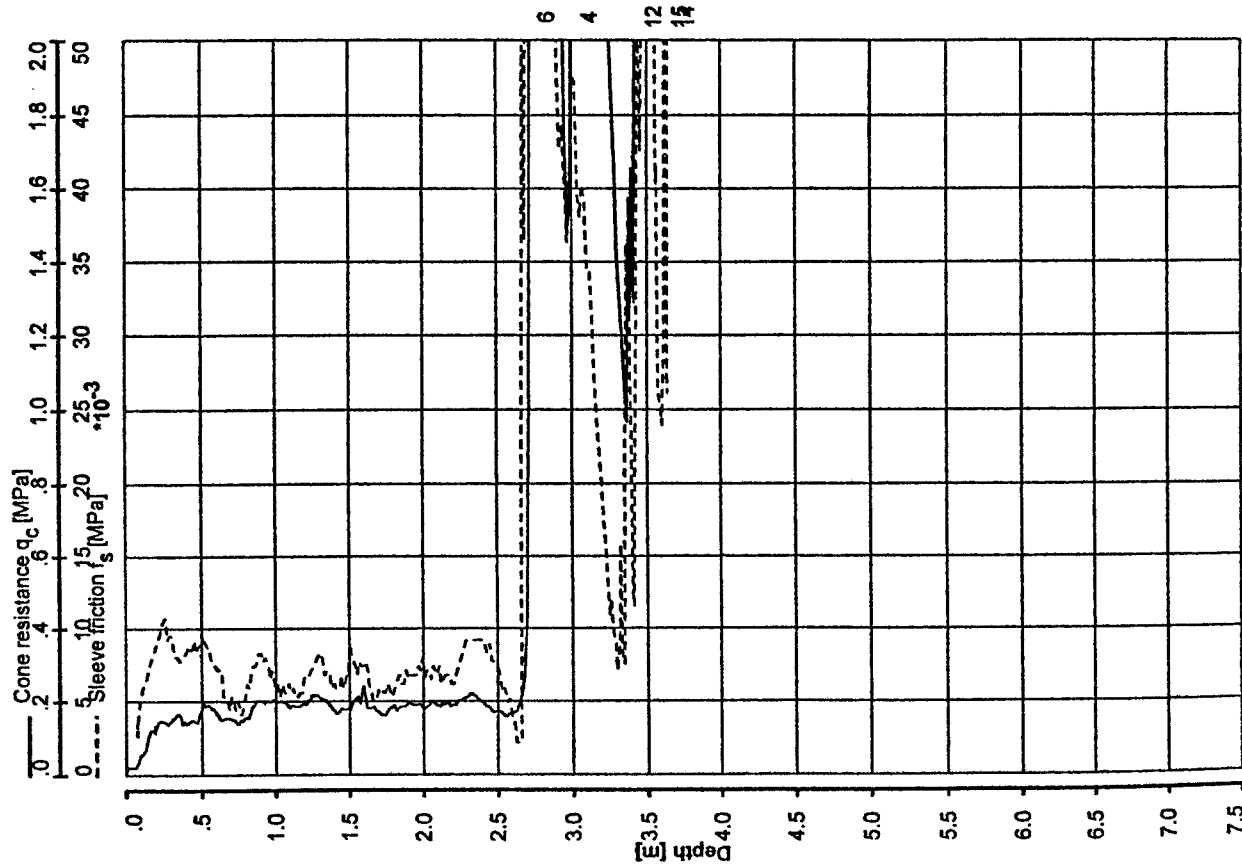
Location : HF2 CP10
 Date of Test : 16-Jan-1990
 Coordinates :
 Date of Plot : 02-Dec-2003
 Ground Level [m] :
 File name : H12cp10.000
 Cone used : F7.5CKEWV 1515
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

HF2 CP10

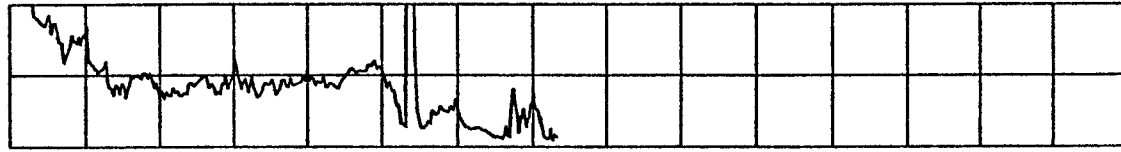
FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

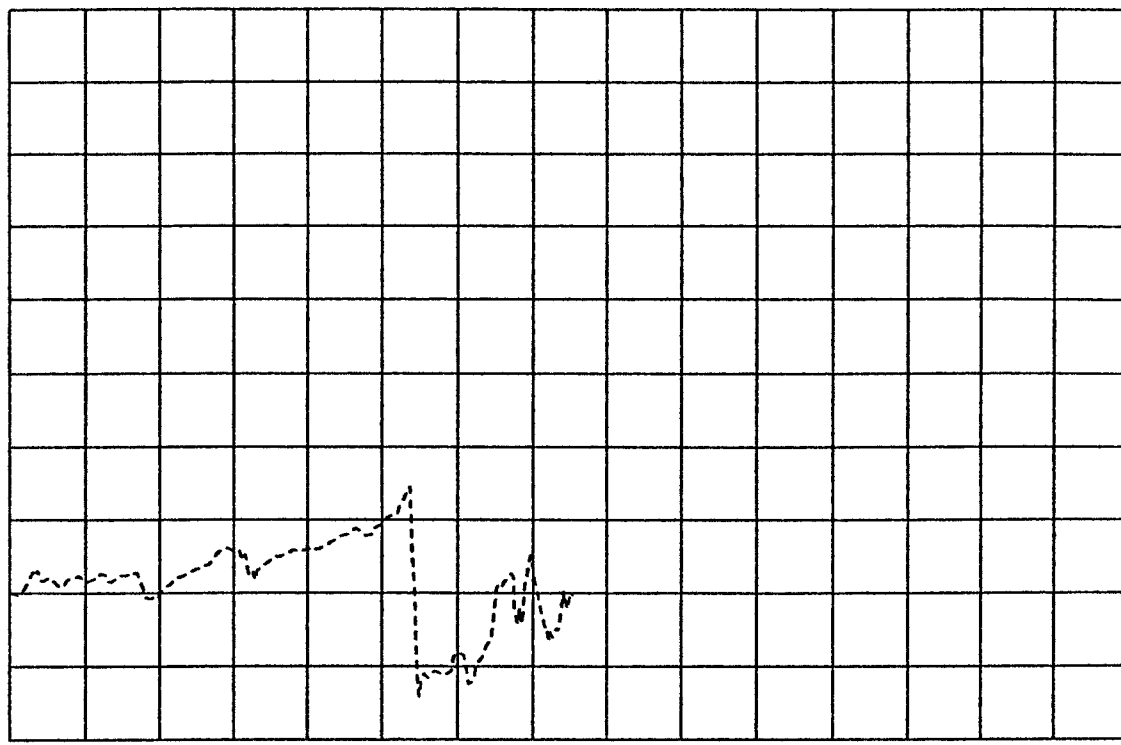


Location : HF2 CP4
 Coordinates :
 Ground Level [m] :
 Cone used : F7.SCKEW_N 1515
 Date of Test : 18-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF2cp4.000
 Interpretation Checked by : ...

Friction ratio R_f [%]



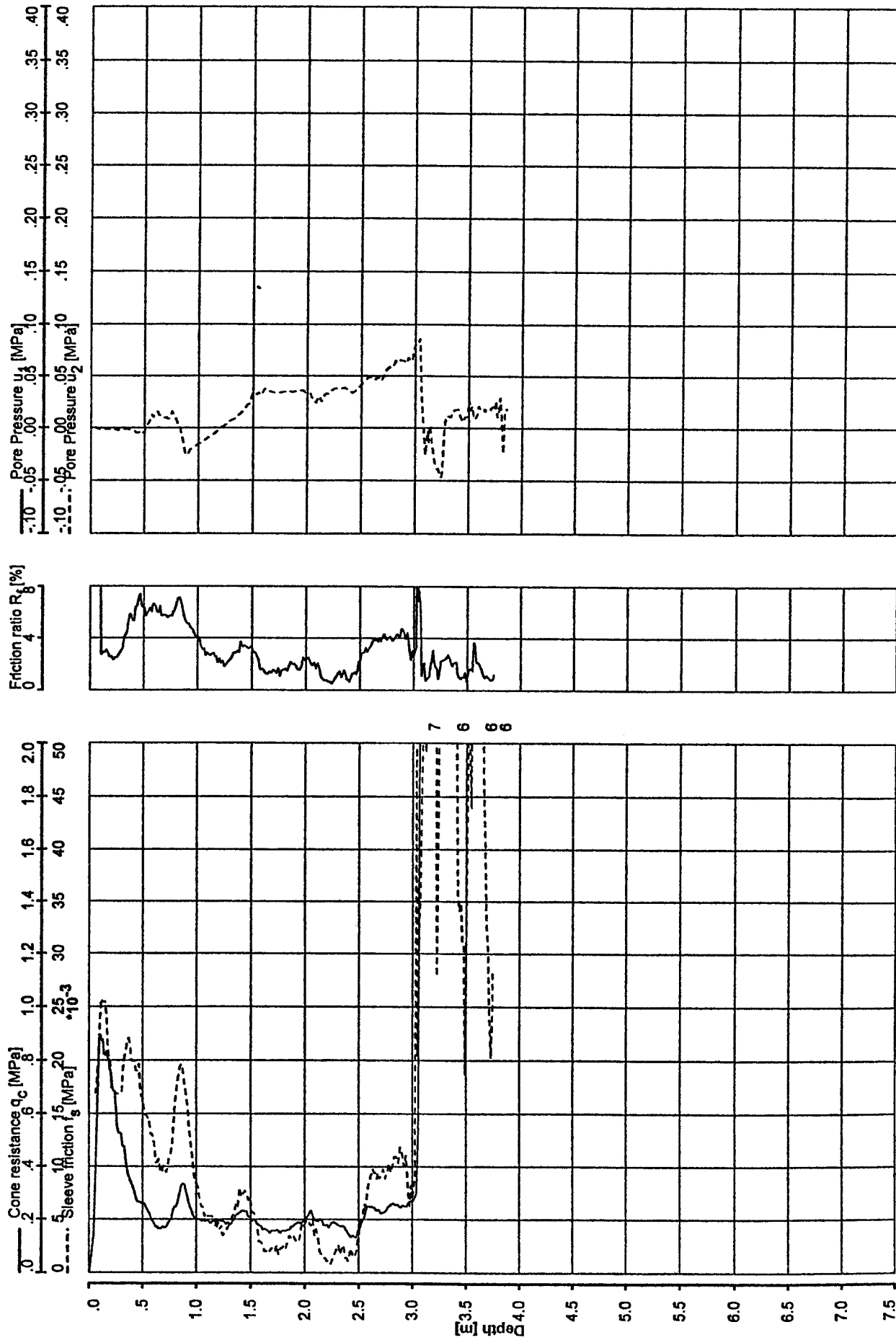
Pore Pressure u_1 [MPa]
 Pore Pressure u_2 [MPa]



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

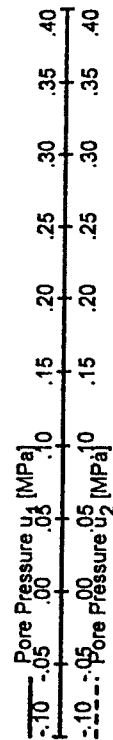
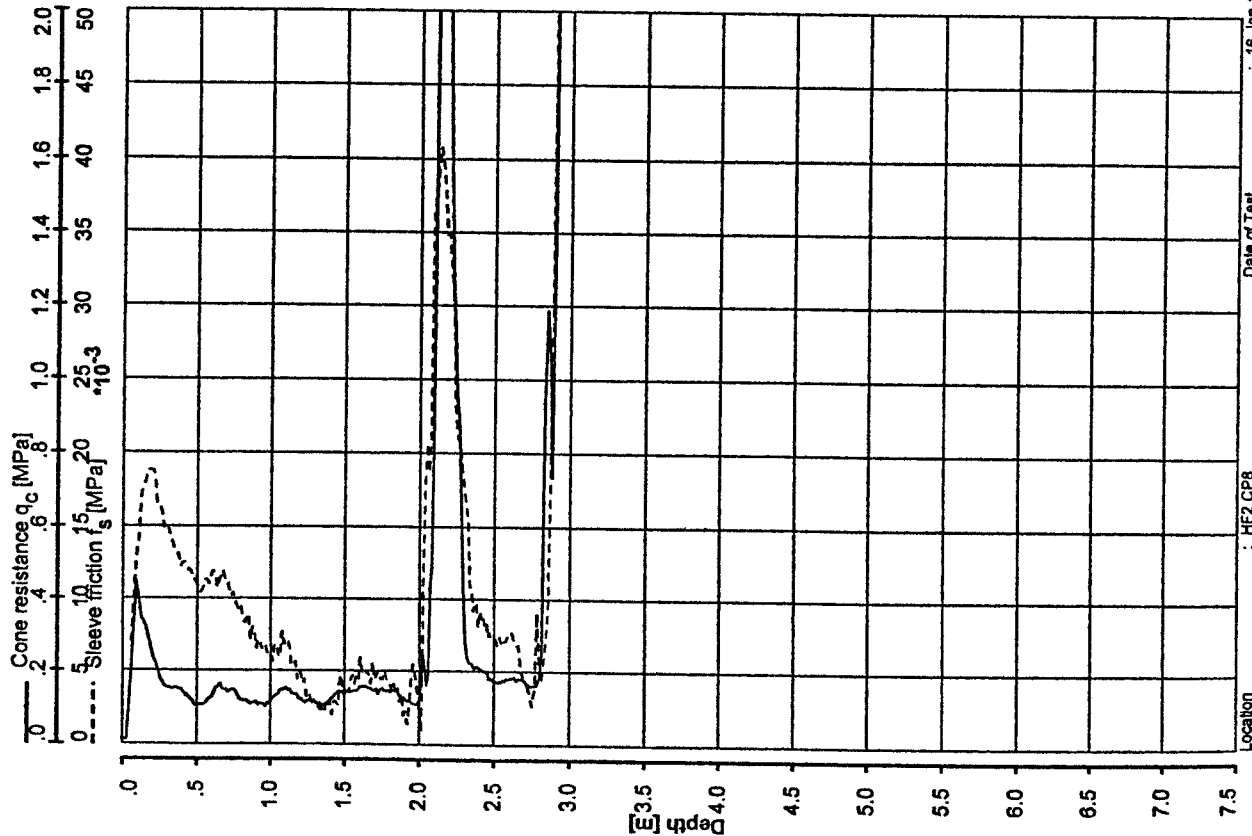


Location : HF2 CP6
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW₂V 1515
 Date of Test : 18-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF2cp6.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



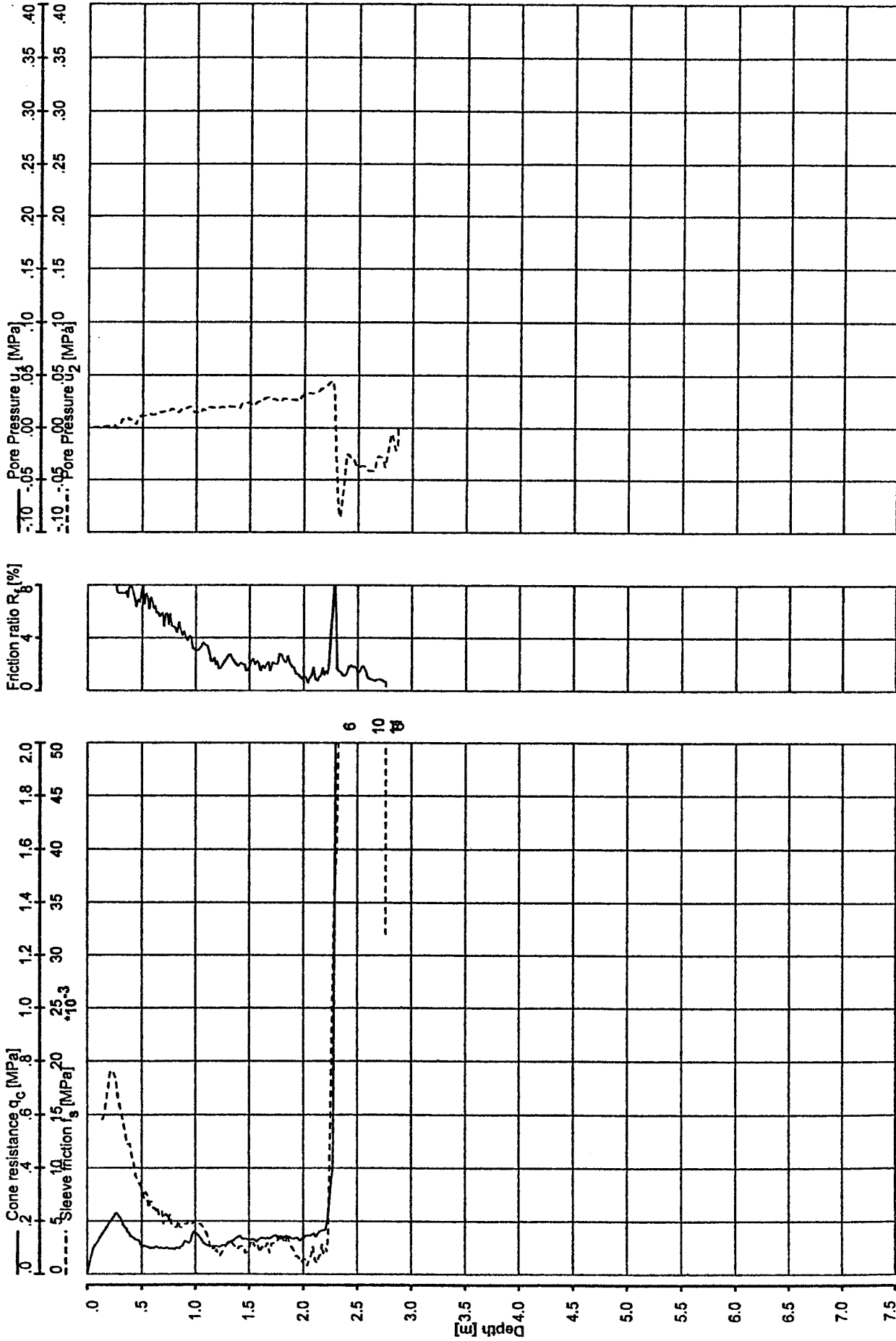
Location : HF2 CP8
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW-V 1515
 Date of Test : 16-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF2cp8.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

