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DIST. 54 REGION \_\_\_\_\_W.P. No. 774-93-00(D)

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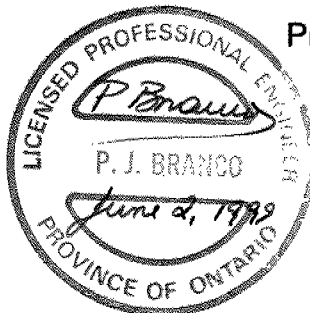
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**DESIGN REPORT  
TROUT CREEK BY-PASS - KING'S HIGHWAY 11  
WICK DRAIN DESIGN AND MONITORING PROGRAM  
SOUTH INTERCHANGE EMBANKMENTS  
DISTRICT 54, SUDBURY, ONTARIO  
GWP No. 774-93-00**

Report  
to  
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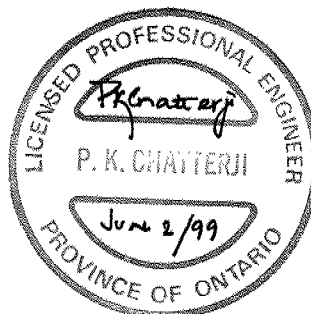
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June 2, 1999  
File: 19-1104-4

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**DRAFT DESIGN REPORT  
TROUT CREEK BY-PASS - KING'S HIGHWAY 11  
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**1. Introduction**

This report presents the results of a supplementary geotechnical investigation and engineering analysis carried out by Thurber Engineering Ltd. (Thurber) for the design of wick drains and monitoring program for the proposed approaches and embankments at the South Interchange located south of Trout Creek, at the proposed King's Highway 11 Trout Creek By-Pass.

Thurber carried out the investigation as a sub-consultant to Trow Consulting Engineers (Trow). The Terms of Reference for this work have been included in a letter by Trow to Thurber dated February 23, 1999. Authorization to proceed with this work was given in a letter by Mr. Eric Gonneau, P.Eng. of Trow, dated March 12, 1999.

**2. Background Information and Scope of Work**

Trow have been retained by Marshall Macklin Monaghan (MMM) to provide geotechnical services as part of the Total Project Management, Detailed Design Services for the above noted project. Trow's scope of work included geotechnical, pavement and foundation investigation and design recommendations for a number of proposed structures along this section of four-laning of Highway 11. The results of Trow's investigation program for the South Interchange were summarized in the following draft report:

- Foundation Investigation: Bridge Structure, Approaches and Embankment Fills - South Interchange (Boundary Road) - Trout Creek by-Pass, King's Highway 11 - District 54, Sudbury, Ontario, GWP No.774-93-00, December 7, 1998



The investigation by Trow at the South Interchange revealed the presence of thick soft foundation clayey deposits. Trow's analysis indicated that a combination of side berms and wick drains are required for successful construction of the high approach embankments, with final design heights up to 11.5 m. The side berms and wick drains are required to prevent a foundation failure during construction and to accelerate the foundation settlements so that most of the settlements are completed prior to bridge foundation construction and paving of the road.

Thurber Engineering Ltd. (Thurber) has been retained by Trow for the detailed design of the wick drains and to design a geotechnical instrumentation monitoring program to control the embankment performance during and after construction. In order to carry out this task Thurber has been provided with the following:

- portions of the above noted report containing the factual geotechnical data, excluding Trow's recommendations for the embankment design;
- drawings including a site plan view, longitudinal profiles and simplified subsurface conditions;
- Boundary Road Bridge General Arrangement and embankment typical cross sections.
- This report should be read in conjunction with Trow's report.

### **3. Methodology**

The work presented herein was developed in the following stages:

- Review of available information;
- Visit to Trow's office in Sudbury for visual inspection of soil samples, on March 18, 1999, by Mr. Scott Peaker, P.Eng. of Thurber. Some soil samples were brought to Thurber's office in Toronto for visual inspection;
- Site visit on March 19, 1999, by Mr. Scott Peaker, P.Eng. of Thurber,

for site reconnaissance and evaluation of site access by a drill rig for piezocone testing

- Piezocone testing on March 25 and 26, 1999
- Engineering Analysis
- Design Recommendations

#### **4. Proposed Interchange**

The South Interchange consists of one bridge structure that will carry the proposed Boundary Road over the proposed realigned and widened Hwy 11, approach embankments to the bridge and access ramp embankments. The proposed bridge consists of a two span structure with integral abutments, with a length of 67.2 m between abutments. A site plan view is shown on Figure A1 in Appendix A.

The embankments at this site will be constructed using blast rock with side slopes of 1.25H:1V and headslopes at the bridge abutments inclined at 2H:1V. The embankments are up to 11.5 m and 10.2 m high at the west and east abutments, respectively.

#### **5. Site Description**

Details about the site location and surface conditions have been included in Trow's report and they will not be repeated herein.

#### **6. Piezocone Testing**

Piezocone testing was carried out with the purpose of:

- confirming the subsurface conditions encountered by Trow
- obtaining continuous strength information at depth
- carrying out pore pressure dissipation tests at selected depths for assessment of the horizontal coefficient of consolidation required for optimizing wick drain design
- measuring the piezometric head at the base of the fine sediments to verify the presence of artesian condition

Piezocone testing (CPTU) was carried out on March 25, 1999, by ConeTec Investigations Ltd. of Vancouver, B.C. The piezocone was pushed using a track mounted CME 75 owned and operated by All Terrain Drilling Ltd. of Waterloo, Ontario.

A total of five CPTUs were carried out at the South Interchange at the approximate locations shown on attached Figure A1. The CPTUs were labelled CPTUS1 through CPTUS5. Table B1 in Appendix B presents approximate coordinates and ground surface elevations at the CPTU locations and the maximum depth of testing where refusal to penetration was encountered.

The results of the CPTUs are summarized in a report by ConeTec included in Appendix C.

Figures A2 to A6 in Appendix A present a summary of both the results of CPTUs and the nearby borehole and laboratory information presented in Trow's report.

## **7. Description of Subsurface Conditions**

### **7.1 Subsurface Soil Conditions**

The subsurface conditions at this site were characterized based on a drilling and laboratory program carried out by Trow and on the results of the CPTUs carried out by ConeTec.

The subsurface conditions at this site consist of a layer of organic soils, to a depth of up to 2 m, overlying interbedded layers of mostly fine sediments with varying percentage of clay, silt and sand content, up to 20 m depth, overlying a layer of sand and sand and gravel, with thickness ranging from 3 m to up to 10 m, overlying bedrock.

Of interest to this project is the sequence of layers containing fine sediments. The fine sediments were encountered with maximum thickness to the south and east of the proposed site. The anticipated location of the western boundary of the soft/loose sediments are shown on Figure A1,

## Appendix A.

The upper portion of the fine sediments, referred to as Upper Silt and Sand, consists mostly of sandy silt to silt which varies in thickness from approximately 1 m to the west of the bridge to 5 m at the eastern boundary of the interchange, close to the existing Hwy 11, where the Upper Silt and Sand consisted mostly of sand and silty sand. The Standard Penetration Test "N" values ranged within a wide range with typical values of 3 in the silt layers and more than 30 in the sand layers, indicating a very loose to dense condition. SPT "N" values interpreted from the CPTUs were generally higher than those measured in the augered holes but both methods indicated approximately the same trend and soil condition. The lower 1 to 1.5 m of the Upper Silt and Sand consisted mainly of silt which appears to be over consolidated with undrained shear strength up to 150 kPa.

Interbedded layers of silty clay and clayey silt, referred to as Clayey Silt, were encountered underlying the Upper Silt and Sand. At the bridge location the Clayey Silt is approximately 8 m thick. The thickness of the Clayey Silt decreases to the north and west of the bridge and it increases to the east and south of the bridge. The maximum depth, 18.3 m, and thickness, 14.0 m, of this layer in the area of interest of this project was encountered south of the EW-N Ramp, in BH31FP.

The CPTUs confirmed the presence of a stiff to very stiff crust of clayey silt to a depth of 3m to 5 m. The undrained shear strength in this crust decreased with depth and ranged typically from 50 kPa to more than 150 kPa. The field vane tests indicated undrained cohesion generally lower than the undrained shear strength ( $S_u$ ) values interpreted from the CPTUs. Pore pressure dissipation tests carried out in the crust indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 180  $\text{m}^2/\text{y}$  (3.5 m depth at CPTUS4) to 690  $\text{m}^2/\text{y}$  (3.5 m depth at CPTU3).

Underlying the upper crust, the Clayey Silt was soft to firm with undrained shear strength ranging from 20 kPa to 50kPa. Atterberg Limits presented in Trow's report indicated that this layer can be classified as clay of low plasticity (CL). An inspection of Shelby tube samples collected from this layer indicated that the low plastic clay is interbedded with layers of silt. The

"noisy" variation of tip resistance with depth detected by the CPTU confirms the layering pattern of the Clayey Silt. The CPTU interpretation of the stratigraphy shows that clayey silt and "sensitive fines" constitute most of the Clayey Silt below the upper crust. Based on the visual inspection of a Shelby tube sample collected from BH16FP (TW5 - ~8m depth), near CPTUS5, the "sensitive fines" consist of uniform firm low plastic clay. A few pocket penetrometer tests carried out on this sample revealed a significant loss of resistance to penetration of the probe after a small initial penetration, confirming the sensitive nature of this deposit. Pore pressure dissipation tests carried out on the Clayey Silt, below the upper stiffer crust, indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 130  $\text{m}^2/\text{y}$  (5.5 m depth at CPTUS2) to 270  $\text{m}^2/\text{y}$  (4.5 m depth at CPTU1). One exception to the above measurements was encountered in the "sensitive fines" in CPTUS5, where one pore pressure dissipation test resulted in a  $C_h$  value of 590  $\text{m}^2/\text{y}$ . This measurement is consistent with the high moisture content and sensitivity of this deposit in the proximity of CPTUS5.

In the area south and east of the bridge, at locations where the Clayey Silt is relatively thick, the bottom 2 m to 4 m of the Clayey Silt presented Undrained shear strength ( $S_u$ ) increasing with depth with typical values between 40 kPa and 50 kPa. Pore pressure dissipation tests carried out on the bottom portion of the Clayey Silt, indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 340  $\text{m}^2/\text{y}$  (15 m depth at CPTU5) to 400  $\text{m}^2/\text{y}$  (8.5 m depth at CPTUS1).

The  $C_h$  values above were significantly higher than those obtained from oedometer tests as reported in Table 1-1 of Trow's report.

Underlying the Clayey Silt layer a layer of silt, referred to as Lower Silt, was encountered with thicknesses ranging from 1 m to 6 m. The SPT "N" in the Lower Silt, interpreted from the CPTUs, ranged typically from 3 to 6, which is consistent with the SPT "N" values from the augered holes. Locally  $S_u$  values interpreted from the CPTUs ranged from 50 kPa to 150 kPa.

The Lower Silt is underlain by a sequence of layers of sandy silt and sand, referred to as Sandy Silt and Sand, with sand content increasing with

depth. The SPT "N" values both measured and interpreted from CPTUs ranged from 2 to more than 20. One pore pressure dissipation test in the sandy silt at 10.5 m depth in CPTUS1 indicated a  $C_h$  value of  $1,310 \text{ m}^2/\text{y}$ .

A more detailed descriptions of the subsoil conditions encountered in the boreholes are presented on the borehole logs in Appendix B of Trow's report. Stratigraphic profiles inferred from the borehole information have been prepared by Trow and are summarized in Appendix A of Trow's report.

## 7.2 Groundwater

The groundwater level observed in the boreholes after completion of drilling carried out by Trow indicated that the groundwater table was within 1 m of the ground surface. The stabilized pore pressure measurements carried out at the bottom of the CPTUs in the Sandy Silt and Sand deposit indicated a piezometric head at or up to 0.3 m above ground surface, implying a small artesian head.

## 7.3 Summary

In summary, the CPTUs confirmed the stratigraphy shown in Trow's report although the soft sediments were detected as mostly clayey silt as opposed to silty clay. The undrained shear strength values were generally higher in the CPTUs.

Of significance importance to the consolidation analysis and wick drain design was the fact that the  $C_h$  values obtained from the CPTUs were significantly higher than those obtained from oedometer tests and that a slight artesian condition was encountered below the soft sediments.

# 8. **Engineering Analysis**

## 8.1 General

The engineering analysis was carried out in the following stages:

- Selection of cross sections for analysis that represent typical subsurface conditions and embankment configurations with respect to embankment height and width;
- Stability analysis to identify the required stabilizing berm dimensions, required construction staging and required gain in strength after each construction stage due to consolidation in the clayey layers, for a minimum factor of safety of 1.3 during construction;
- Settlement analysis to identify the required height of surcharge and the need for and the spacing of wick drains to accommodate the construction schedule.

Based on the analysis of the subsurface conditions and the geometry of the embankments the following testholes and embankment geometries were selected for analysis:

- *Bridge West Approach, West and East Abutments; Boundary Road: 9+800 to 10+070; E-S Ramp: 9+100 to 9+160:*  
Characteristics: High embankment closest to structure  
Subsurface Conditions: CPTUS1  
Embankment Height (excluding surcharge): typically 10.0m to 11.5m  
Embankment Width (at the top): 17.4 m  
Berm Elevation: 6 m below the top of the embankment
- *Region east of the East Abutment; Boundary Road: 10+070 to 10+150; EW-N Ramp: 8+313 to 8+420; S-EW Ramp: 8+760 to 8+890*  
Characteristics: High to intermediate embankment height, thick soft deposits  
Subsurface Conditions: CPTUS3  
Embankment Height (excluding surcharge): 5 m to 10 m  
Embankment Width (at the top): 17.4 m to ~ 40 m  
Berm Elevation: 6 m below the top of the embankment
- *Boundary Road: 10+150 to 10+310; EW-N Ramp: 8+420 to 8+500; S-EW Ramp: 8+670 to 8+760*  
Characteristics: Intermediate to low embankment height, thick soft deposits

Subsurface Conditions: CPTUS5

Embankment Height (excluding surcharge): 3 m to 5 m

Embankment Width (at the top): 17.4 m to ~ 40 m

Berm Elevation: No berm

- *EW-N Ramp: Sta. > 8+500; S-EW Ramp: Sta. < 670; Hwy 11 south of the Interchange:*

Characteristics: Low embankment, very thick soft deposits

Subsurface Conditions: BH31FP

Embankment Height (excluding surcharge): less than 3 m

Embankment Width (at the top): 14 m to ~ 60 m

Berm Elevation: no berm

- *Hwy 11 and Access Ramps north of the Interchange:*

Characteristics: Low to intermediate embankment height, thick soft deposits

Subsurface Conditions: BH23FP

Embankment Height (excluding surcharge): 3 m to 5 m

Embankment Width (at the top): ~ 60 m

Berm Elevation: no berm

Table B2, Appendix B, presents a summary of the soil properties used in the stability and settlement analysis for each of the testholes above. The soil properties presented in Table B2 were selected based on the interpretation of the field and laboratory data. In order to avoid an extensive parametric analysis the following criteria was used for the selection of soil properties:

- *Strength:*  
select most likely values in view of the slight conservatism inherent to the undrained analysis and the selected factor of safety during constructions (F.S. ~ 1.3)
- *Pore Pressure Generation:*  
select conservative values of  $B_{bar}$  equal to 1 for silt and clayey deposits.



### Elastic Properties:

Compression Ratio:  $\{C_c/(1+e_o)$  and  $C_s/(1+e_o)\}$  - same as above.

This parameter impacts both the time-independent and time-dependent settlements. The latter occurs because the coefficient of consolidation ( $C_v$  and  $C_h$ ) values are significantly impacted by the over-consolidation ratio.  $P_c$  values obtained from oedometer tests provided in Trow's report (Figures C9 to C11) indicate an Over-consolidation ratio ranging from 1.2 to 3.1 for  $P_c$  values ranging from 90 kPa to 110 kPa. Due to the importance of properly assessing the  $P_c$  values Two values of pre-consolidation pressures were selected:

- *Time Dependent Deformation:*

Ch (horizontal):	Over-consolidated: select values interpreted from the CPTUs Normally Consolidated: select the minimum Ch value interpreted from the CPTUs in that deposit;
Cv (vertical):	20% of Ch above (lower bound values <sup>2</sup> )

<sup>2</sup> Hansbo, S. (1979). "Consolidation of clay by band-shaped prefabricated drains". Ground Engineering, July, Vol.12, NO.5, 16-25, 1979

### Secondary Compression Ratio ( $C_{\alpha}$ ):

Select the values measured in the pre-consolidated range of oedometer tests assuming that the surcharge will be removed after 100% completion of primary consolidation.

## 8.2 Stability Analysis

The stability analysis was carried out based on the following assumptions:

- Embankment Geometry:
  - Side slopes: 1.25H:1V
  - The width of the embankment at the top of the surcharge will be the same as the final design width. Hence, the embankment side slopes above the berm will be temporarily steeper than 1.25H:1V. This is required to maintain the minimum required embankment width at the top after settlements due to primary consolidation take place.
  - When possible the berm height was maintained 6 m below the top of the final embankment height
- Surcharge: Up to 1.5 m above the embankment design height. Actual height of surcharge to be verified based on the settlement analysis
- Site Preparation: All organic soils will be removed within the footprint of the embankment
- Limit Equilibrium Analysis: Bishop Modified using G-Slope, developed by Mitre Software.
- Soil Shear Strength: Undrained shear strength ( $S_u$ ) for cohesive soils; Drained ( $\phi'$ ) for cohesionless soils.  $S_u$  increases with vertical stress; for vertical stress larger than the pre-consolidation pressure ( $P_c$ ):

use  $S_u = 0.235 \cdot \sigma'_v$ , for  $\sigma'_v > P_c$ .

