GREGG DRILLING AND TESTING, INC.
GREGG IN SITU, INC.
ENVIRONMENTAL AND GEOTECHNICAL INVESTIGATION SERVICES

May 20, 2005

Mactec
Attn: Hussein Benkhayal
1725 Louisville Drive
Knoxville, TN 37921

Subject: CPT Site Investigation
Kingston TVA
Kingston, TN
GREGG Project Number: 05-062SC

Dear Mr. Benkhayal:

The following report presents the results of GREGG IN SITU's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☐
4	Resistivity Cone Penetration Tests	(RCPTU)	☐
5	UVIF Cone Penetration Tests	(UVIFCPTU)	☐
6	Groundwater Sampling	(GWS)	☐
7	Soil Sampling	(SS)	☐
8	Vapor Sampling	(VS)	☐
9	Vane Shear Testing	(VST)	☐
10	SPT Energy Calibration	(SPTE)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (843) 832-4918.

Sincerely,
GREGG IN SITU, Inc.

Adam Hyer
Operations Manager

Cone Penetration Testing Procedure (CPT)

Gregg In Situ, Inc. carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT.* The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and dynamic pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2002) ASTM standards (D 5778-95).

The cone also contains a porous filter element located directly behind the cone tip (u_2), *Figure CPT.* It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain dynamic pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with silicon oil under vacuum pressure to ensure accurate and fast dissipation.

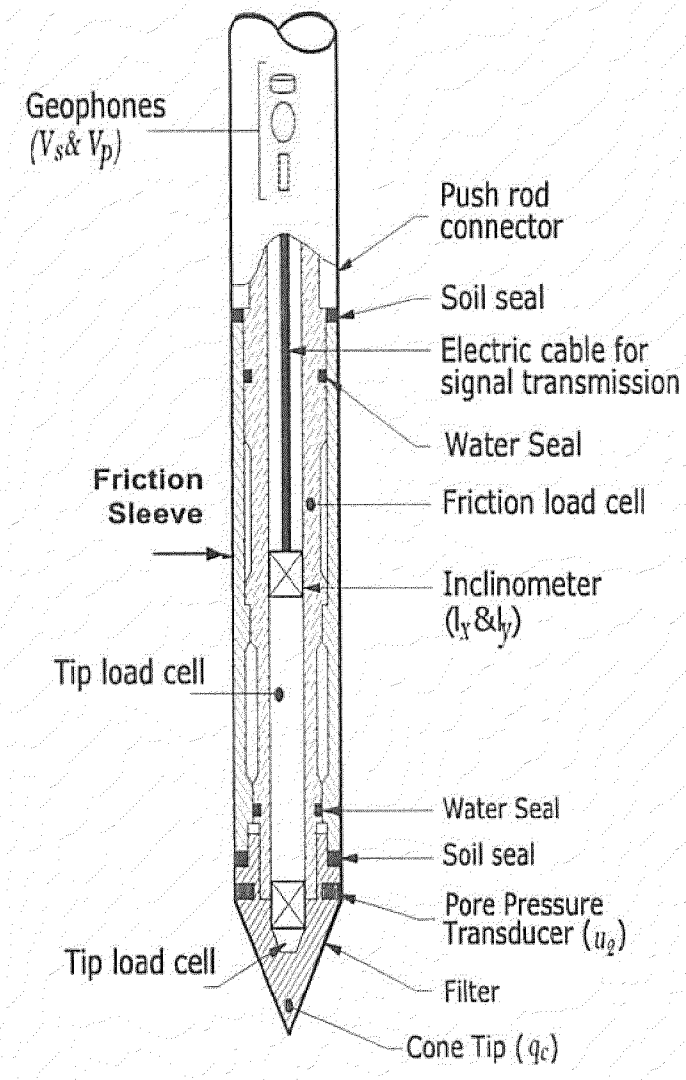


Figure CPT

When the soundings are complete, the test holes are grouted using a Gregg In Situ support rig. The grouting procedure consists of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Client Identification	Date	Termination Depth (Feet)	Depth of Soil Samples (ft)	Depth of Pore Pressure Dissipation Tests (ft)
CPT-01	NB-79	5/16/05	24.4	-	24.4
CPT-02	NB-82	5/16/05	22.3	-	-
CPT-03	NB-71	5/16/05	33.0	-	-
CPT-04	NB-62	5/16/05	58.7	-	56.7
CPT-05	NB-57	5/17/05	41.7	-	-
CPT-06	NB-54	5/17/05	28.8	-	-
CPT-07	NB-58	5/17/05	36.7	-	36.8
CPT-08	NB-56	5/17/05	33.9	-	-
CPT-09	NB-11	5/17/05	30.9	-	30.9
CPT-10	NB-26	5/17/05	35.6	-	35.6

Cone Penetration Test Data & Interpretation

Soil behavior type and stratigraphic interpretation is based on relationships between cone bearing (q_c), sleeve friction (f_s), and pore water pressure (u_2). The friction ratio (R_f) is a calculated parameter defined by $100f_s/q_c$ and is used to infer soil behavior type. Generally:

Cohesive soils (clays)

- High friction ratio (R_f) due to small cone bearing (q_c)
- Generate large excess pore water pressures (u_2)

Cohesionless soils (sands)

- Low friction ratio (R_f) due to large cone bearing (q_c)
- Generate very little excess pore water pressures (u_2)

A complete set of baseline readings are taken prior to and at the completion of each sounding to determine temperature shifts and any zero load offsets. Corrections for temperature shifts and zero load offsets can be extremely important, especially when the recorded loads are relatively small. In sandy soils, however, these corrections are generally negligible.

The cone penetration test data collected from your site is presented in graphical form in Appendix CPT. The data includes CPT logs of measured soil parameters, computer calculations of interpreted soil behavior types (SBT), and additional geotechnical parameters. A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Soil interpretation for this project was conducted using recent correlations developed by Robertson et al, 1990, *Figure SBT*. Note that it is not always possible to clearly identify a soil type based solely on q_c, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type.

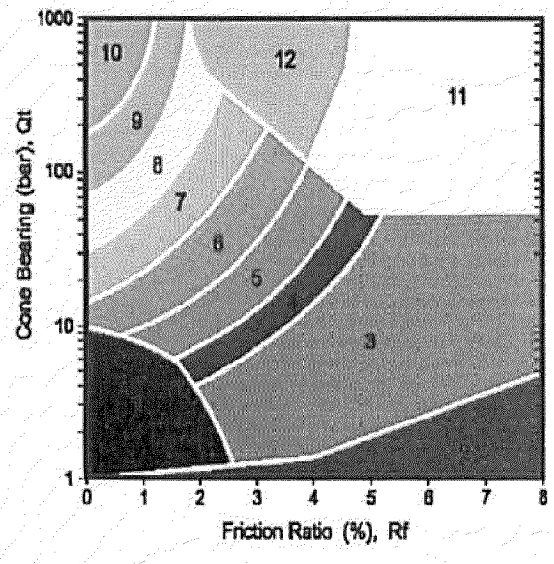


Figure SBT

ZONE	Qt/N	SBT
1	2	Sensitive, fine grained
2	1	Organic materials
3	1	Clay
4	1.5	Silty clay to clay
5	2	Clayey silt to silty clay
6	2.5	Sandy silt to clayey silt
7	3	Silty sand to sandy silt
8	4	Sand to silty sand
9	5	Sand
10	6	Gravely sand to sand
11	1	Very stiff fine grained*
12	2	Sand to clayey sand*

*over consolidated or cemented

Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals measured hydrostatic water pressures and determined the approximate depth of the ground water table. A PPDT is conducted when the cone is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (u) with time is measured behind the tip of the cone and recorded by a computer system.

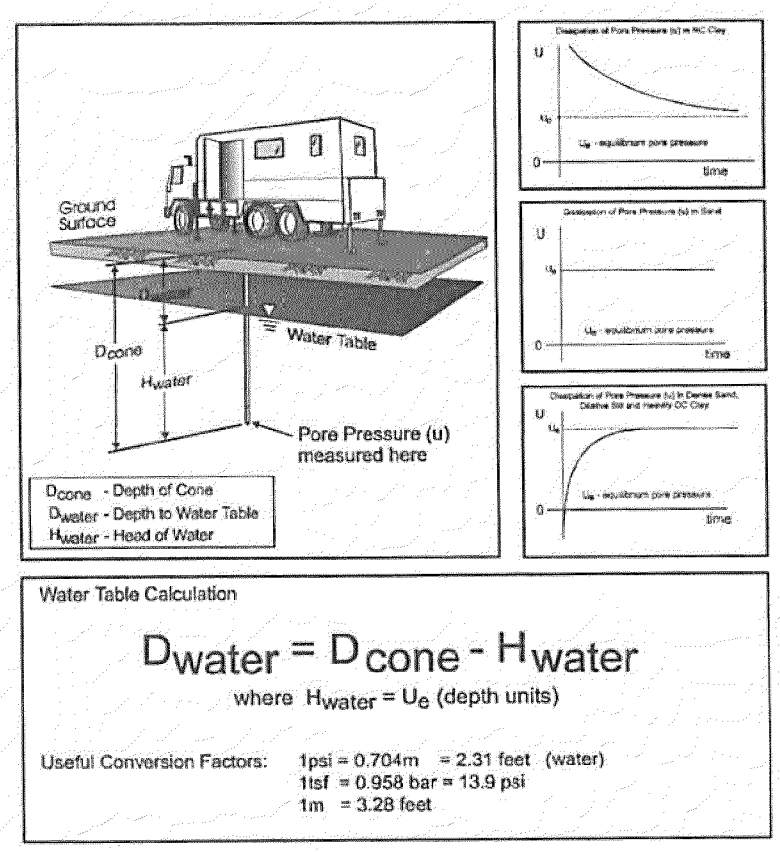
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until such time as there is no variation in pore pressure with time, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1991.

A summary of the pore pressure dissipation tests is summarized in Table 1. Pore pressure dissipation data is presented in graphical form in Appendix PPDT.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors: 1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