HF2 CP8

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

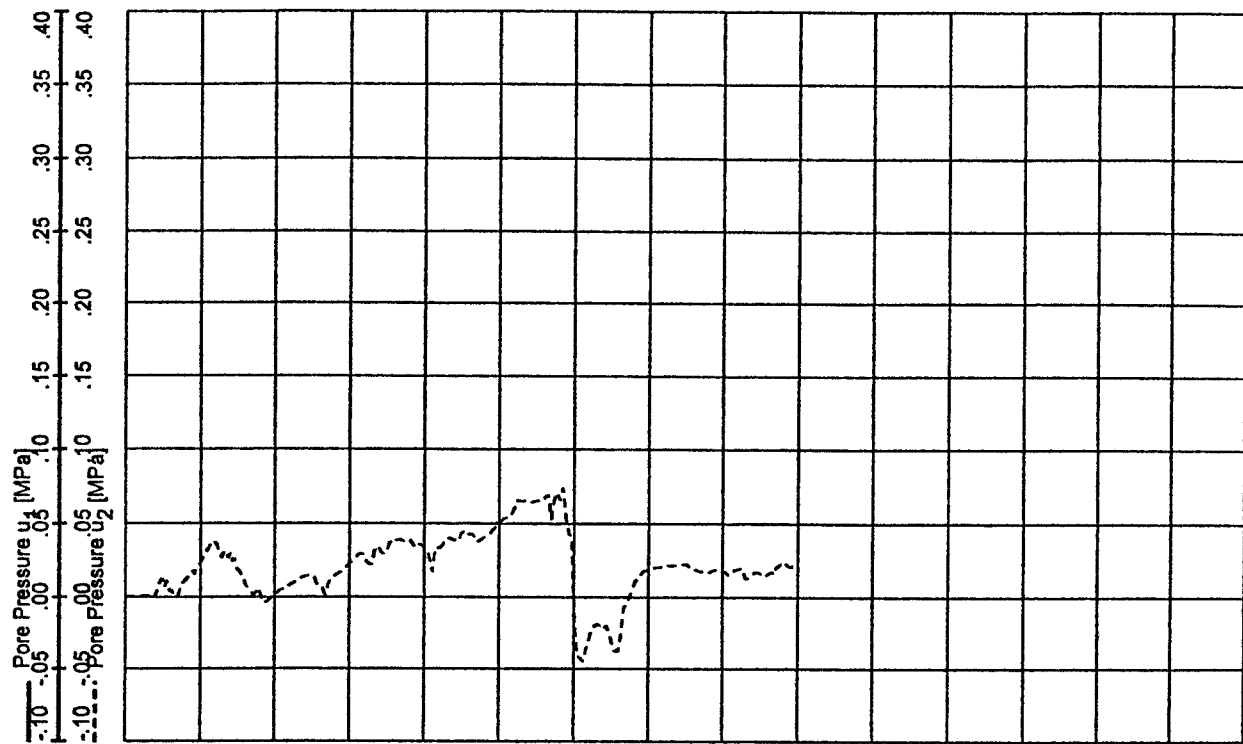
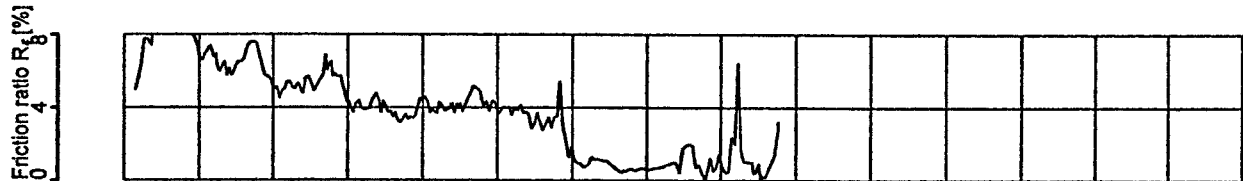
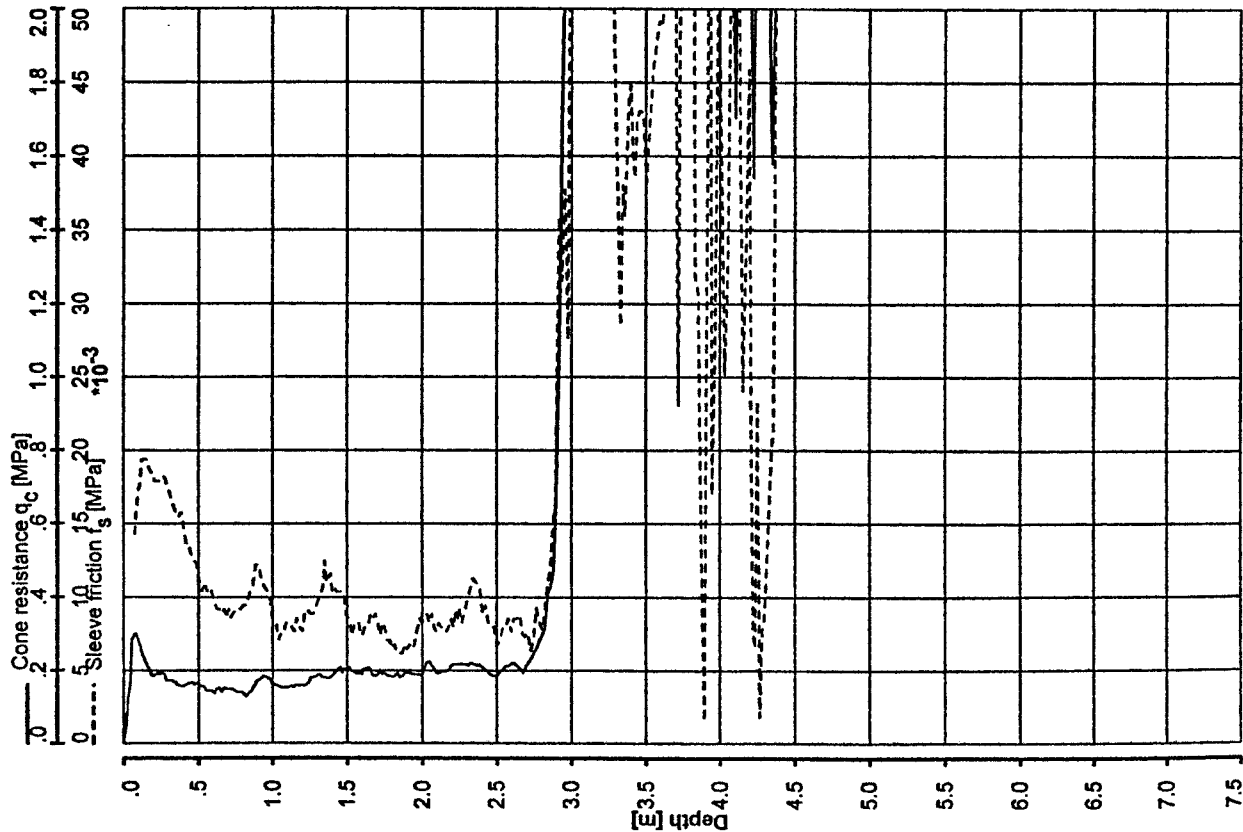


STATIC CONE PENETRATION TEST HF3 CP10
EASINGTON LANFALL PIPELINE
STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

Location : HF3 CP10 Date of Test : 15-Jan-1990
Coordinates : Date of Plot : 02-Dec-2003
Ground Level [m] : File name : HF3cp10.000
Cone used : F7.5CKEW-N 1515 Interpretation Checked by : ...

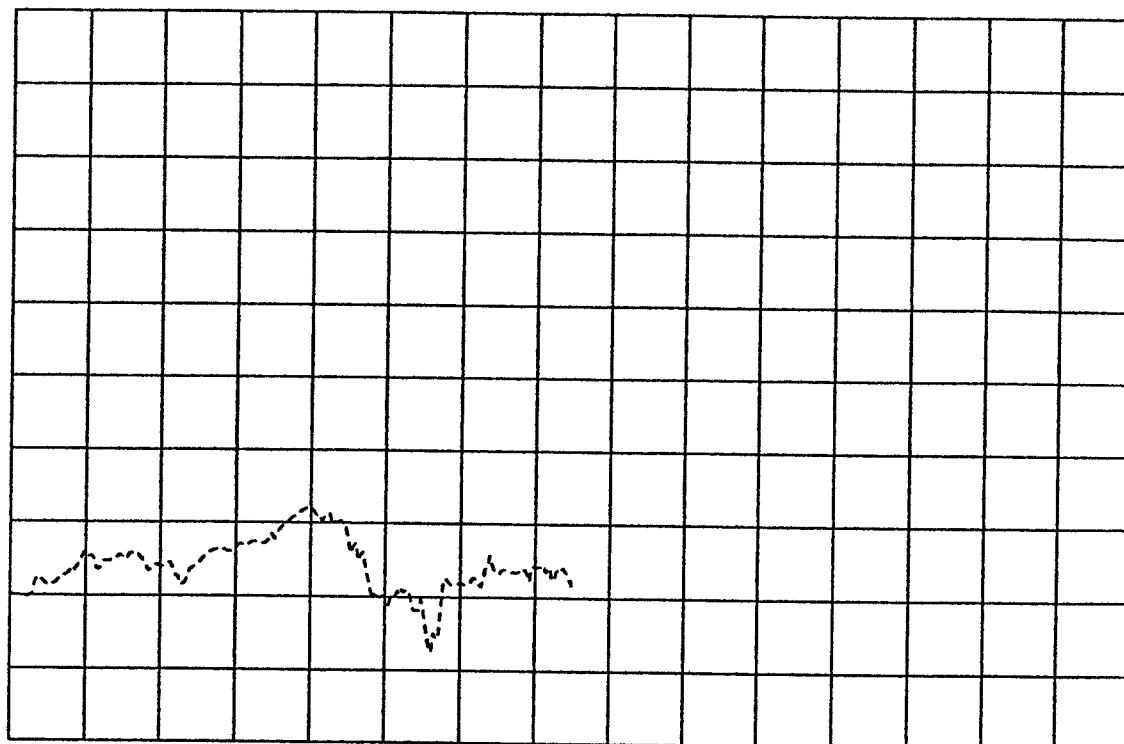
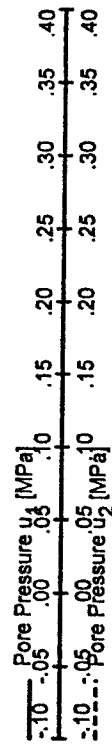
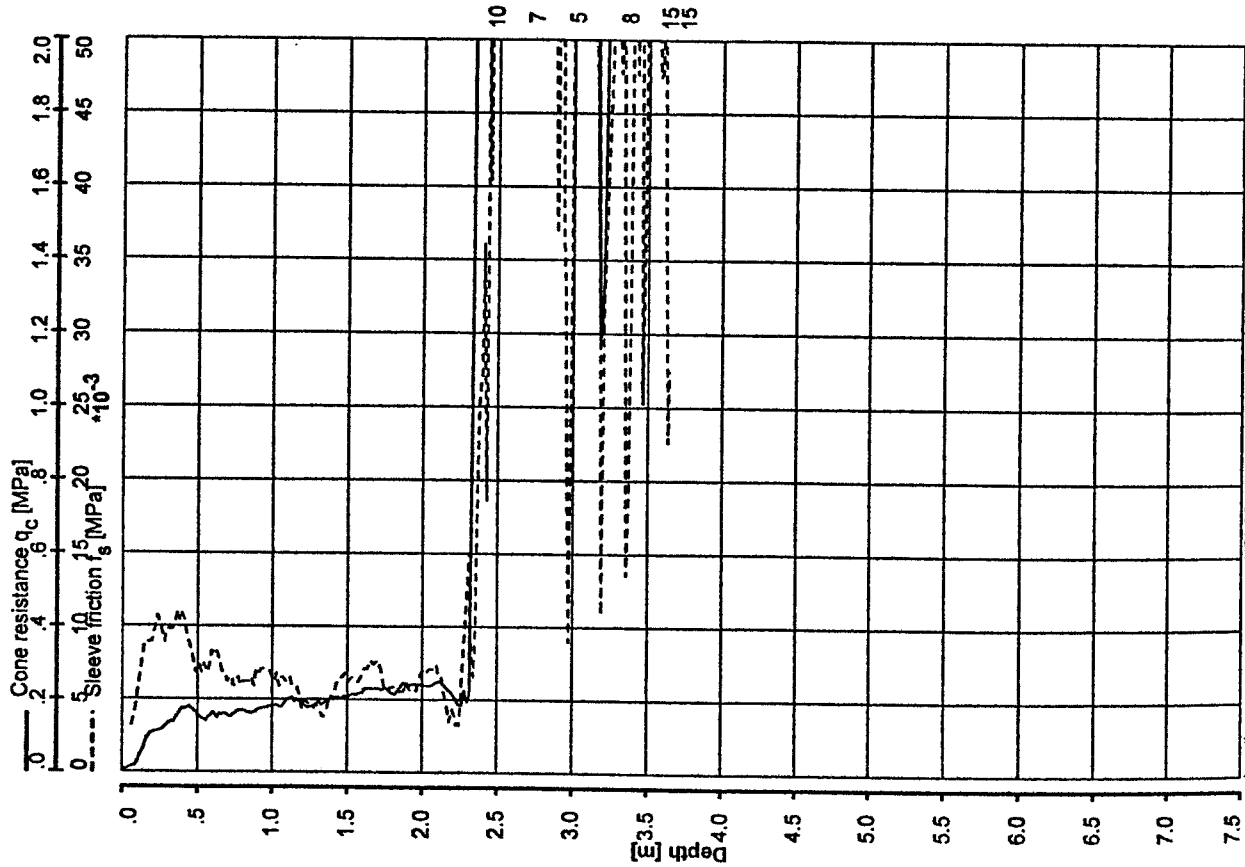


Location : HF3 CP2
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5KEW/V 1515
 Date of Test : 16-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : Hf3cp2.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



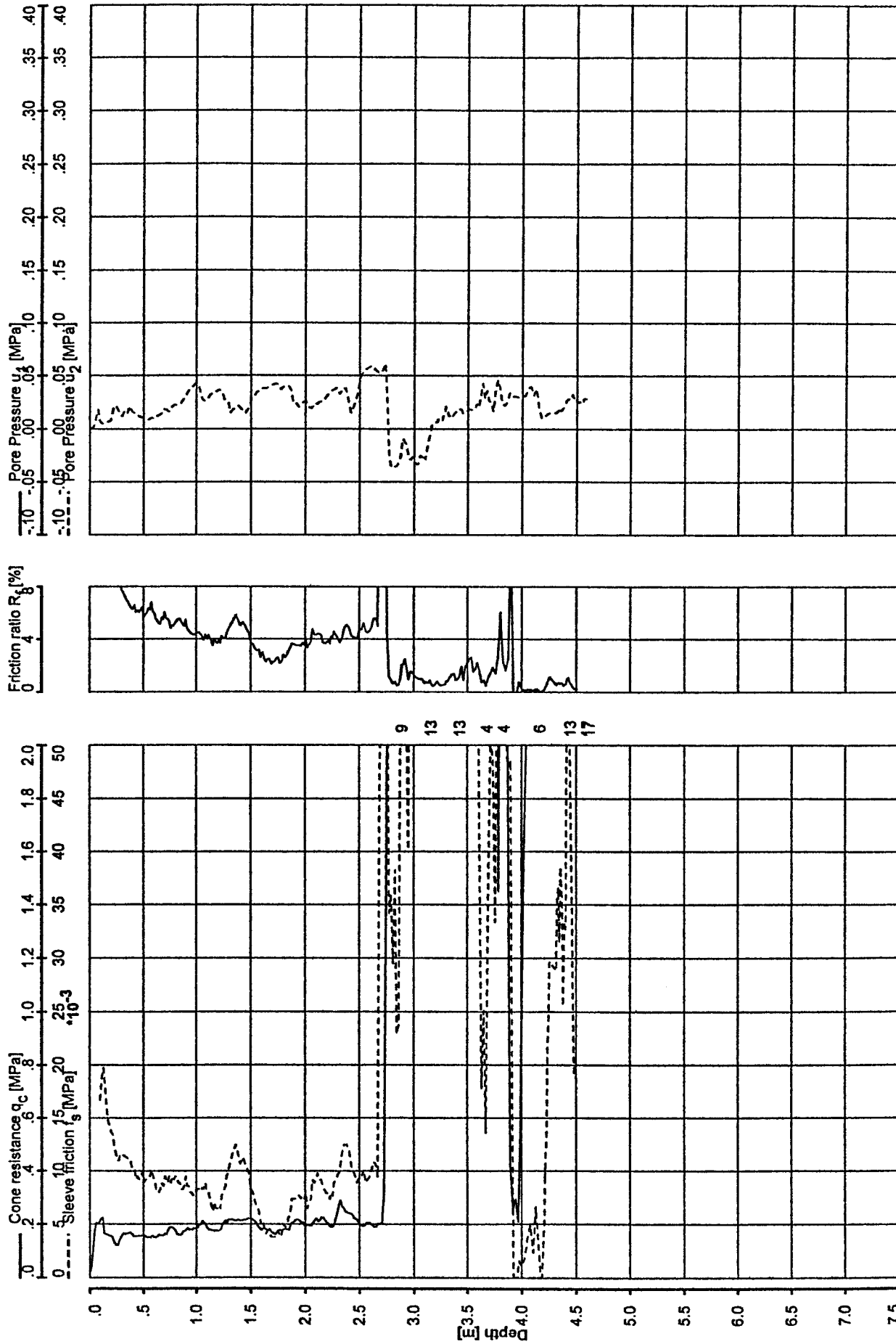
Location : HF3 CP4
Coordinates :
Ground Level [m] :
Cone used : F7.5CKEW/V 1515
Date of Test : 16-Jan-1990
Date of Plot : 02-Dec-2003
File name : HF3cp4.000
Interpretation Checked by : ..

STATIC CONE PENETRATION TEST
EASINGTON LANFALL PIPELINE
STATOIL

HF3 CP4

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

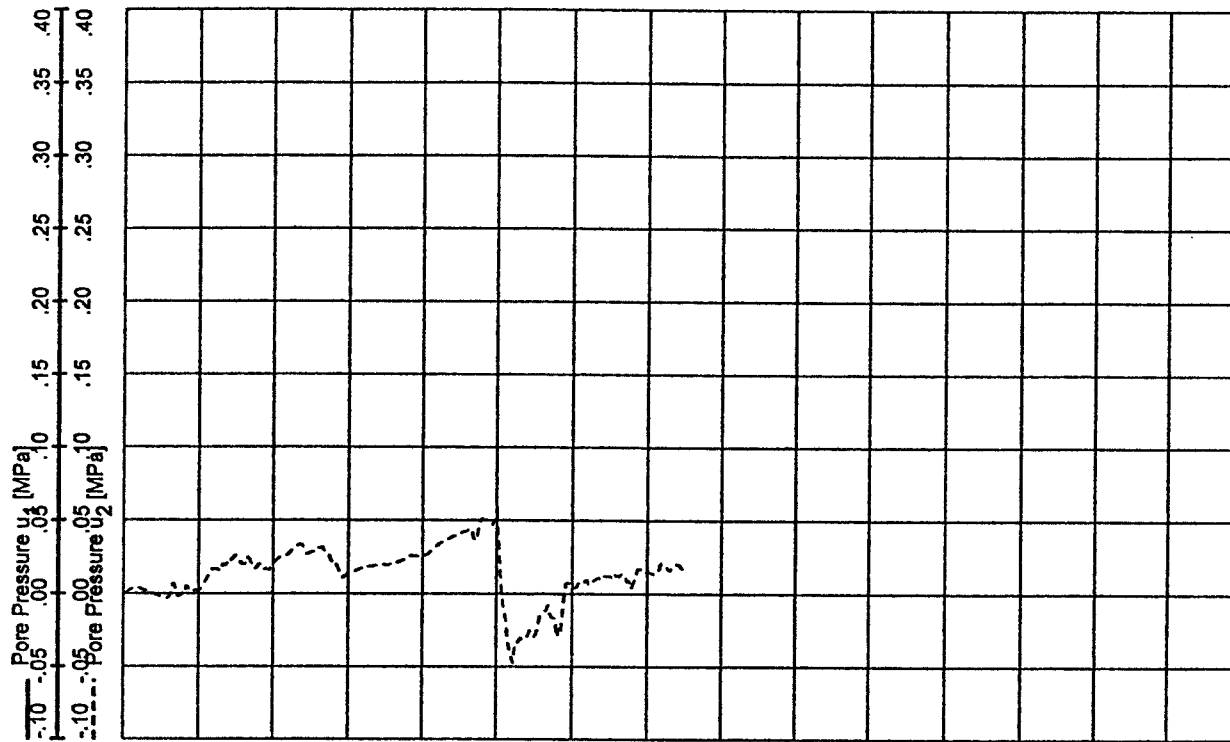
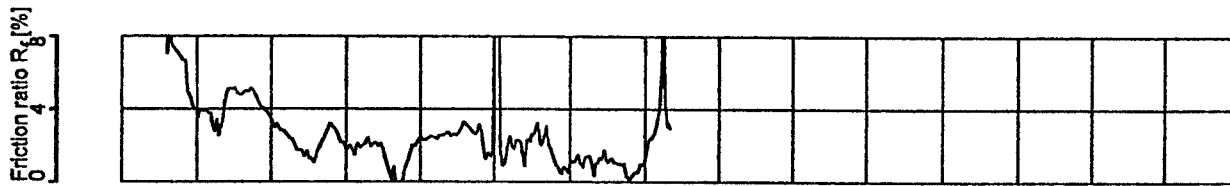
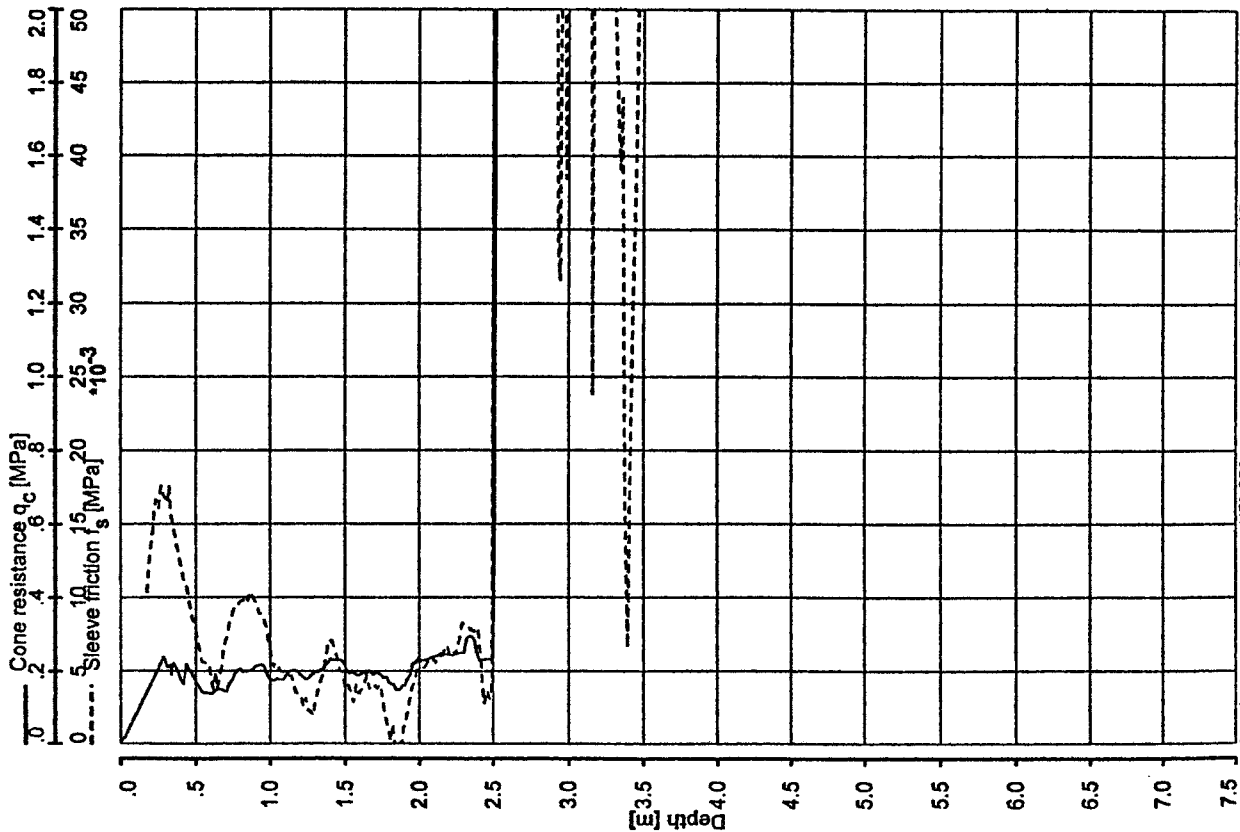


STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

Location : HF3 CP6
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW2V 1515
 Date of Test : 15-Jan-1980
 Date of Plot : 02-Dec-2003
 File name : HF3cp6.000
 Interpretation Checked by : ...