- Groundwater Table: At the original ground surface

The results of the stability analysis are summarized in Table B3. The analysis of Table B3 indicates the following:

*Location: West Approach, West and East Abutments - CPTUS1*

- The construction of the embankment with a berm width of 2 m is not feasible with an end of construction FS of 1.3;
- The construction of the embankment to a height of 13 m, including surcharge, with a berm width of 7 m is feasible in two construction stages:
  - Stage 1: from 0 m to 10 m
  - Stage 2: from 10 m to 13 m with 50% dissipation of excess pore pressure (EPP) after Stage 1
- The embankment temporary headslopes at the abutment locations will be constructed according to the above schedule. The headslope crest will be located at the abutment location, with maximum height of 13 m, sloping towards Hwy 11 inclined at 1H:1V, provided that the Hwy 11 embankments under the bridge are constructed prior to the temporary abutment embankments.

*Location: East Approach to Bridge - CPTUS3*

- The construction of the embankment with a berm width of 2 m is not feasible with a FS of 1.3;
- The construction of the embankment, with a berm width of 6 m, to a height of 11.5 m, including 1.5 m surcharge, is feasible in three construction stages:
  - Stage 1: from 0 m to 8.5 m
  - Stage 2: from 8.5 m to 9.5 m with 40% dissipation of EPP after Stage 1
  - Stage 3: From 9.5 to 11.5 m with 100% dissipation of EPP after Stage 2

Due to the fact that it is not practical to wait for 100% consolidation between Stages 2 and 3, a berm width of 8 m was considered in the analysis, as follows:

- The construction of the embankment with a berm width of 8 m to a

maximum height of 11.5 m, including 1.5 m surcharge, will require the following construction stages maintaining a FS of 1.3 :

Design Height (m)	Target Height (m) (Incl. 1.5 m Surcharge)	Berm Height (m)	Height at Stage 1 (m)	EPP Dissipation after Stage 1	Additional Fill at Stage 2 (m)
10	11.5	4	9.5	75%	2
9	10.5	3	9	75%	1.5
8	9.5	2	8.5	75%	1
7	8.5	1	8	75%	0.5
6	7.5	0	7.5	-	-

*Location: EW-N Ramp and Boundary Road - CPTUS5*

- The construction of the embankment to a target height of 6 m, including 1 m of surcharge, is feasible in one stage without side berms.

### 8.3 Settlement Analysis

#### 8.3.1 General

The settlement analysis was carried out in the following steps:

- One dimensional primary consolidation analysis: no wick drains
- Pseudo three dimensional consolidation analysis: with wick drains
- One dimensional secondary consolidation analysis

#### 8.3.2 One Dimensional Consolidation - No Wick Drains

The one dimensional consolidation analysis was carried out in order to:

- establish the required height of surcharge;
- establish the need for wick drains;
- provide input for the vertical consolidation component in the wick

### drain design

The analysis was carried out using the finite difference software Consol Version 2.0, developed at Virginia Polytechnic Institute and State University. The program allows the one dimensional consolidation analysis of multilayered soil masses, taking into account non-linear constitutive law, variable parameters as a function of the over-consolidation ratio, impeded drainage and variable boundary conditions. The ability to model impeded drainage was considered a key factor in the selection of this software, due to the presence of layers of silt above and below and a harder, over-consolidated crust above the softer clayey silt deposit.

The vertical stress distribution under the embankment was estimated using Gray's<sup>3</sup> (1936) derivation for the area represented by CPTUS1 and Boussinesq's stress distribution under an infinite strip loaded area for the remaining areas. The latter method was the preferred method for this analysis since it is easier to use with Consol and both methods provide very similar vertical stresses under the centreline and at the crest of the embankment.

The following simplified embankment construction schedule was used in our analysis:

- Stage 1: the embankment load was applied instantly at time zero
- Stage 2: the additional load was applied instantly at the time after the EPP had dissipated enough for a minimum FS of 1.3 against global stability according to the stability analysis presented in the preceding section.

This is a simplified model of the actual construction process in which several days or weeks will be required to construct the embankment to the specified height. The adopted approach predicts larger settlements and lower EPP in the soft sediments at any point in time provided the time

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<sup>3</sup>

Gray, H. (1936), "Stress Distribution in Elastic Solids", First International Conference, ISSFME

elapsed between the construction stages is adopted as the time elapsed between the end of the embankment construction at Stage 1 and beginning of Stage 2.

Figures A13 to A18B and Tables B4 to B13 present a summary of the results of the one dimensional consolidation analysis. The bottom portion of Tables B4 to B13 show the minimum amount of time after the end of the embankment construction when the surcharge may be removed for stabilization of settlements due primary consolidation. However, in order to minimize long term settlements due to secondary consolidation it is desirable to achieve stabilization of settlements due to primary consolidation for an embankment height 0.5 to 1.0 m higher than the final embankment height. Therefore the elapsed times shown in the bottom part of Tables B4 to B13 should be treated as the minimum and not necessarily the ideal elapsed times after the end of construction for removal of the surcharge and reshaping of the embankment.

The construction schedules that Thurber has been requested to analyse are:

Schedule 1:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including surcharge: 3 months
- Waiting period for primary consolidation: 12 months

Schedule 2:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including surcharge and stabilization of settlements: 12 months

Schedule 3:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including

surcharge and stabilization of settlements: 6 months

Based on this schedule and on the analysis of Figures A13 to A18B and Tables B4 to B13, the following can be concluded:

- *General:* The pre-consolidation pressure has a significant impact on the magnitude and the time required for the dissipation of EPP
- *Location: West Approach West and East Abutments and East Approach (CPTUS1 and CPTUS3); high embankments; Figures A13 to A15*
  - The maximum settlement is approximately 0.5 m to 1.0 m for the most likely (M.L.) and reduced Pc values, respectively. Hence, the 1.5 m surcharge is suitable for compensation of settlements and also allows for some surplus surcharge which is desirable in order to minimize long term settlements due to secondary consolidation. At these locations, a time delay of 60 to 180 days will be required prior to Stage 2, for dissipation of EPP generated during Stage 1. Also, settlements due to primary consolidation are not anticipated to stabilize before 360 days after the end of the embankment construction. Based on this analysis wick drains will be required to accommodate Construction Schedules 1 and 3. For Most Likely (M.L.) Pc values, Schedule 2 is feasible without wick drains. For Reduced Pc values, wick drains are required for Schedule 2.
- *Location: EW-N Ramp and Boundary Road (CPTUS5), embankments 3 m to 5 m high (excluding surcharge), Figure A16 and Tables B4 to B7*
  - For a 6 m high embankment, which includes a surcharge of 1m, more than 720 days are required for the stabilization of settlements due to primary consolidation for M.L. and Reduced Pc values. Therefore wick drains will be required to accommodate the proposed construction schedules.

- For embankment heights lower than 6 m and variable embankment width, a settlement analysis was carried out in order to assess the required height of surcharge to accommodate the proposed construction schedule without wick drains. Tables B4 to B7 summarize the results of this analysis. The analysis of these tables indicate that for most likely  $P_c$  and for embankment heights up to 3.7 m, a 1.3 m surcharge is required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction without wick drains. For reduced  $P_c$ , very large surcharges and extended periods of time are required for the stabilization of settlements due to primary consolidation within 12 months of the end of construction. The analysis of Tables B4 and B5 also indicate that the anticipated immediate elastic settlements are small and in the order to 20mm to 75 mm for the range of embankment heights analysed.
- *Location: EW-N Ramp, S-EW Ramp and Hwy 11 south of the Interchange (BH31FP); embankment less than 3 m high; Tables B8 to B11*
  - Tables B8 to B11 show that for embankment heights up to 3.0 m (excluding surcharge) and M.L.  $P_c$  values no wick drains will be required for all proposed construction schedules. However, a minimum of 1.2 m surcharge will be required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction. For Reduced  $P_c$ , very large surcharges and/or extended periods of time are required for the stabilization of settlements due to primary consolidation. Therefore, for Reduced  $P_c$ , wick drains are required to comply with the requirements of all proposed construction schedules.
- *Hwy 11 north of the Interchange and EW-S Ramp (BH23FP); Figure A18 and Tables B12 and B13:*



- Figure A18 and Tables B12 and B13 show that, for embankment heights up to 3.0 m (excluding surcharge) and M.L.  $P_c$  values, no wick drains are required for the construction schedules considered herein. However, a minimum of 1.2 m surcharge will be required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction. For reduced  $P_c$  values, very large surcharges and/or extended periods of time are required for the stabilization of settlements due to primary consolidation. In this case, wick drains would be required to comply with Construction Schedules 1, 2 and 3.

### 8.3.3 Settlements due to Primary Consolidation - With Wick Drains

The one-dimensional consolidation analysis above identified the following areas where wick drains will be required to accelerate dissipation of EPP (for M.L.  $P_c$  values):

- West and East Abutments (CPTUS1)
- East Approach (CPTUS3), high embankments
- EW-N Ramp (CPTUS5), embankments higher than 4 m

The presence of slight artesian pressures in the sandy deposits underlying the Clayey Silt deposit poses a potential for loss of fines due to the continuous flow of water around the wick drains. In order to minimize this potential, the wick drains should be terminated within the Lower Silt, within 1 to 1.5 m above the underlying layer of Sandy Silt and Sand. The one-dimensional consolidation analysis indicated that the pore pressures within the Lower Silt dissipate quickly due to the relatively high coefficient of consolidation values and due to the proximity of the underlying Sandy Silt and Sand that provides a free draining boundary .

The wick drain spacing was selected based on the percentage consolidation required within the clayey silt layer, determined from the stability analysis, for the construction schedule presented in the preceding

section.

Two methods were used for the wick drain design:

- Hansbo (1979, opt.cit.)
- Robertson, Campanella and Brown<sup>4</sup> (1988)

The former method includes well resistance and disturbance factors due to the wick drain installation. The latter method uses the original derivation by Hansbo<sup>5</sup> (1960) adjusted for wick drain design based on Ch values interpreted from the CPTU. EPP dissipation due to vertical drainage was coupled with EPP due to horizontal drainage into the wick drains according to the following equation:

$$U = 1 - (1 - U_v)(1 - U_h)$$

where U is the combined total percentage consolidation and U<sub>v</sub> and U<sub>h</sub> are the percentage consolidation values due to vertical and horizontal drainage only, respectively, divided by 100.

The design parameters and required percentage consolidation at specific times used in the analysis are summarized in Table B14. It has been assumed that the wick drains will be installed in a triangular pattern. Because the wick drains will be terminated within the layer of lower silt, the wick drain drainage length has been assumed equal to the entire length of the wick drain.

The results of the wick drain analysis are presented in Tables B15 to B30. A summary of the embankment configurations and required wick drain spacing is presented below. The wick drain spacing has been selected as the smallest of the two spacings provided by the methods described above.

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<sup>4</sup> Robertson, P.K., Campanella, R.G., and Brown, P.T. (1988). "Prediction of wick drain performance using piezometer cone data". Canadian Geotechnical Journal 25, 56-61 (1988)

<sup>5</sup> Hansbo, S. (1960). "Consolidation of clay, with special reference to influence of vertical sand drains. Swedish Geotechnical Institute, Proceedings No.18 (1960)

- West Approach, West and East Abutments and East Approach (CPTUS1 and CPTUS2), high embankments (Tables B15 to B18)

Embankment Height: 11.5m+1.5m surcharge (West Abutment)  
10.2m+1.5m surcharge (East Abutment)

Berm Width: 7 m

Berm Height: 6 m below design height

Wick Drain Spacing: 3.5 m

Construction Sequence: Stage 1 to 10m; wait for 50% dissipation of EPP:  $EPP < 100$  kPa (~1 month); Stage 2 to 11.7m or 13m; wait for 100% consolidation (~3 months); trim surcharge.

- East Approach (CPTUS3), (Tables B19 to B26)

*Alternative 1 - 6 m wide berm*

Embankment Height: 6 m to 10 m + 1.5 m surcharge

Berm Width: 6 m

Berm Height: 6 m below design height

Wick Drain Spacing: 2.2 m

Construction Sequence: Stage 1 to 8.5m; wait for EPP to dissipate to 40%:  $EPP < 68$  kPa (~2 weeks); Stage 2 to 9.5m; wait for 100% dissipation of EPP (~2 months); Stage 3 to 11.5 m; wait for 100% consolidation (~2 months); trim surcharge.

Since it is not practical to wait for 100 % dissipation of EPP during the embankment construction, the following berm width was analysed:

*Alternative 2 - 8 m wide berm*

Embankment Height: 6 m to 10 m + 1.5 m surcharge

Berm Width: 8 m

Berm Height: 6 m below design height

Wick Drain Spacing: 3.5 m

Construction Sequence: Stage 1 to 9.5m; wait for 75% dissipation of EPP:  $EPP < 48$  kPa (~1 month); Stage 2 to 11.5 m; wait for 100% consolidation (~5 months); trim surcharge.

- EW-N Ramp and Boundary Road (CPTUS5), embankments higher than 4 m (Tables B27 to B30)  
 Embankment Height: 4m to 6m + 1.5 m surcharge  
 Berm Width: N/A  
 Berm Height: N/A  
 Wick Drain Spacing: 3.5 m  
 Construction Sequence: Stage 1 to 6m; wait for 100% consolidation (~11 months); trim surcharge.

#### 8.3.4 Settlements due to Secondary Consolidation

Settlements due to secondary consolidation have been assessed based on the following equation:

$$\Delta T_{cs} = C\alpha\epsilon \cdot T \cdot \text{Log } t_{sc}/t_p,$$

where:

$\Delta T_{cs}$  = settlement due to secondary consolidation

$C\alpha\epsilon$  = secondary compression ratio

$T$  = initial thickness of compressible layer

$t_{sc}$  = time over which secondary consolidation is to be calculated

$t_p$  = time to complete primary consolidation

As indicated in Table B2, a value of 0.002 has been selected for  $C\alpha\epsilon$ . This value reflects the fact that upon completion of primary consolidation, a minimum of 0.5 m to 1.0 m will be removed from the embankment top and the compressible soils will be slightly over-consolidated.

The following are the settlements due to secondary consolidation anticipated at the interchange embankments:

### Secondary Consolidation Analysis

Location	T (m)	$t_{sc}$ (years)	$t_p$ (years)	$\Delta T_{cs}$ (mm)
West and East Abutments (CPTUS1)	7	35	1	25
East Approach (CPTUS3)	6	35	1	20
EW-N Ramp and Boundary Rd. (CPTUS5), embankments higher than 3 m	11	35	1	35
EW-N Ramp (BH31FP), embankments lower than 3 m	14	35	1	45

The above settlements indicate that the design requirement of maximum long term settlement of 25 mm, after removal of the surcharge, is met only at the two abutments and east approach embankment. At the lower embankments away from the abutments, in the south and east portion of the interchange, where thicker soft deposits are present, the maximum additional long term settlement is anticipated to be up to 45 mm. In view of the extended period of time considered in the calculations (35 years) and the fact that the embankments where the design specifications, for on going secondary settlements, are exceeded are not in the proximity of the bridge, these anticipated long term settlements may be acceptable to MTO. This should be discussed with MTO.

#### 8.4 Lateral Displacement at Depth at the East Abutment

Provided that the abutment piles are installed after most of the settlements due to primary consolidation have taken place, relatively small time dependent lateral displacements are anticipated to occur along the piles. For monitoring purposes and verification of the structural capacity of the abutment piles, the maximum outstanding pile lateral deflection should be equal to 20% (Ladd, opt.cit.) of the maximum outstanding settlement of the embankment at the centre of the clayey silt layer, at EL. 308. The lateral deflections can be assumed decreasing to zero above and below the point of maximum deflection, at ground surface and at El. 297 (point below which the Sand and Sand with Gravel layer, in BH-6FP, becomes dense), respectively.

## **9. Embankment Design Recommendations**

### **9.1 Embankment Geometry and Construction Schedule**

Based on the analysis presented in the preceding sections, the embankment design, wick drain location and spacing and construction sequence summarized in Table B31 is proposed. For simplicity of construction, we have provided uniform berm width and excess pore pressure dissipation requirements for the embankments.

### **9.2 Site Preparation**

All organic soils should be removed within the footprint of the embankments, including side berms. Due to the relatively high groundwater table at this site, a NSSP should be included in the contract documents warning the contractor that the removal of organic soils will probably be carried out below water at most locations. Where unwatering of excavation is required, it shall comply with the requirements of OPSS 517

Following the removal of organic soils, at locations where wick drains will be installed, free draining material, complying with the NSSP included in Appendix D, should be placed to an elevation at least 0.5 m above the groundwater table with minimum thickness of 0.5 m.

### **9.3 Wick Drain Specifications**

In order to satisfy the design requirements for discharge capacity, soil retention, permeability and clogging criteria, and installation, the wick drains should be supplied and installed according to the NSSP included in Appendix D.