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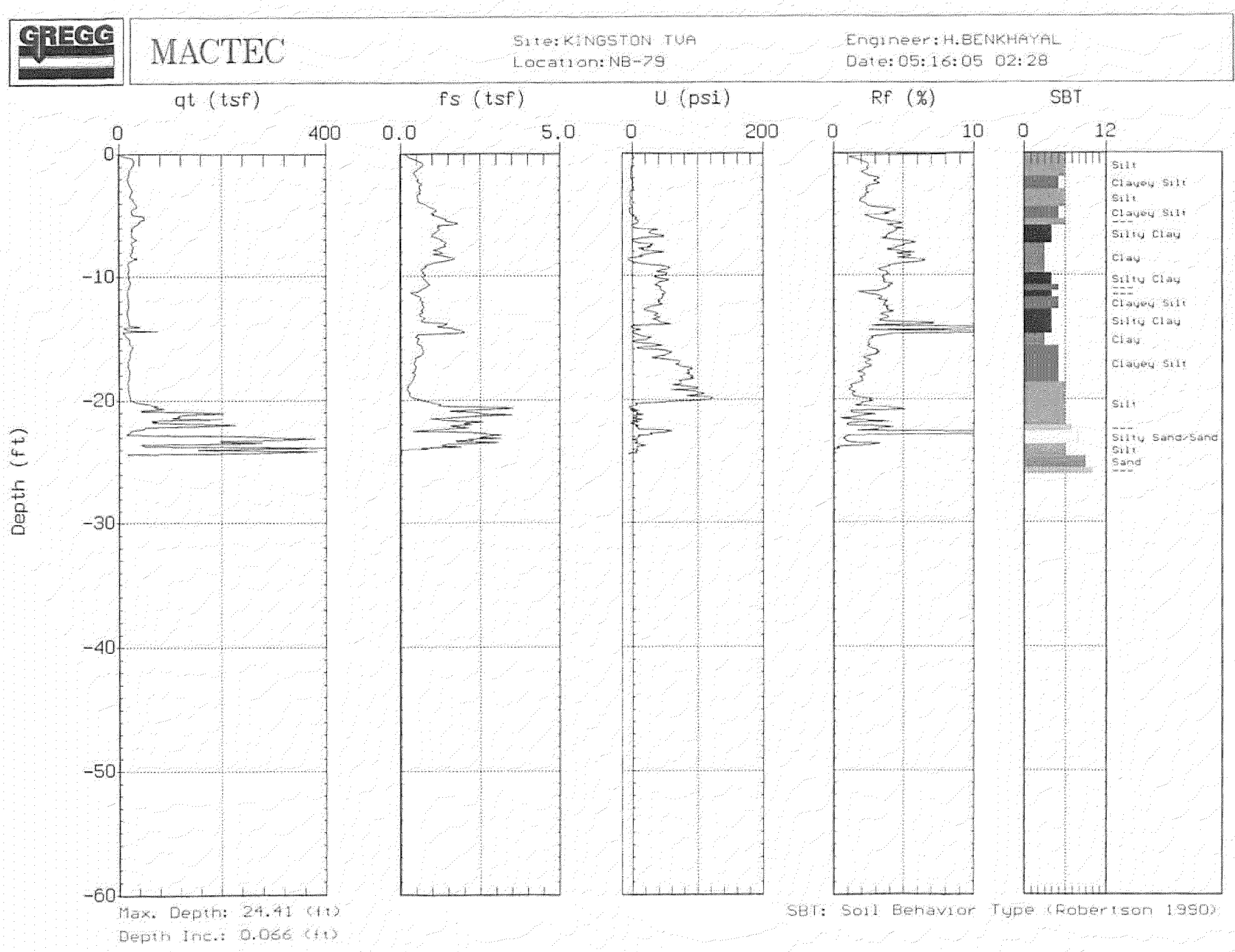
Copies of ASTM Standards are available through www.astm.org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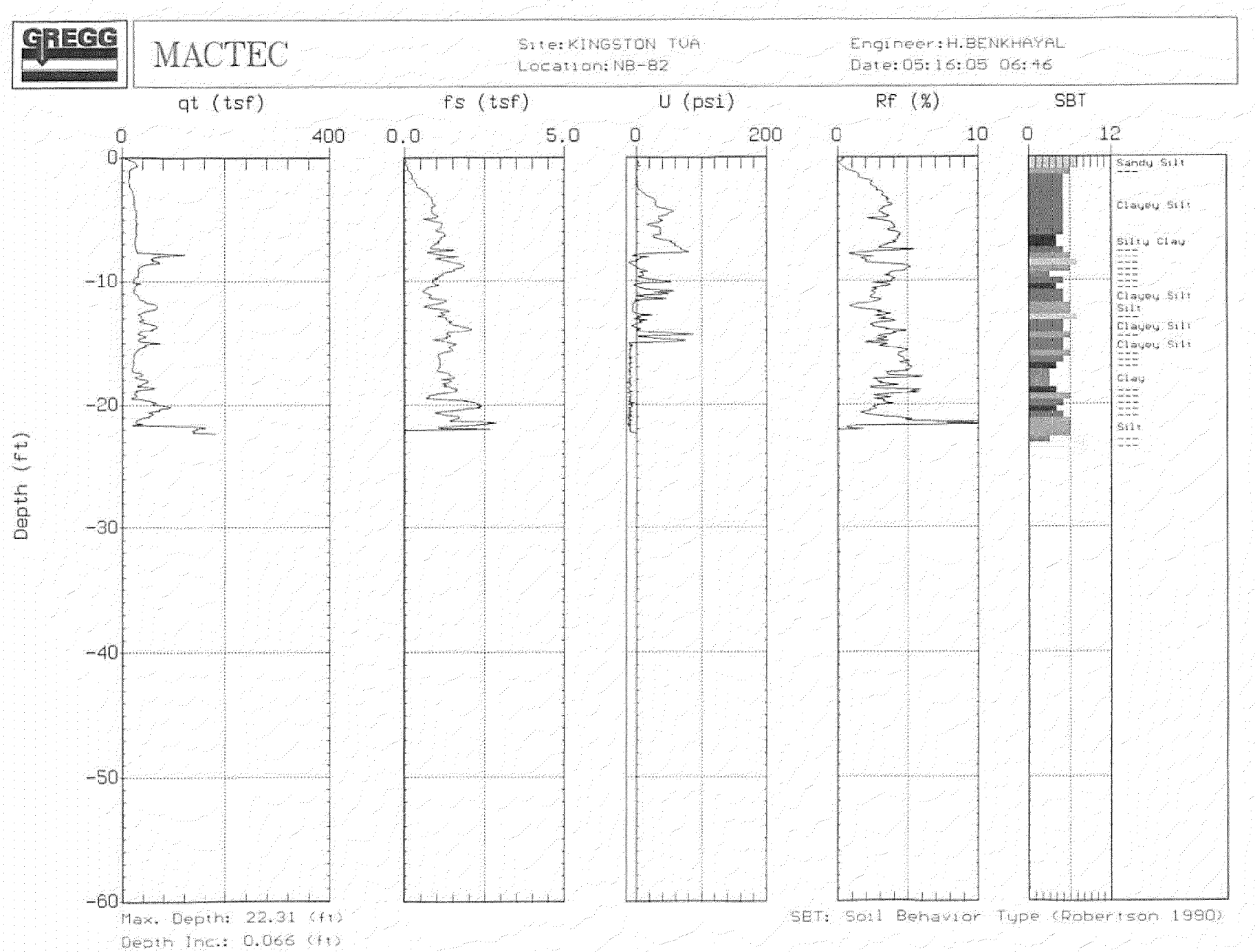
MACTEC
Site: KINGSTON TVA
Location: NB-79
Engineer: H.BENKHAYAL
Date: 05:16:05 02:28
qt (tsf)
fs (tsf)
U (psi)
Rf (%)
SBT
0
400
0.0
5.0
200
10
12
Depth (ft)
-10
-20
-30
-40
-50
-60
Silt
Clayey Silt
Silt
Clayey Silt
Silty Clay
Clay
Silty Clay
Clayey Silt
Silty Clay
Clay
Clayey Silt
Silt
Silty Sand/Sand
Silt
Sand
Max. Depth: 24.41 (ft)
Depth Inc.: 0.066 (ft)
SBT: Soil Behavior Type (Robertson 1990)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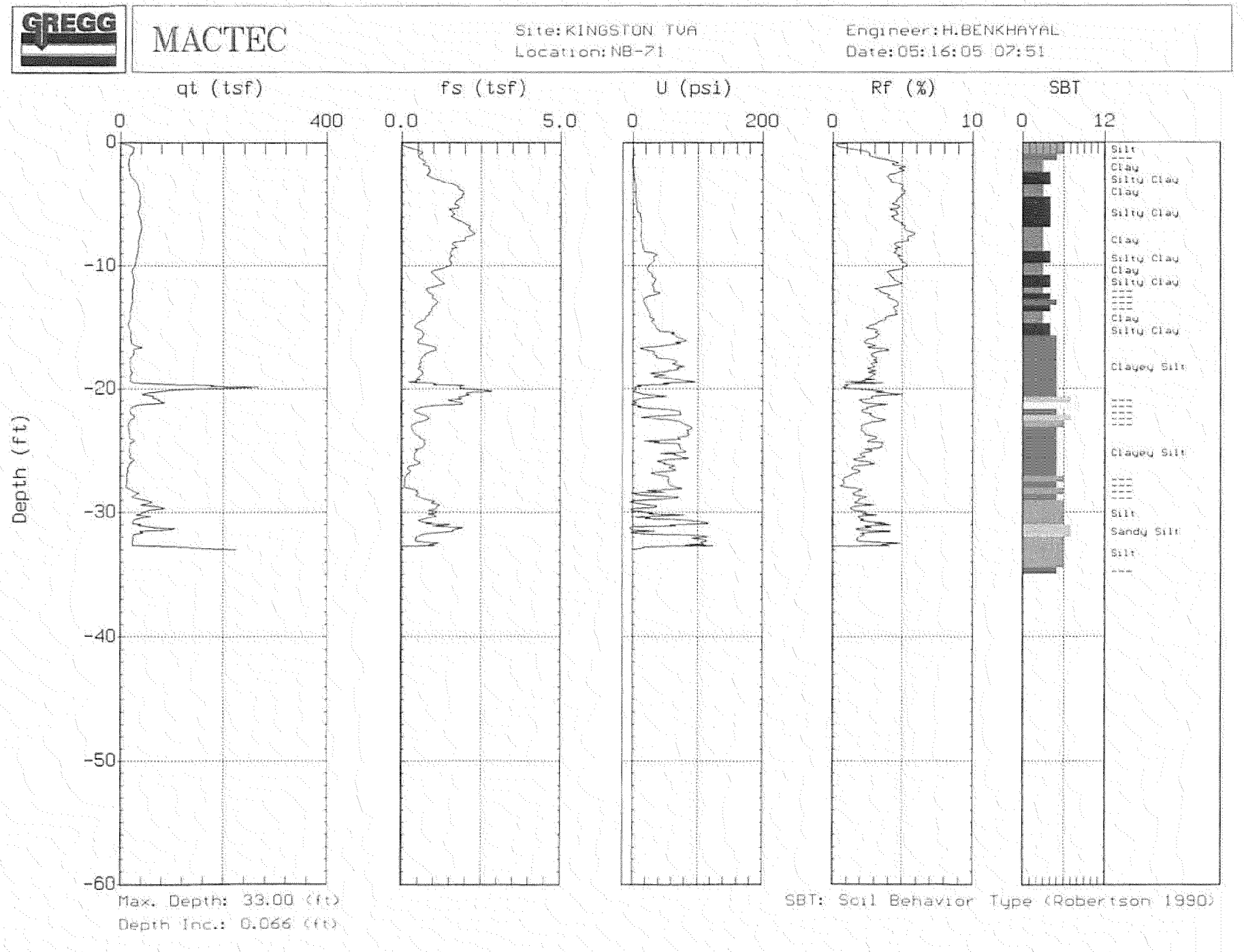
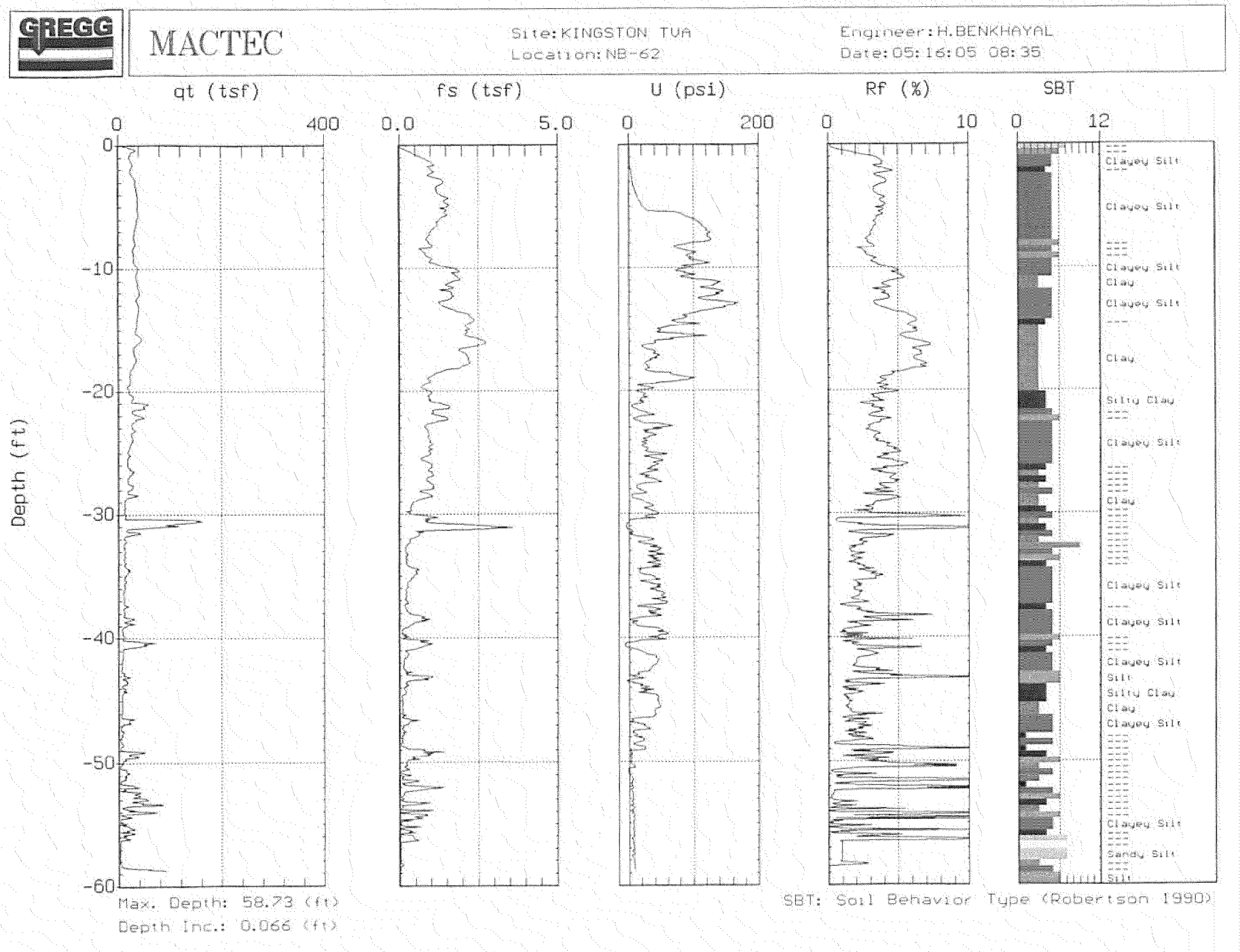
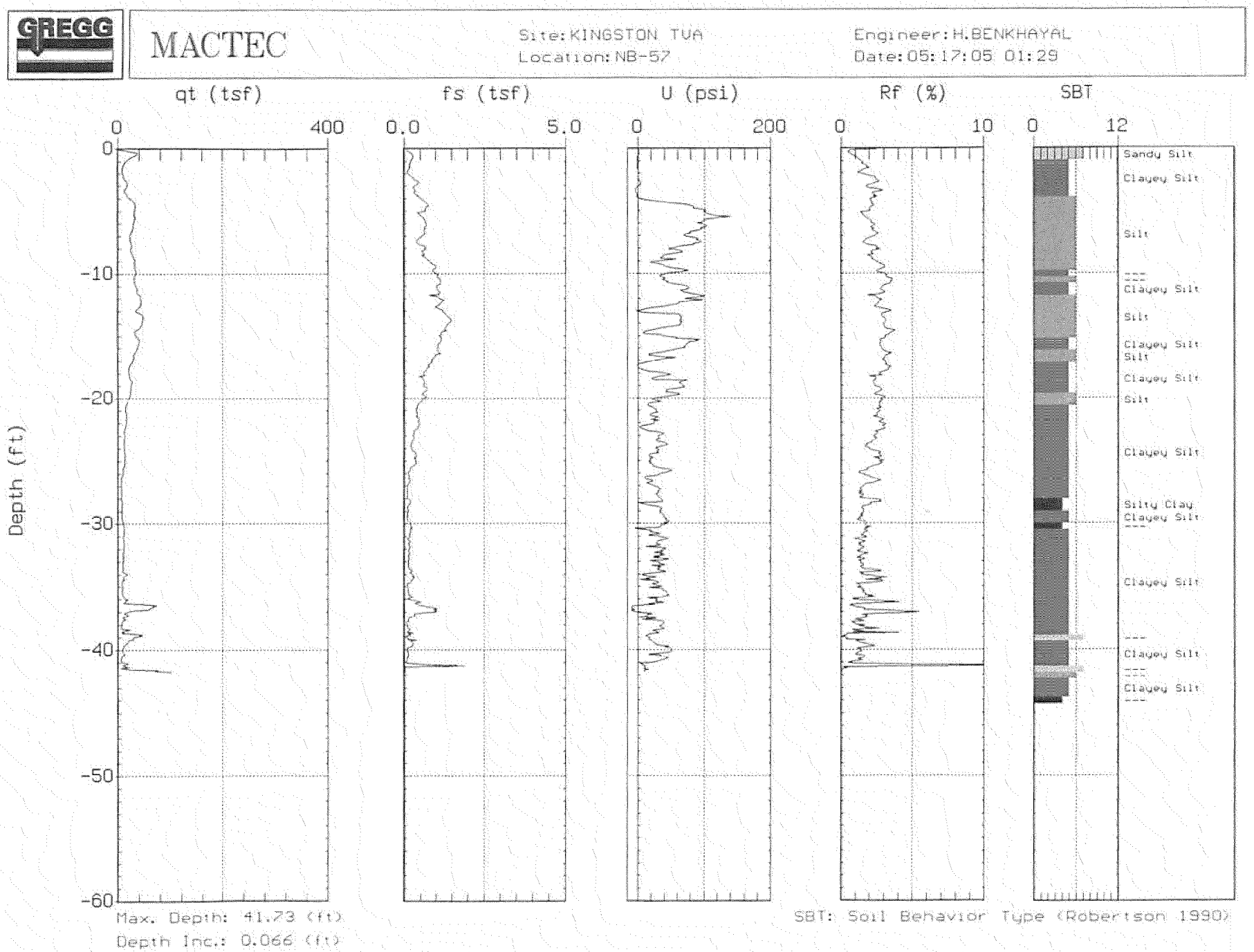
Engineer: H.BENKHAYAL
Date: 05:16:05 06:46
qt (tsf)
fs (tsf)
U (psi)
Rf (%)
SBT
0
400
0.0
5.0
0
200
0
10
0
12
Depth (ft)
0
-10
-20
-30
-40
-50
-60
Sandy Silt
Clayey Silt
Silty Clay
Clayey Silt
Silt
Clayey Silt
Clayey Silt
Clay
Silt
Max. Depth: 22.31 (ft)
Depth Inc.: 0.066 (ft)
SBT: Soil Behavior Type (Robertson 1990)