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

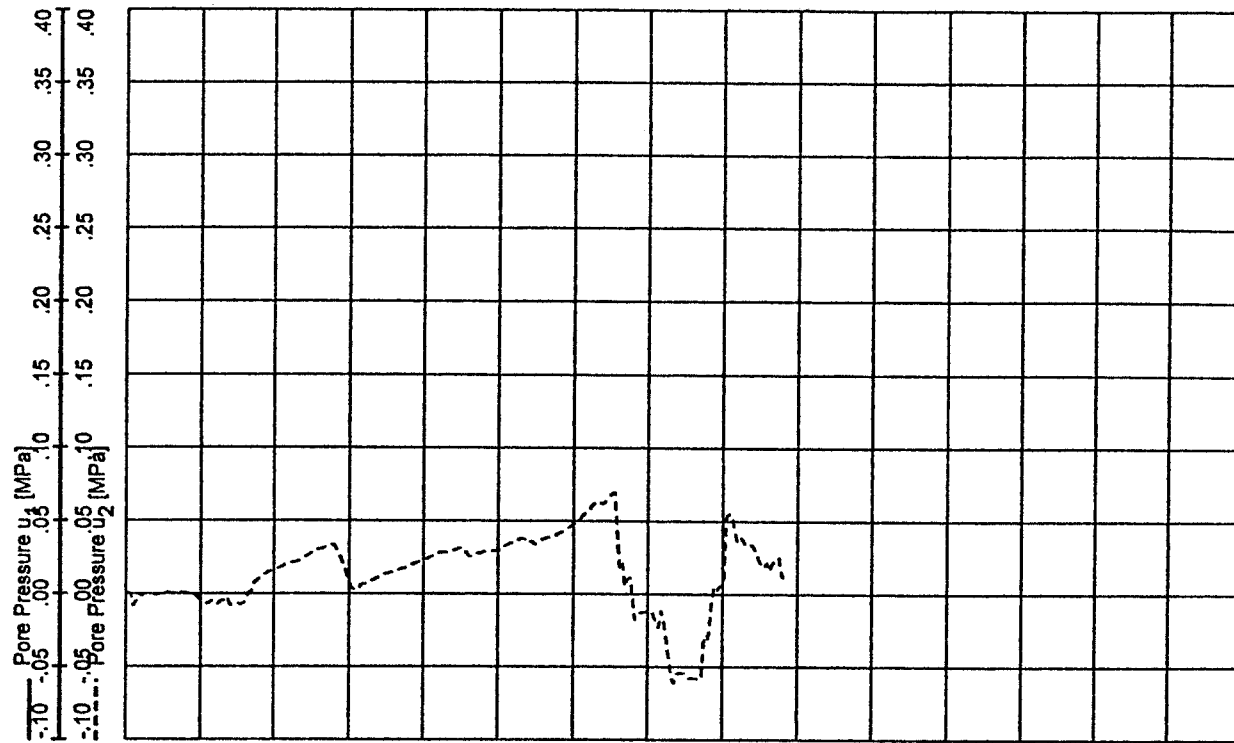
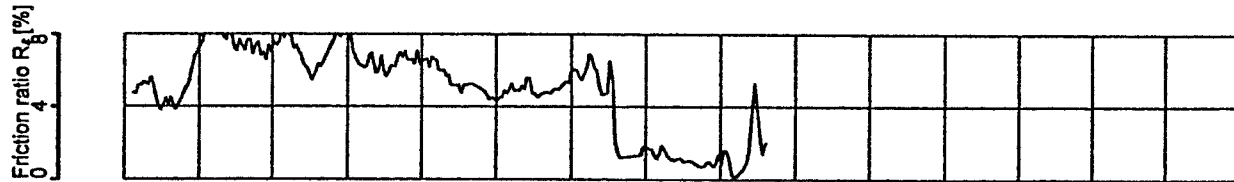
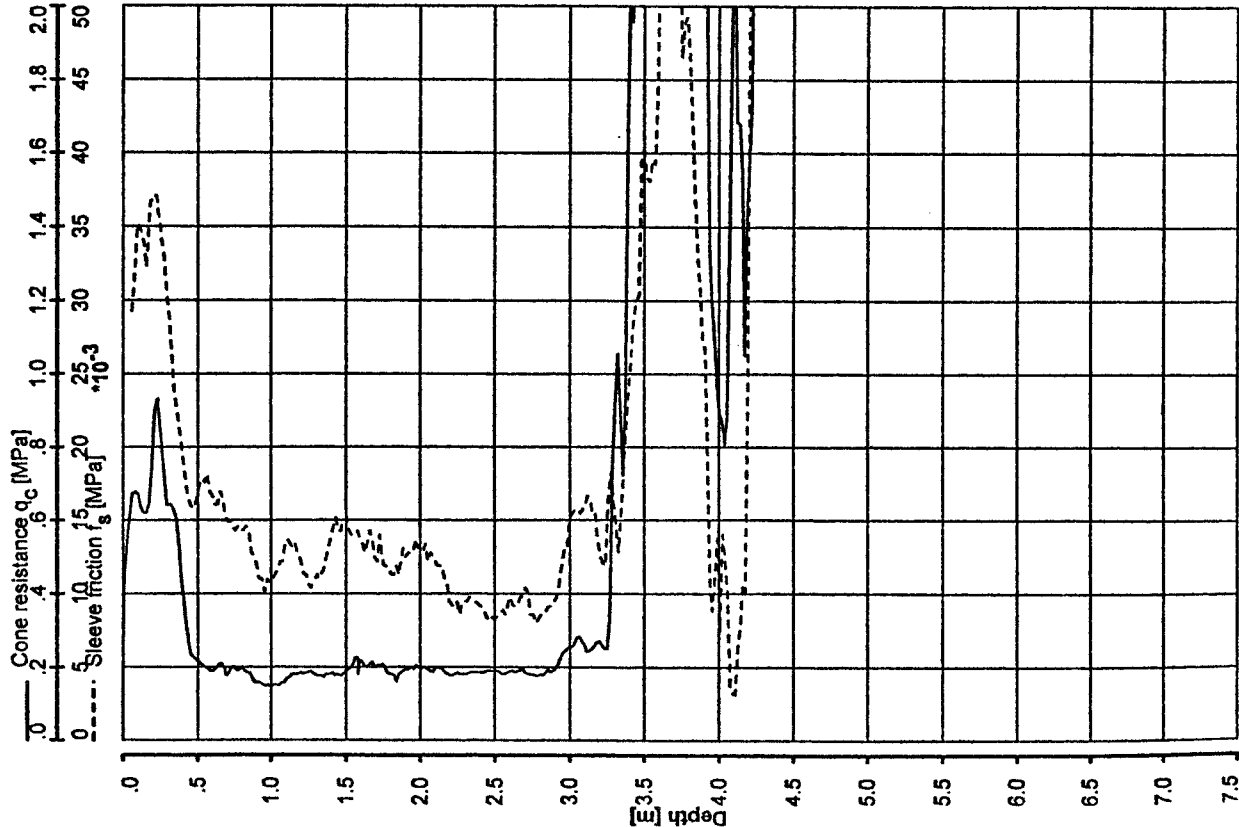


Location : HF3 CP8
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW_N 1515
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : Hf3cp8.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

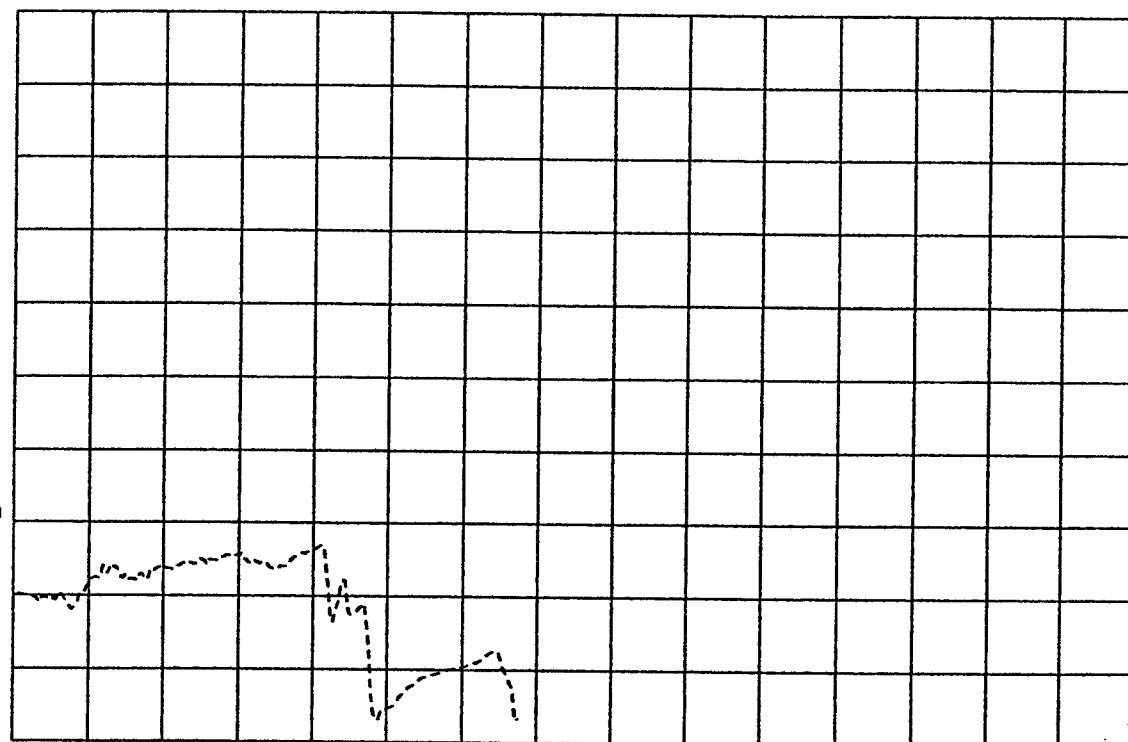
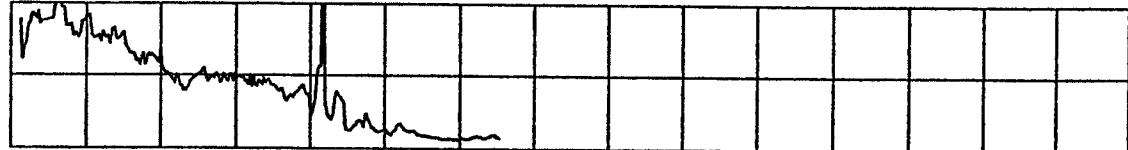
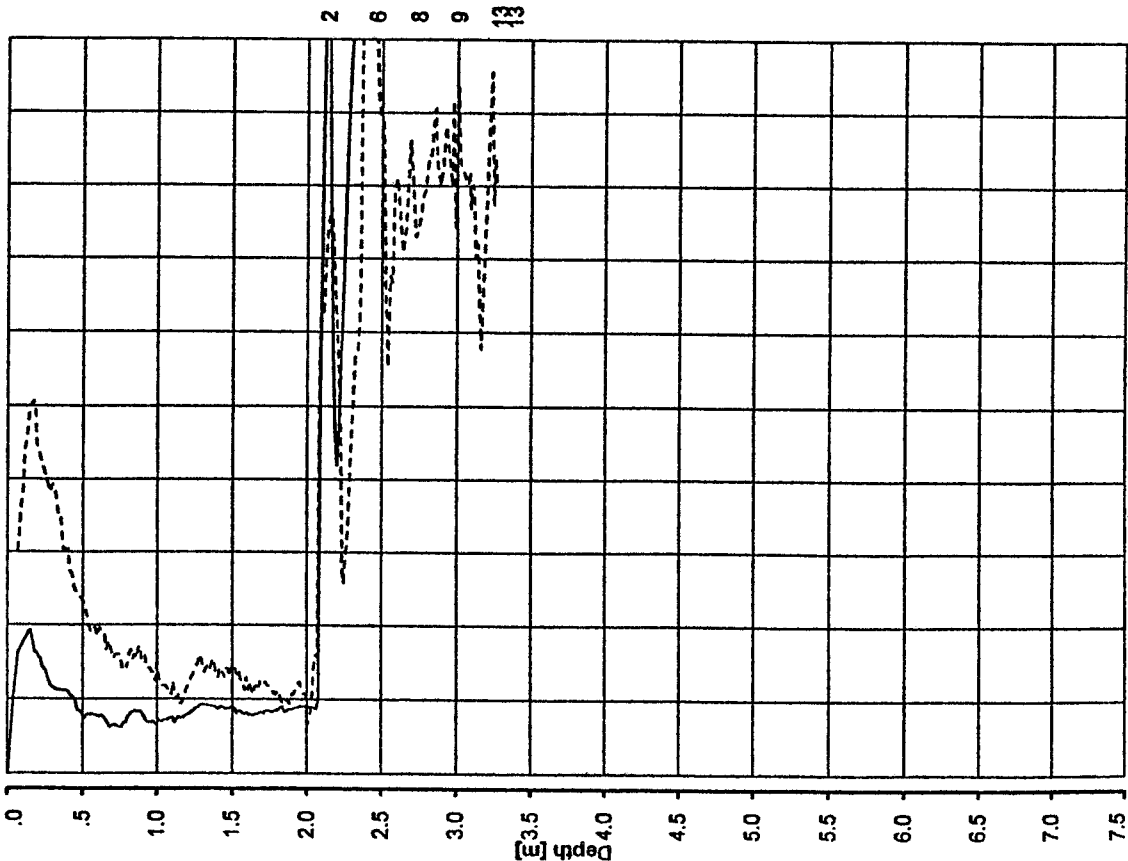
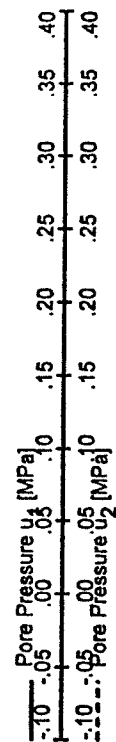
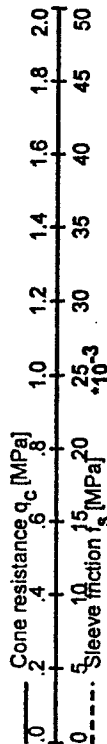


Location : HF4 CP1
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW-V 1515
 Date of Test : 14-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF4cp1.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL
 HF4 CP1

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

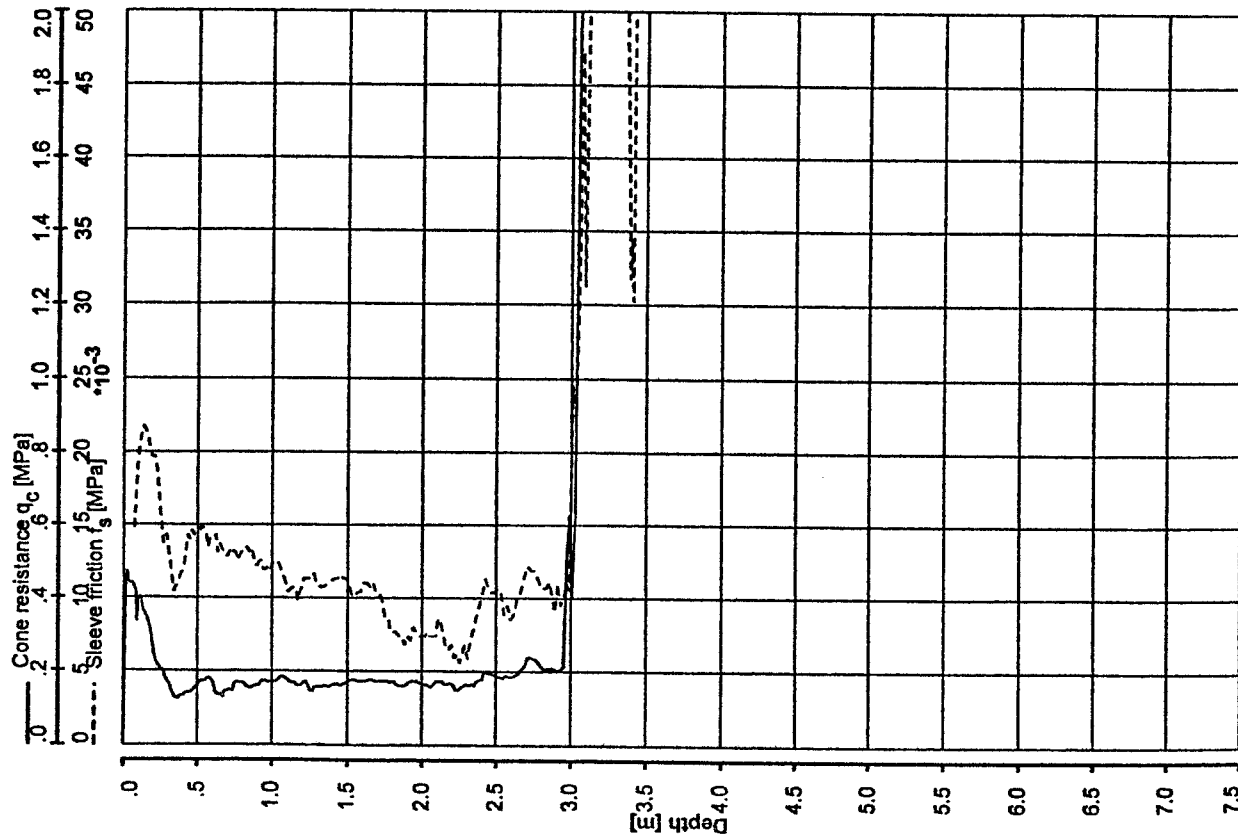


Location : HF4 CP10
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW2V 1515
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF4cp10.000
 Interpretation Checked by : ...

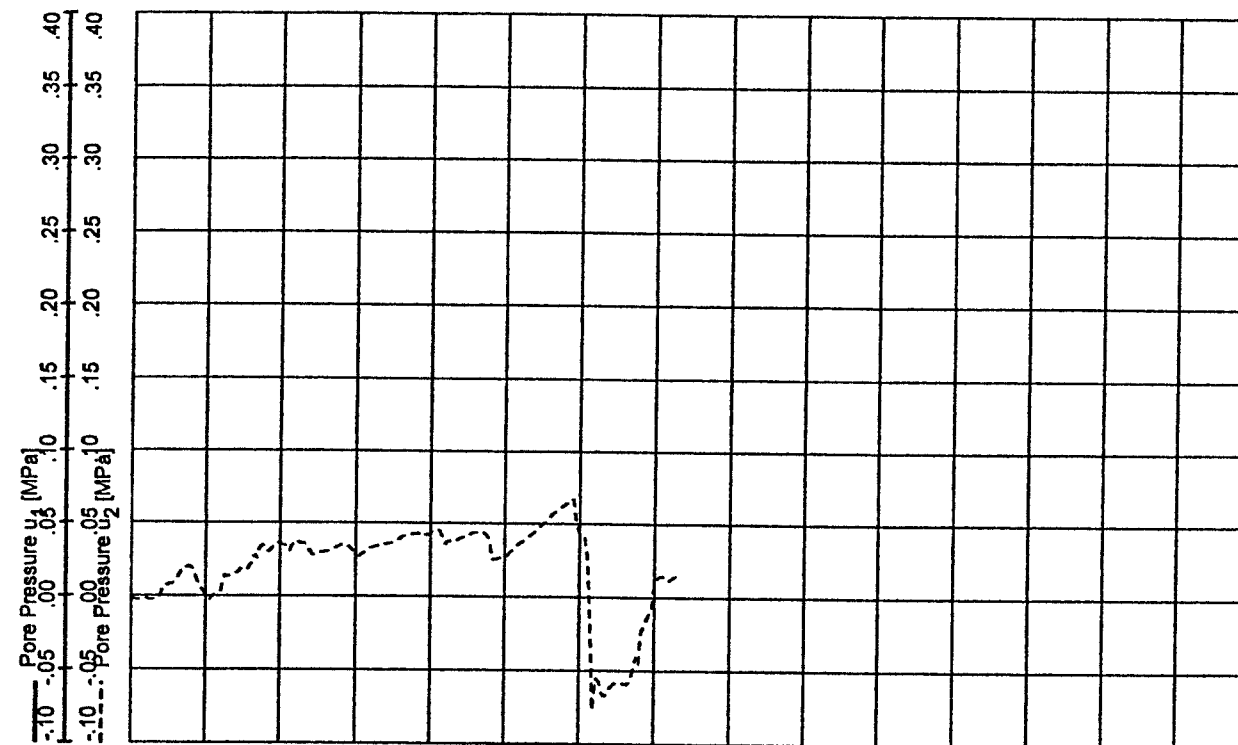
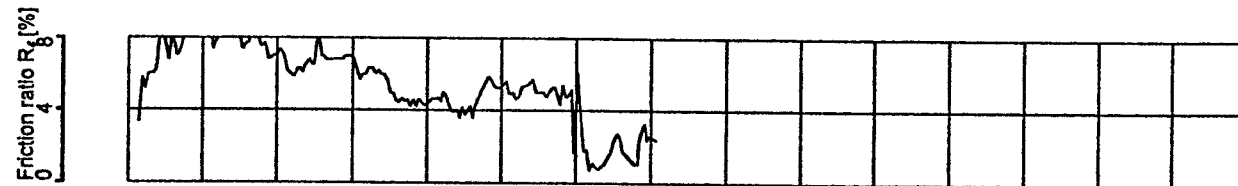
STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