## 9.4 Monitoring Program

### 9.4.1 Types of Instruments

The performance of the embankment will be monitored using the following instruments:

- **Slope Indicator (SI):** to monitor horizontal displacements at depth at the abutment locations. Due to the potential for large settlements at the abutment locations telescopic casings should be used and selected to accommodate settlements of up to 1 m;
- **Vibrating Wire Settlement Cells with Pressurized Reservoir (SC):** for the remote monitoring of settlements of the embankment base at the abutment locations;
- **Settlement Rods (SR):** anchored on a steel plate at ground surface, at the base of the embankment, extended to the top of the embankment for monitoring of settlements of the embankment base with conventional survey methods. The rods should be protected by a PVC or ABS pipe of larger diameter, to minimize the development of friction along the rods, and by a 400 mm CMP, for protection against damage during the embankment construction. The rods and protection pipes should be erected in 3 m increments as the embankment increases in height.
- **Settlement Pins (SP):** standard steel pins anchored in a concrete block cast on top of the embankment surcharge.
- **Vibrating Wire Piezometers (VWP):** installed in the compressible clayey silt and silty clay deposits and underlying sand deposit. The VWPs should be installed as close as possible to the centre of the triangle defined by the nearby three wick drains.
- **Shallow Standpipe (SSP):** installed near each of the monitoring sections to monitor the near surface groundwater table
- **Read-out Unit:** depending on the economics of the monitoring program, the vibrating wire instruments may be read automatically at specified time increments by an automatic acquisition system

### 9.4.2 Monitoring Sections

The instruments will be installed in the following three typical monitoring sections:

#### ***Monitoring Section Type A***

- Location: at the Abutment locations, 3 m behind the line of piles
- One SI: at the embankment centreline
- Two SC: at the centreline of the E/B and W/B lanes
- Two SR: at the centreline of the E/B and W/B lanes (1.0 m from the SC)
- Four SP: Two at the top of the surcharge: at the centreline of the E/B and W/B lanes (1.0 m from the SR);  
Two: one on each side berm, near the side slope of the main embankment.
- Two strings of VWP: at the centreline of the E/B and W/B lanes.  
One string will include three VWP installed at the following elevations: In the Middle of, 1.5 m above the bottom of and 1.5 m below the top of the clayey silt layer.  
The other string of VWPs should include the VWPs above plus one VWP installed in the Sand and Gravel layer, at EL. 301.
- One Standpipe: Installed to 3 m depth and slotted in the bottom 1 m

#### ***Monitoring Section Type B***

- Location 50 m behind the Abutment locations
- Two SR: at the centreline of the E/B and W/B lanes
- Four SP: Two at the top of the surcharge: at the centreline of the E/B and W/B lanes (1.0 m from the SR);  
Two: one on each side berm, near the side slope of the main embankment
- Two strings of VWP: at the centreline of the E/B and W/B lanes.  
Each string will include three VWP installed at the following elevations: In the Middle of, 1.5 m above the bottom of and 1.5 m below the top of the clayey silt layer.



One Standpipe: Installed to 3 m depth and slotted in the bottom 1 m

***Monitoring Section Type C:***

Locations: Boundary Road - Sta. 10+160  
W-N Ramp - Sta. 8+360  
EW-N, E-N, SW and S-E Ramps - Sta. 8+420 at EW-N  
EW-N and SE-W Ramps - Sta. 8+480 at EW-N  
EW-N and SE-W Ramps - Sta. 8+540 at EW-N  
EW-N Ramp - Sta. 8+540  
Hwy 11 - Sta. 8+620  
Hwy 11 - Sta. 8+670  
Hwy 11 - Sta. 8+733 (Bridge)  
Hwy 11 - Sta. 8+780  
Hwy 11 - Sta. 8+830

One SR: at the embankment centreline

Two SPs: each at 3 m from the embankment crest

**9.4.3 Installation of Instruments**

With the exception of the Settlement Pins, all instruments should be installed after the site preparation, construction of the drainage blanket and installation of wick drains. It would be preferable to have the instruments installed before the wick drains but the potential for damaging the instruments during installation of the wick drains is too high.

The Settlement Pins should be installed immediately after the embankment target height (top of surcharge) is reached.

**9.4.4 Frequency of Readings**

All instruments should be initialized and read at least three times in three different days before placement of any rock fill.

During construction the instruments should be read at least once immediately before the placement of 1 m high fill lifts and at least once a week between construction 1 m lifts and between Stage 1 and Stage 2.

Upon completion of Stage 2 the instruments should be read:

- weekly for the period of 2 months
- monthly thereafter until the removal of the surcharge
- weekly for the period of 1 months after the removal of surcharge
- monthly for a period of one year following the removal of surcharge
- once every three months following the paving of the roads for a period of three years

#### 9.4.5 Monitoring Levels

There are basically three parameters that should be monitored closely during and after construction:

- Excess Pore Pressures (EPP)
- Embankment Base Settlement
- Lateral Displacements at Depth

The EPP requirements for stability purposes during construction are shown in Table B31. The EPP shown have priority over the estimated times shown in Table B31.

The monitoring of settlements after the end of construction of the embankment to top of surcharge, allows the assessment of long term settlements due to primary consolidation and when the surcharge can be removed for the pavement construction. It is recommended that the Rectangular Hyperbola Method<sup>6</sup> be used for reduction of and prediction of long term settlements due to primary consolidation.

Lateral deflections at the abutment pile locations should also be monitored in order to confirm that the lateral displacements due to primary consolidation have mostly stabilized prior to installation of piles.

---

<sup>6</sup>

Sridharan, A., Murthy, N.S. and Prakash, K (1987). "Rectangular hyperbola method of consolidation analysis". Geotechnique 37, No. 3, 355-368 and,  
Tan, S.A., (1993). "Ultimate Settlement by Hyperbolic Plot for Clays with Vertical Drains". ASCE Journal of Geotechnical Engineering, Vol. 119, No.5, May, 1993, 950-956

### 9.5 Trial Embankment

Although the CPTUs provided a significant increase in confidence about the material properties and expected performance of the embankment, some issues regarding the pre-consolidation pressures and time required for stabilization of settlements in areas where wick drains are not required remain unanswered.

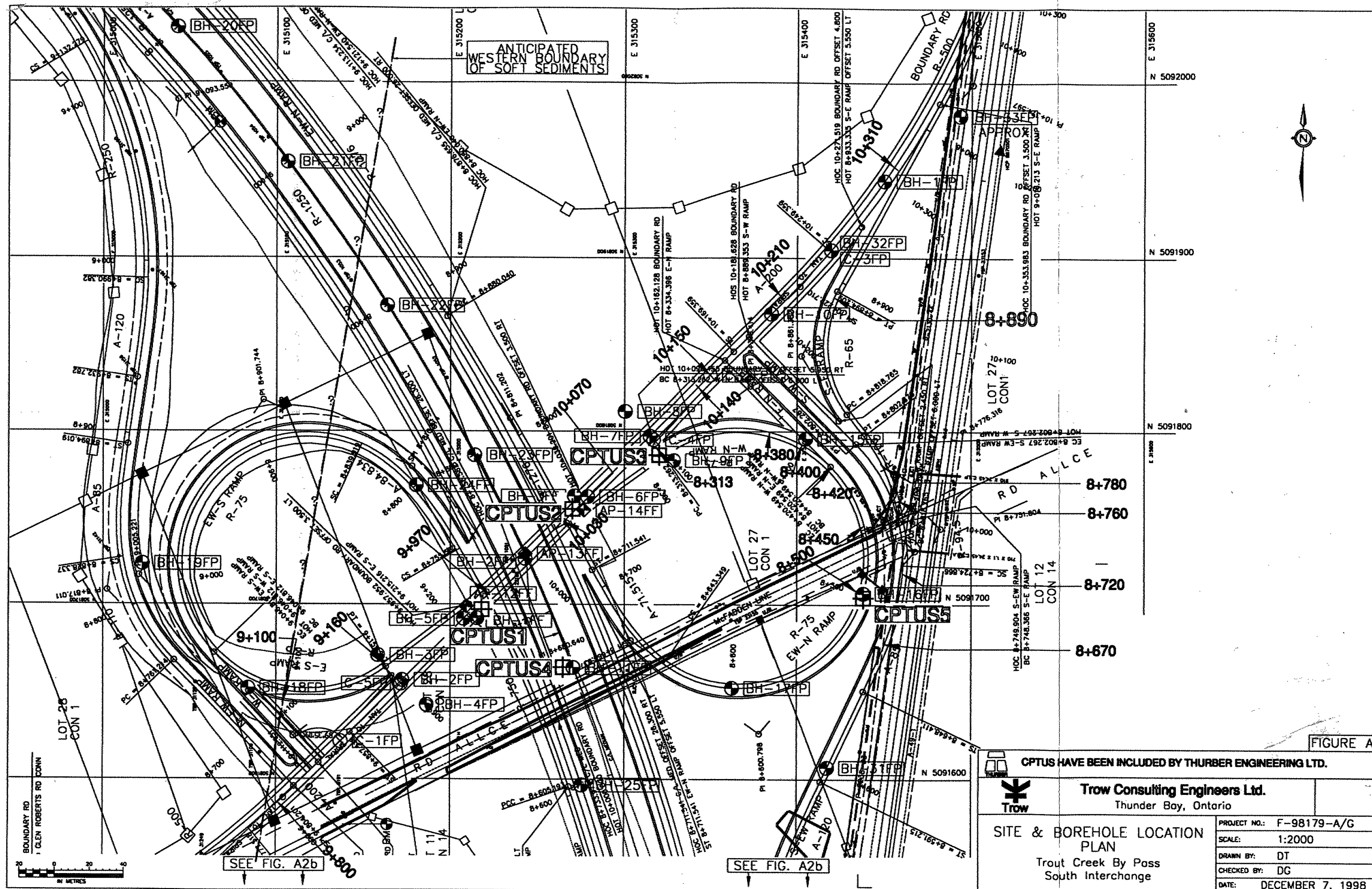
In order to confirm the design assumptions and possibly further optimize the wick drain design, it is recommended that portion of the proposed embankment be constructed in an advance contract.

In our opinion, the trial embankment is a prudent investment that should minimize the potential for construction schedule delays.

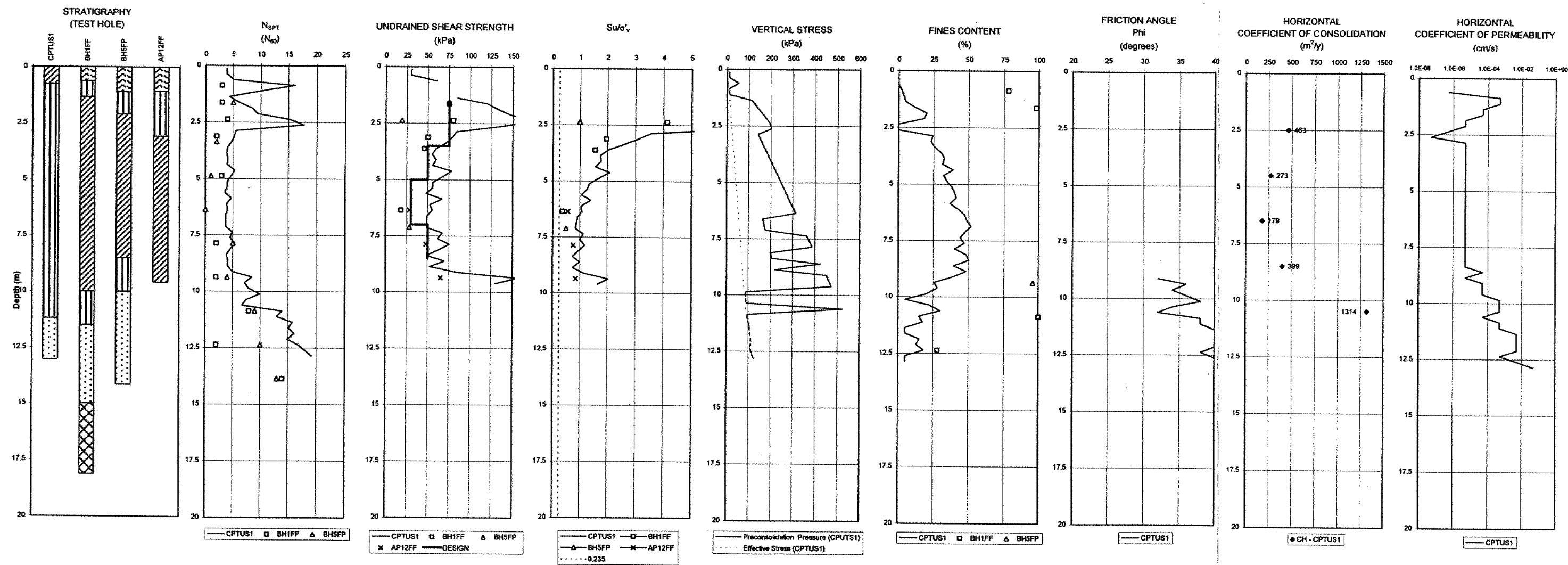


**APPENDIX A**

**FIGURES**



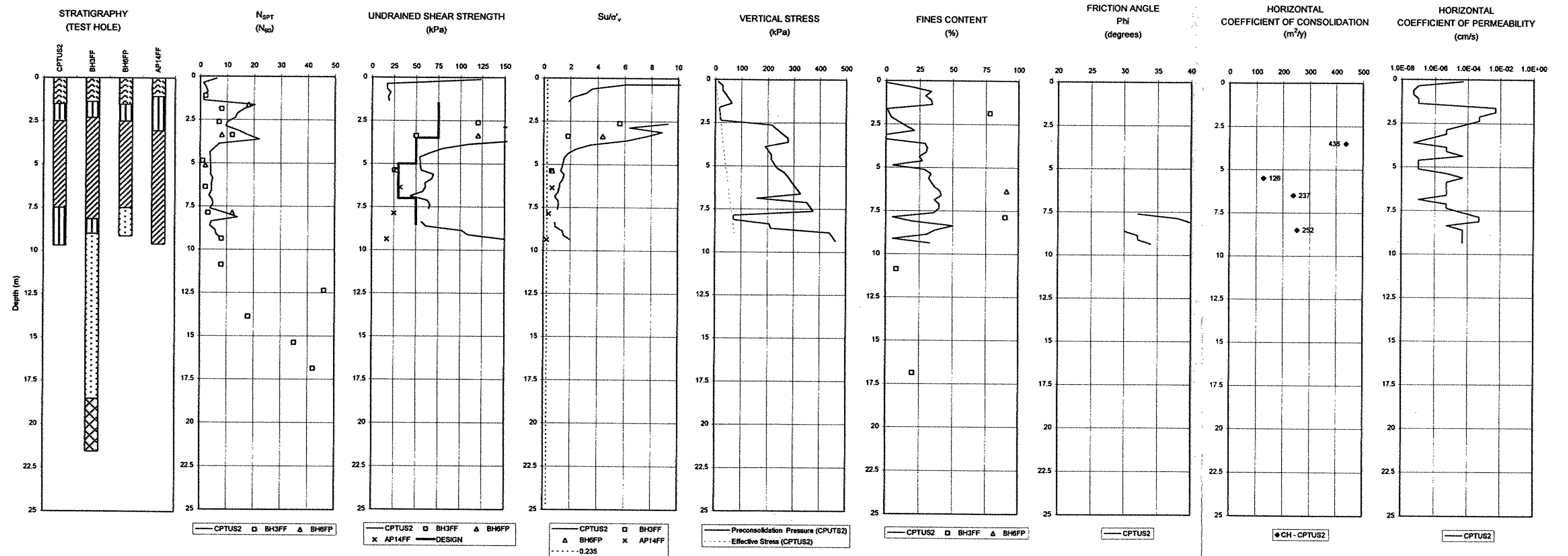
HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
BOUNDARY ROAD - WEST ABUTMENT - APPROXIMATE STATION 9+760



MASTER PLOT

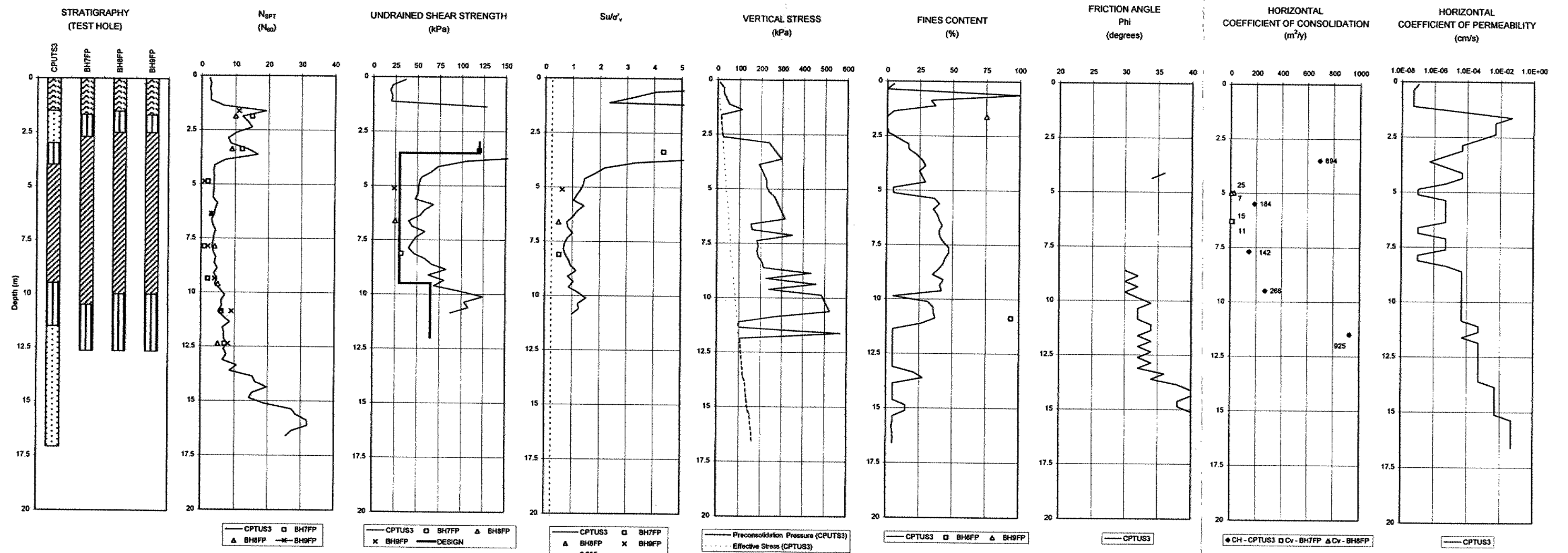
FIGURE A2

**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE**  
**SUMMARY OF SUBSURFACE CONDITIONS**  
**BOUNDARY ROAD - EAST ABUTMENT - APPROXIMATE STATION 10+041**