GREGG

MACTEC

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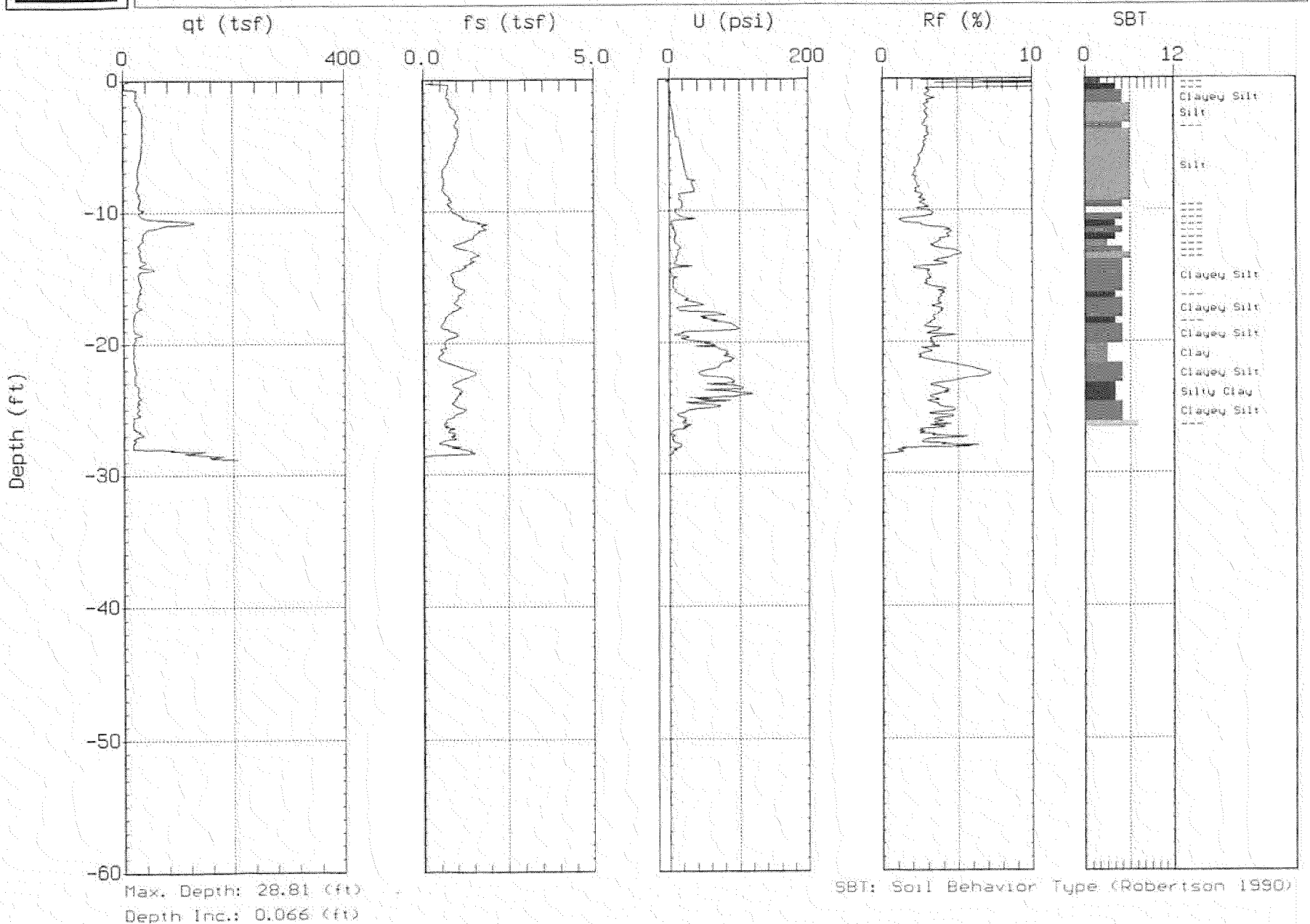
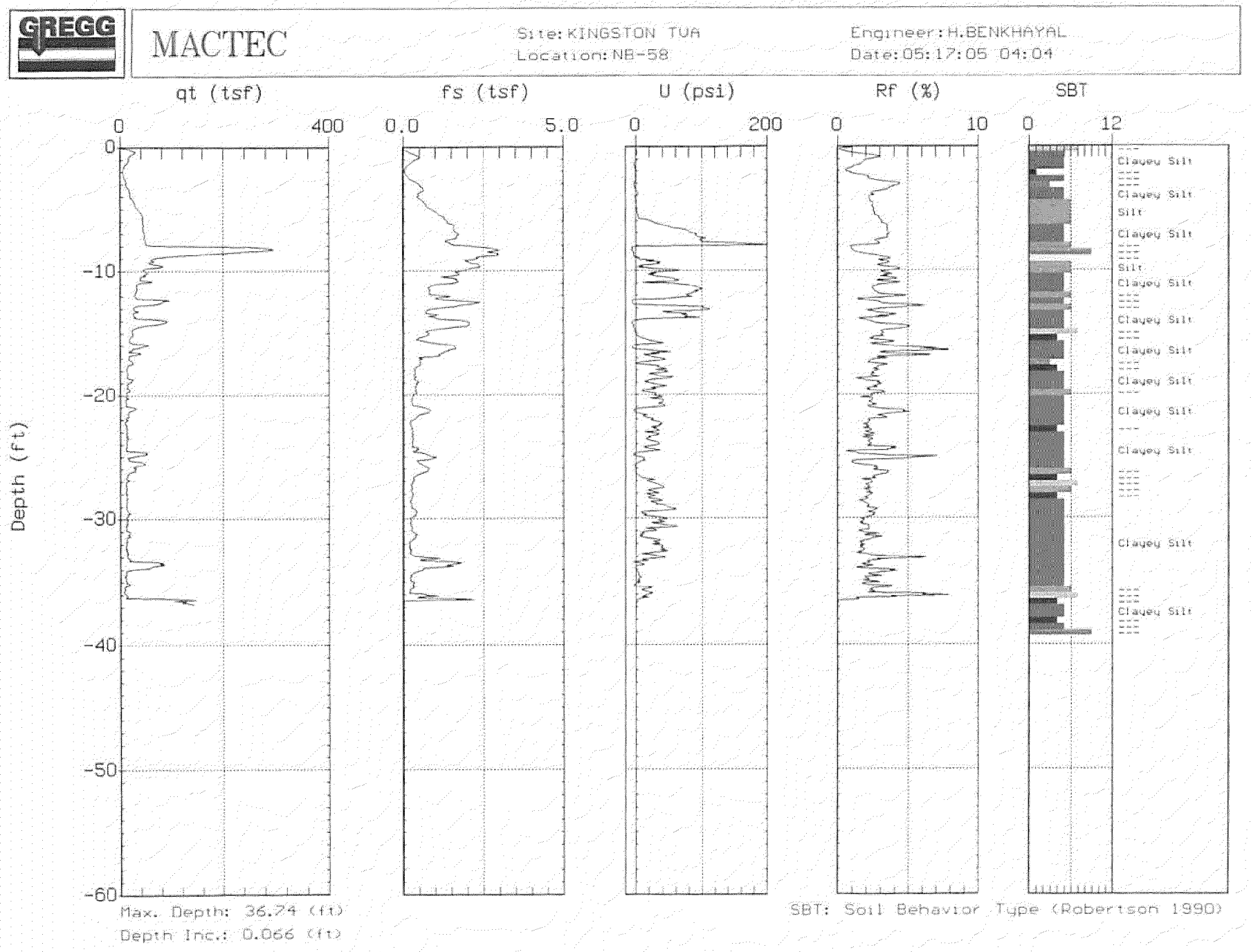
Engineer: H.BENKHAYAL
Date: 05:17:05 03:13



Max. Depth: 28.81 (ft)
Depth Inc.: 0.066 (ft)

SBT: Soil Behavior Type (Robertson 1990)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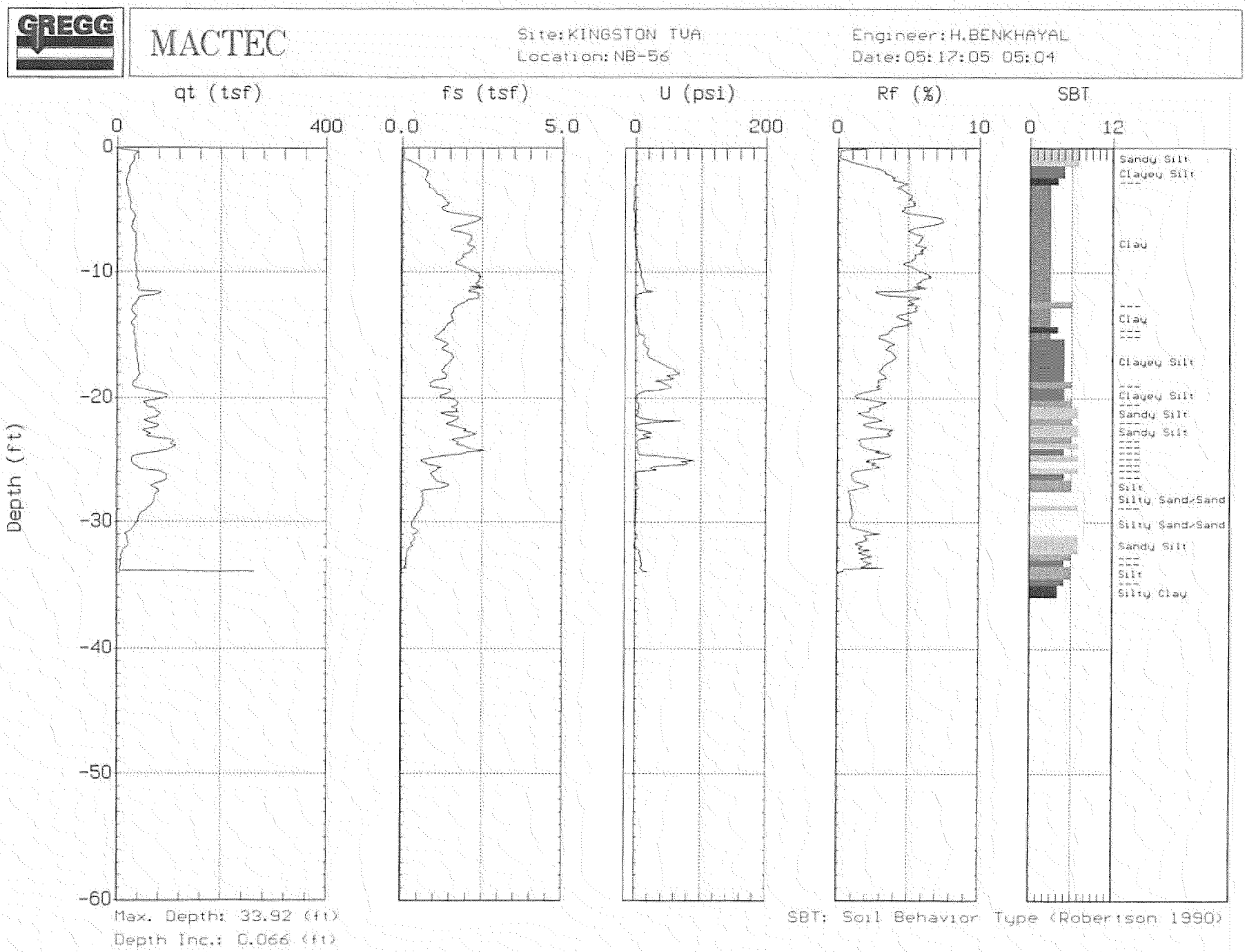
Site: KINGSTON TVA
Location: NB-58
Engineer: H.BENKHAYAL
Date: 05:17:05 04:04
qt (tsf)
fs (tsf)
U (psi)
Rf (%)
SBT
0
400
0.0
5.0
200
10
12
-10
-20
-30
-40
-50
-60
Depth (ft)
Clayey Silt
Silt
Max. Depth: 36.74 (ft)
Depth Inc.: 0.066 (ft)
SBT: Soil Behavior Type (Robertson 1990)