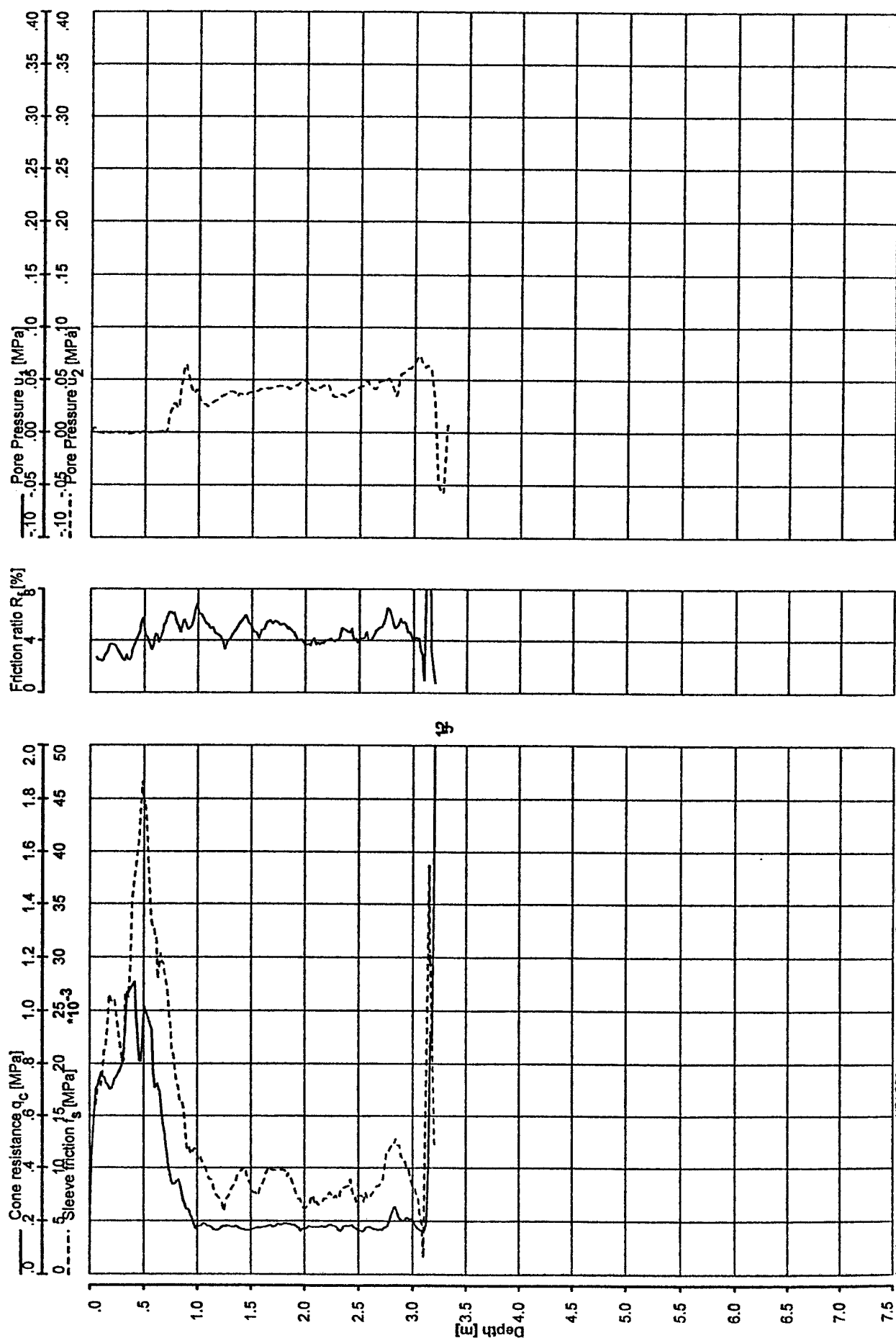


Location : HF4 CP2
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF4cp2.000
 Interpretation Checked by : ...



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

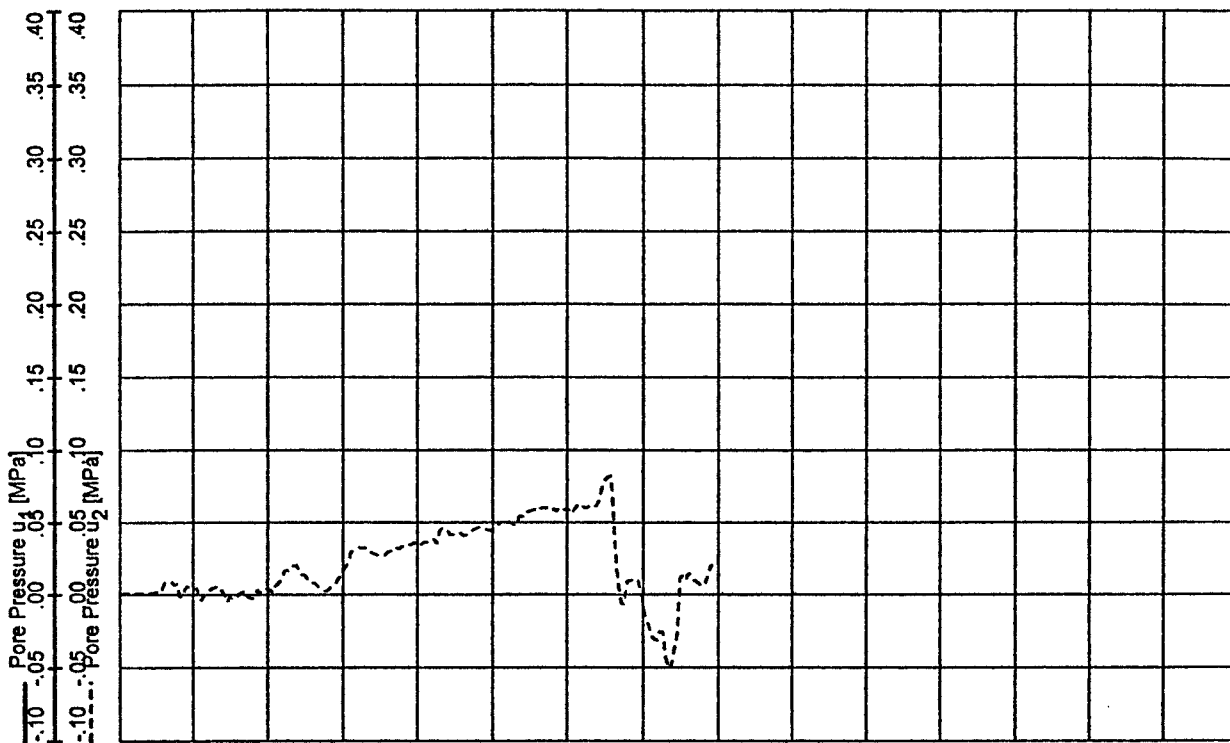
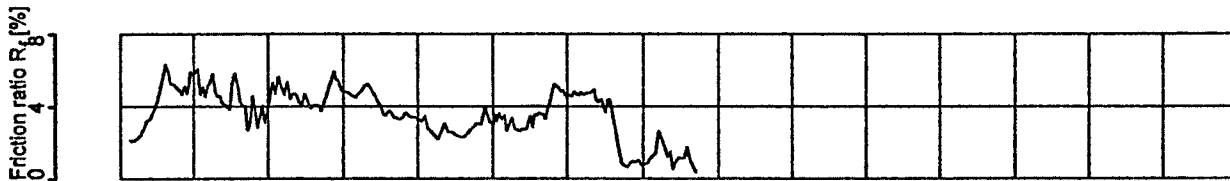
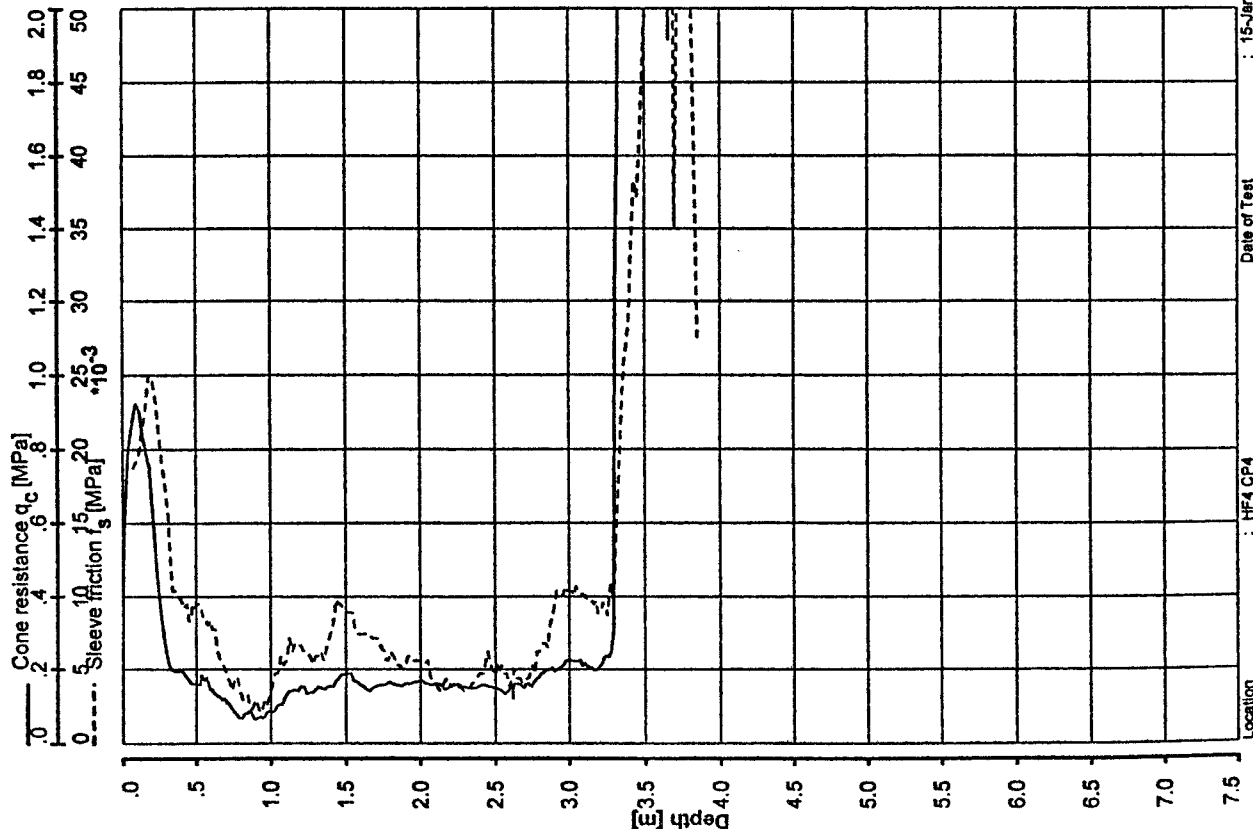
FUGRO ENGINEERING SERVICES LIMITED



STATIC CONE PENETRATION TEST EASINGTON LANFALL PIPELINE STATOIL	HF4 CP3
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FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

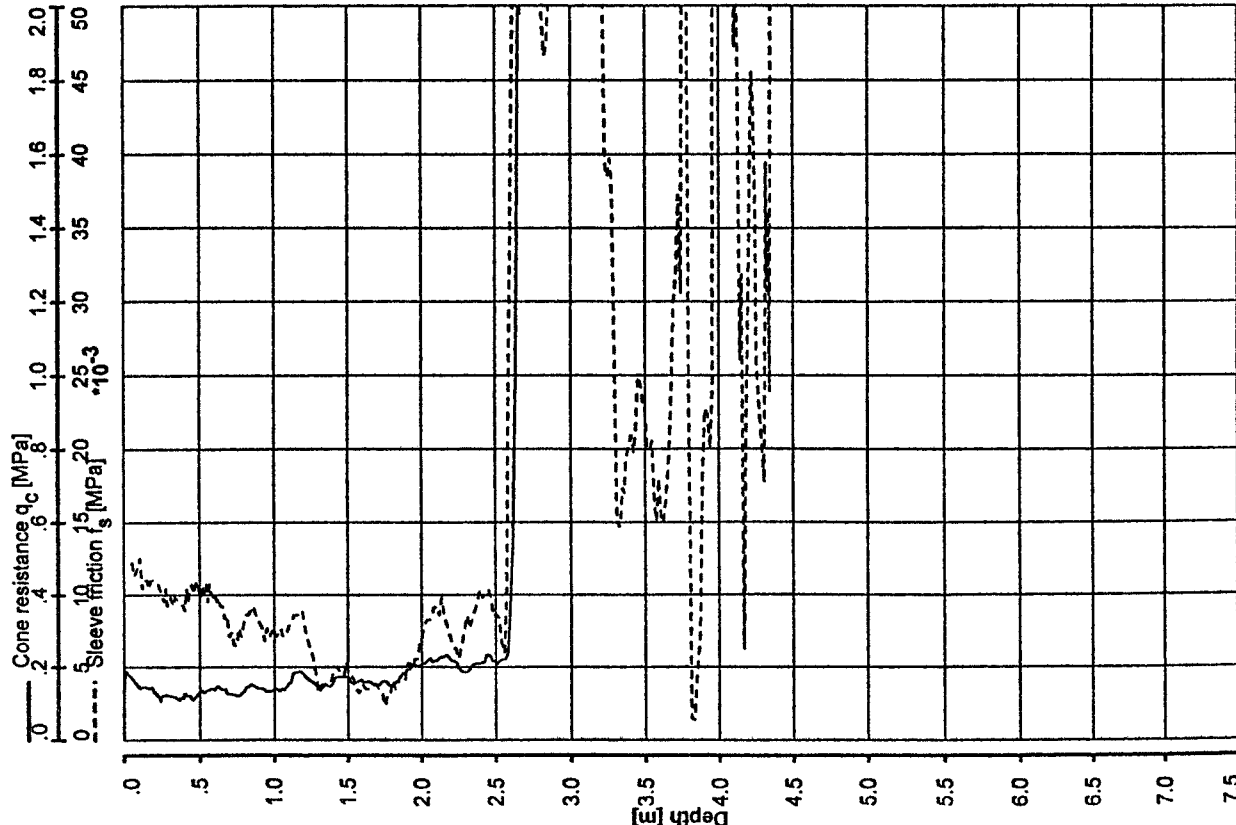


Location : HF4 CP4
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW-V 1515
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : Hf4cp4.000
 Interpretation Checked by : ...

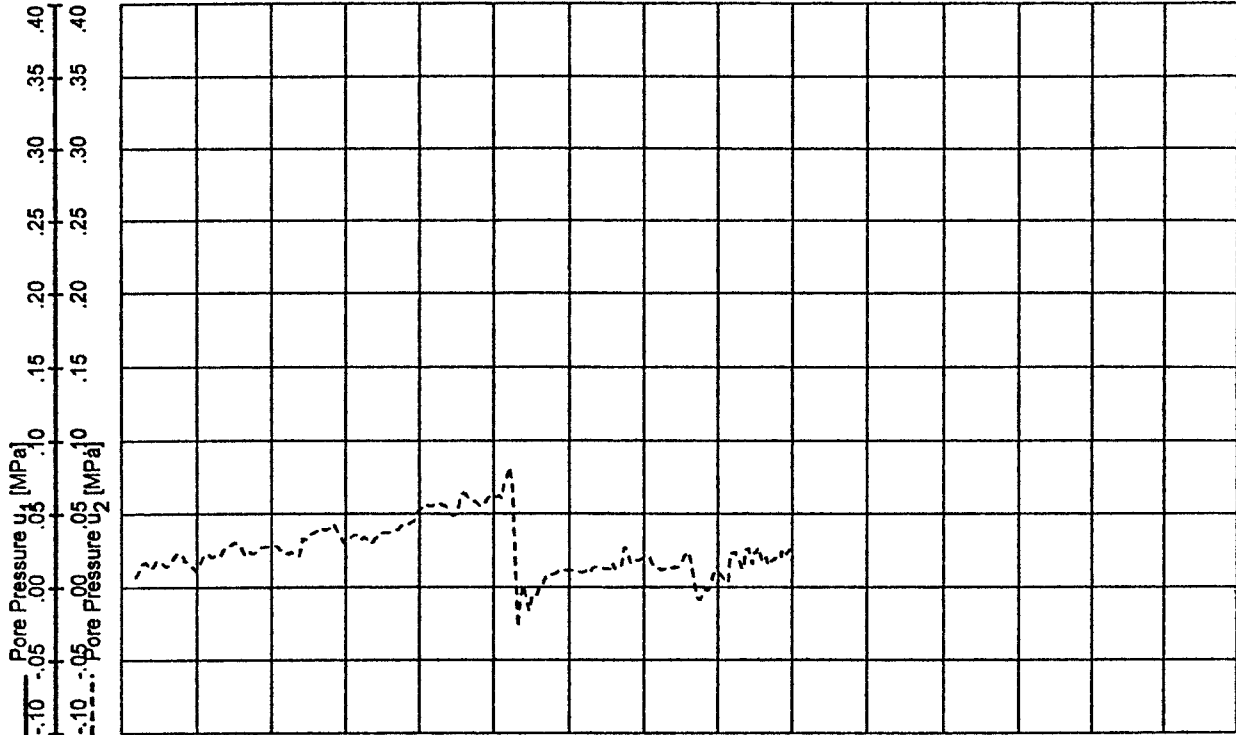
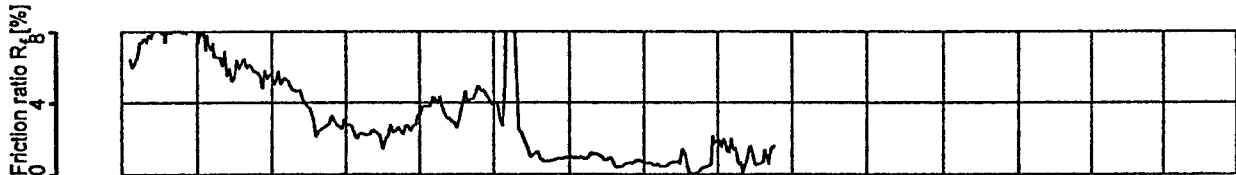
STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



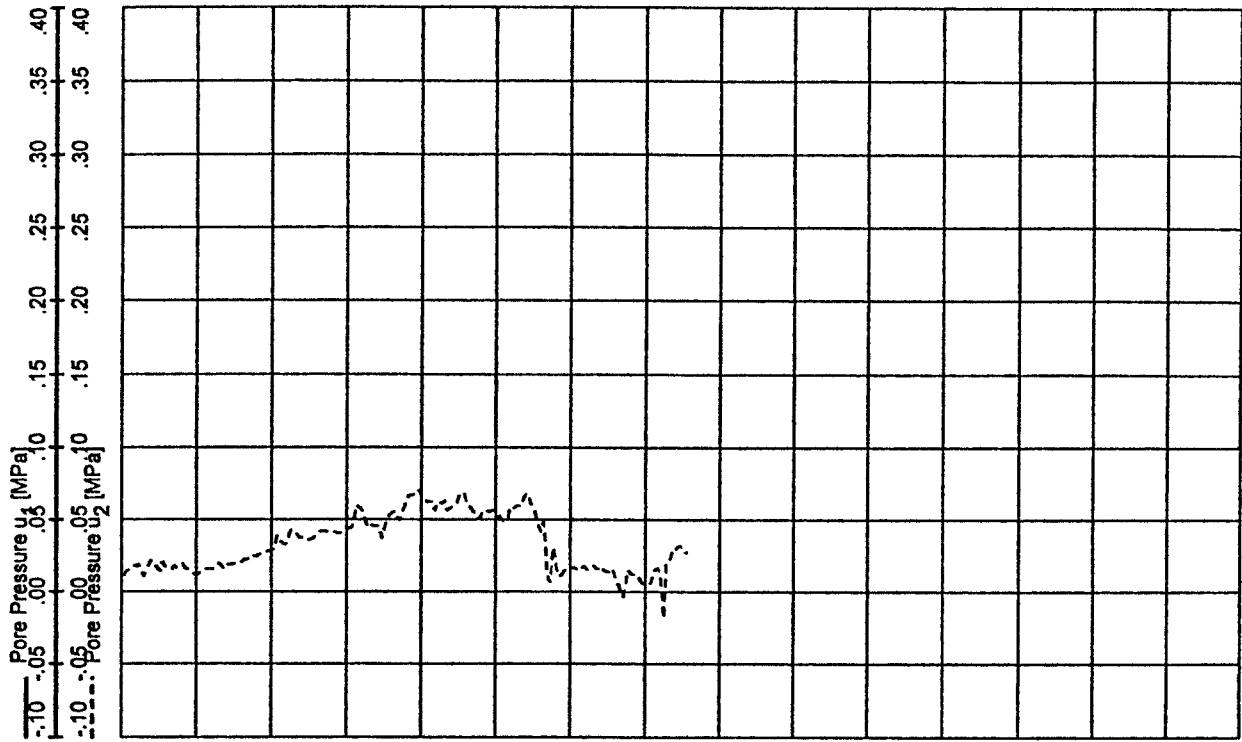
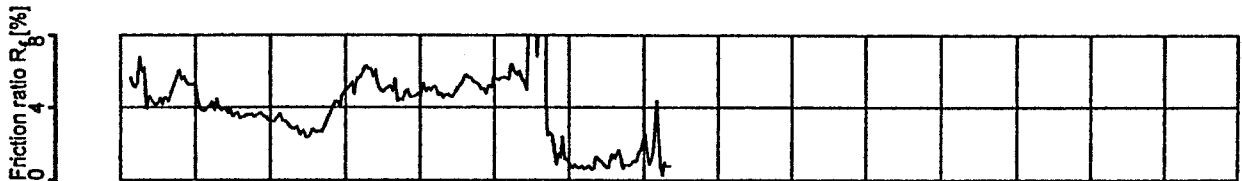
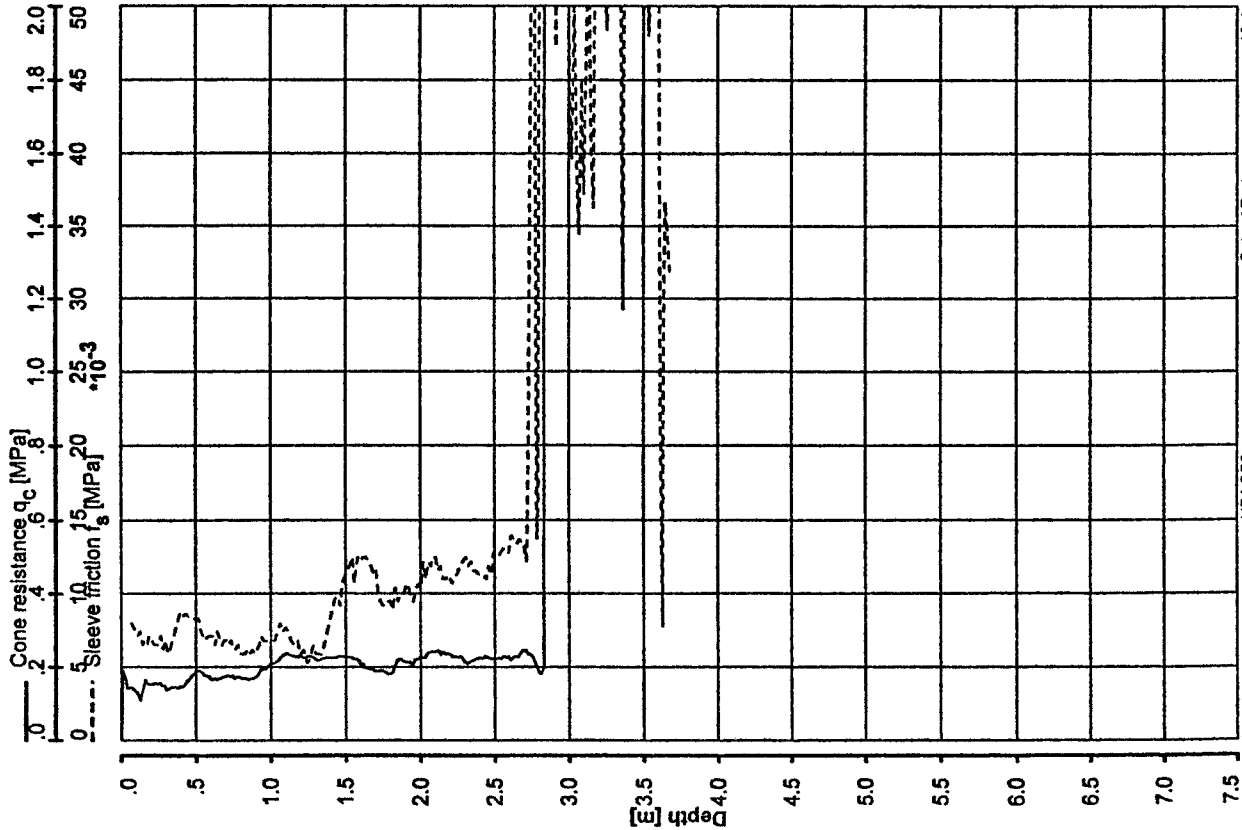
Location : HF4 CP5
 Date of Test : 15-Jan-1990
 Coordinates :
 Date of Plot : 02-Dec-2003
 Ground Level [m] :
 File name : HF4CP5.000
 Cone used : FT.5CKEW-V 1515
 Interpretation Checked by : ...