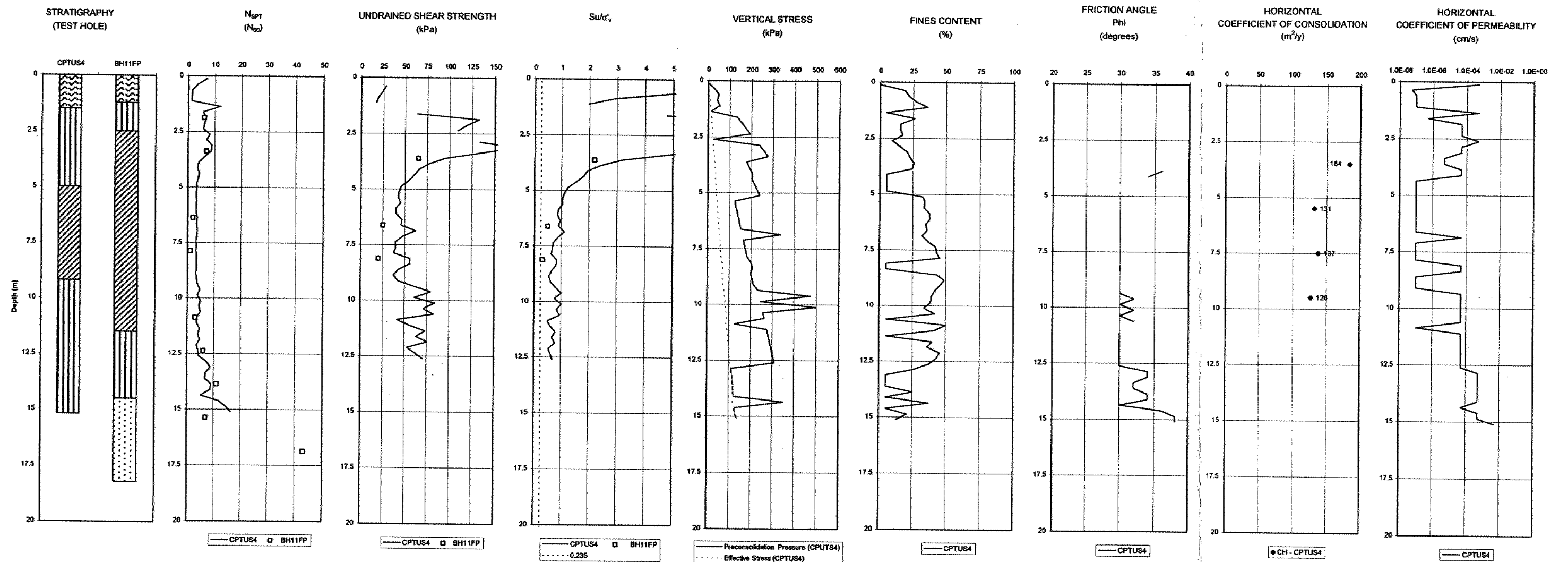




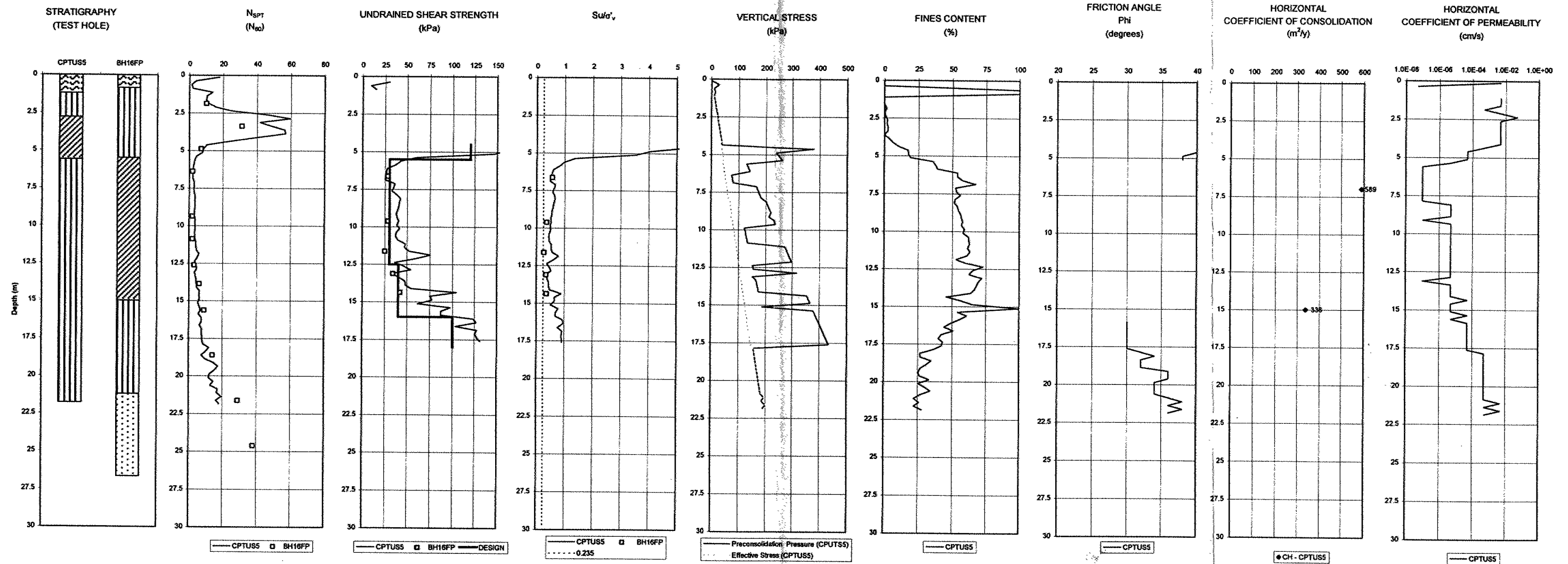
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**SUMMARY OF SUBSURFACE CONDITIONS**  
**RAMP FROM BOUNDARY ROAD EAST TO HWY 11 NORTH - APPROXIMATE STATION 8+310**



HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
HIGHWAY 11 - CENTRELINE - APPROXIMATE STATION 8+665

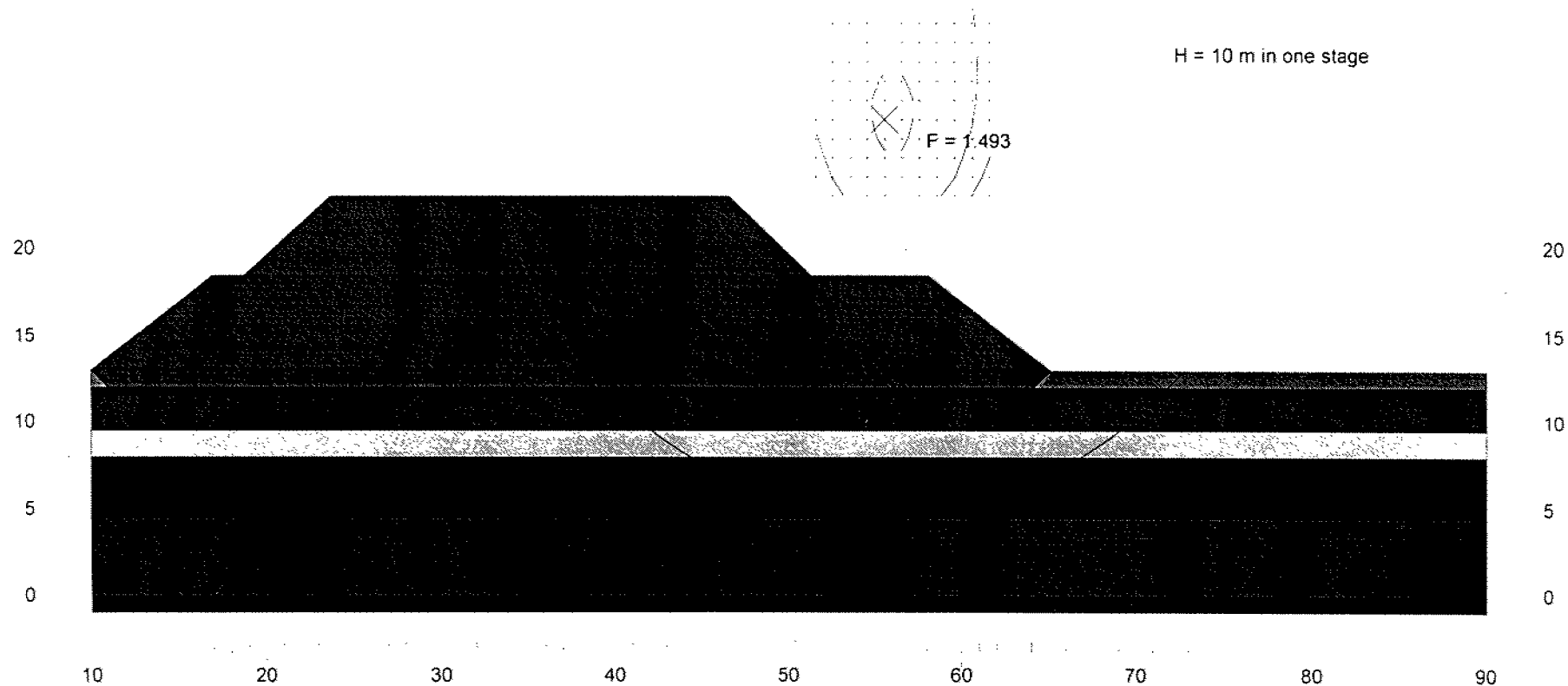


**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
HIGHWAY 11 AND MCFADDEN LANE - APPROXIMATE STATION 8+500**



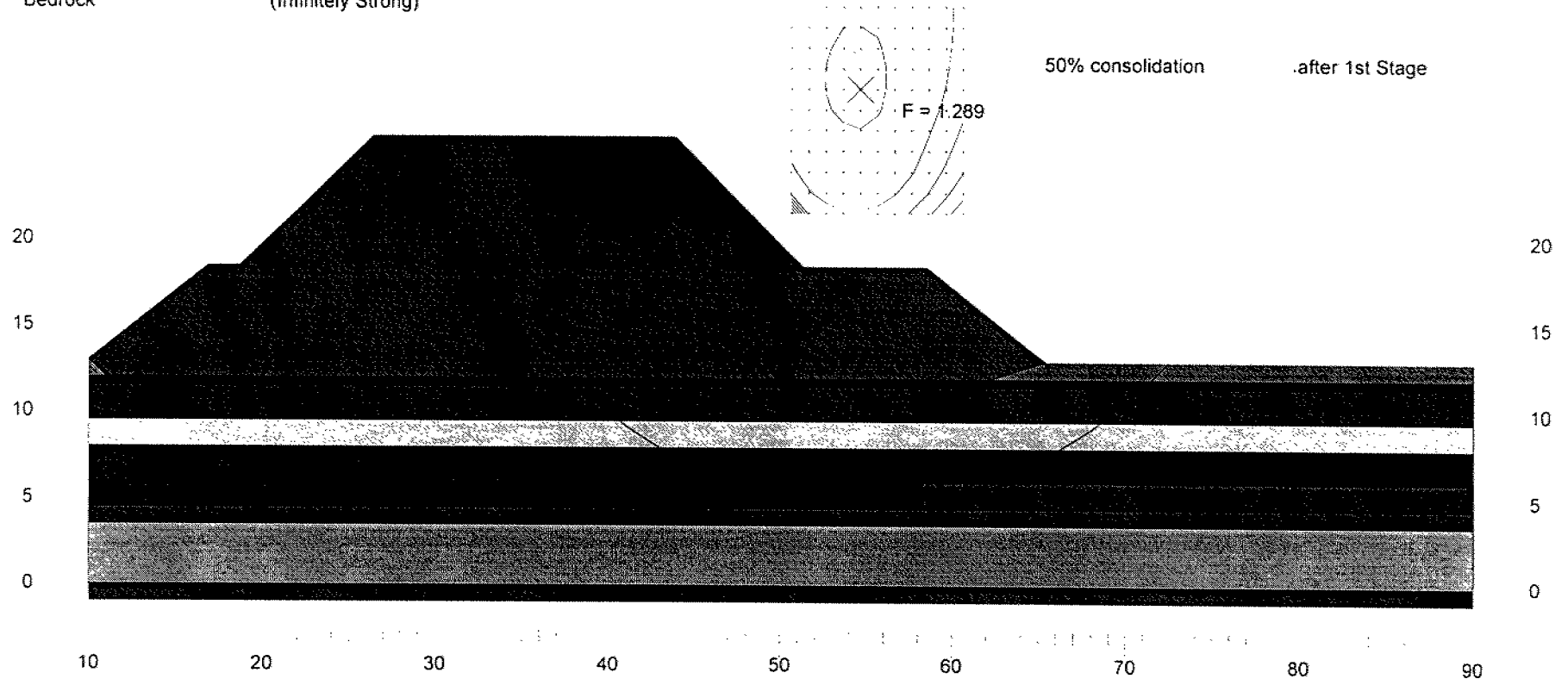
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Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	50	0	1	0
Clayey Silt C	17.5	30	0	1	0
Clayey Silt D	18	50	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				

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 Hwy 11 - Trout Creek By-Pass  
 April 2, 1999  
 South Interchange/West Abut  
 Third Trial - First Stage for F.S=1.3



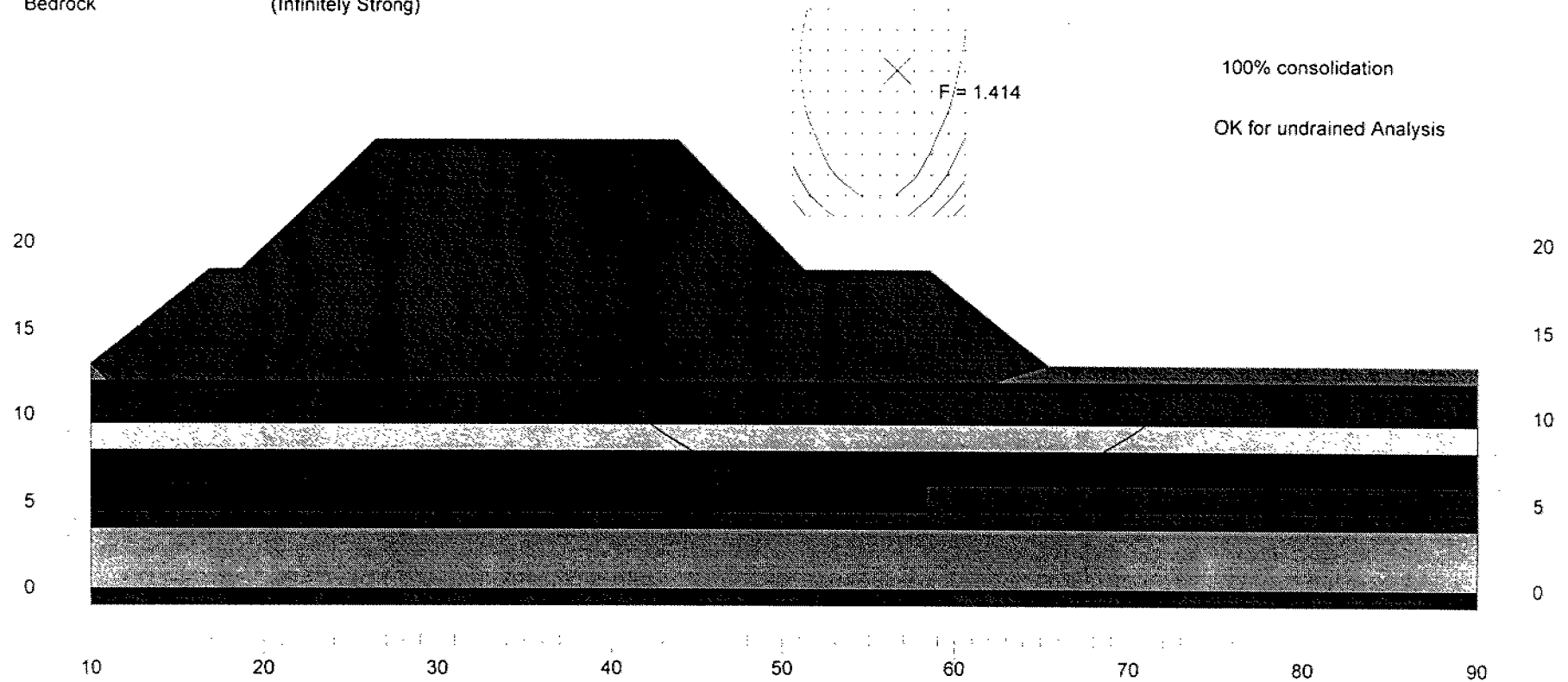
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Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	50	0	1	0
Clayey Silt C1	17.5	30	0	1	0
Clayey Silt C2	17.5	37	0	1	0
Clayey Silt C3	17.5	44	0	1	0
Clayey Silt D1	18	50	0	1	0
Clayey Silt D2	18	52	0	1	0
Clayey Silt D3	18	55	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				