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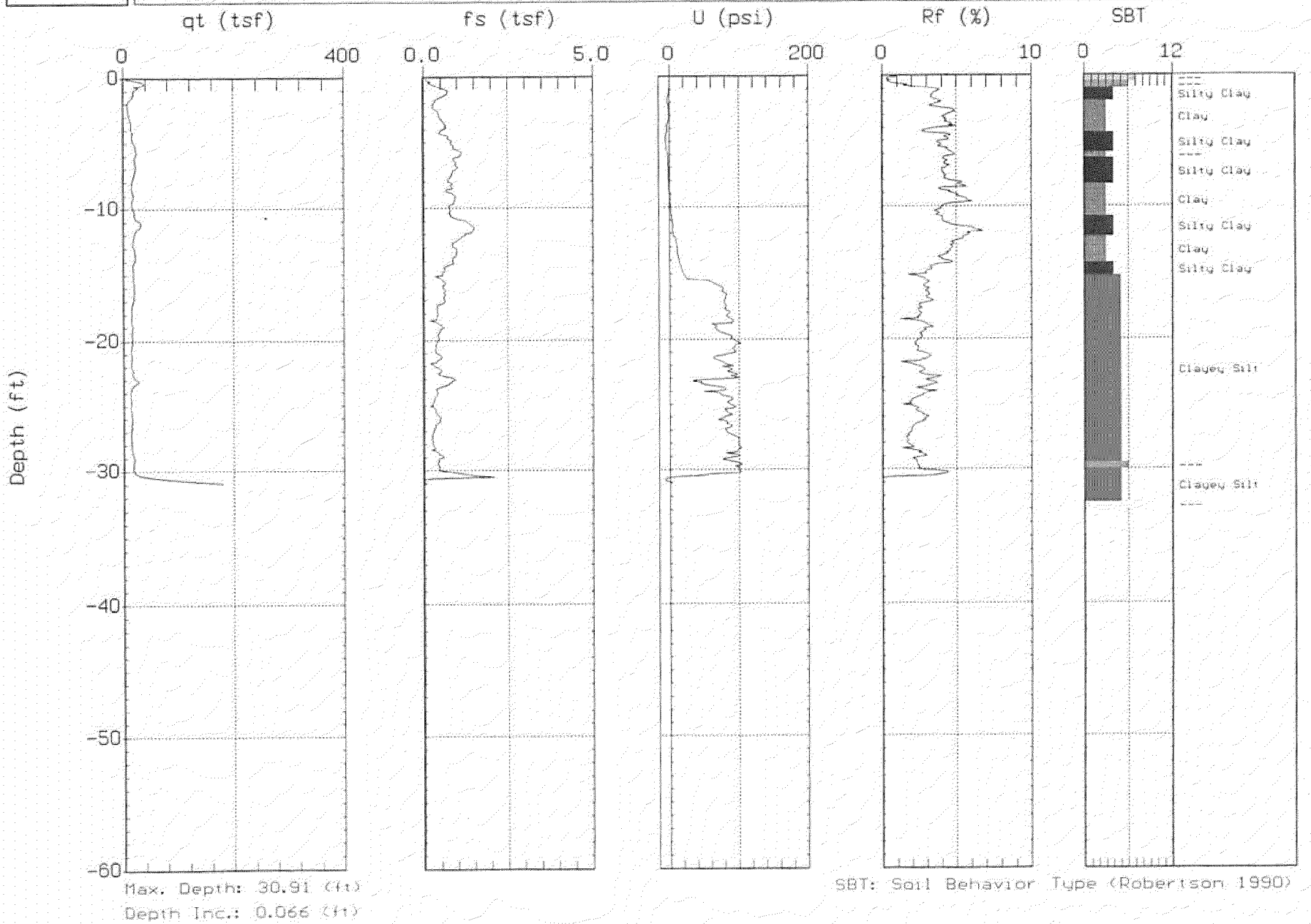

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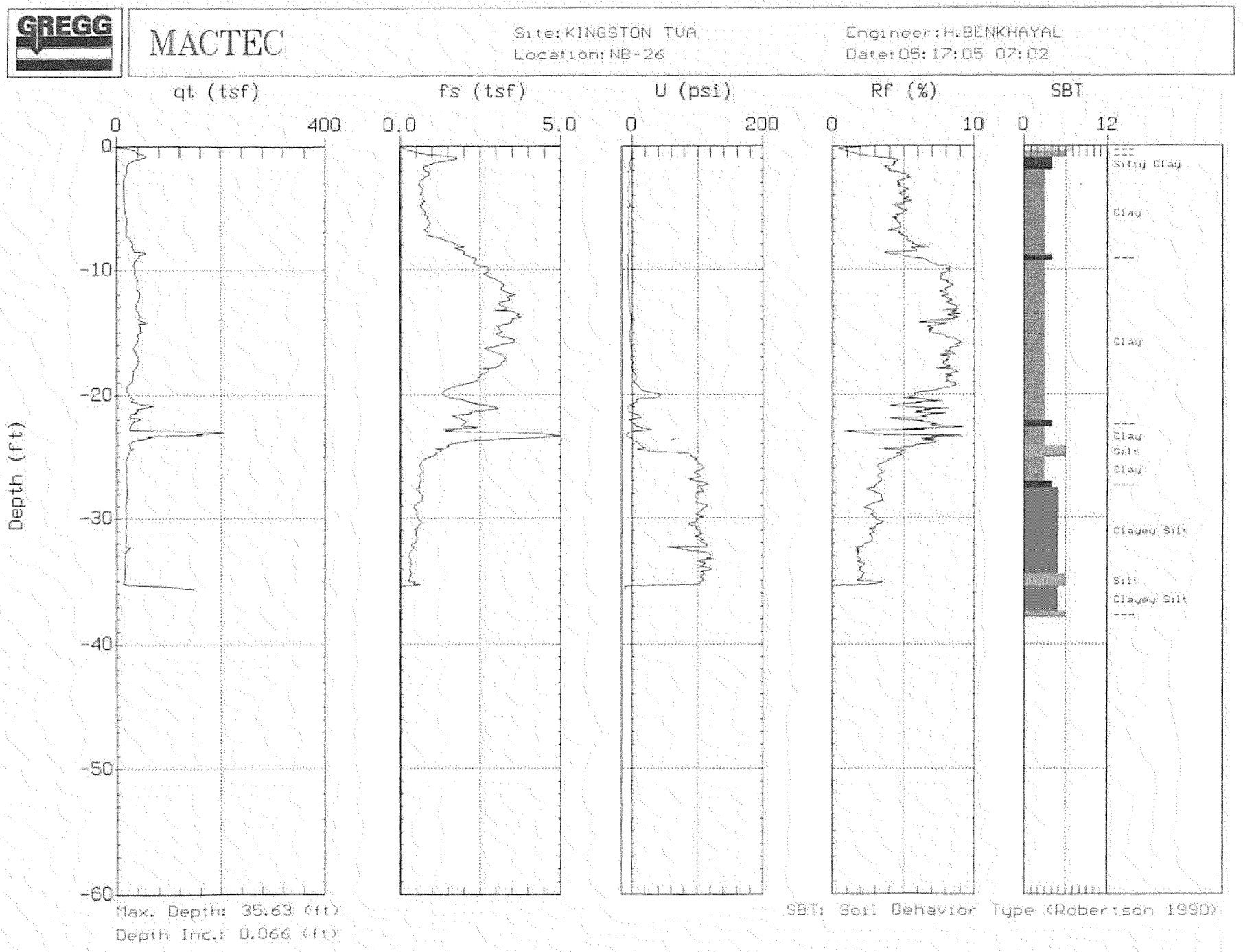