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL
 HF4 CP5

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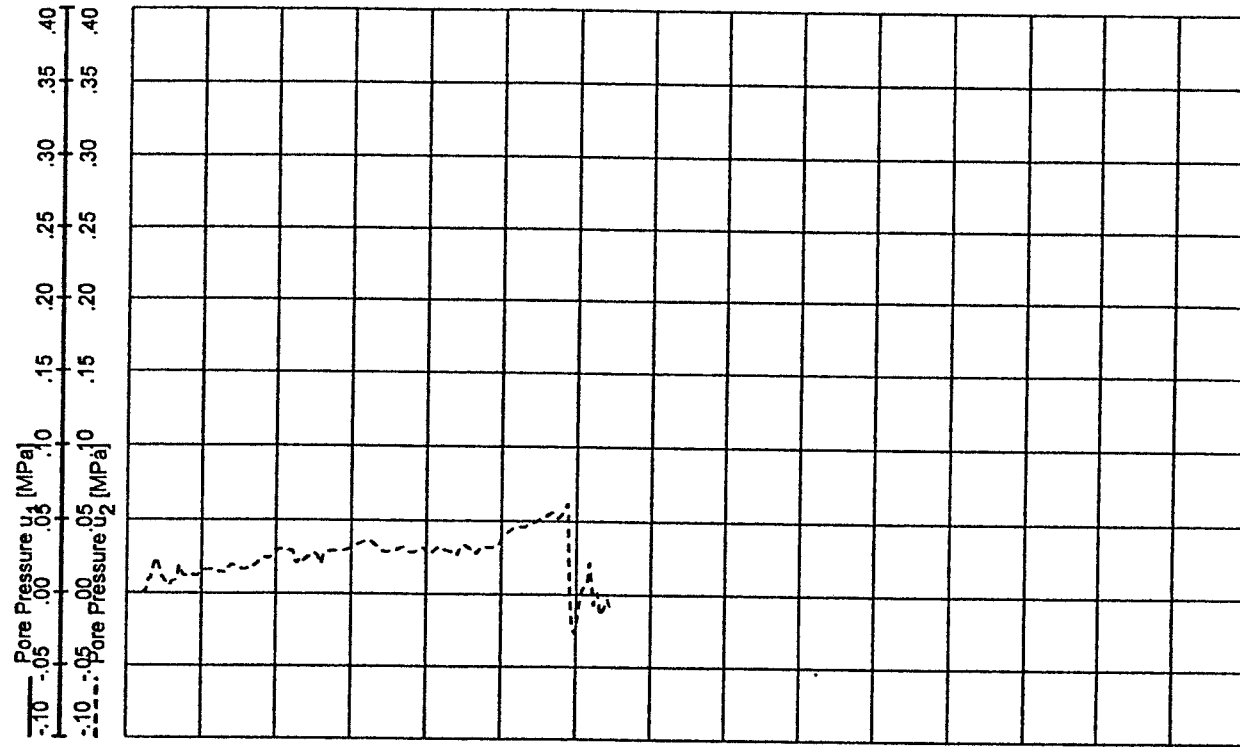
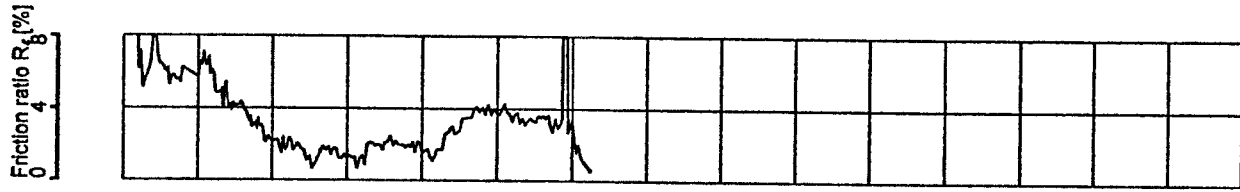
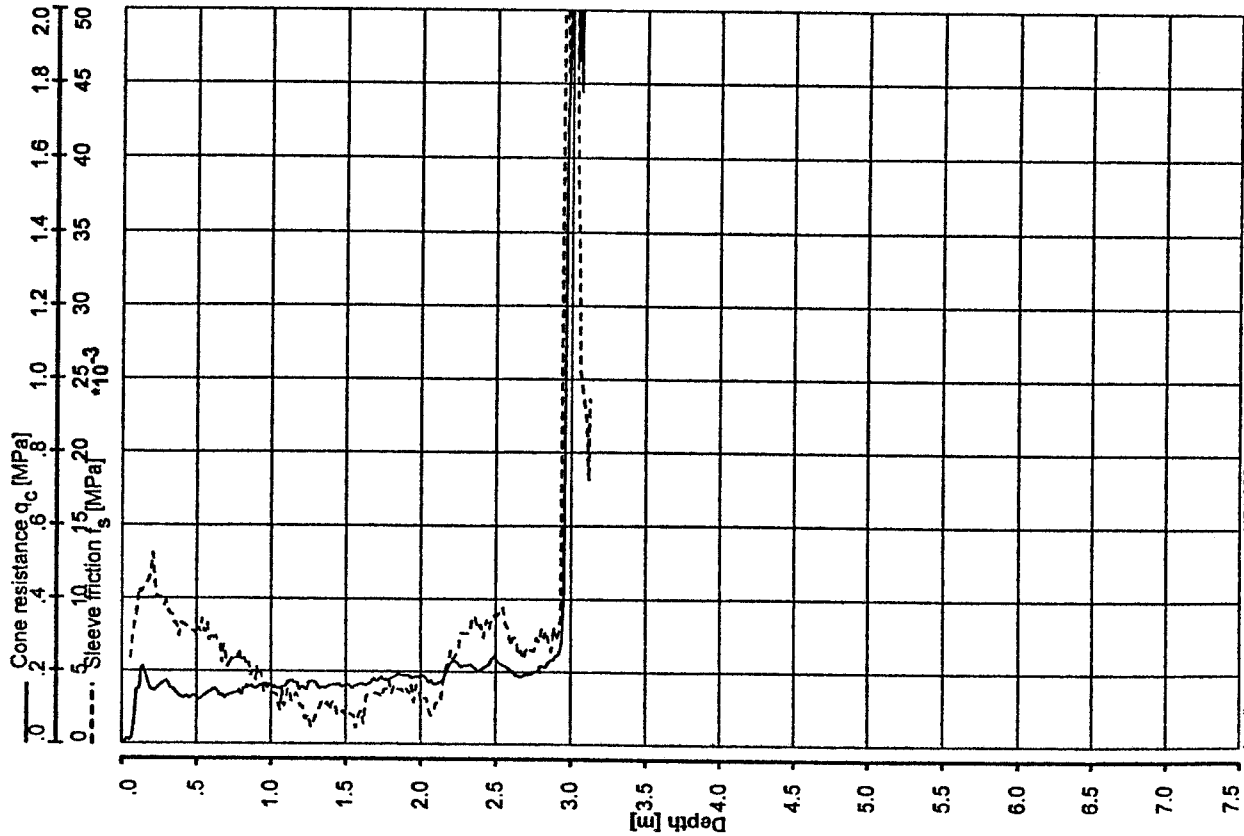


Location : HF4 CP6
 Coordinates :
 Ground Level [m] :
 Cone used : F7.SCKEW JV 1515
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : HF4cp6.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL
 HF4 CP6

FUGRO ENGINEERING SERVICES LIMITED

31819-1 (01)

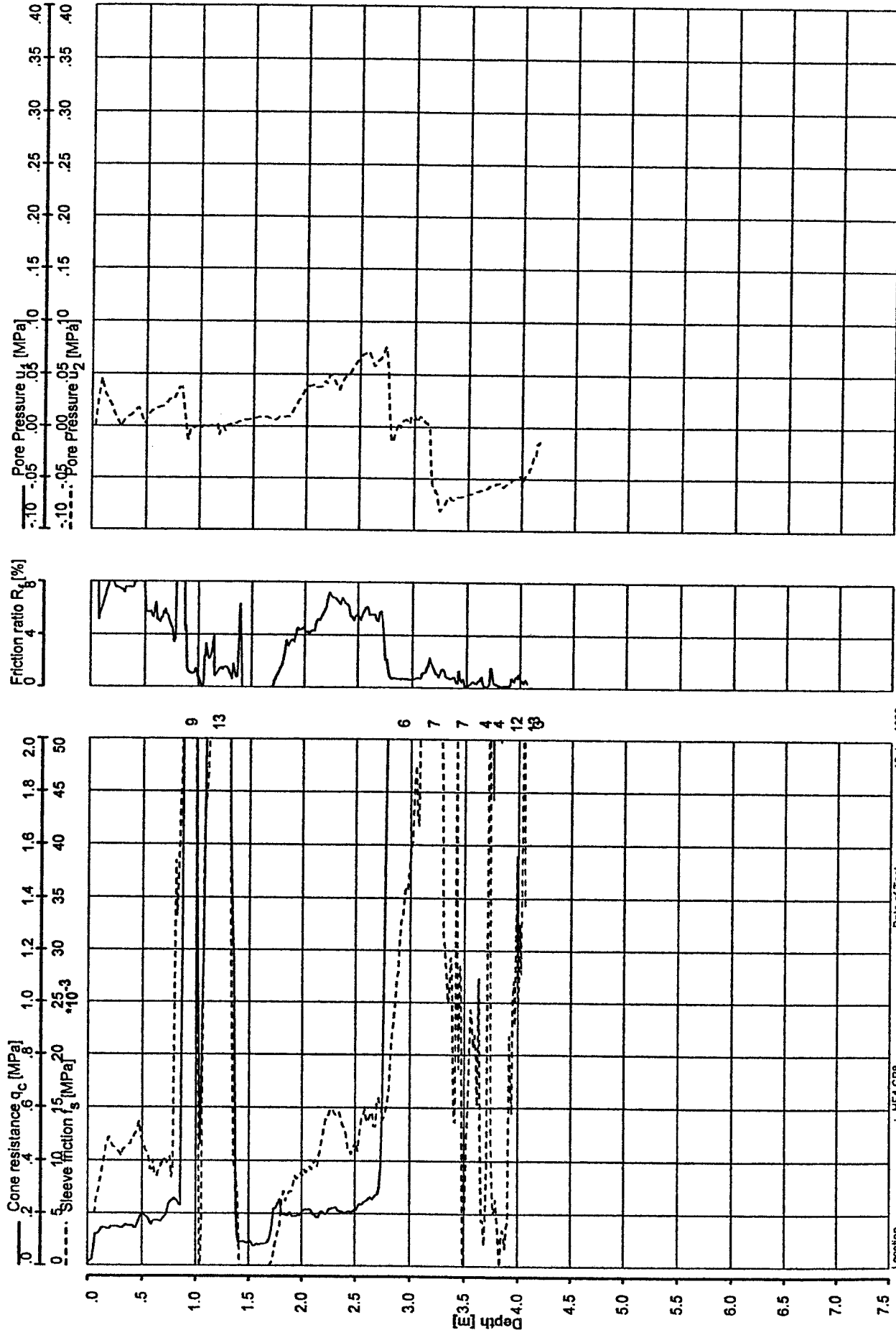


STATIC CONE PENETRATION TEST
EASINGTON LANFALL PIPELINE
STATOIL

HF4 CP7

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



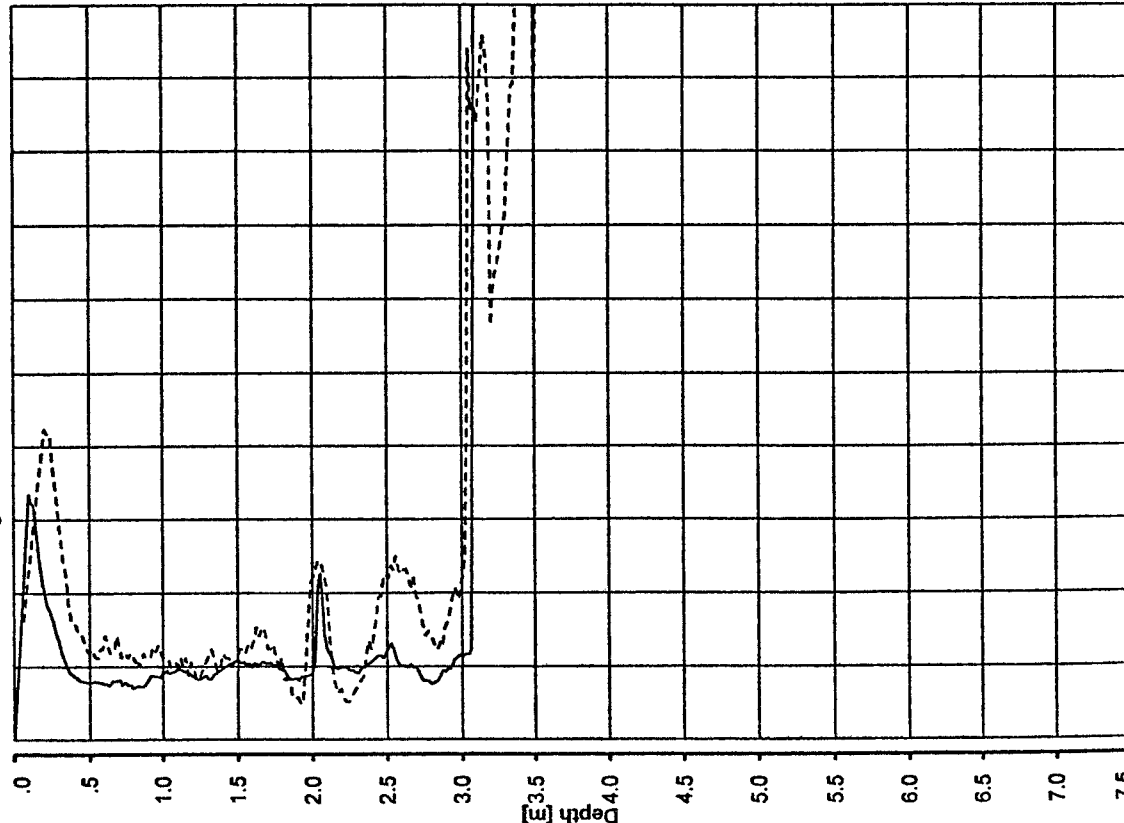
STATIC CONE PENETRATION TEST
EASINGTON LANFALL PIPELINE
STATOIL

Location : HF4 CP8
Coordinates :
Ground Level [m] :
Cone used : F7.5CKEW JV 1515
Date of Test : 15-Jan-1990
Date of Plot : 02-Dec-2003
File name : HF4cp8.000
Interpretation Checked by : ...

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

Cone resistance q_c [MPa] : 0 2 4 6 8 10 12 14 16 18 20
 Sleeve friction f_s [MPa] : 0 5 10 15 20 25 30 35 40 45 50

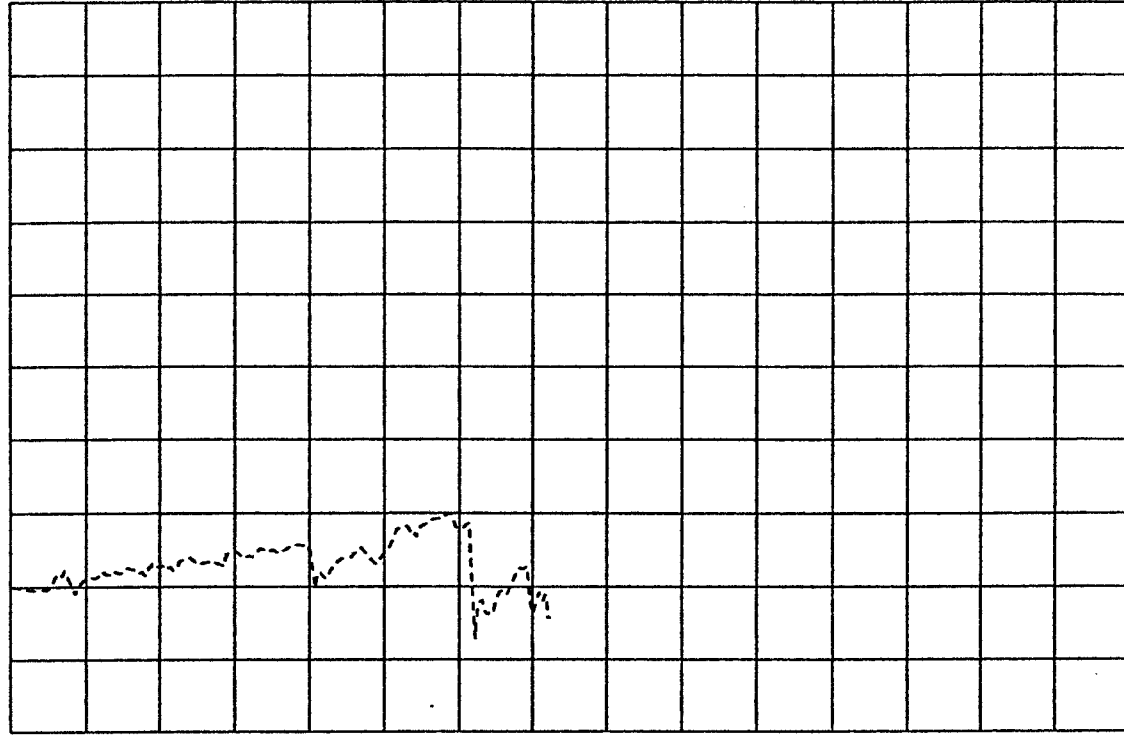


Location : HF4 CP9
 Date of Test : 15-Jan-1990
 Coordinates :
 Date of Plot : 02-Dec-2003
 Ground Level [m] :
 File name : HF4cp9.000
 Cone used : F7.5CKEW-NV 1515
 Interpretation Checked by : ...