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Hwy 11 - Trout Creek By-Pass  
April 2, 1999  
South Interchange/West Abut  
First Trial - Second Stage for F.S.=1.3



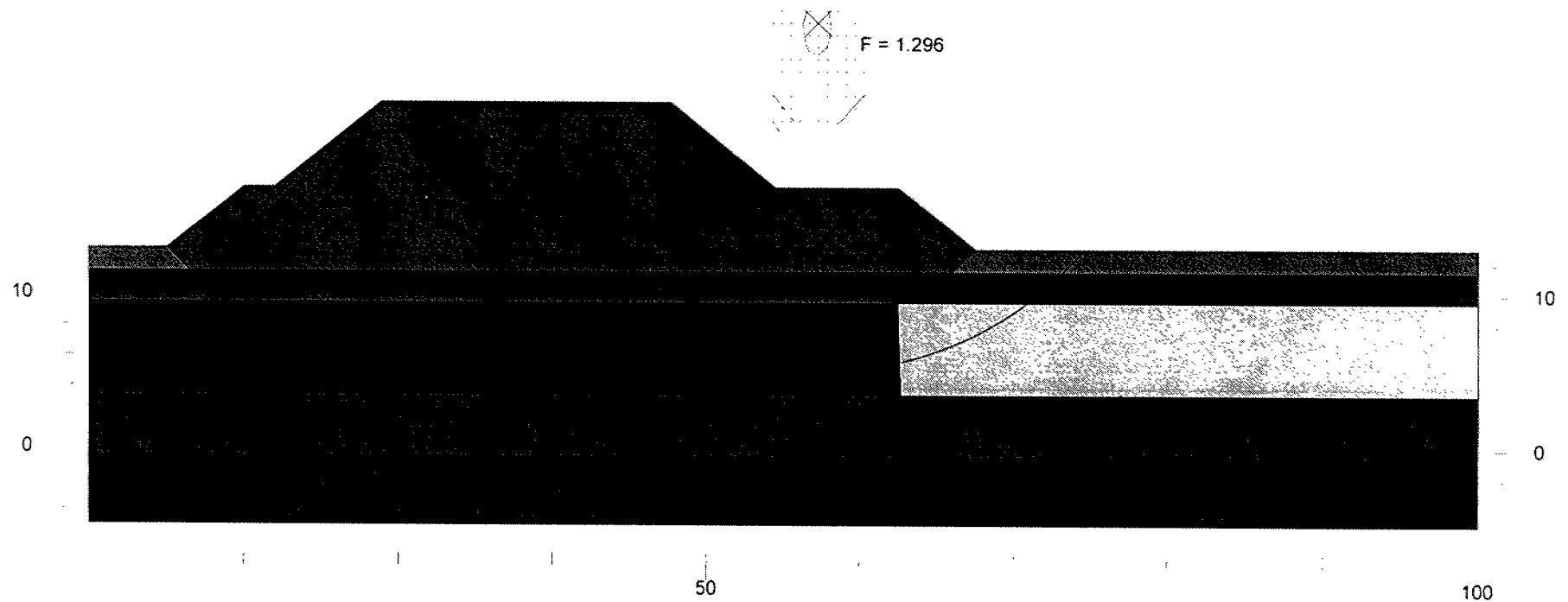
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Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	52	0	1	0
Clayey Silt C1	17.5	30	0	1	0
Clayey Silt C2	17.5	50	0	1	0
Clayey Silt C3	17.5	71	0	1	0
Clayey Silt D1	18	50	0	1	0
Clayey Silt D2	18	62	0	1	0
Clayey Silt D3	18	74	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				

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Hwy 11 - Trout Creek By-Pass  
April 2, 1999  
South Interchange/West Abut  
Long Term Stability



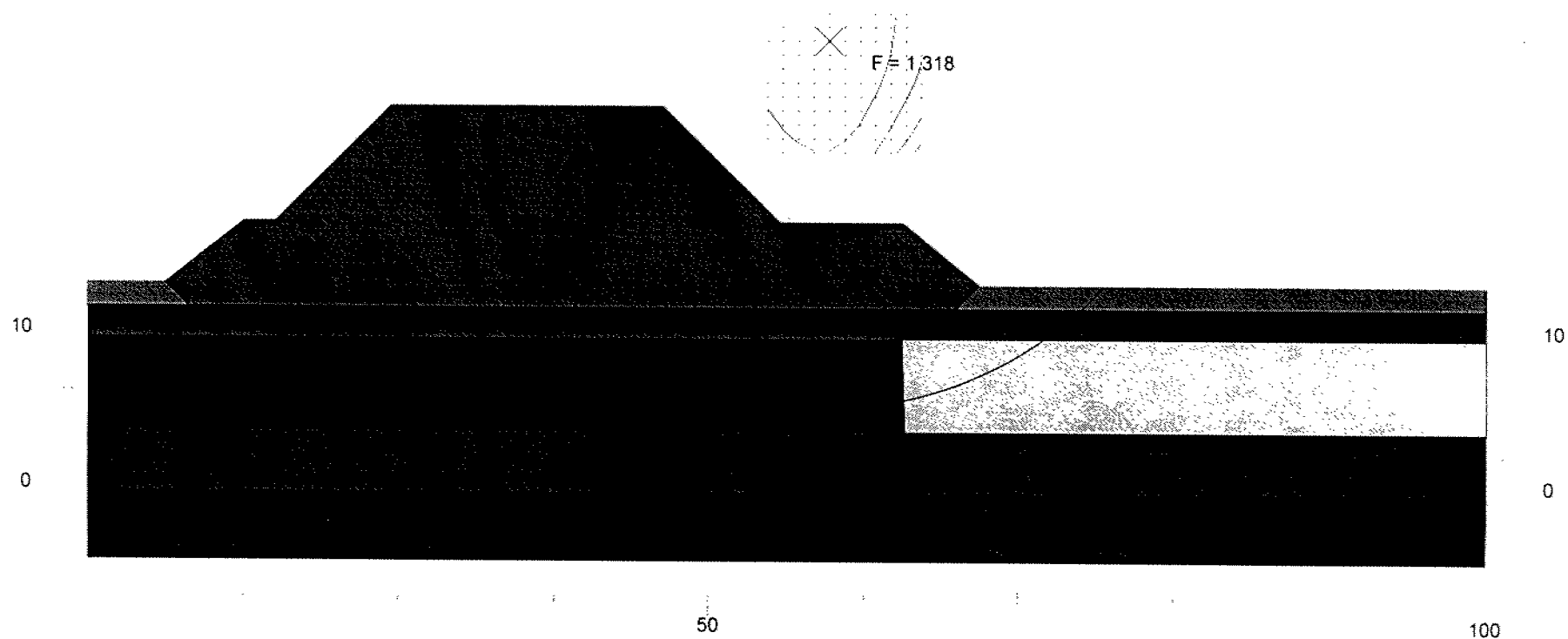
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Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Sand	19	0	30	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	18	30	0	1	0
Clayey Silt B	18	30	0	1	0
Clayey Silt C	18	30	0	1	0
Lower Silt	18	65	0	1	0
Sandy Silt	18.5	0	30	1	0
Sand	19	0	33	1	0
Bedrock	(Infinitely Strong)				

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 19-1104-4  
 Hwy 11 - Trout Creek By-Pass  
 April 5, 1999  
 South Interchange/CPTUS3/8+310  
 8m berm-0% Consolidation 1st Stage; H=9.5 m



	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Sand	19	0	30	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	18	30	0	1	0
Clayey Silt B	18	40	0	1	0
Clayey Silt C	18	50	0	1	0
Lower Silt	18	65	0	1	0
Sandy Silt	18.5	0	30	1	0
Sand	19	0	33	1	0
Bedrock	(Infinitely Strong)				

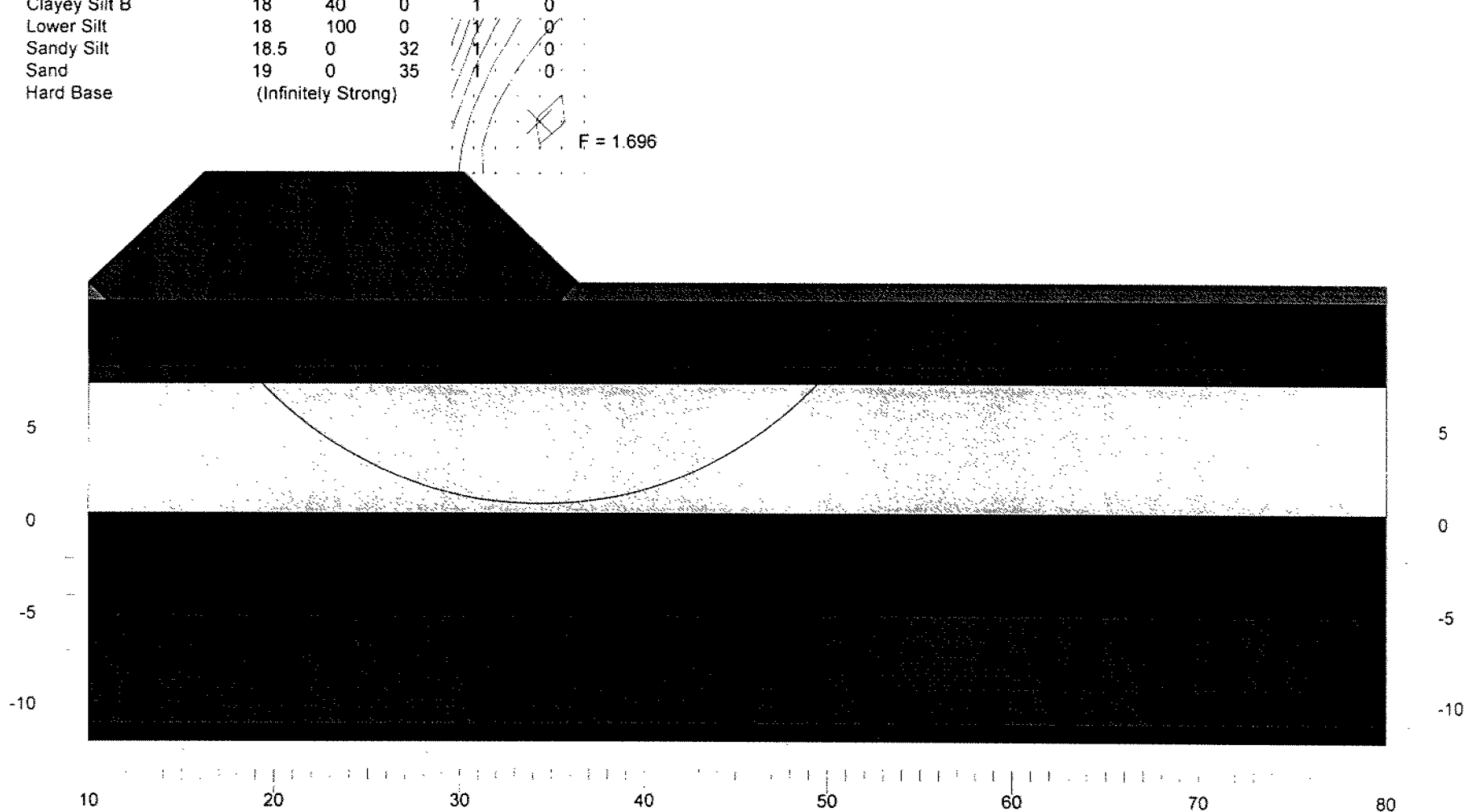
Thurber Engineering Ltd. - Toronto  
19-1104-4  
Hwy 11 - Trout Creek By-Pass  
April 5, 1999  
South Interchange/CPTUS3/8+310  
8m berm-75% Consolidation after 2nd Stage(H=9.5 m);H=11.5 m





	Gamma	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Sand	19	0	33	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	17.5	30	0	1	0
Clayey Silt B	18	40	0	1	0
Lower Silt	18	100	0	1	0
Sandy Silt	18.5	0	32	1	0
Sand	19	0	35	1	0
Hard Base	(Infinitely Strong)				

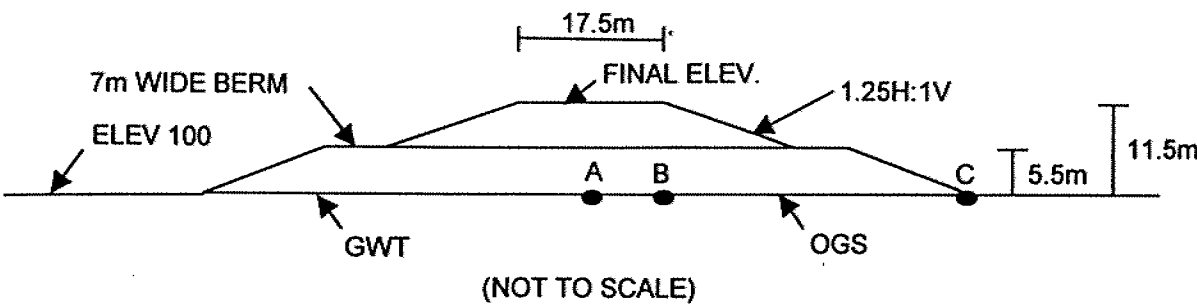
Thurber Engineering Ltd. - Toronto  
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Hwy 11 - Trout Creek By-Pass  
April 6, 1999  
South Interchange - CPTU5  
(5+1) m embankment



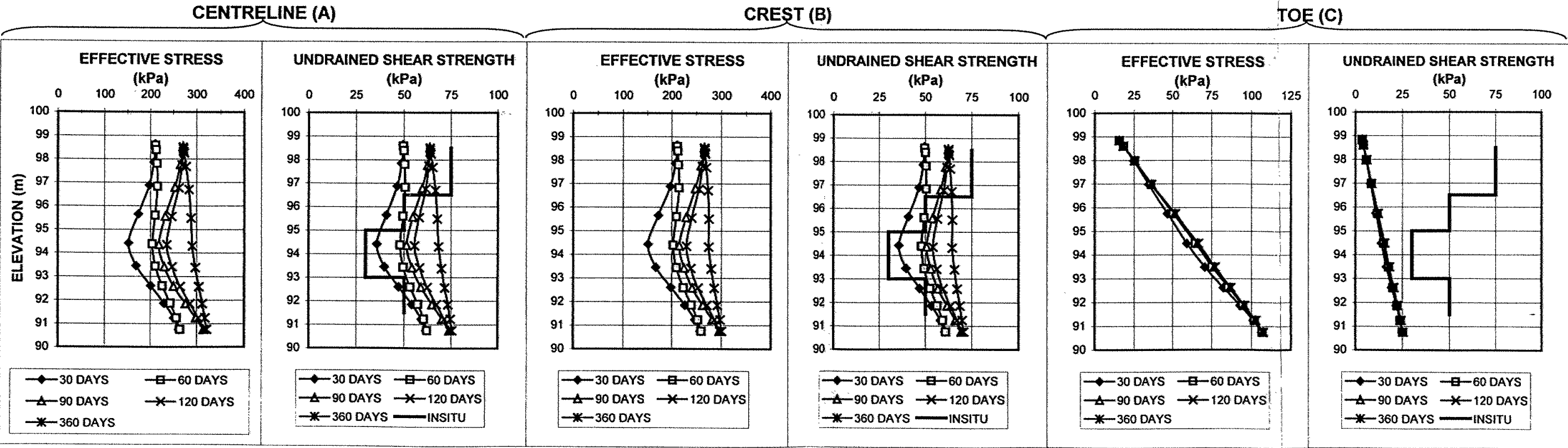
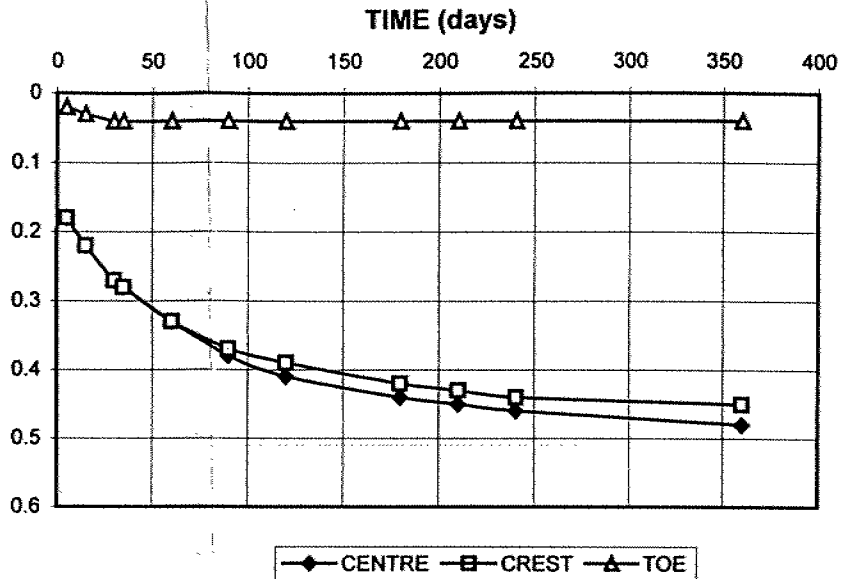
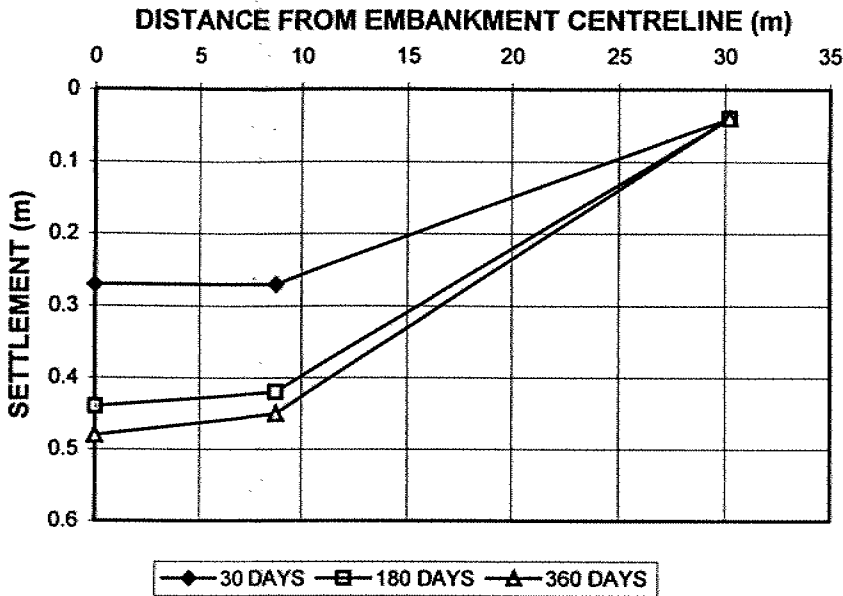
4/6/1999 12:17 16 PM Thurber Engineering Ltd. - Toronto F = 1.696