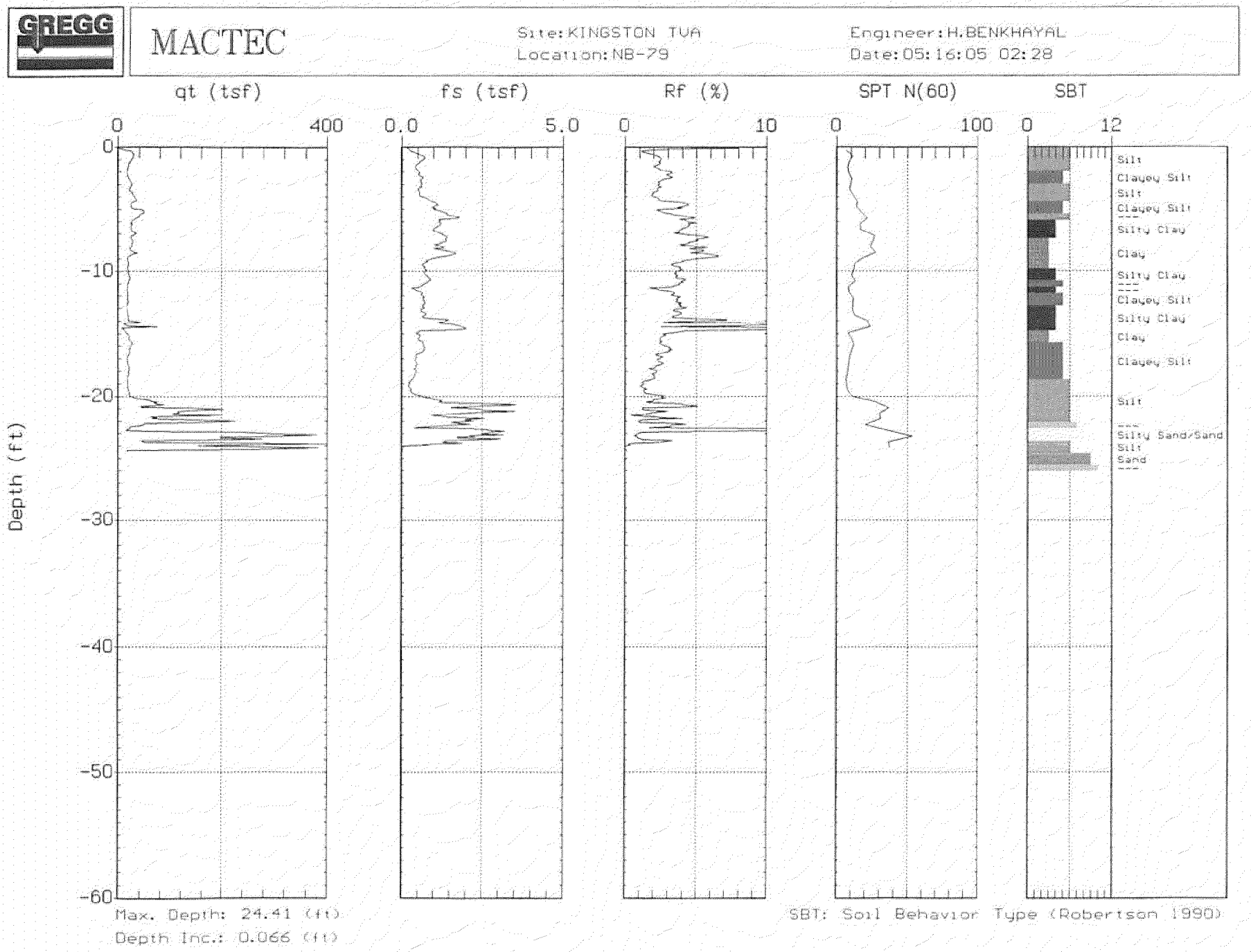
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Engineer: H.BENKHAYAL
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fs (tsf)
Rf (%)
SPT N(60)
SBT
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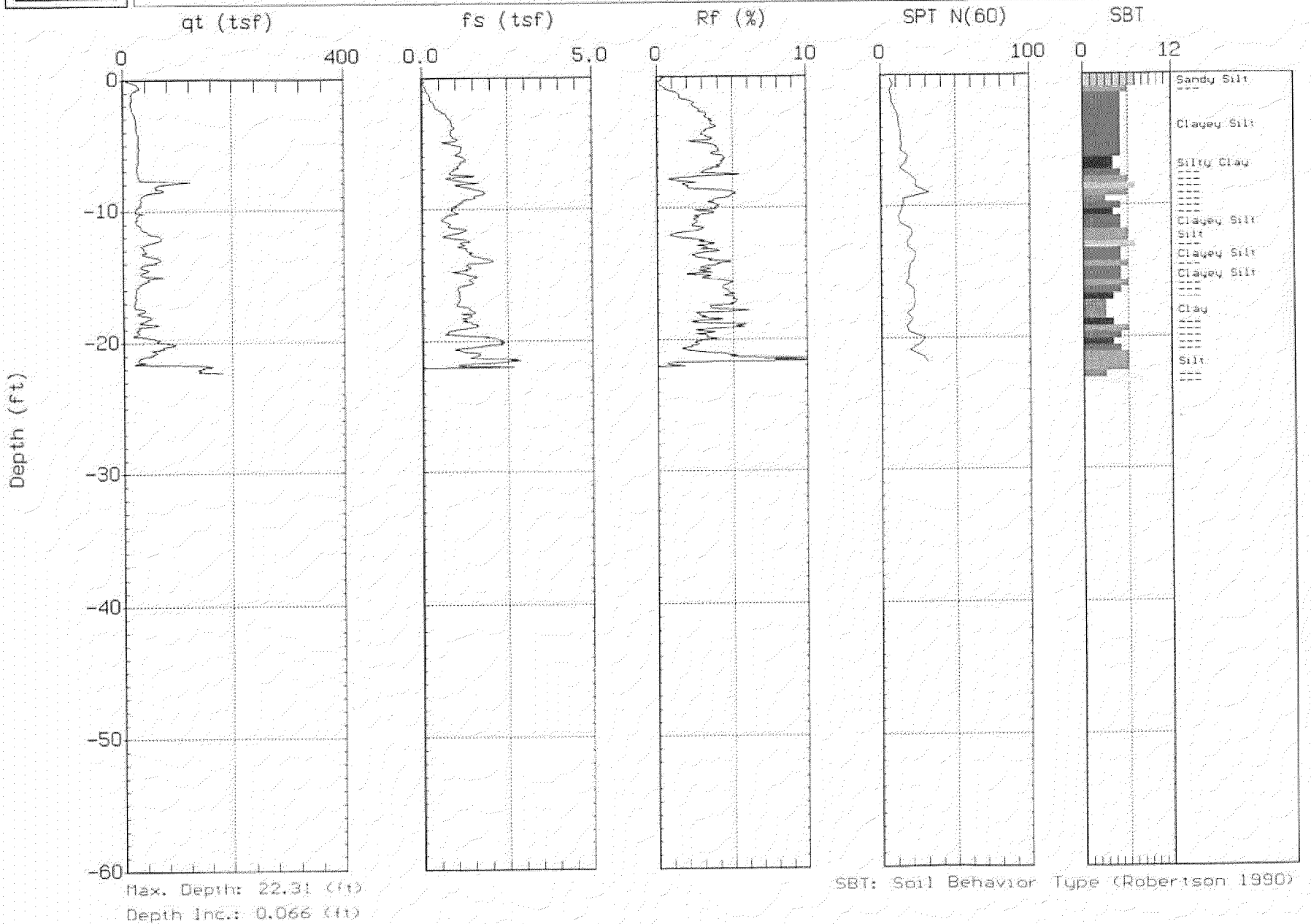
400
0.0
5.0
0
10
0
100
0
12
Depth (ft)
0
-10
-20
-30
-40
-50
-60
Silt
Clayey Silt
Silt
Clayey Silt
Silty Clay
Clay
Silty Clay
Clayey Silt
Silty Clay
Clay
Clayey Silt
Silt
Silty Sand/Sand
Silt
Sand
Max. Depth: 24.41 (ft)
Depth Inc.: 0.066 (ft)
SBT: Soil Behavior Type (Robertson 1990)

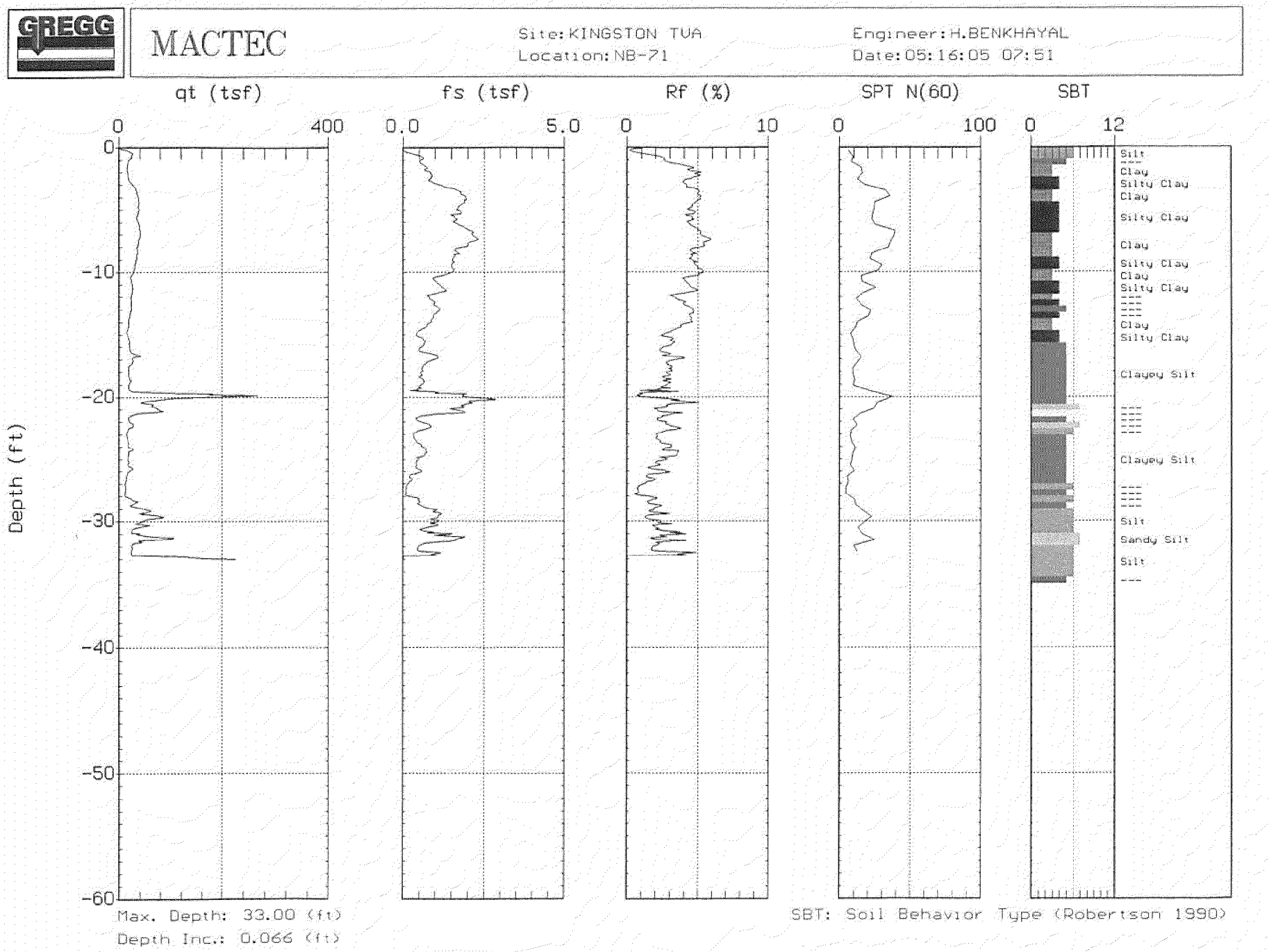
GREGG

MACTEC

Site: KINGSTON TVA
Location: NB-82

Engineer: H.BENKHAYAL
Date: 05:16:05 06:46

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Engineer: H.BENKHAYAL
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fs (tsf)
Rf (%)
SPT N(60)
SBT
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400
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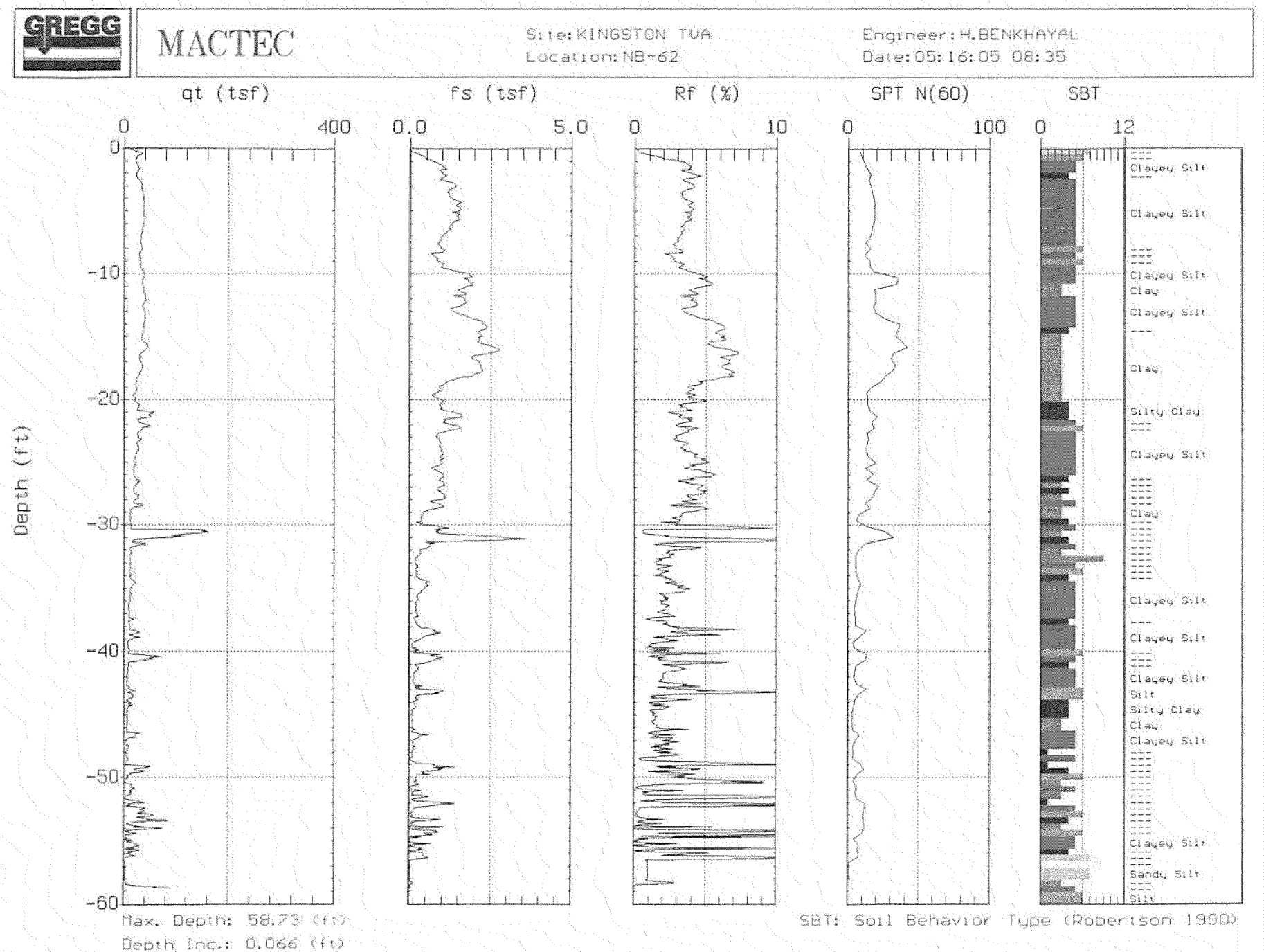
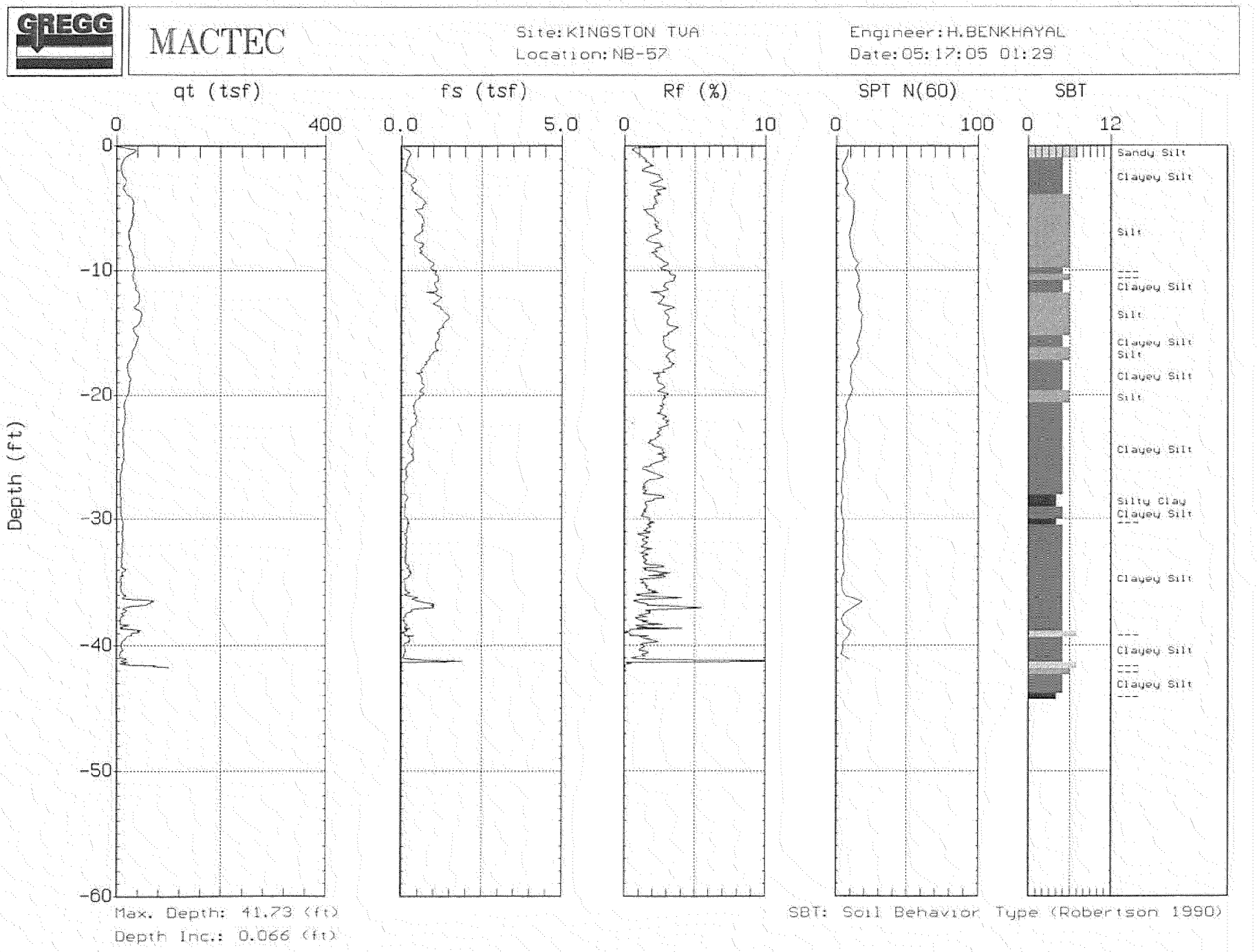
5.0
10
100
12
Depth (ft)
-10
-20
-30
-40
-50
-60
Silt
Clay
Silty Clay
Clay
Silty Clay
Clay
Silty Clay
Clay
Silty Clay
Clay
Silty Clay
Clayey Silt
Clayey Silt
Silt
Sandy Silt
Silt
Max. Depth: 33.00 (ft)
Depth Inc.: 0.066 (ft)
SBT: Soil Behavior Type (Robertson 1990)