Friction ratio R_f [%]



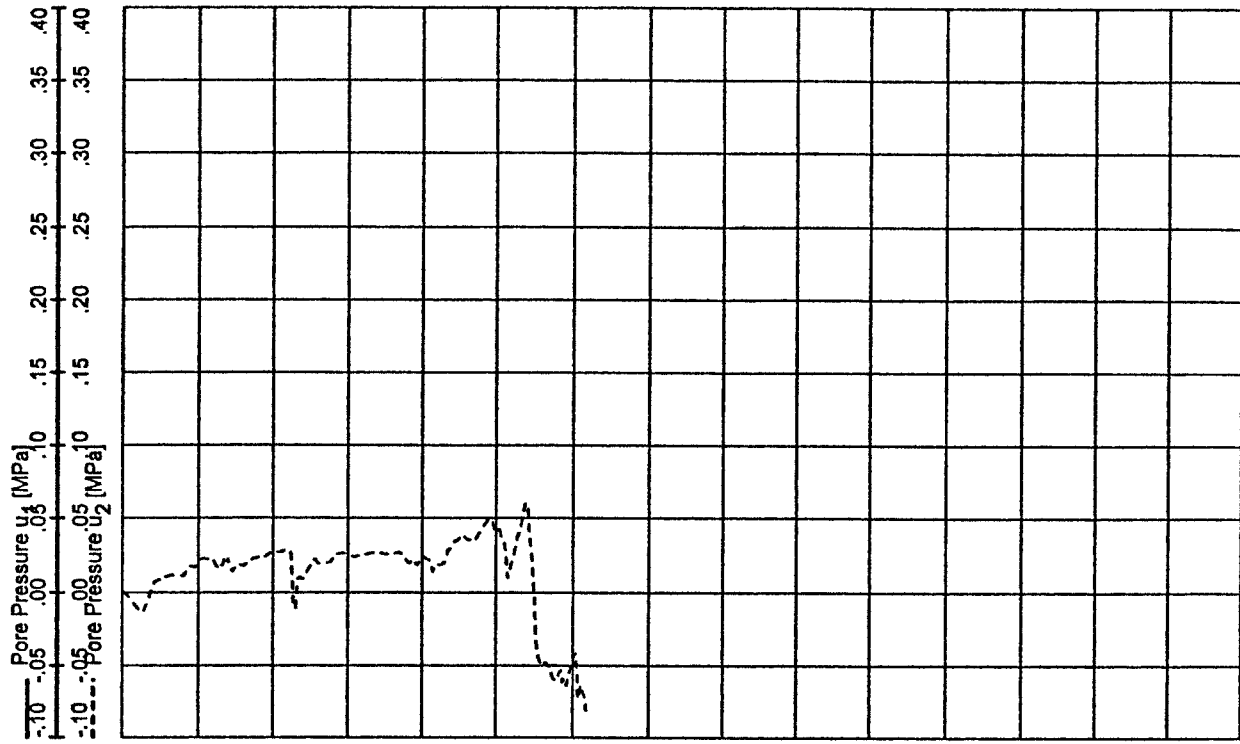
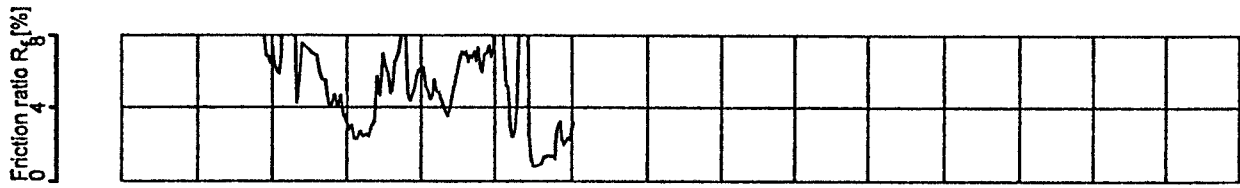
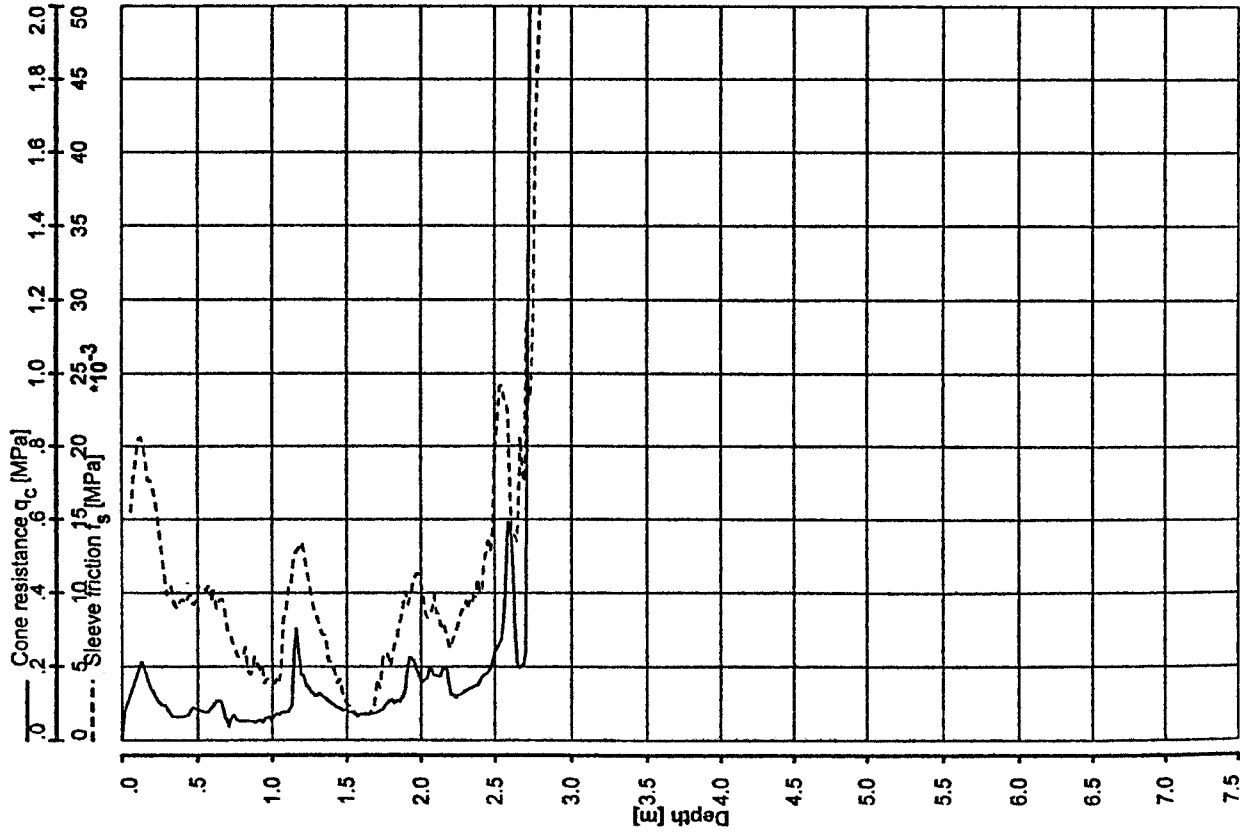
Pore Pressure u_1 [MPa] : -0.10 -0.05 0.00 0.05 0.10
 Pore Pressure u_2 [MPa] : -0.10 -0.05 0.00 0.05 0.10



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

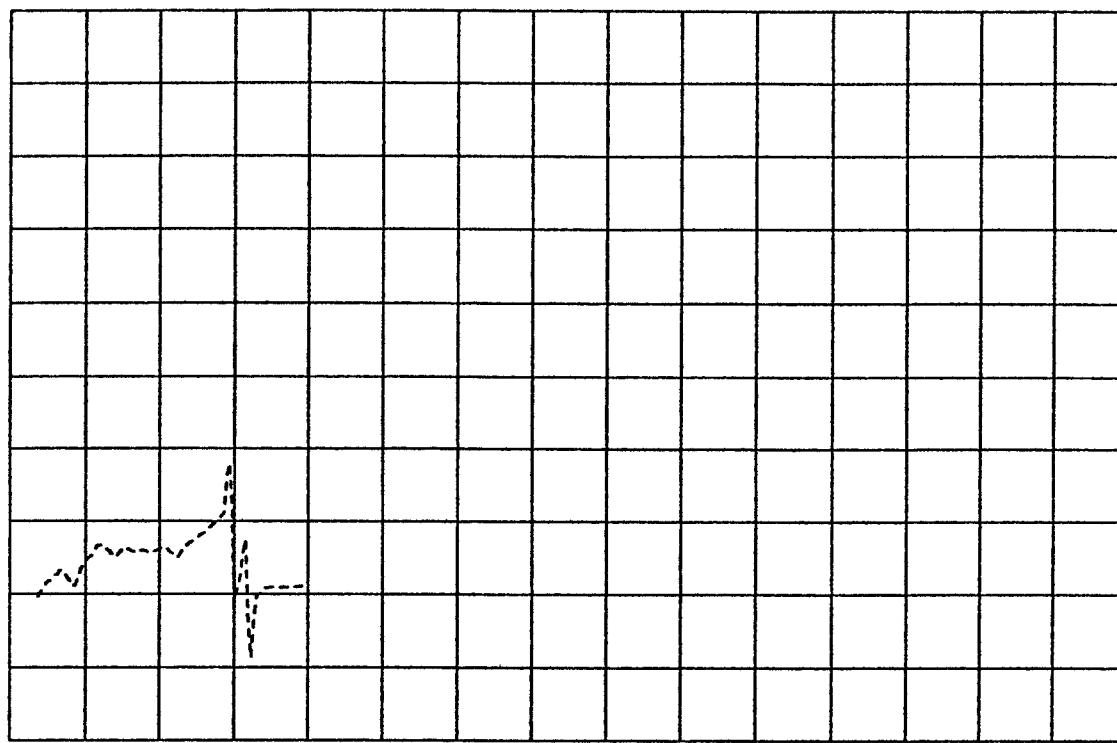
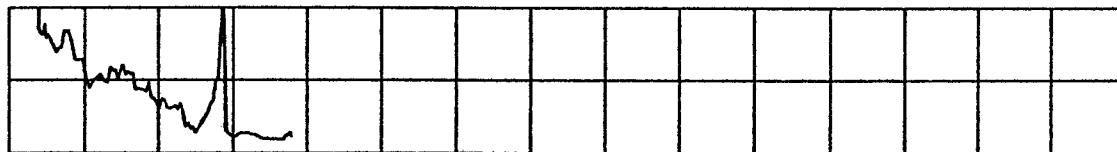
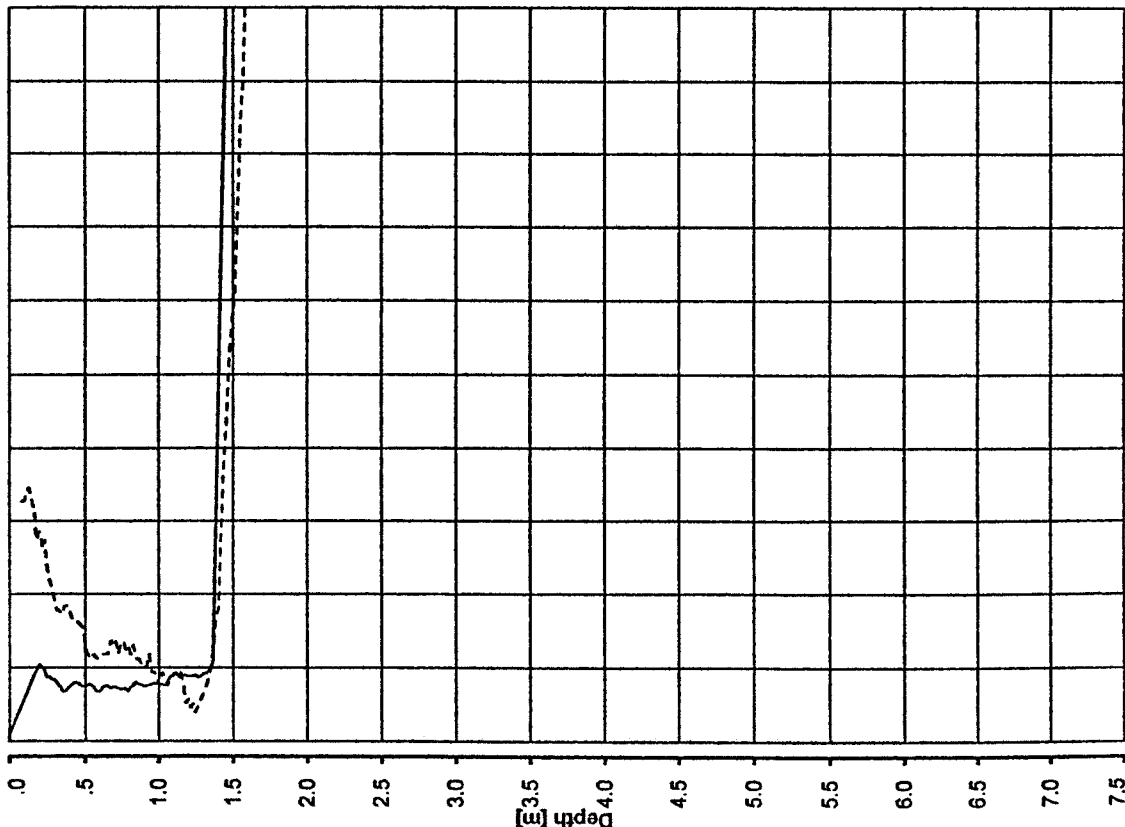
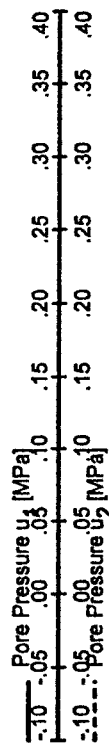
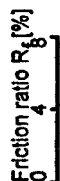
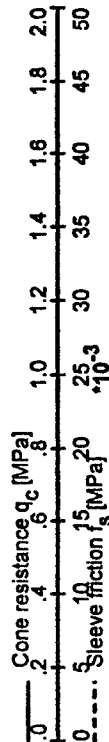


STATIC CONE PENETRATION TEST IF2 CP10

EASINGTON LANFALL PIPELINE
STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

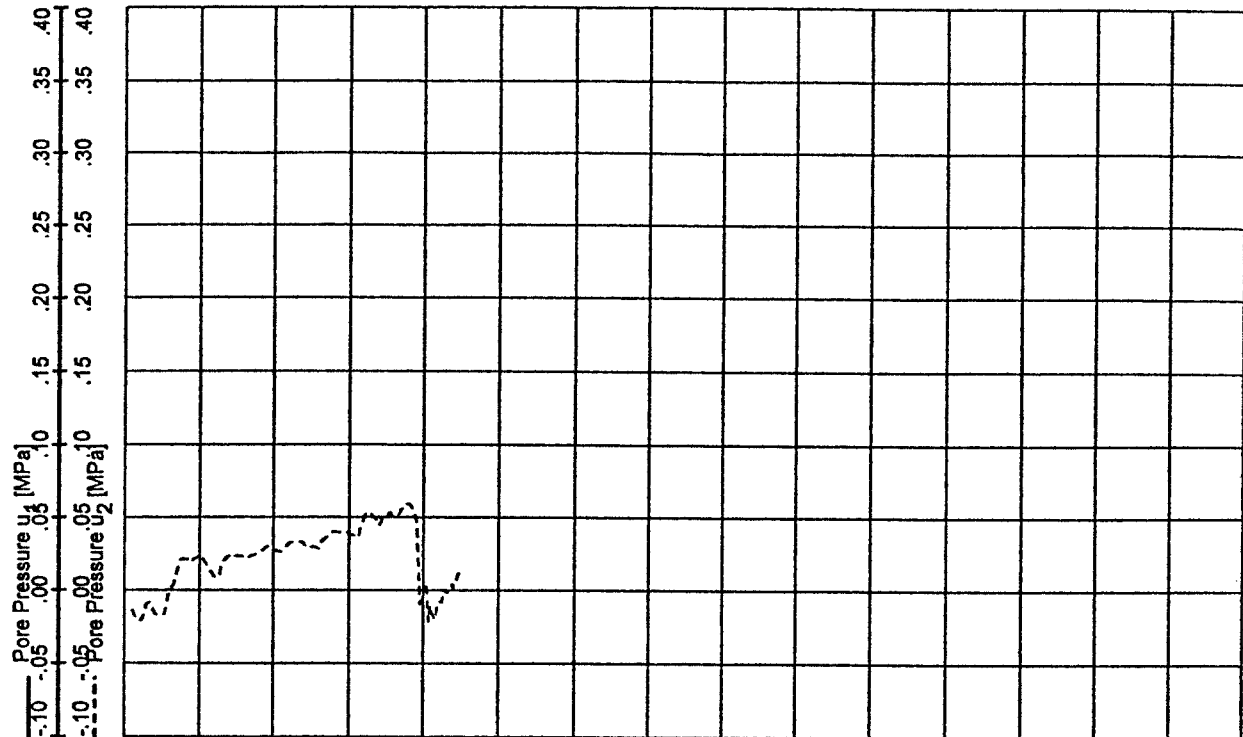
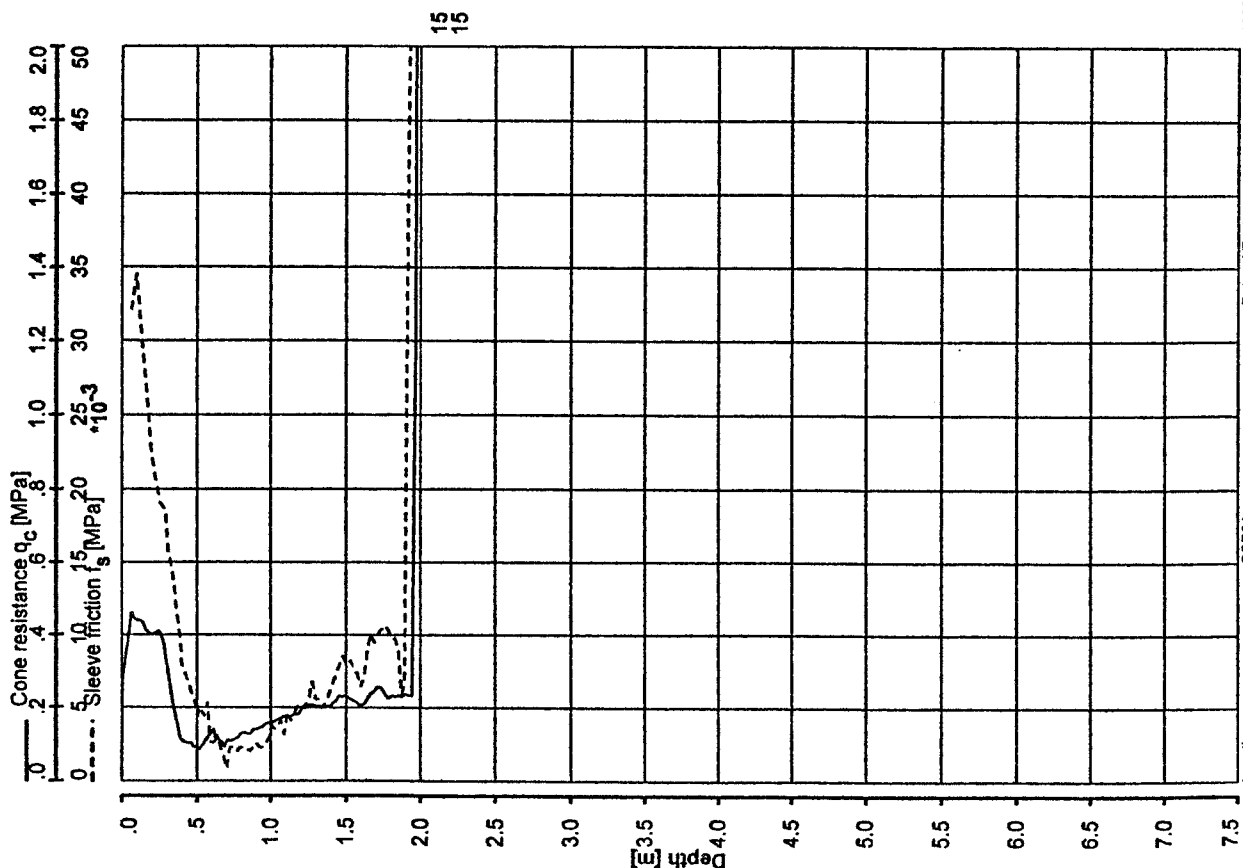