FIGURE A12

HIGHWAY 11 - TROUT CREEK BY-PASS  
 SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1)  
 SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
 (MOST LIKELY PRECONSOLIDATION PRESSURES)



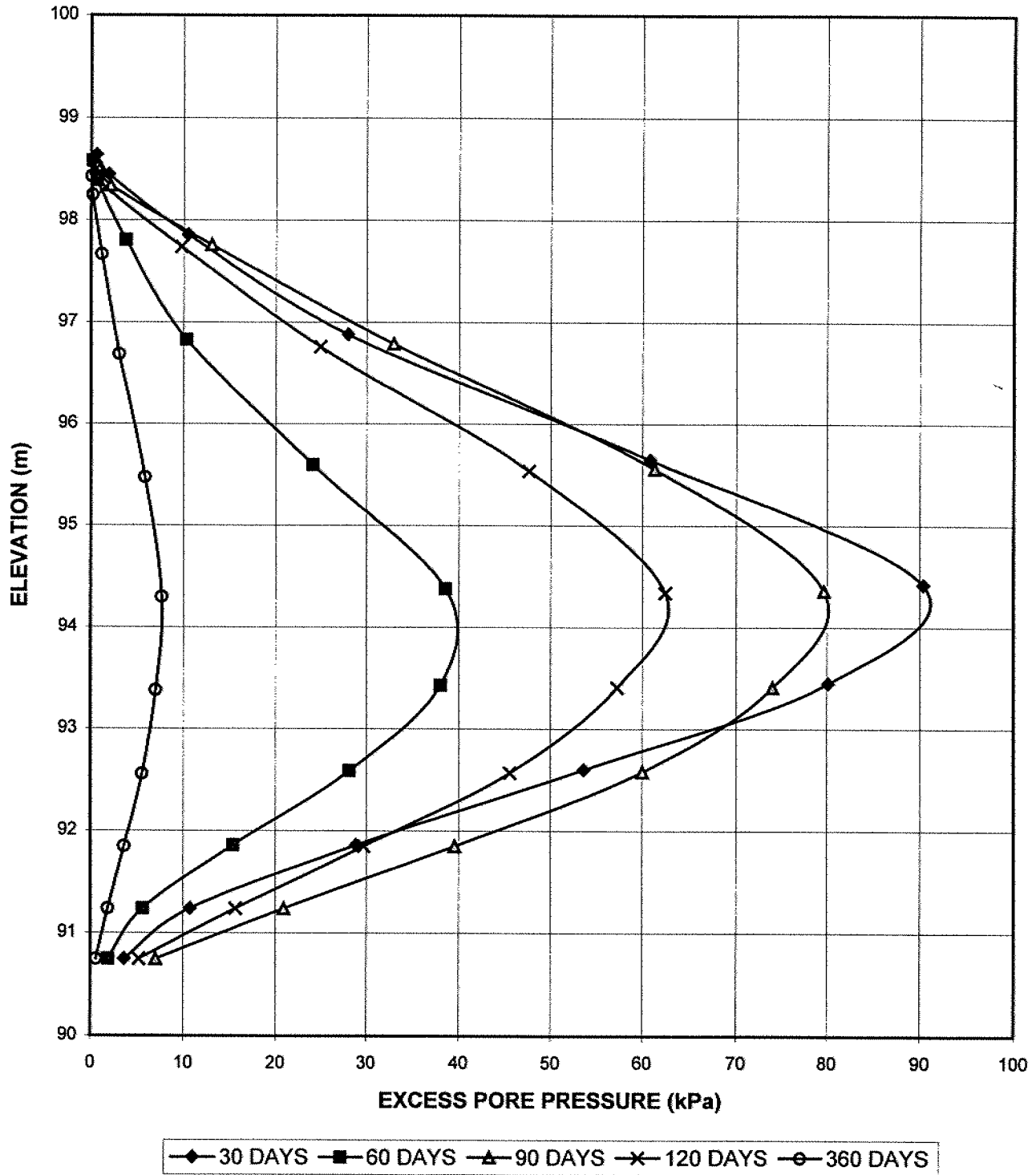
CONSTRUCTION STAGES		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	10	0
2	13	60



MASTER PLOT

FIGURE A13

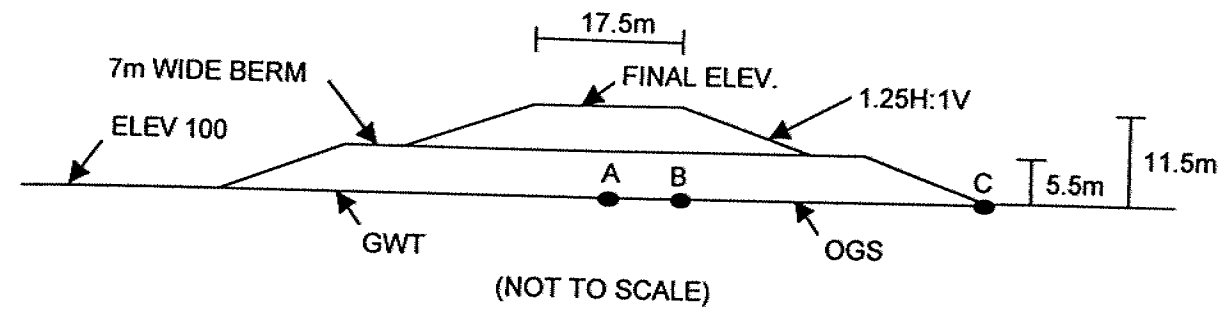
**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)**



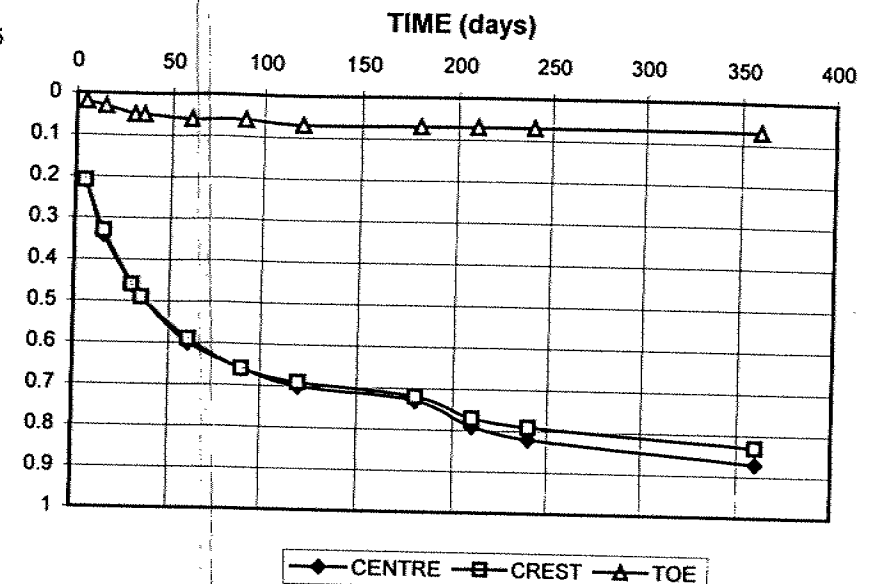
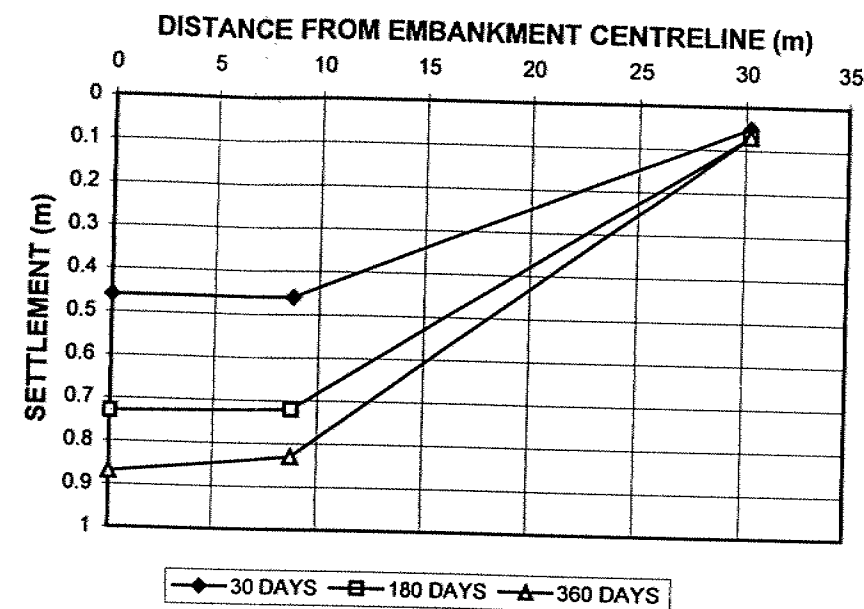
EPP - CHART

FIGURE A13-B

# HIGHWAY 11 - TROUT CREEK BY-PASS SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1) SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS (REDUCED PRECONSOLIDATION PRESSURES)



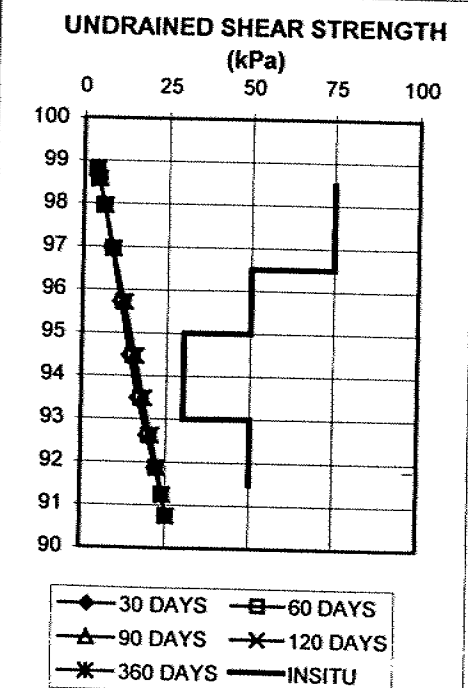
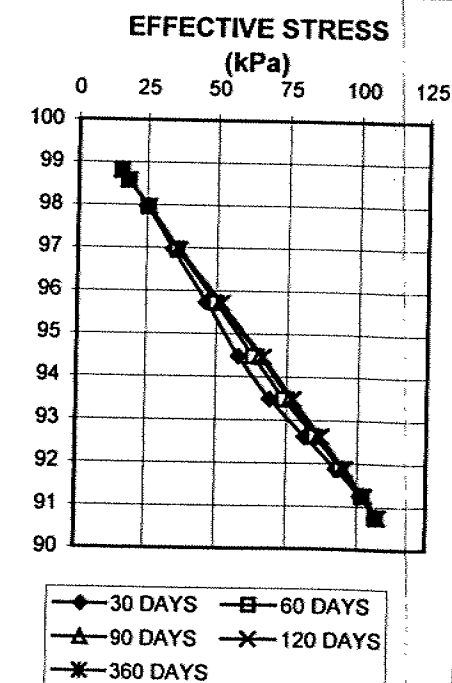
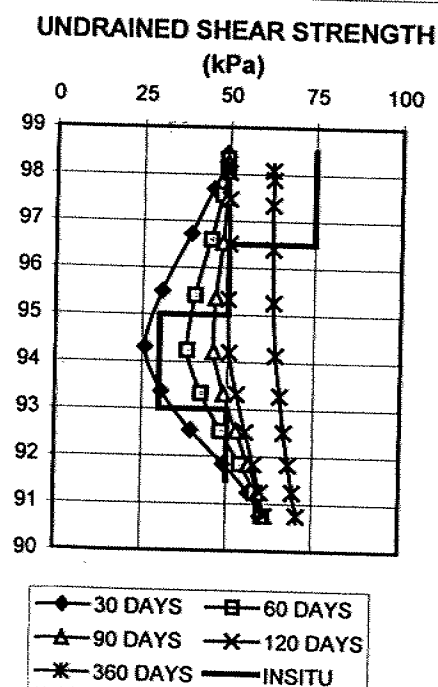
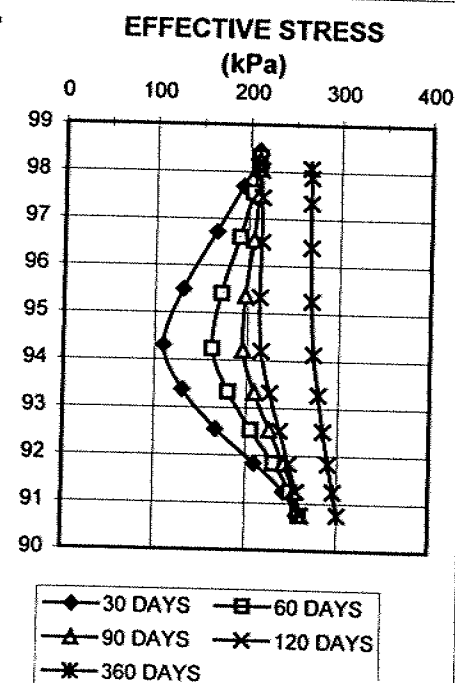
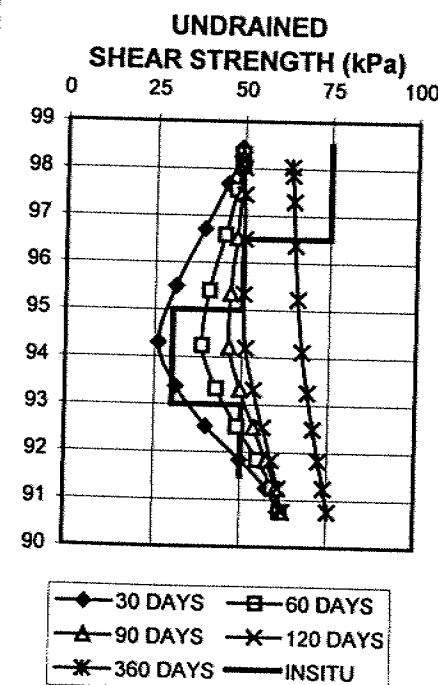
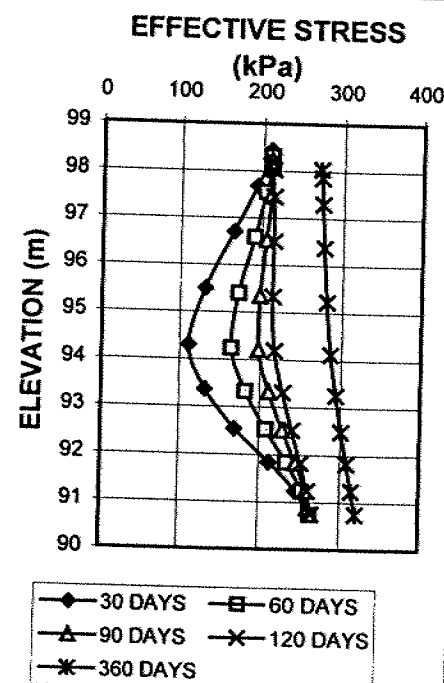
CONSTRUCTION STAGES		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	10	0
2	13	180



CENTRELINE (A)

CREST (B)