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Location: NB-54

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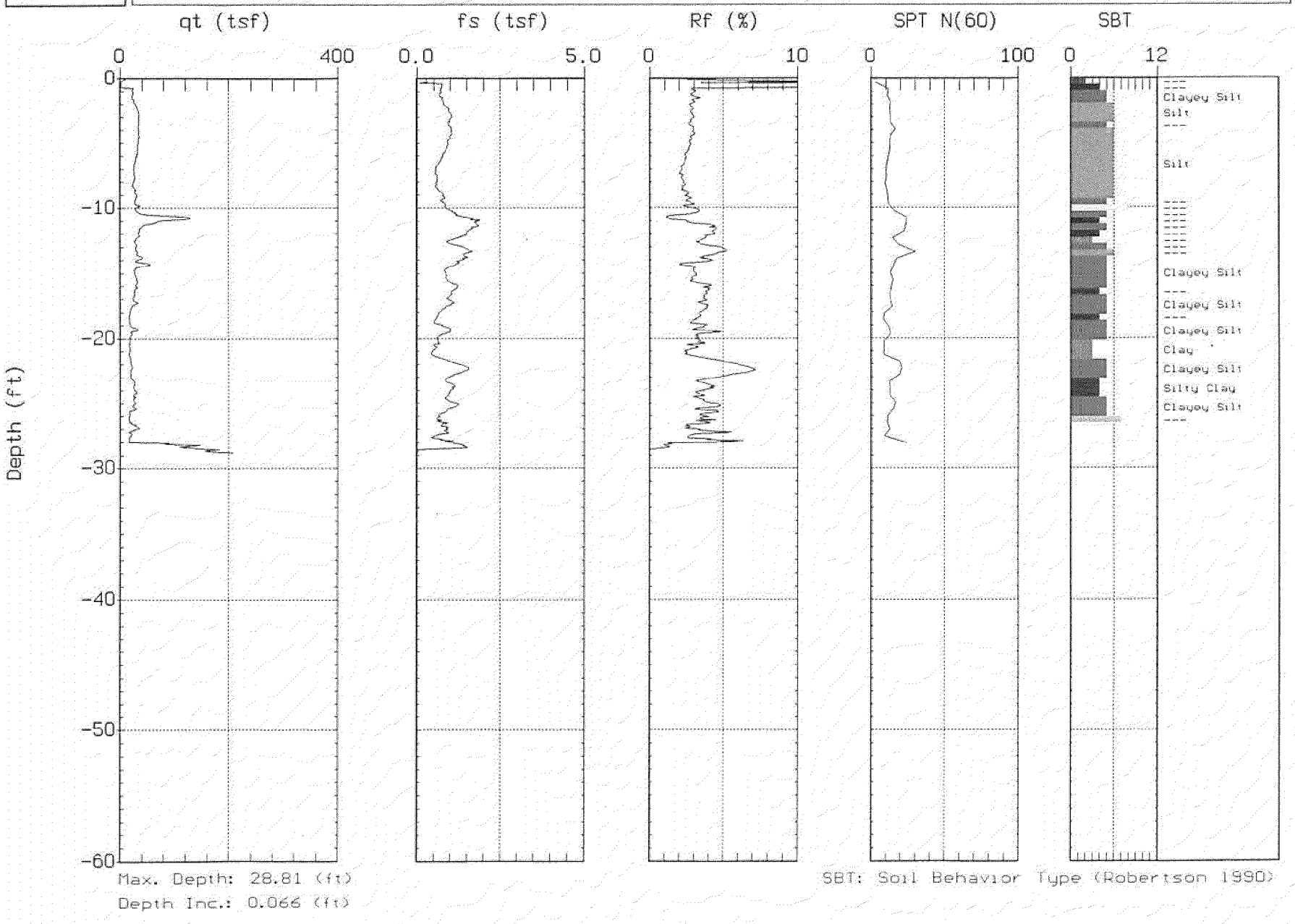
Date: 05:17:05 03:13



Max. Depth: 28.81 (ft)
Depth Inc.: 0.066 (ft)

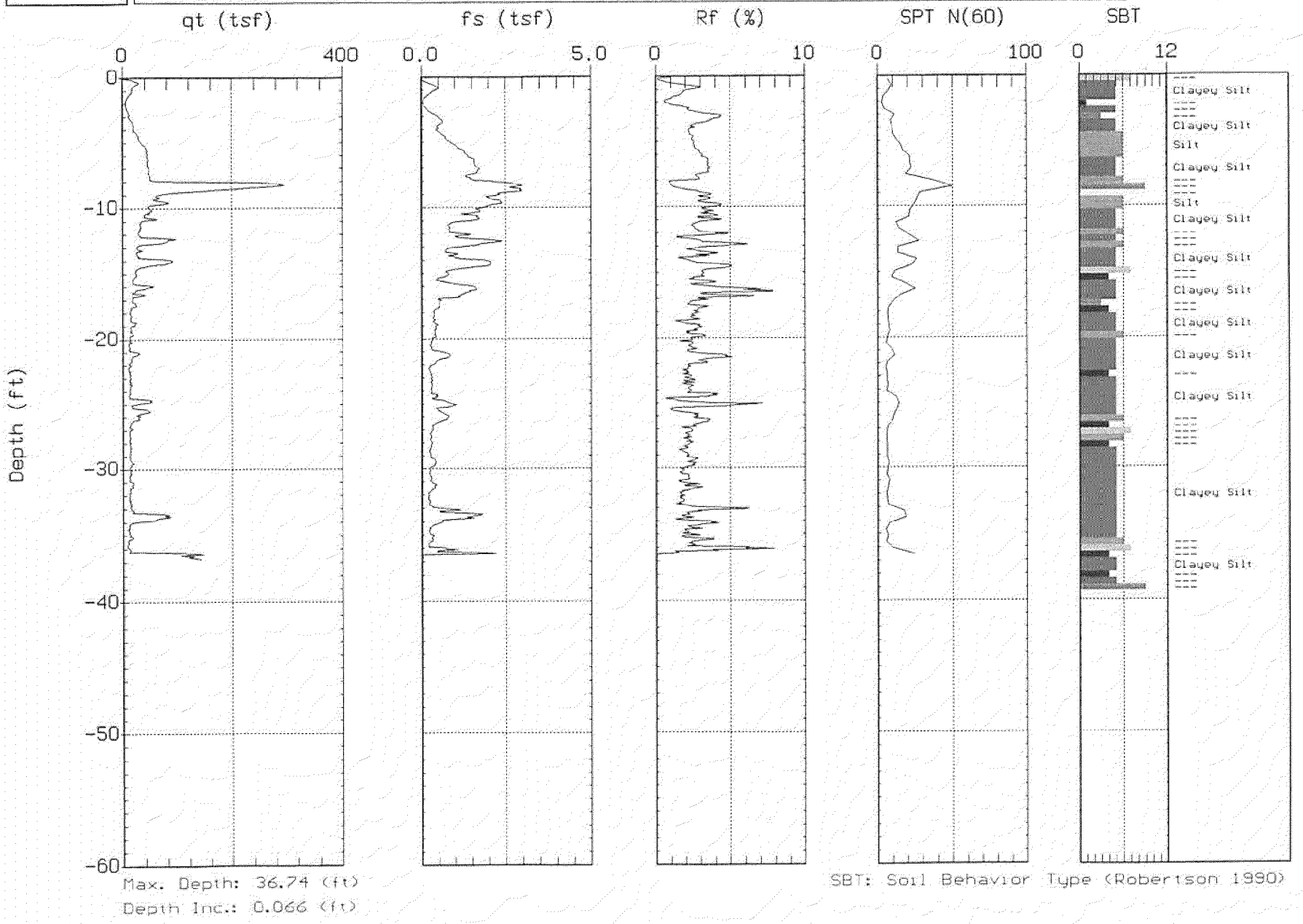
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: KINGSTON TVA
Location: NB-58

Engineer: H.BENKHAYAL
Date: 05:17:05 04:04



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Depth Inc.: 0.066 (ft)

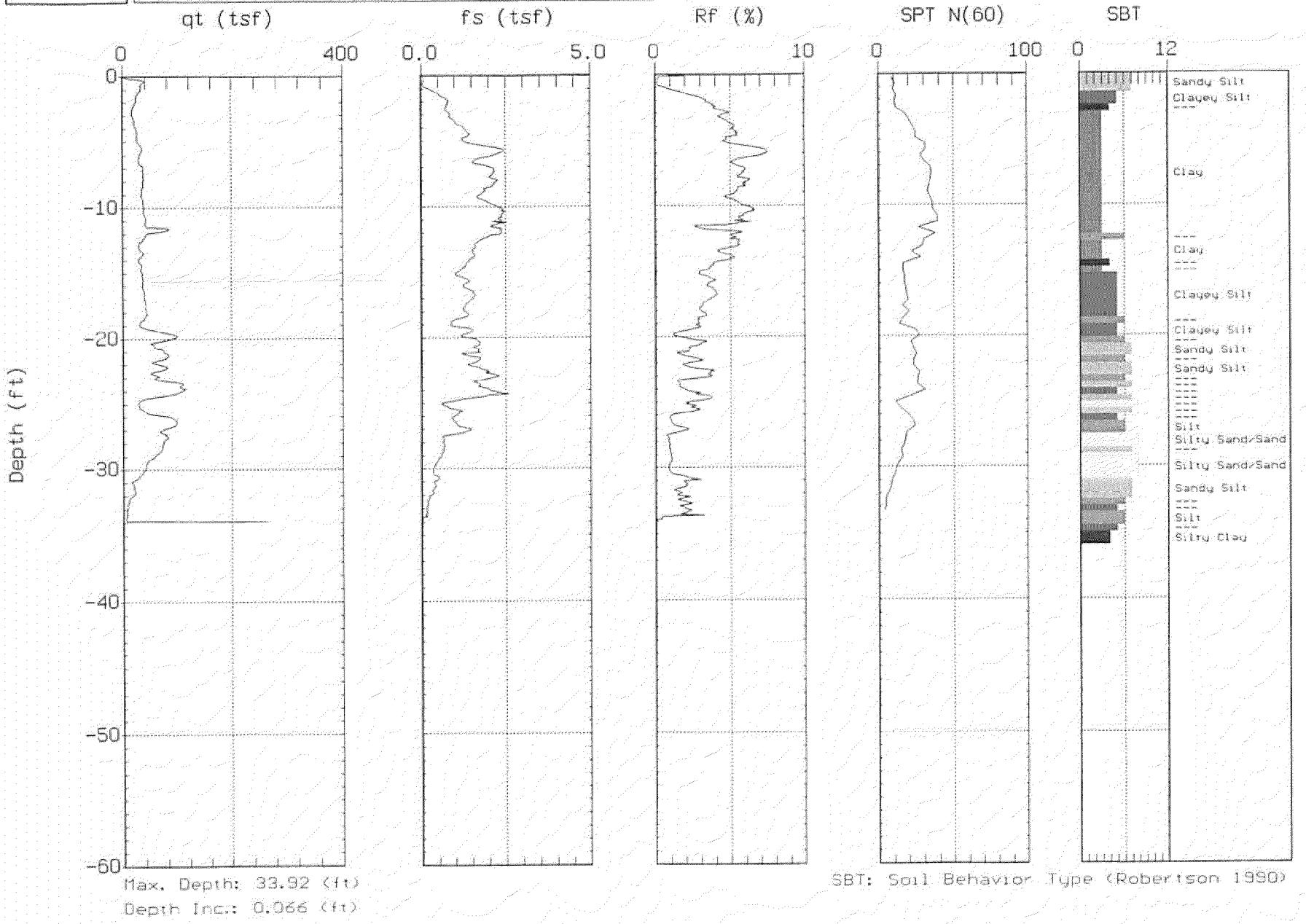
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: KINGSTON TVA
Location: NB-56