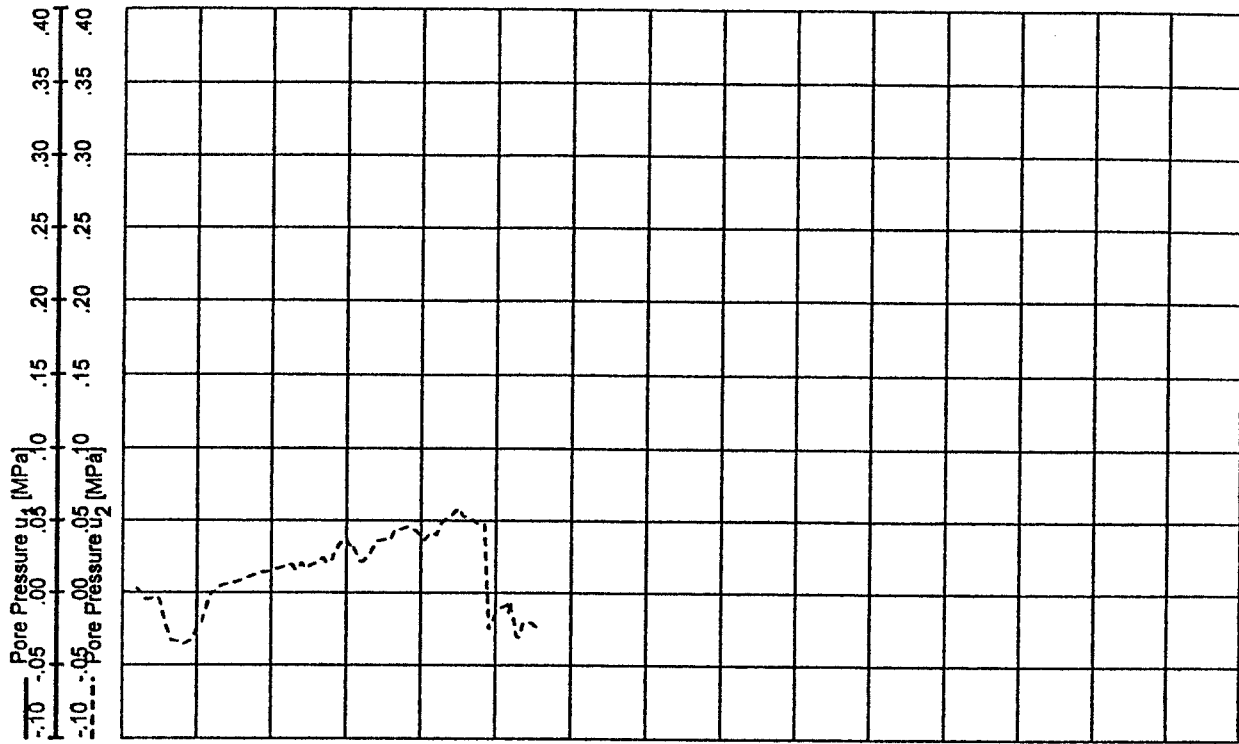
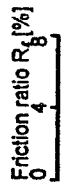
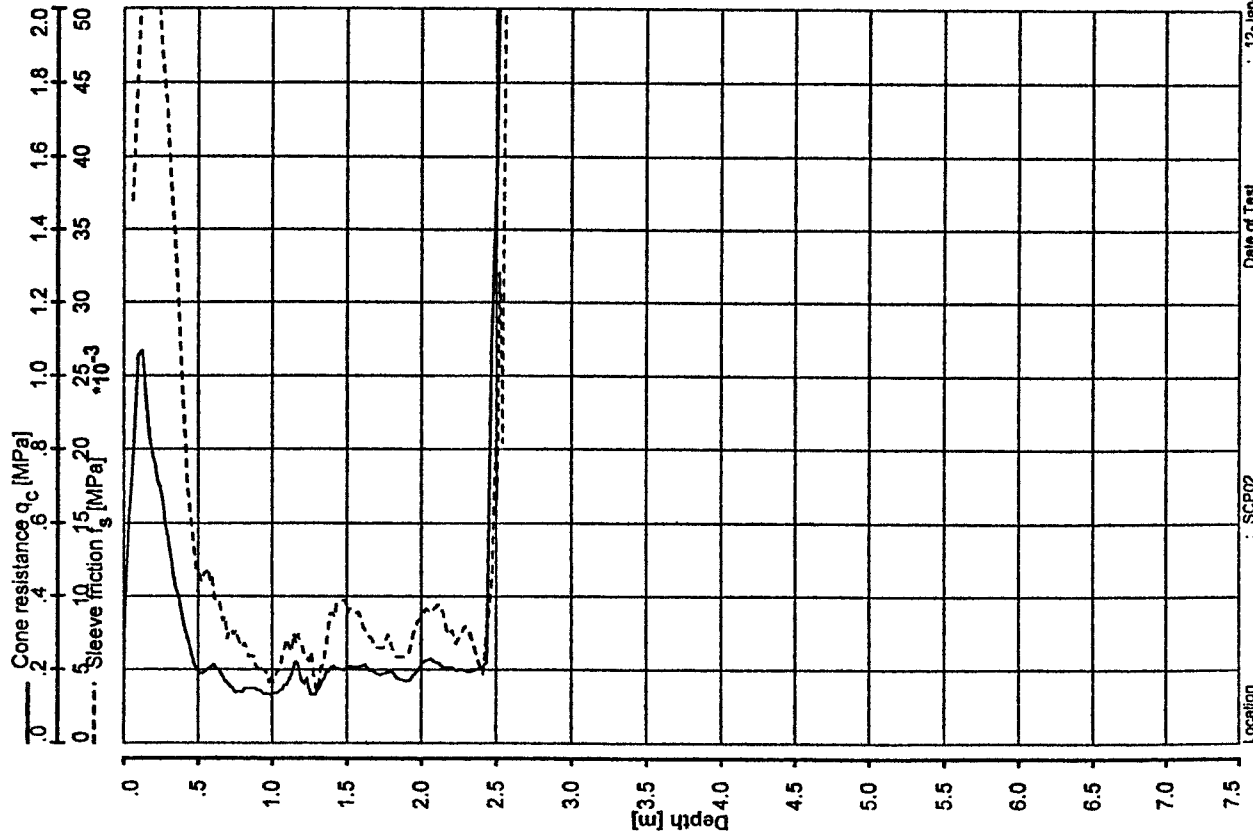
Location : IF3 CP10
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEW-V 1515
 Date of Test : 15-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : L2cp10.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



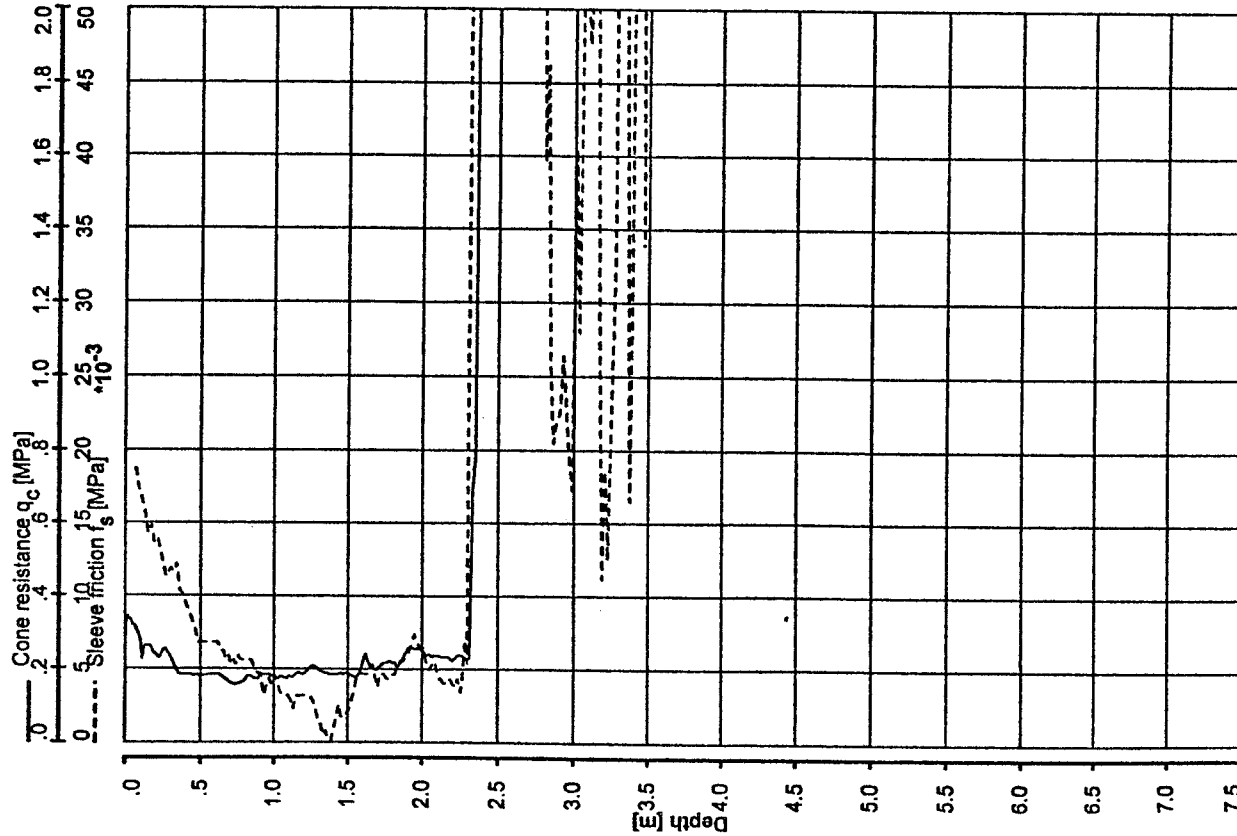


Location : SCP02
 Coordinates :
 Ground Level [m] :
 Cone used : F7.5CKEWN 1515
 Date of Test : 12-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : Scp02.000
 Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

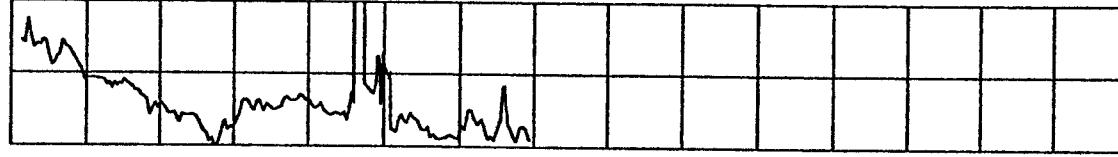
FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

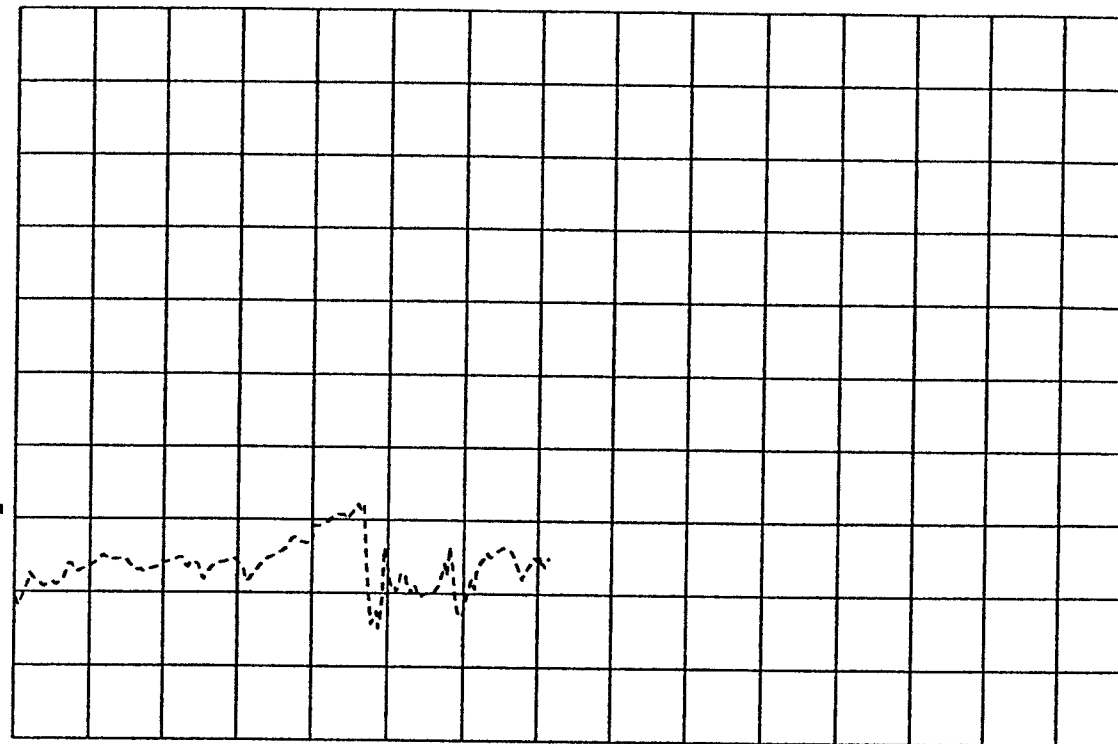


Location : SCP03
 Date of Test : 13-Jan-1990
 Coordinates :
 Date of Plot : 02-Dec-2003
 Ground Level [m] :
 File name : Scp03.000
 Cone used : F7.5CKEW₂V 1515
 Interpretation Checked by : ...

Friction ratio R_f [%]



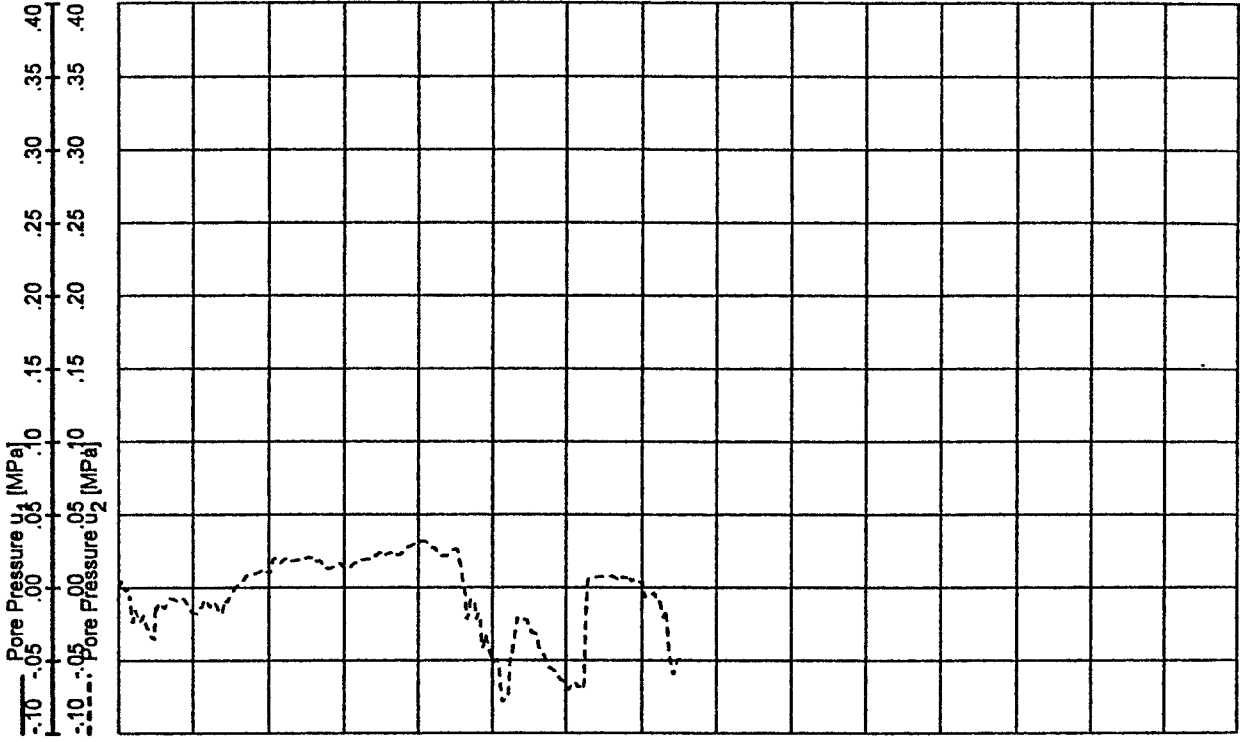
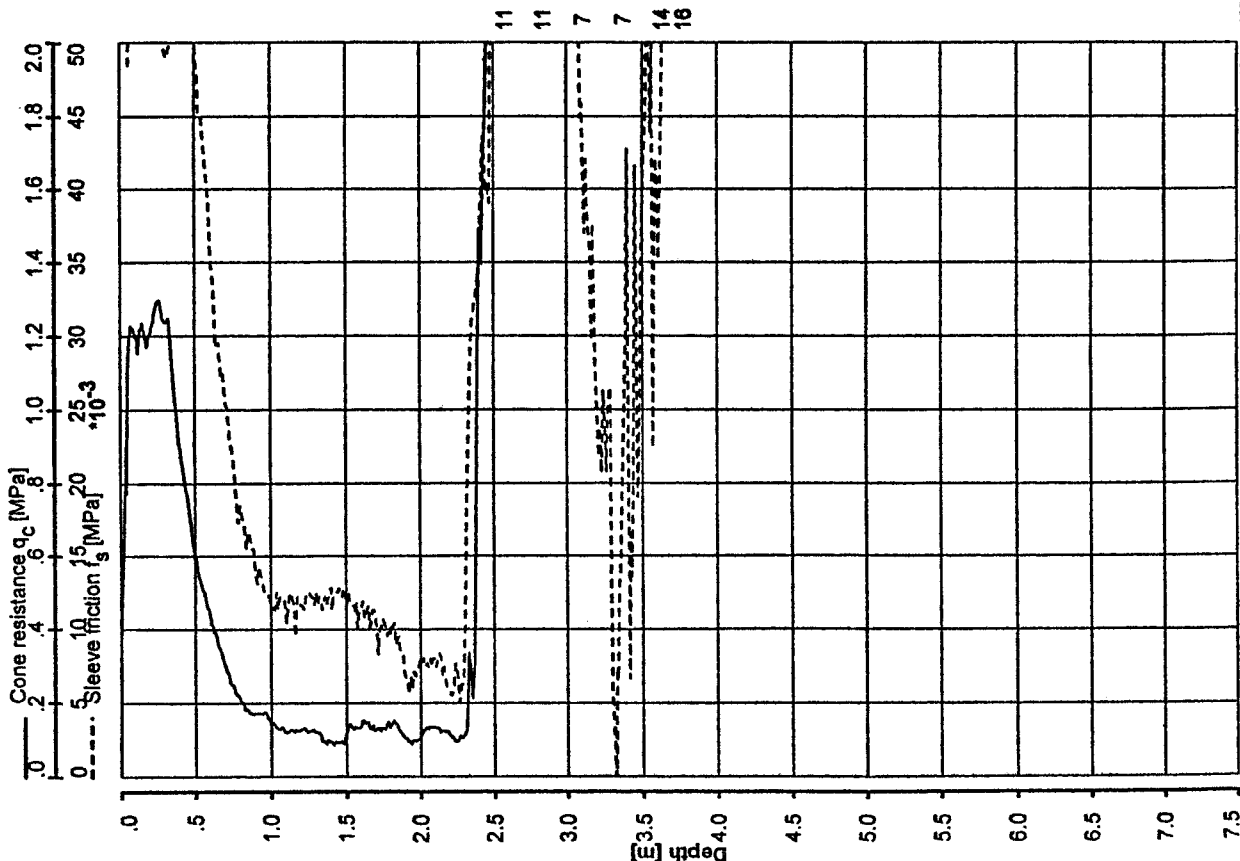
Pore Pressure u_1 [MPa]
 Pore Pressure u_2 [MPa]



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

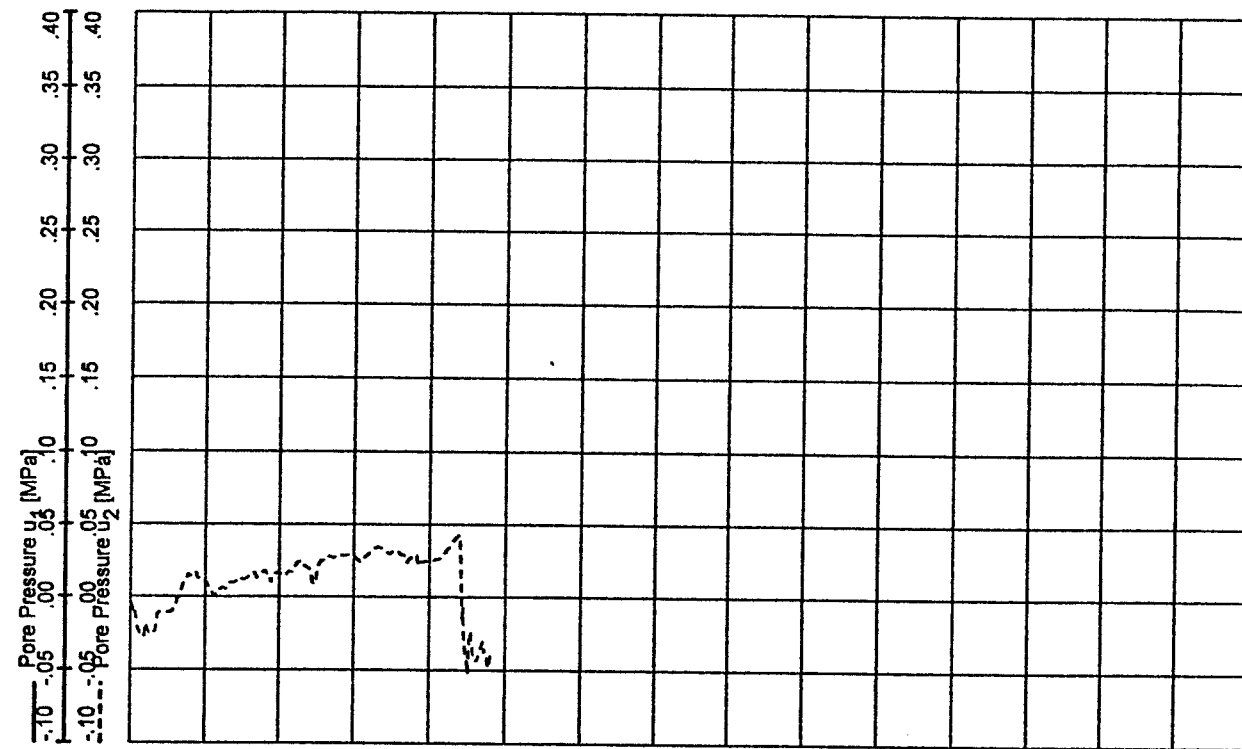
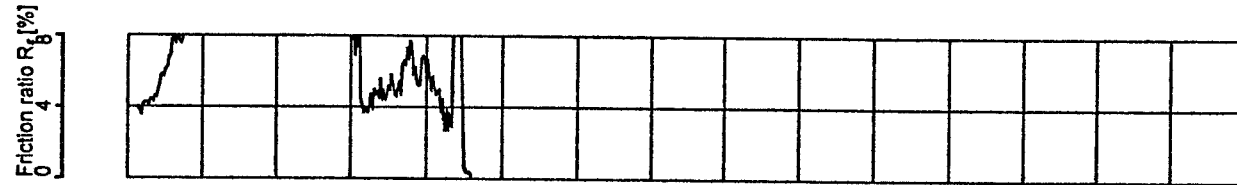
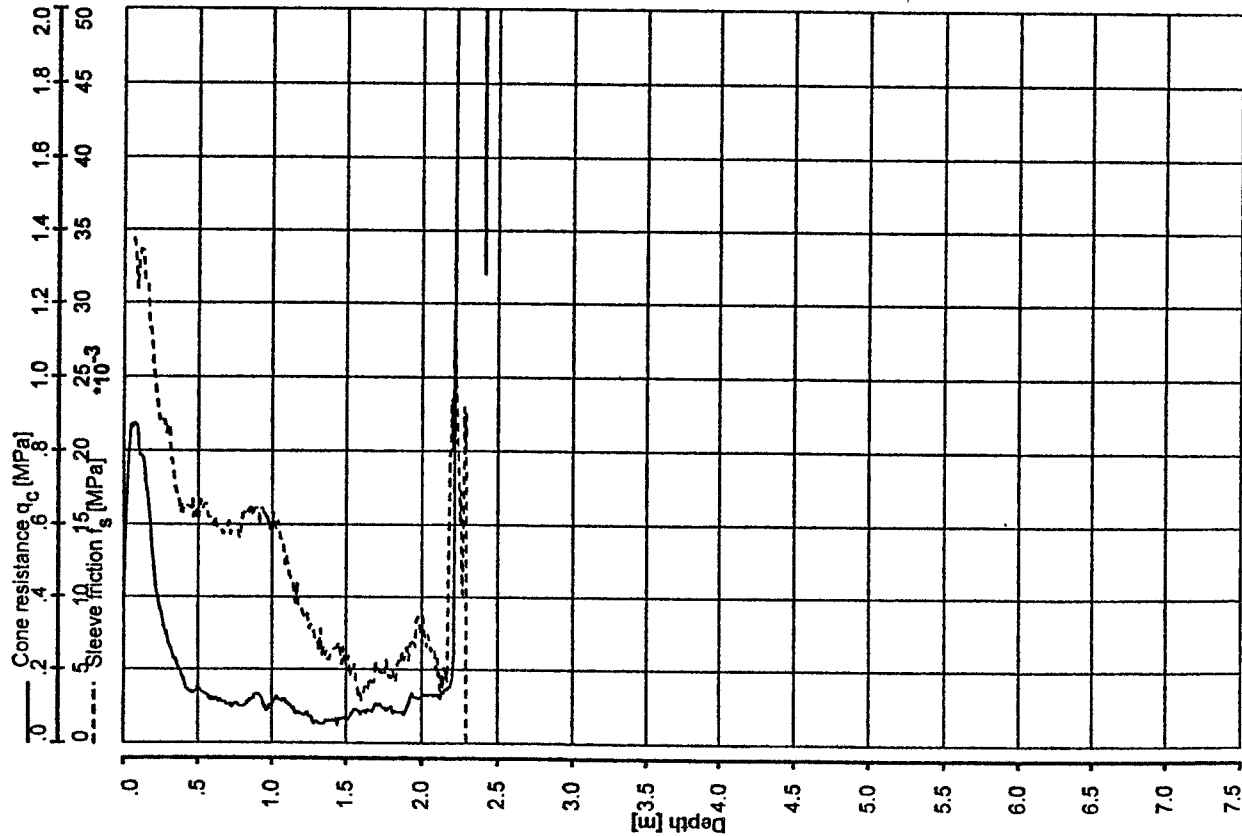
FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



Location : SCP04
Coordinates :
Ground Level [m] :
Cone used : F7.5KEW-NV 1515
Date of Test : 13-Jan-1990
Date of Plot : 02-Dec-2003
File name : Scp04.000
Interpretation Checked by : ...