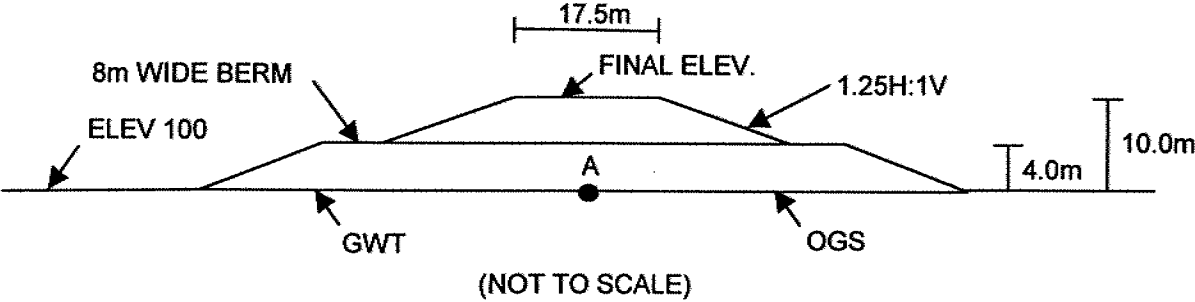
TOE (C)



MASTER PLOT

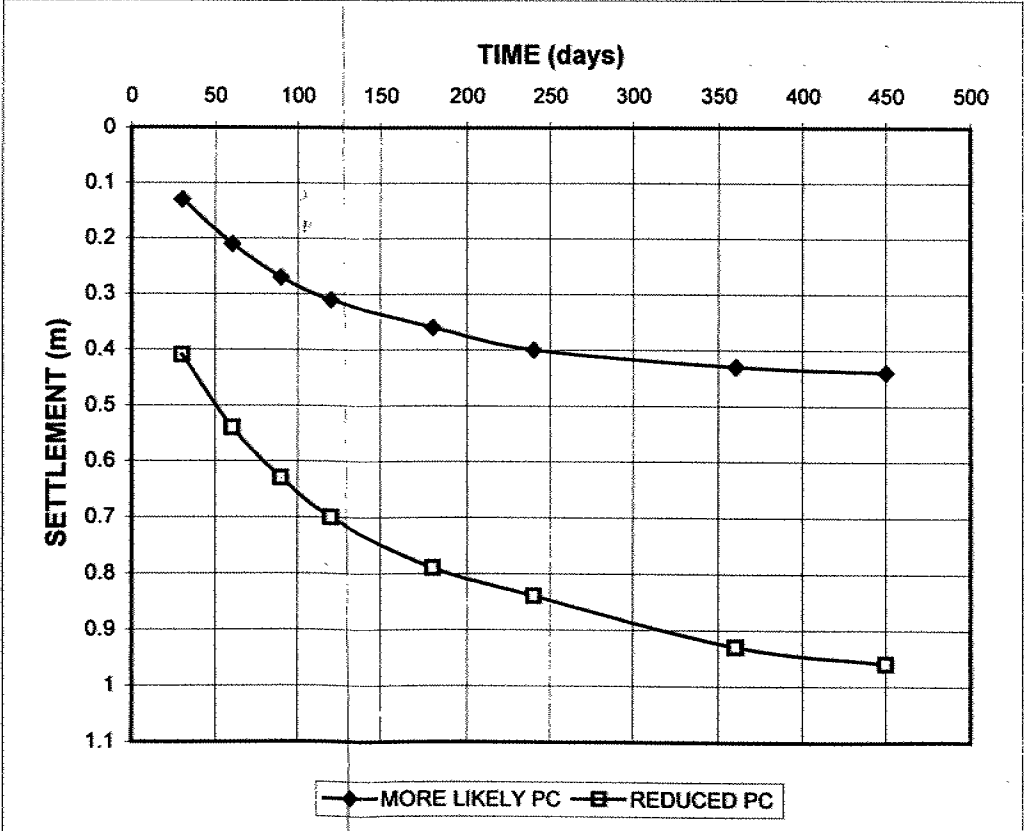
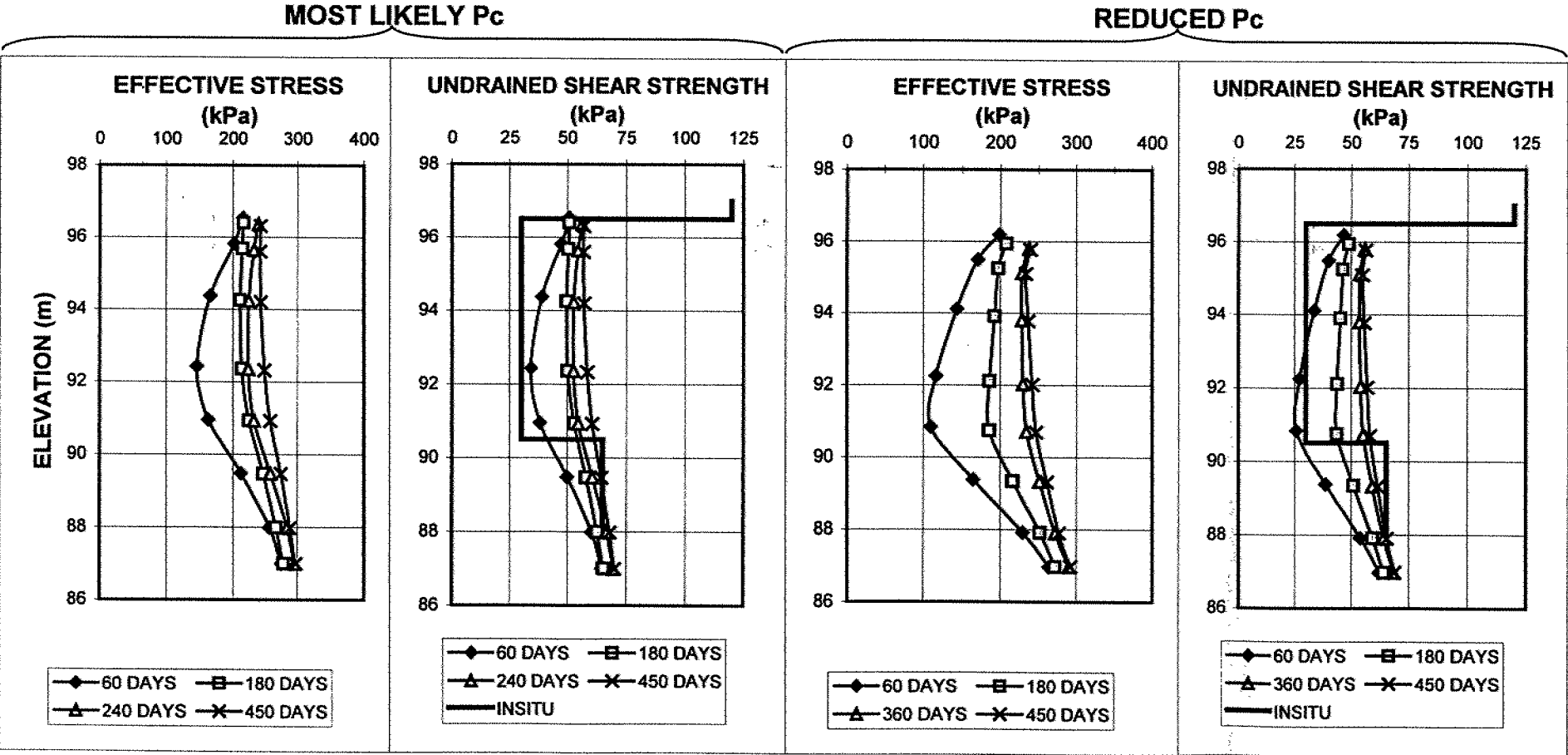
FIGURE A14

HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - STATION 8+310, RAMP FROM BOUNDARY ROAD EAST TO HWY 11 NORTH (CPTUS3)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(AT THE CENTRELINE OF THE EMBANKMENT)



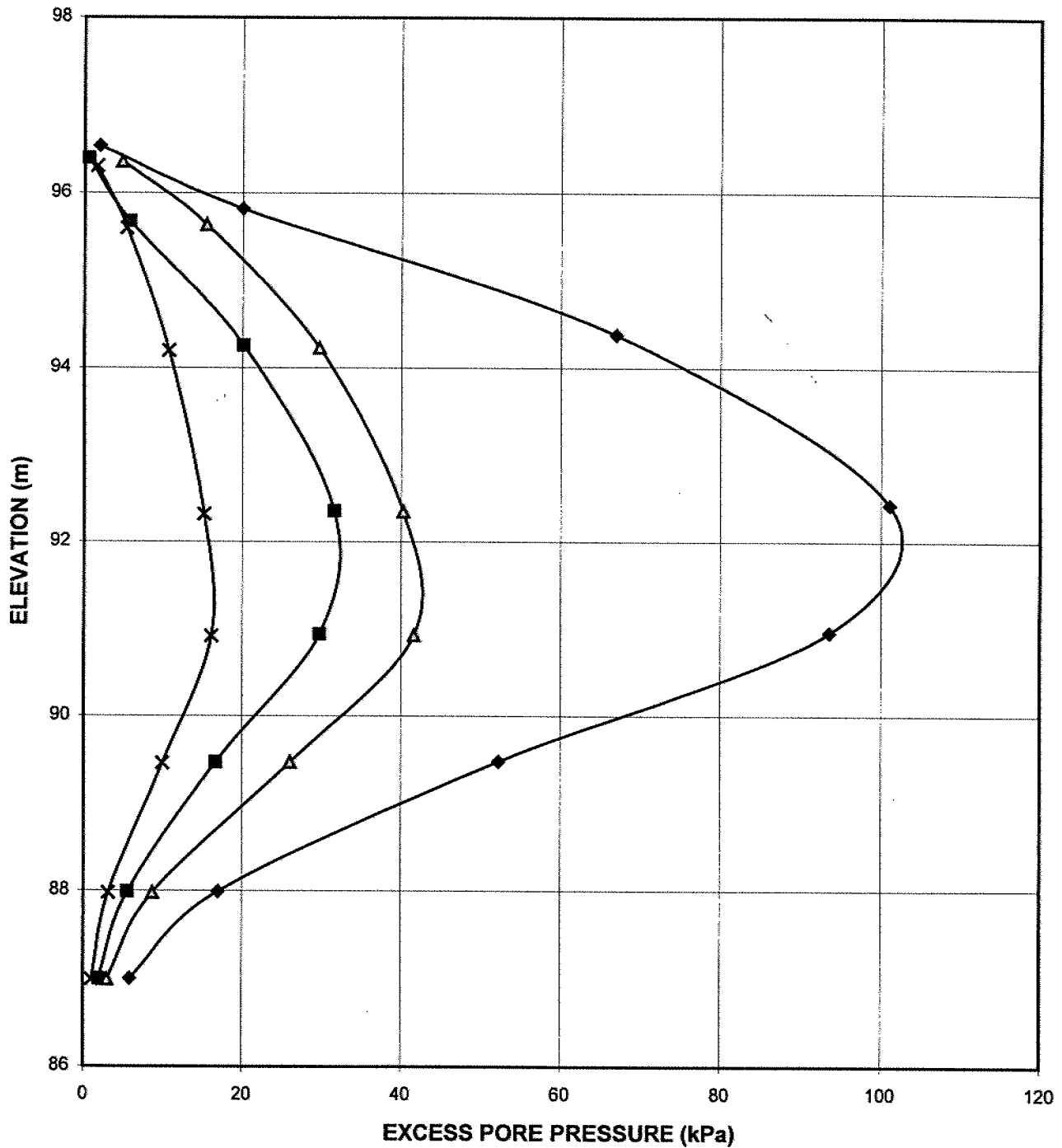
CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	9.5	0
2	11.5	180

CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	9.5	0
2	11.5	240



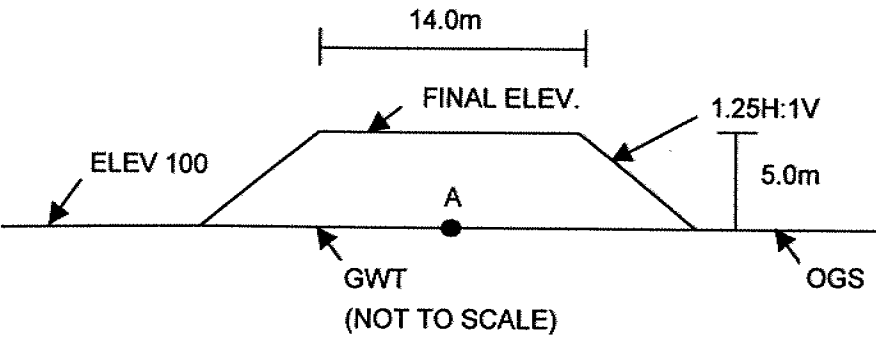
MASTER PLOT

HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
APPROX. STATION 8+310 RAMP FROM BOUNDARY RD E TO HWY 11 N (CPTUS3)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



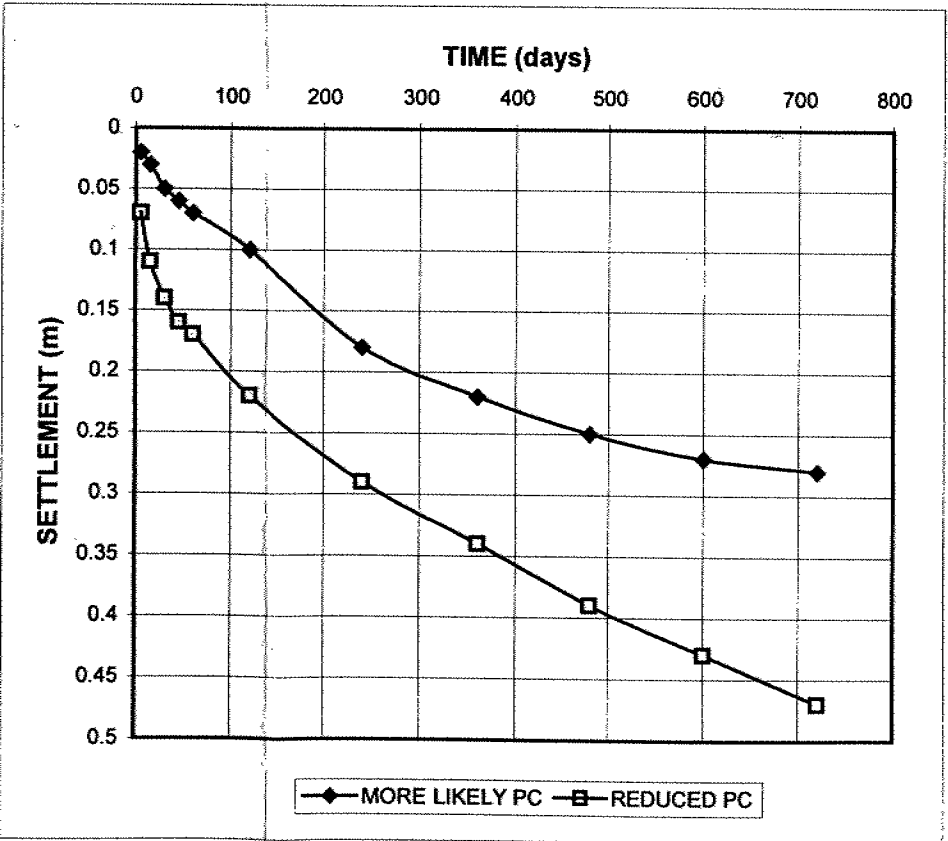
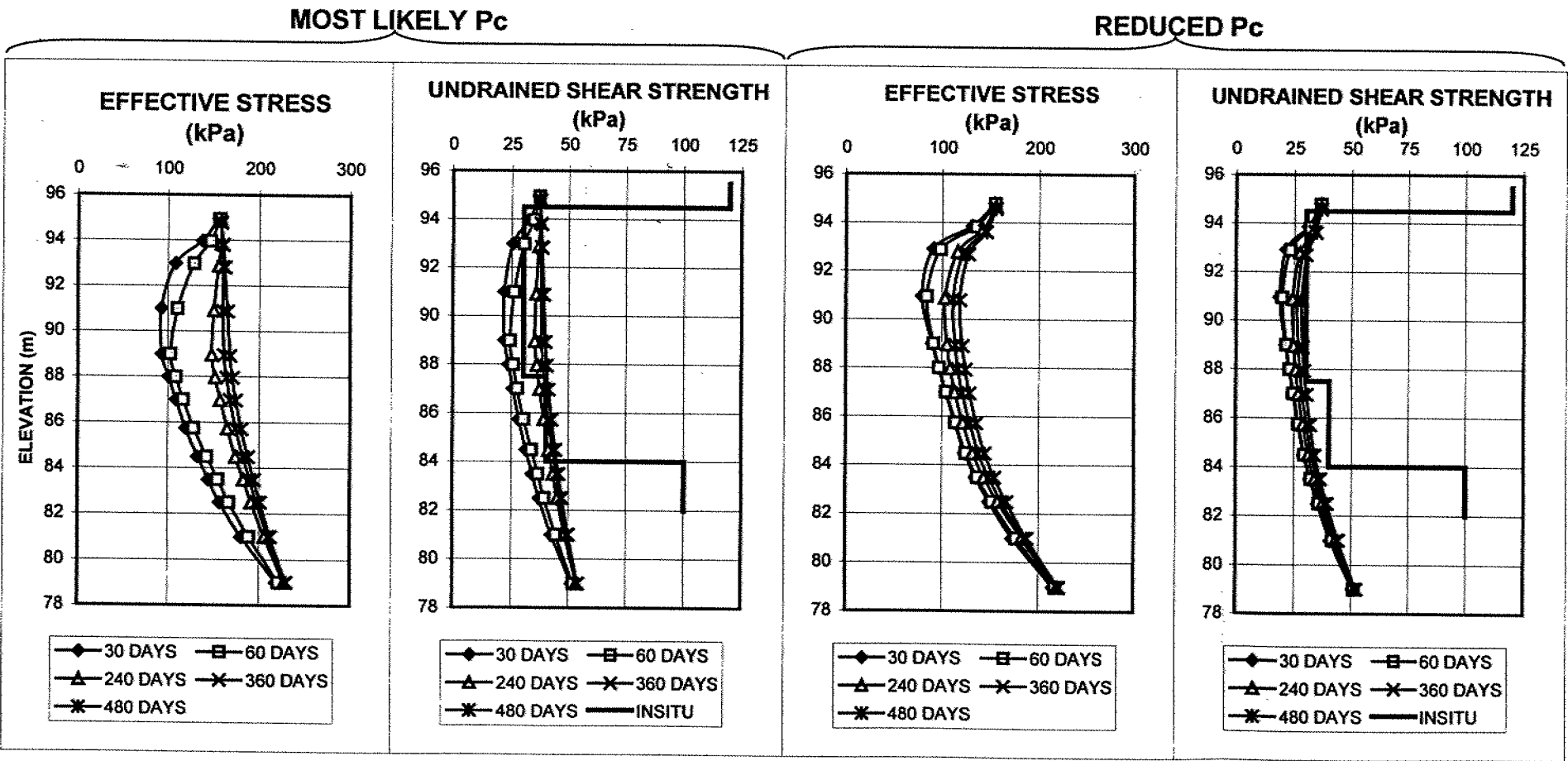
—◆— 60 DAYS —■— 180 DAYS —▲— 240 DAYS —×— 450 DAYS