Engineer: H.BENKHAYAL
Date: 05:17:05 05:04



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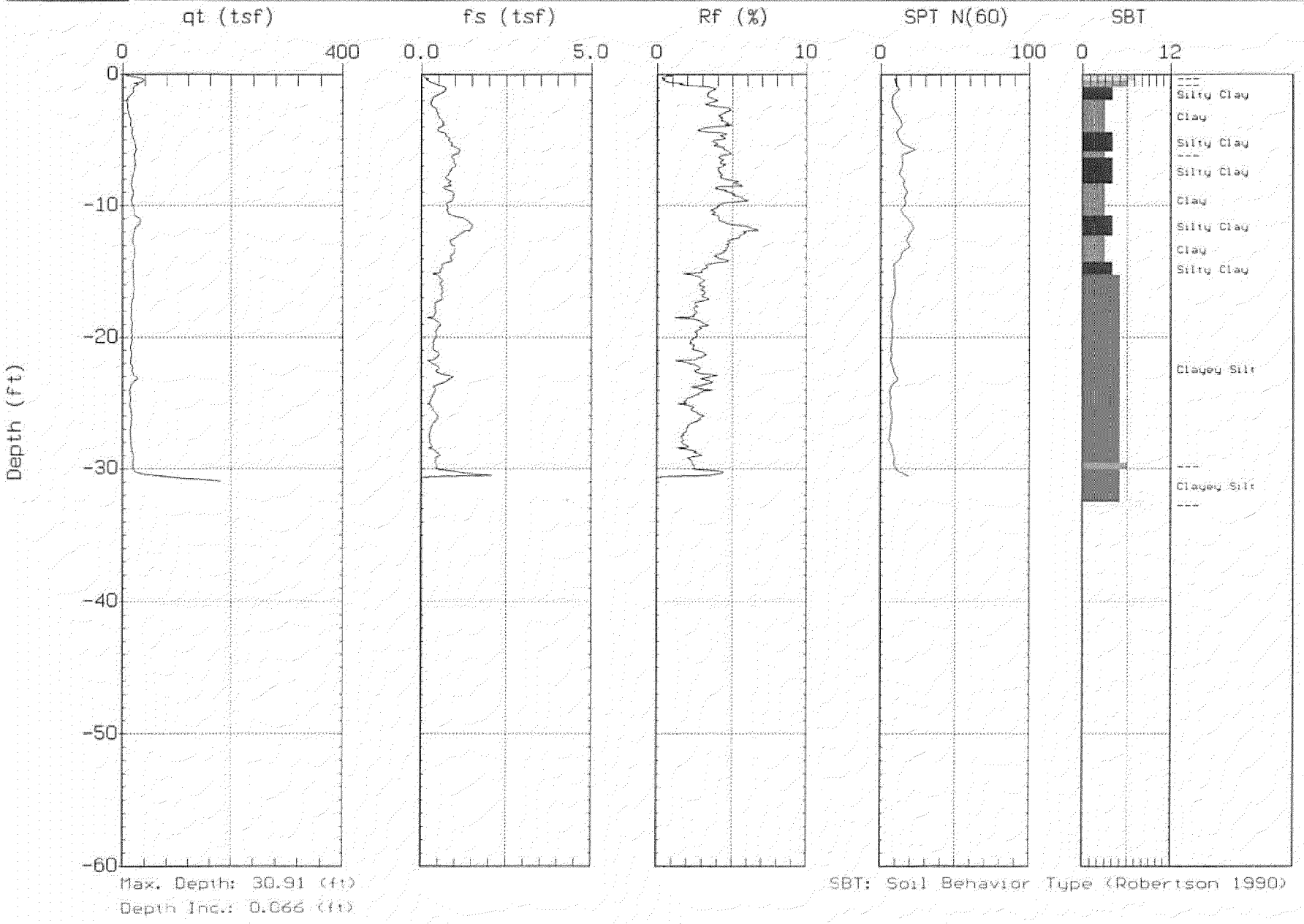
SBT: Soil Behavior Type (Robertson 1990)

GREGG

MACTEC

Site: KINGSTON TVA
Location: NB-11

Engineer: H.BENKHAYAL
Date: 05:17:05 06:07



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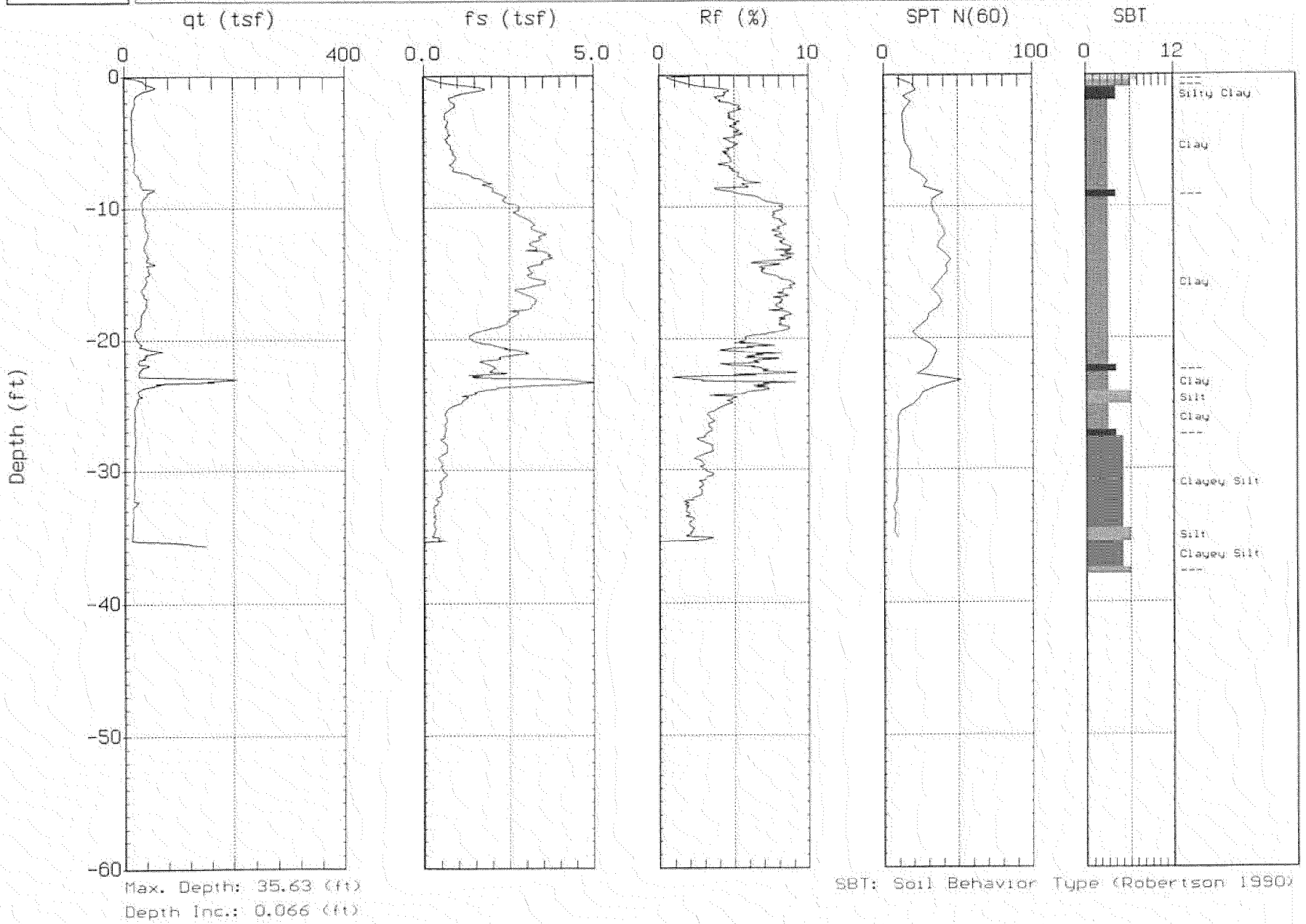
Location: NB-26

Engineer: H.BENKHAYAL
Date: 05:17:05 07:02



MACTEC

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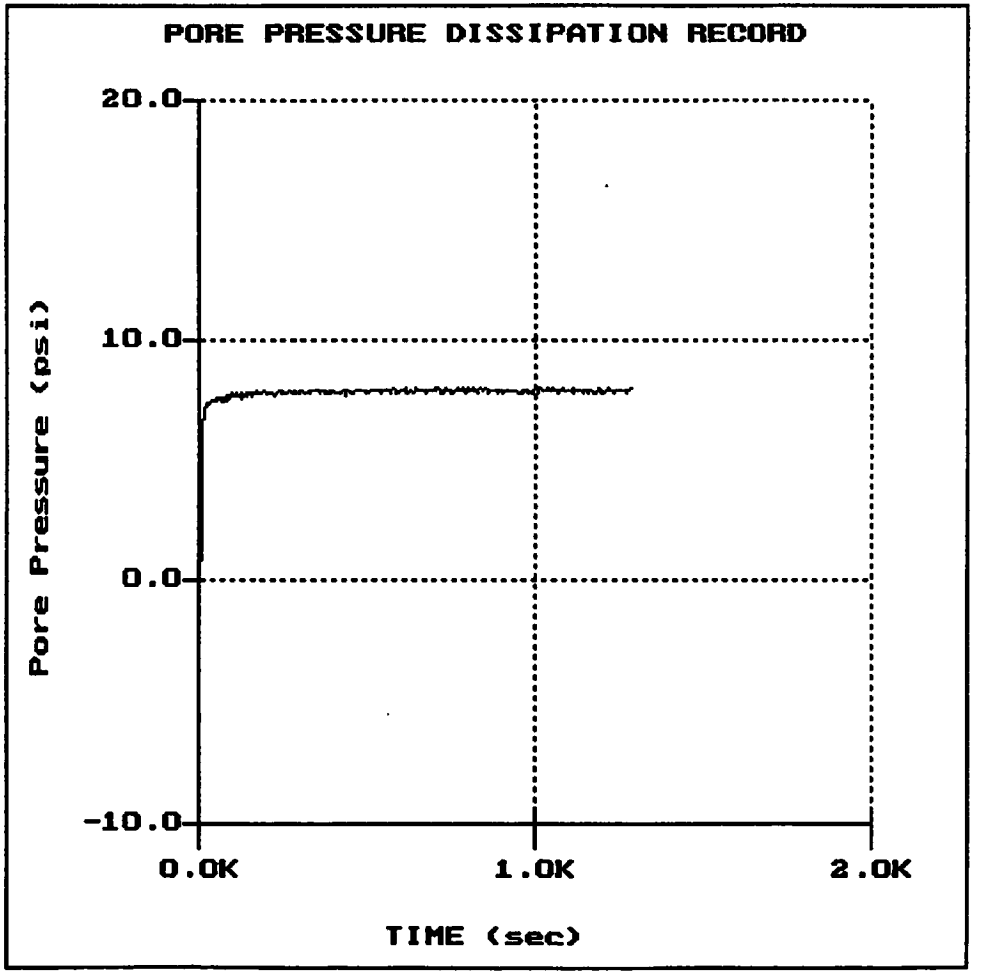
Location:NB-79