STATIC CONE PENETRATION TEST
EASINGTON LAINFALL PIPELINE
STATOIL
SCP04
FUGRO ENGINEERING SERVICES LIMITED
31619-1 (01)



Location : SCP05
Coordinates :
Ground Level [m] :
Cone used : F7.SCKE/W 1515
Date of Test : 13-Jan-1990
Date of Plot : 02-Dec-2003
File name : Scp05.000
Interpretation Checked by : ...

STATIC CONE PENETRATION TEST

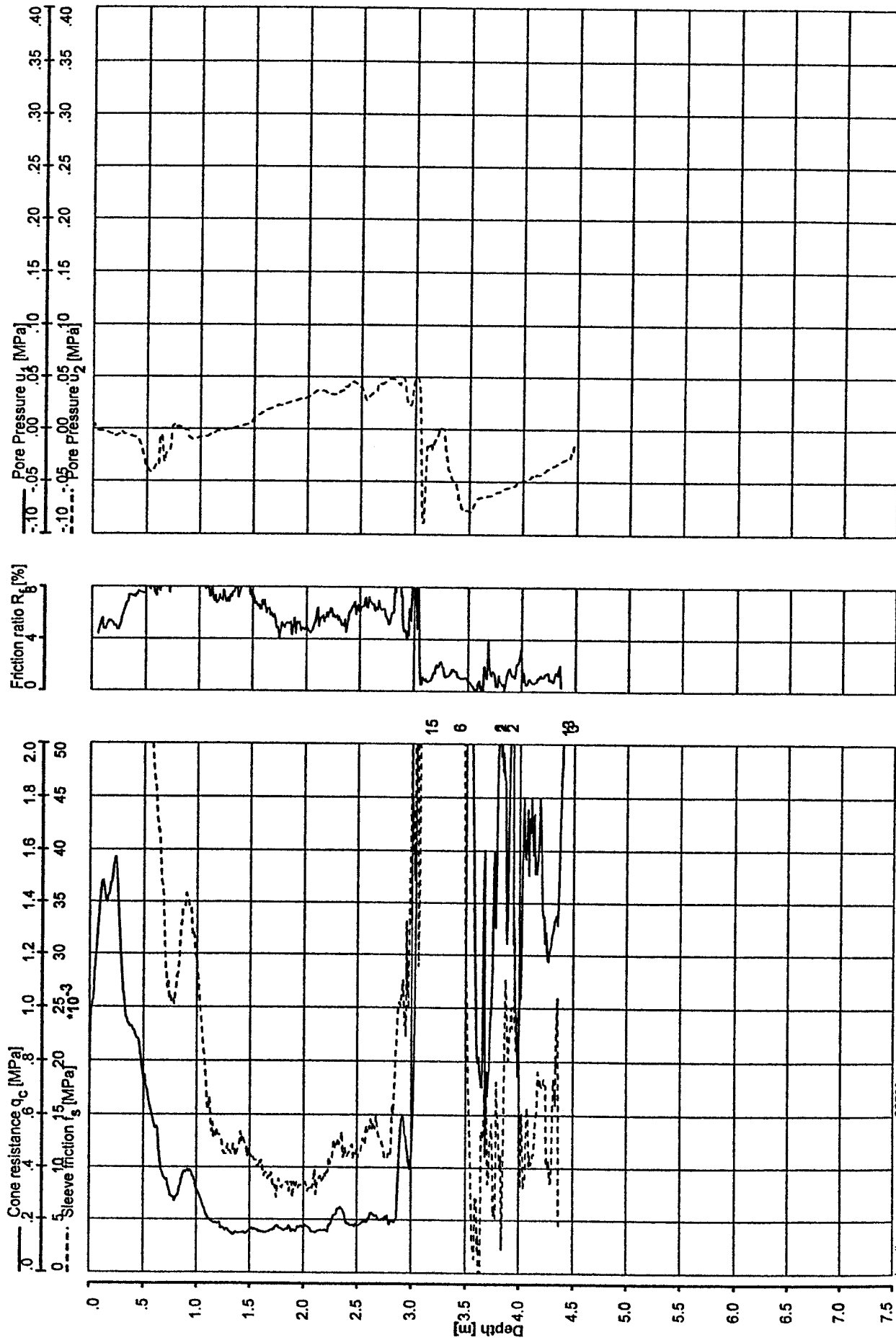
EASINGTON LANFALL PIPELINE

STATOIL

SCP05

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

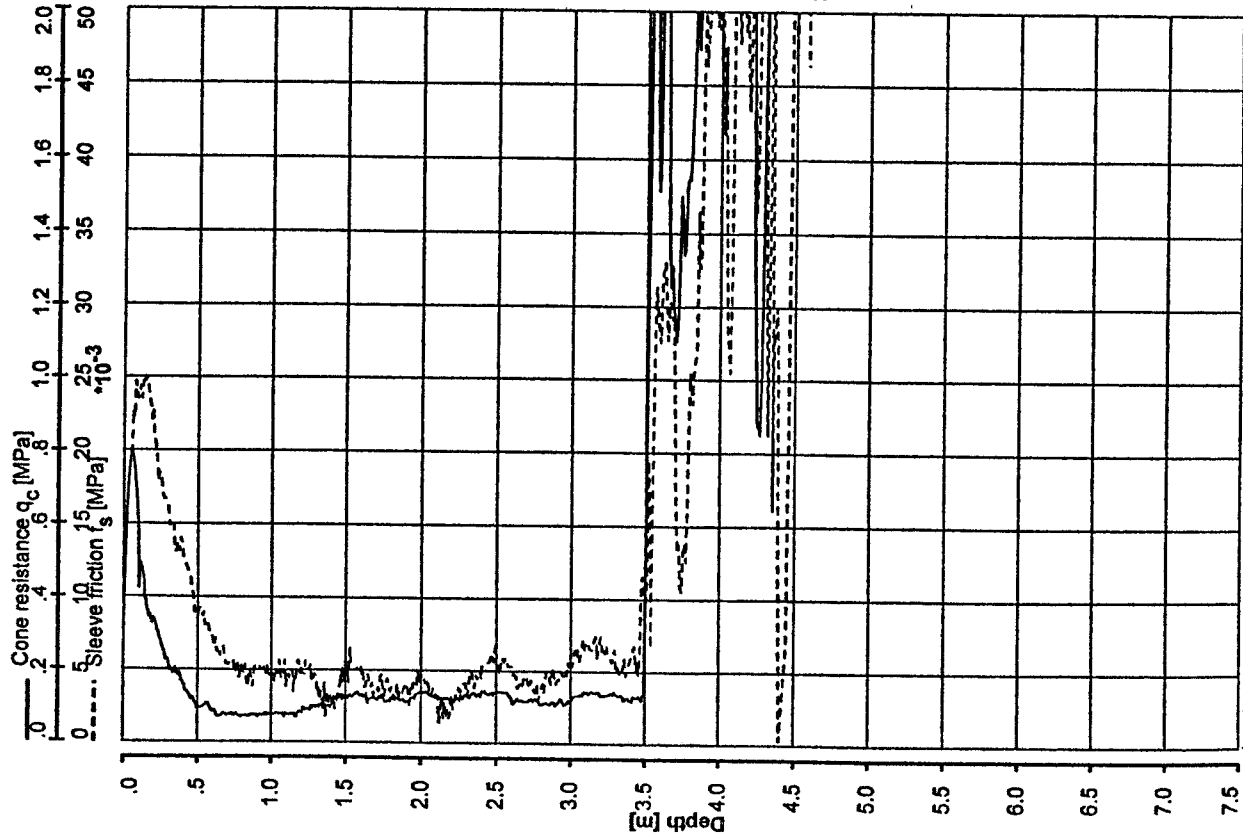


STATIC CONE PENETRATION TEST
EASINGTON LANFALL PIPELINE
STATOIL

Location : SCP06
Coordinates :
Ground Level [m] :
Cone used : F7.5CKEWV 1515
Date of Test : 13-Jan-1990
Date of Plot : 02-Dec-2003
File name : Scp06.000
Interpretation Checked by : ...

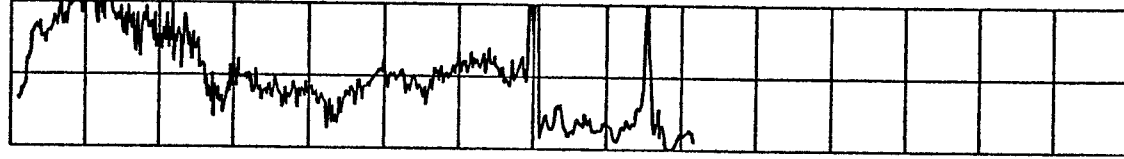
FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)



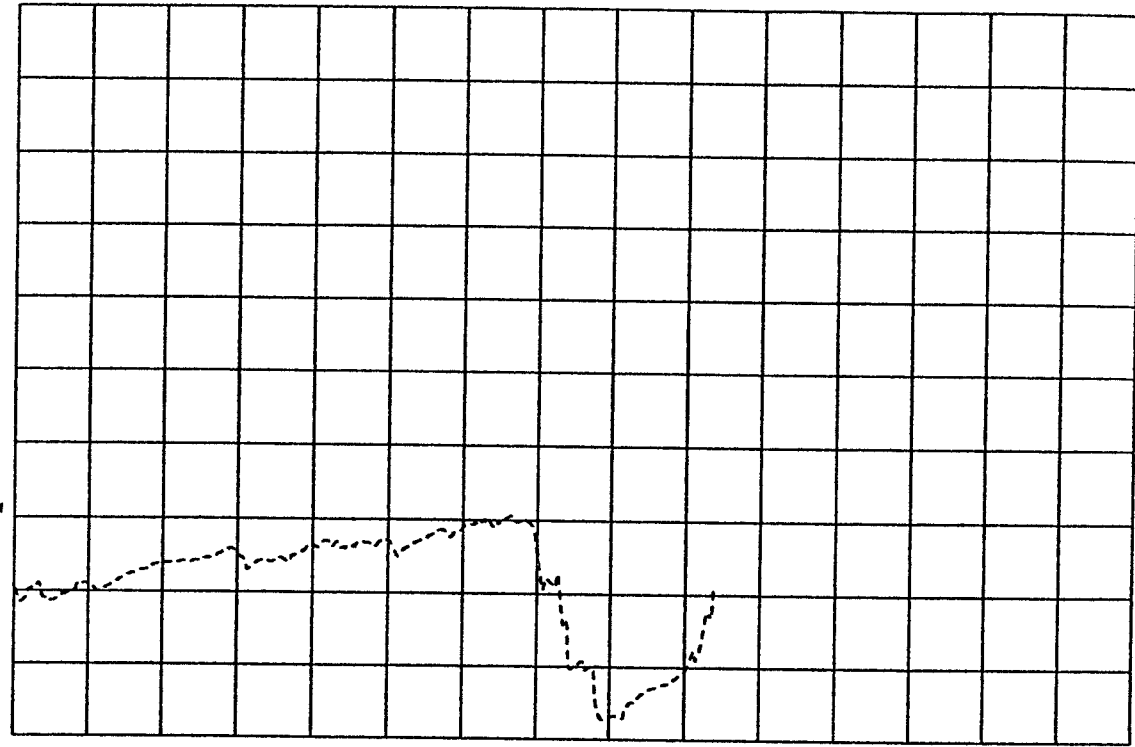
Location : SCP07
 Coordinates :
 Ground Level [m] :
 Cone used : FT.5CKEW-N 1515
 Date of Test : 13-Jan-1990
 Date of Plot : 02-Dec-2003
 File name : SCP07.000
 Interpretation Checked by : ...

Friction ratio R_f [%]



Legend:
 — Pore Pressure u_1 [MPa]
 - - - Pore Pressure u_2 [MPa]

Y-axis: Pore Pressure u_1 [MPa] (-0.10 to 0.40), Pore Pressure u_2 [MPa] (-0.10 to 0.40)
 X-axis: Depth [m] (0 to 7.5)



STATIC CONE PENETRATION TEST
 EASINGTON LANFALL PIPELINE
 STATOIL

SCP07

FUGRO ENGINEERING SERVICES LIMITED

31619-1 (01)

APPENDIX C REVIEW OF EFFECTIVE STRESS PARAMETERS FOR PEAT

Reference	Cohesion, c' (kPa)	Friction angle, ϕ' (degs.)	Testing Apparatus/ Comments
Hanrahan et al (1967)	5 to 7	36 to 43	From triaxial apparatus
Rowe and Mylleville (1996)	2.5	28	From simple shear apparatus
Landva (1980)	2.4	27.1 to 32.5	Mainly ring shear apparatus for normal stress greater than 13kPa
	5 to 6	-	At zero normal stress
Farrell and Hebib (1998)	0	38	From ring shear and shear box apparatus
	0.61	31	From DSS apparatus. Result considered too low therefore DSS not considered appropriate
Rowe, Maclean and Soderman (1984)	1.1	26	From simple shear apparatus
	3	27	From DSS apparatus
Sandorini et al (1984)	4.5	28	From triaxial apparatus
McGreever and Farrell (1988)	6	38	From triaxial apparatus using soil with 20% organic content
	6	31	From shear box apparatus using soil with 20% organic content
Hungr and Evans (1985)	3.3	-	Back-analysed from failure
Madison et al (1996)	10	23	-

Table: Review of Effective Stress Parameters for Peat

APPENDIX D RISK REGISTER

D.1 Geotechnical Risk Register

A Geotechnical Risk Register has been compiled to show the degree of risk attached to various elements of the design. The purpose of the register is to provide an outline description of the hazard, identify the potential likely cause, describe the consequence or impact of the hazard and identify the design and construction controls to be implemented in order to reduce the probability to a tolerable level. The overall application of the risk register will allow the management of geotechnical risk.

Whilst probability of a hazard occurring can be reduced to a minimum by geotechnical design, the probability cannot be reduced below Negligible. The likelihood of a hazard occurring has been judged on a qualitative scale. The scale has been derived from Clayton (2001) as follows:

Scale	Probability	Chance, per section of Works
>1	Negligible	< 10 %
2	Unlikely	10 – 30 %
3	Likely	30 – 50 %
4	Probable	50 – 70 %
5	Very Likely	> 70 %

Table of Qualitative Probability Scales

The severity of the risk is also assessed qualitatively and depends on the risk tolerance. The risk results from the combination of the hazard and the impact/consequence. A similar qualitative scale has been derived for the impact of the hazard as follows:

Scale	Impact
5	Very High
4	High
3	Medium
2	Low
1	Very Low

Table of Qualitative Impact Scales

The impact of a hazard manifesting itself can be either financial, health & safety or environmental or combinations of all three.

The degree of risk is determined by combining the probability and impact assessments and has been judged against a third qualitative scale, the Risk Rating which includes a descriptive response as follows:

Risk	Risk Rating	Response
1 to 4	Trivial	Monitor
5 to 8	Tolerable	Regular Attention
9 to 12	Substantial	Early Attention
13 to 25	Intolerable	Unacceptable

Table of Qualitative Risk Scales

The probability of a hazard manifesting itself can be reduced by geotechnical design but the impact cannot be influenced. Whilst a high impact event with low probability may have a similar risk rating as a low impact event with a high probability, the net effect of these separate hypothetical events may be viewed differently by the different parties involved with the project.

During construction, the ground conditions will be observed, monitored and recorded as appropriate. This will allow methods of construction and revision in design to be appropriately amended whilst the risks highlighted in the Geotechnical Risk Register are continuously monitored.

HAZARD	CAUSE	IMPACT	Design Controls	Construction Controls	AFTER CONTROL				CONTINGENCY MEASURES
					P	I	R		
1. Rutting of haul road from transfer area to deposition area.	Over trafficking of previously unknown weaker surface areas.	Impede operations and/or loss of ground.	Incorporate geotextile with drainage layer material where required. Design appropriate geotechnical instrumentation for monitoring.	Place geotextile and drainage layer material where necessary.	0.5	1.5	0.75		Install additional geotextile, increase thickness of haul road, import selected granular material, switch to lighter construction plant, reduce trafficking.
2. Movement of placed peat over the top of highfield	Overestimating the geotechnical properties of the ex-situ peat and/or allowing the peat to be reworked to low shear strengths. Drainage not provided or impeded.	Overtopping could allow movement of peat within deposition area blocking construction traffic. Loss of strength of placed material.	Review the site investigation of ex-situ peat and use conservative values for geotechnical parameters. Ensure no overfilling of placed peat.	Adopt construction measures to minimise disturbance of ex-situ peat. Provide adequate drainage and also maintain existing drainage. Adopt observational approach	0.75	2	1.5		Peat must be allowed to regain sufficient strength either by ceasing operations or some artificial means. Increased windrowing time for ex-situ peat prior to transport from gas terminal site.
3. Failure of internal highfield	Inadequate shear strength. Overloading of wagons. Too close spacing of wagons. Piling fill materials too high. Severe dynamic effects, e.g. imposing speed limits and requiring fills to be spread as trucks are emptied.	Loss of plant, closure of access, danger to operatives	Undertake conservative ground investigation & adopt conservative design strength.	Limit plant weight & spacing of plant. Limit loading on roadway. Adopt observational approach	1	2	2		Import selected granular material for improved strength & drainage, relocate access road.
4. Bog slide	Insufficient understanding of the mechanisms of failure and inadequate design. Presence of weak peat.	Movement of placed and in-situ peat form deposition area. Cessation of works. Loss of ground. Existing and proposed drainage inundated.	Understand mechanisms of a 'bog slide' and assess the site for sliding potential, based on published information and site investigation data. Undertake stability analysis of the site.	Adopt observational approach	0.25	5	1.25		Cease operations, remove displaced material, provide check barriers to impede/contain slide.
5. Failure of perimeter highfield	Ground too weak.	Movement of placed and in-situ peat form deposition area. Cessation of works. Loss of ground. Existing and proposed drainage inundated.	Undertake comprehensive ground investigation, adopt conservative design parameters. Undertake stability analysis for design proposal.	Adopt observational approach	1	1	1		Import selected granular fill, flatten slope, use granular haunch.
6. Bearing failure of access road from R313	Inadequate strength in ground. Excess water in retained peat and access track. Inadequate drainage provisions.	Movement of ground below access road with loss of ground strength.	Undertake comprehensive ground investigation, interpret and adopt conservative design parameters. Provide design that avoids weak founding material.	Install geotechnical instrumentation prior to construction where road is on peat. Establish threshold/trigger values and engage appropriate personnel to monitor and interpret geotechnical instrumentation during and post construction. Where road is not founded on peat/weak material then no requirement for instrumentation and monitoring	1	4	4		Cease traffic operations. Excavate failed area and replace with selected granular fill.

Table: Preliminary Geotechnical Design for Srahmore Peat Deposition Site - Geotechnical Risk Register