Engineer:H.BENKHAYAL
Date:05:16:05 02:28



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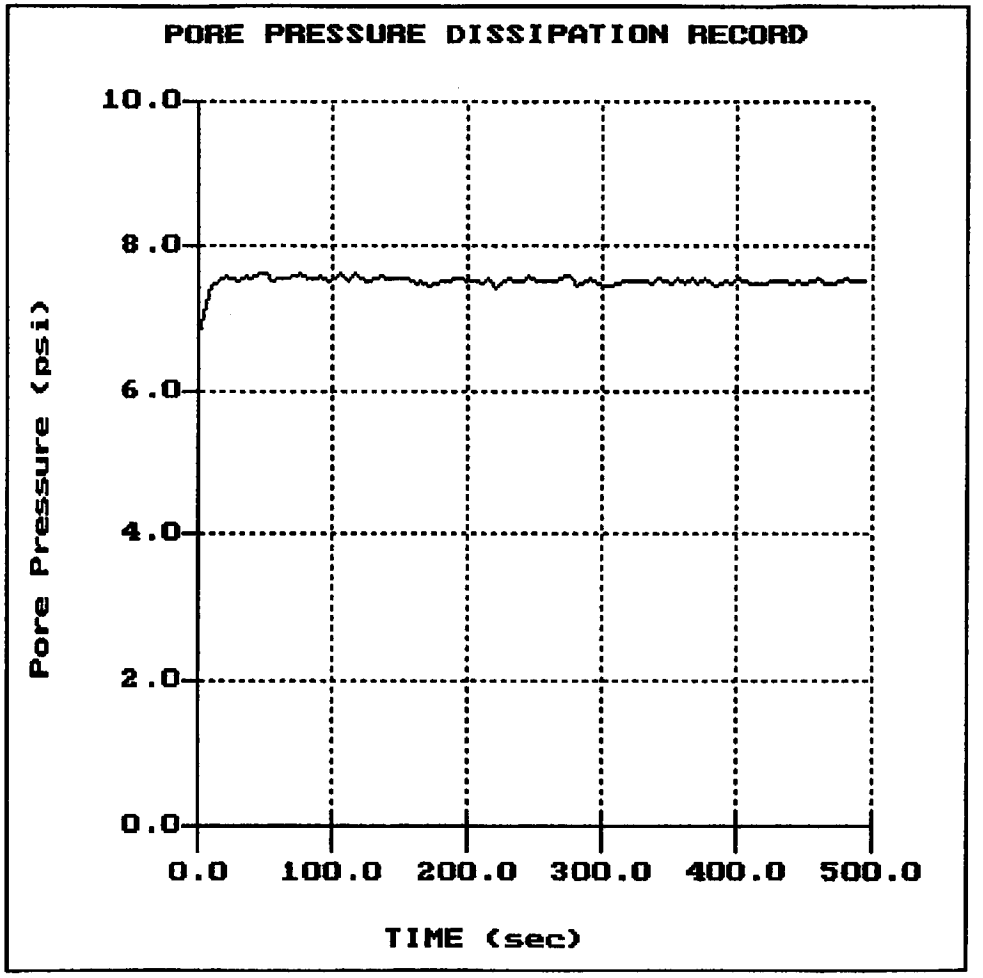
Depth (m): 7.44
(ft): 24.41
Duration : 1285.0s
U-min: -3.21 0.0s
U-max: 8.06 770.0s

MACTEC

Site:KINGSTON TVA
Location:NB-62

Engineer:H.BENKHAYAL
Date:05:16:05 08:35



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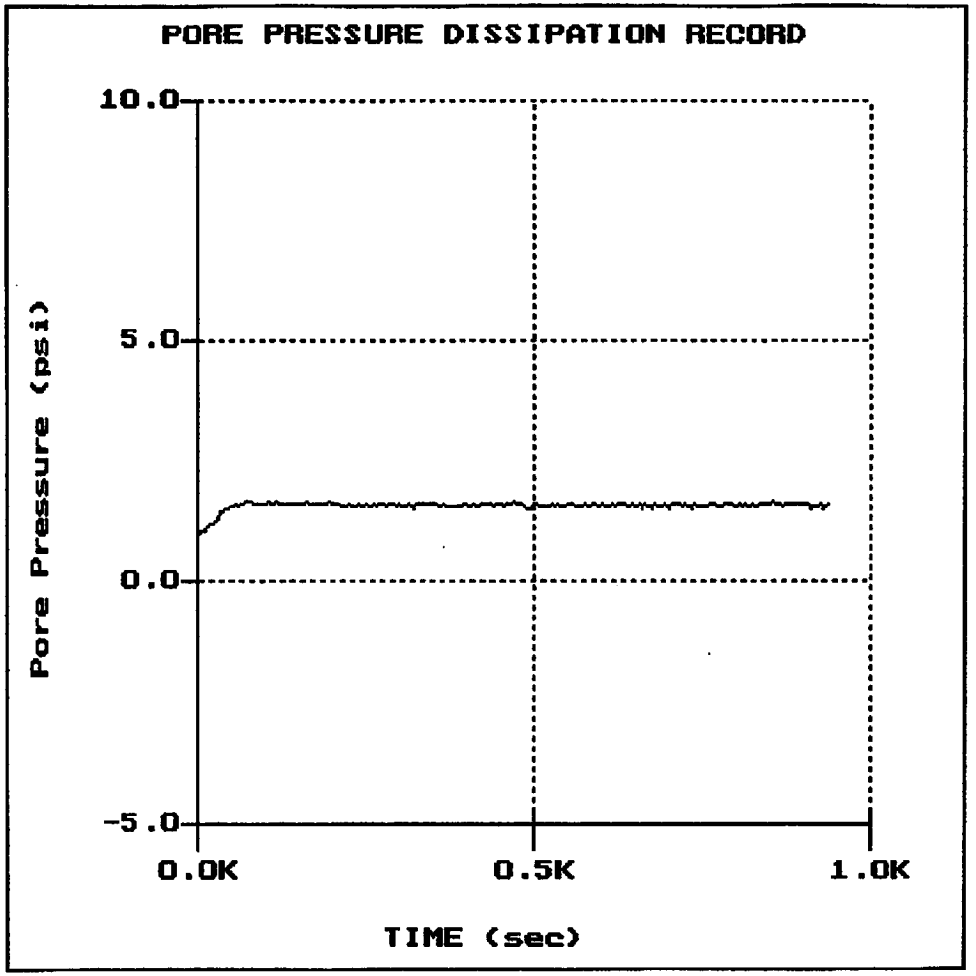
Depth (m): 17.28
(ft): 56.69
Duration : 495.0s
U-min: 6.73 0.0s
U-max: 7.59 115.0s

MACTEC

Site:KINGSTON TVA
Location:NB-58

Engineer:H.BENKHAYAL
Date:05:17:05 04:04

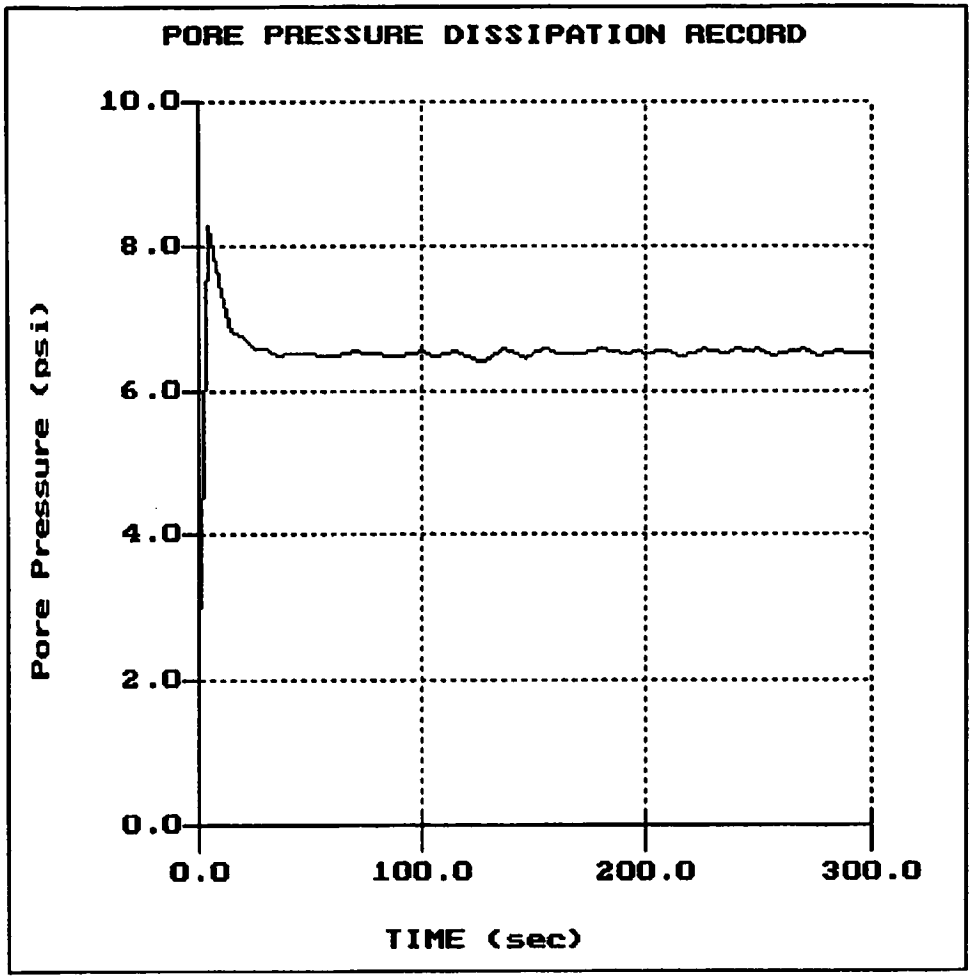


File: 062CP07.PPC
Depth (m): 11.20
(ft): 36.75
Duration : 935.0s
U-min: 0.81 0.0s
U-max: 1.67 855.0s

MACTEC

Site:KINGSTON TVA
Location:NB-11

Engineer:H.BENKHAYAL
Date:05:17:05 06:07

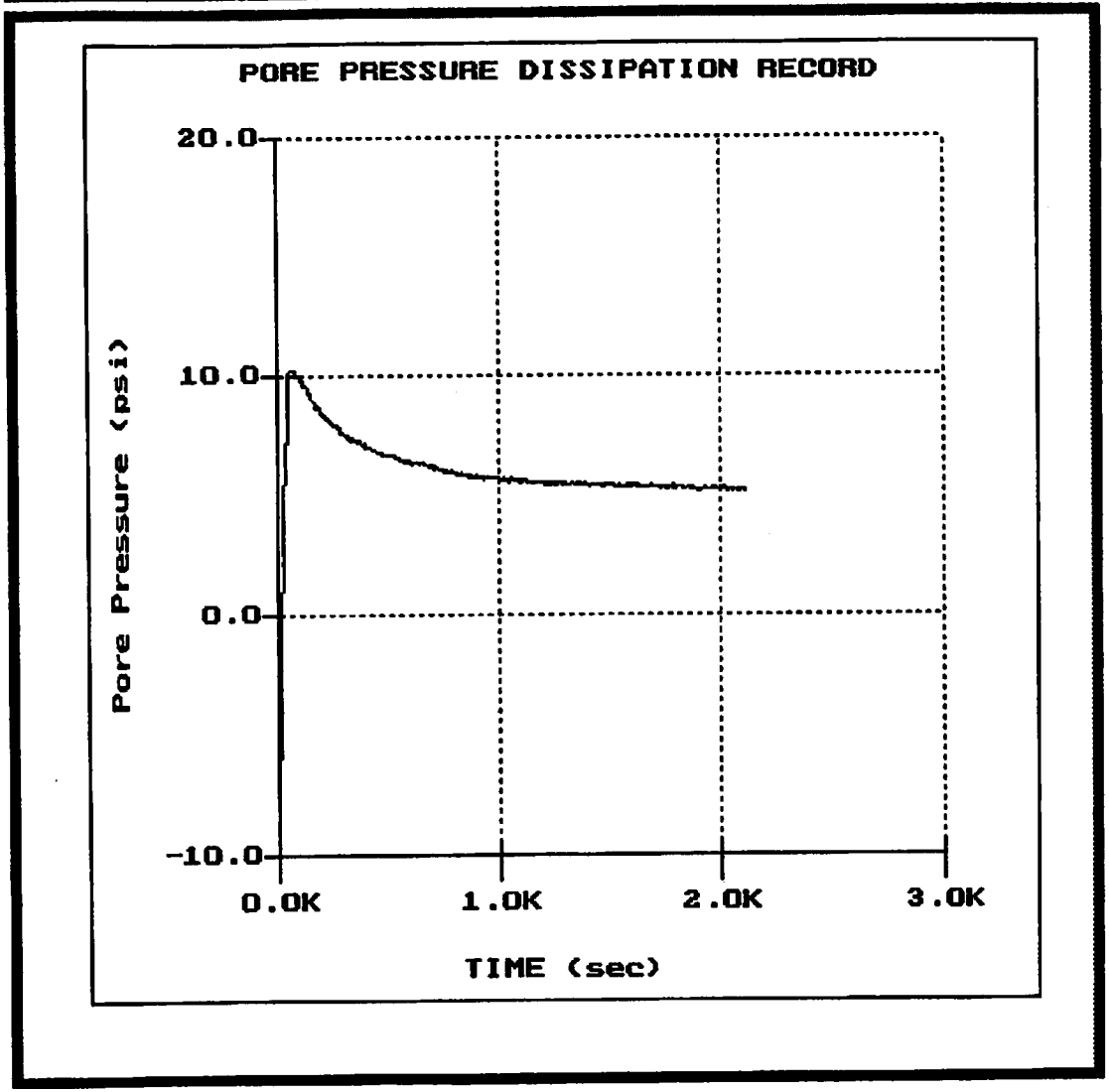


File: 062CP09.PPC
Depth (m): 9.42
(ft): 30.91
Duration : 300.0s
U-min: 2.22 0.0s
U-max: 8.26 5.0s

MACTEC

Site:KINGSTON TVA
Location:NB-26

Engineer:H.BENKHAYAL
Date:05:17:05 07:02



File: 062CP10.PPC
Depth (m): 10.86
(ft): 35.63
Duration : 2105.0s
U-min: -9.03 0.0s
U-max: 10.23 75.0s