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - STATION 8+500, EASTWEST-NORTH RAMP (CPTUS5)**  
**SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS**  
**(AT THE CENTRELINE OF THE EMBANKMENT)**

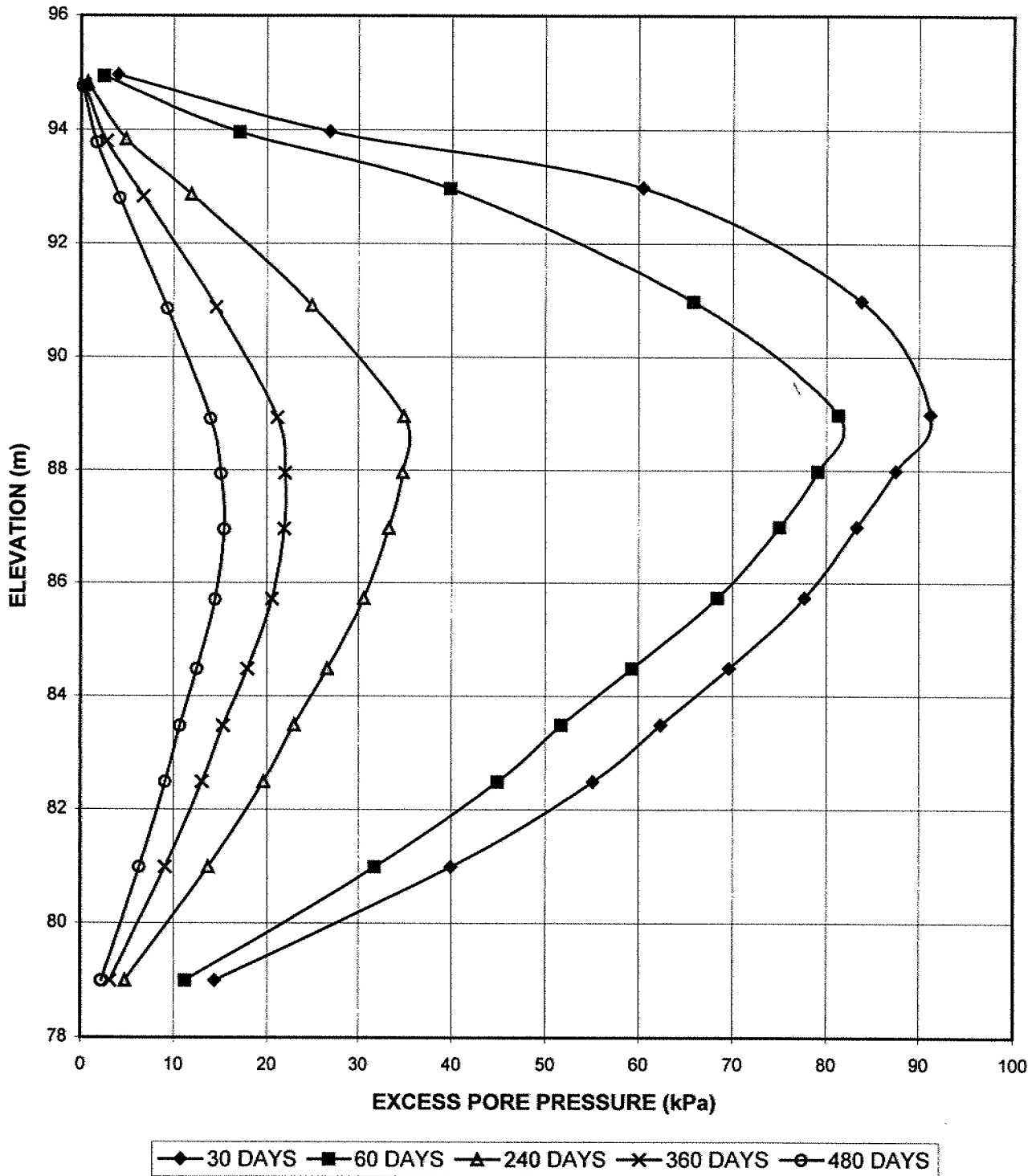


CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0

CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0



HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+500 EW-N RAMP (CPTUS5)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)

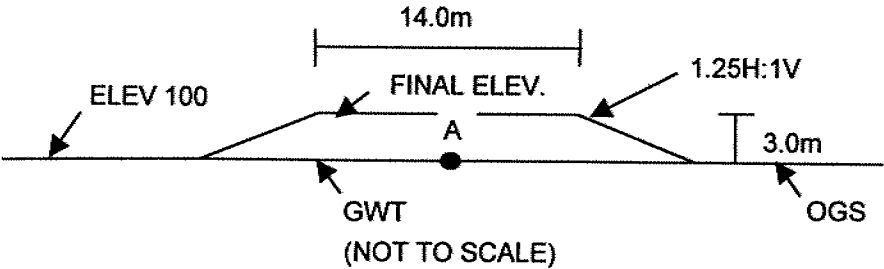


EPP - CHART

FIGURE A16-B

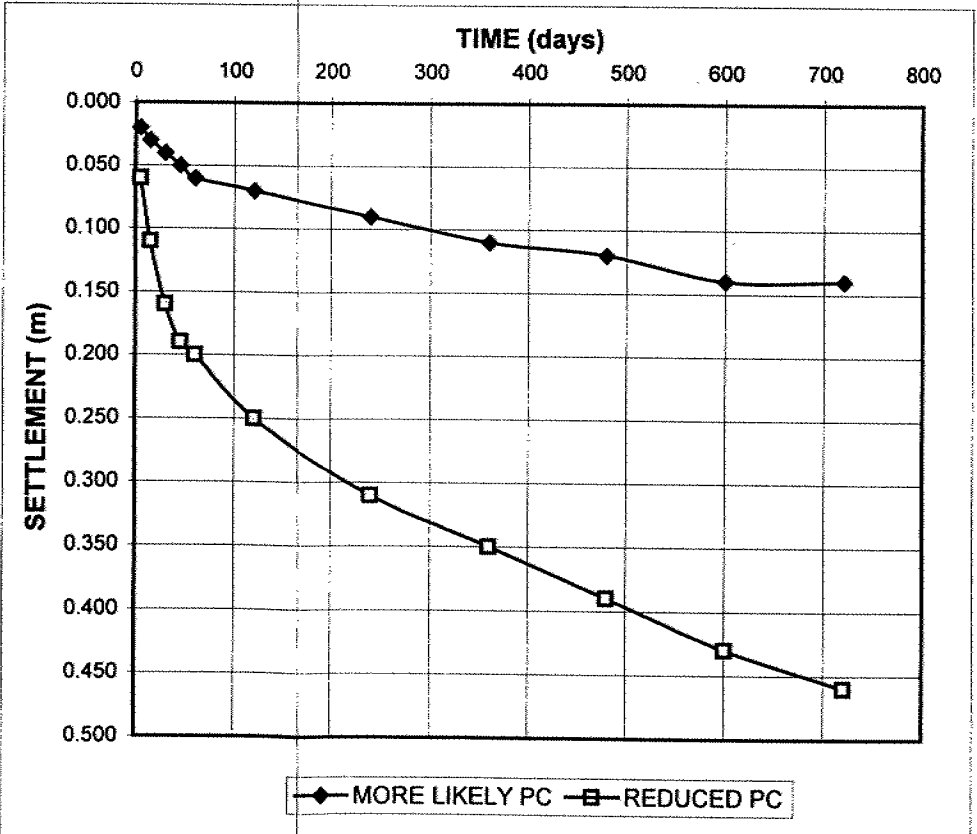
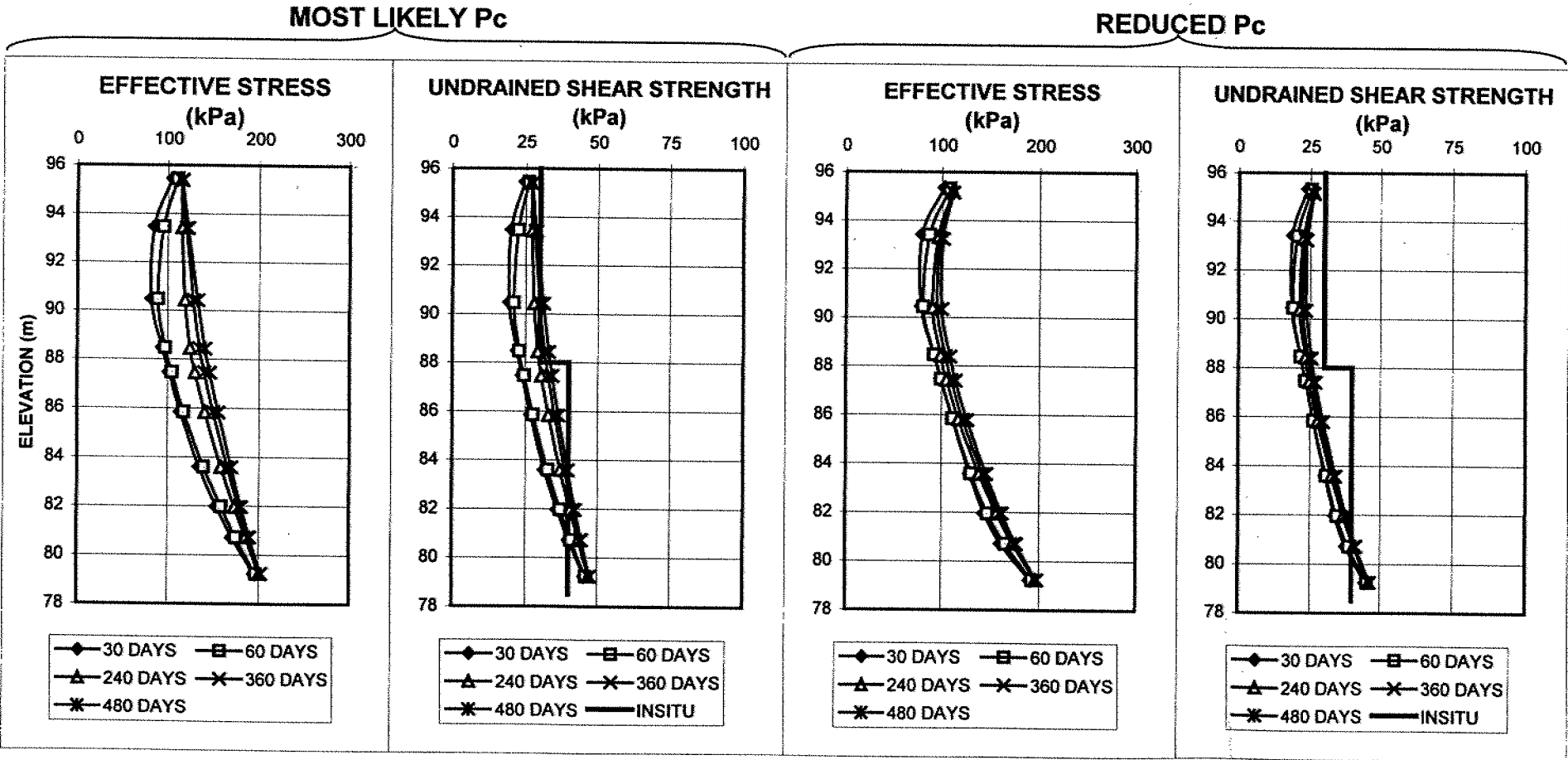


HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - STATION 8+600, S-EW RAMP (BH31FP)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(AT THE CENTRELINE OF THE EMBANKMENT)



CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	4	0

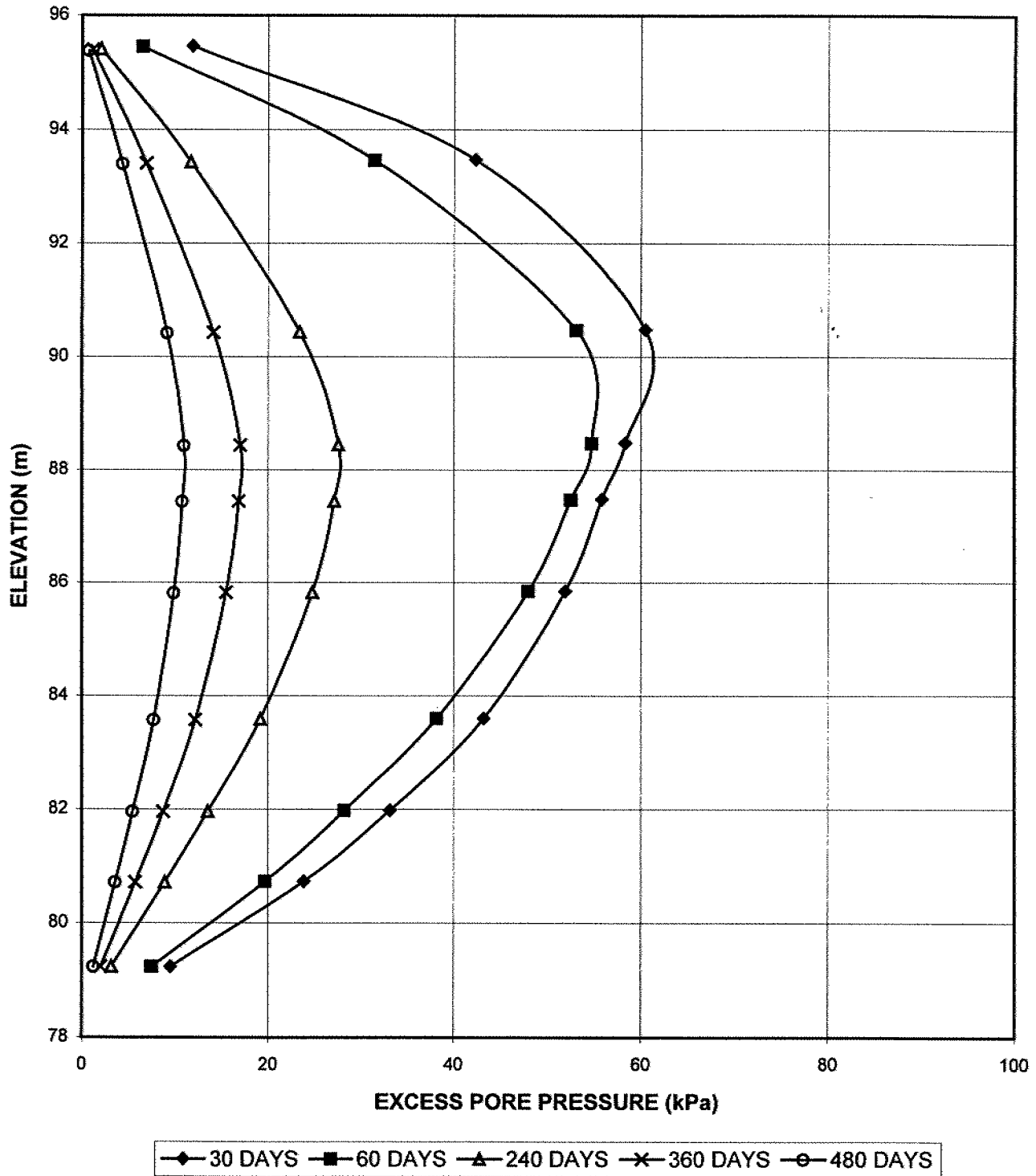
CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	4	0



MASTER PLOT

FIGURE A17

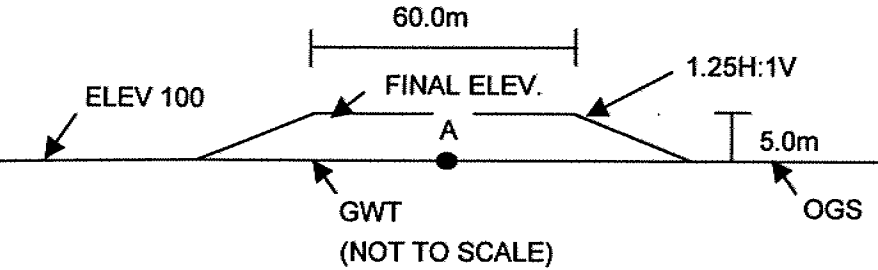
HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+600 S-EW RAMP (BH31FP)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



EPP - CHART

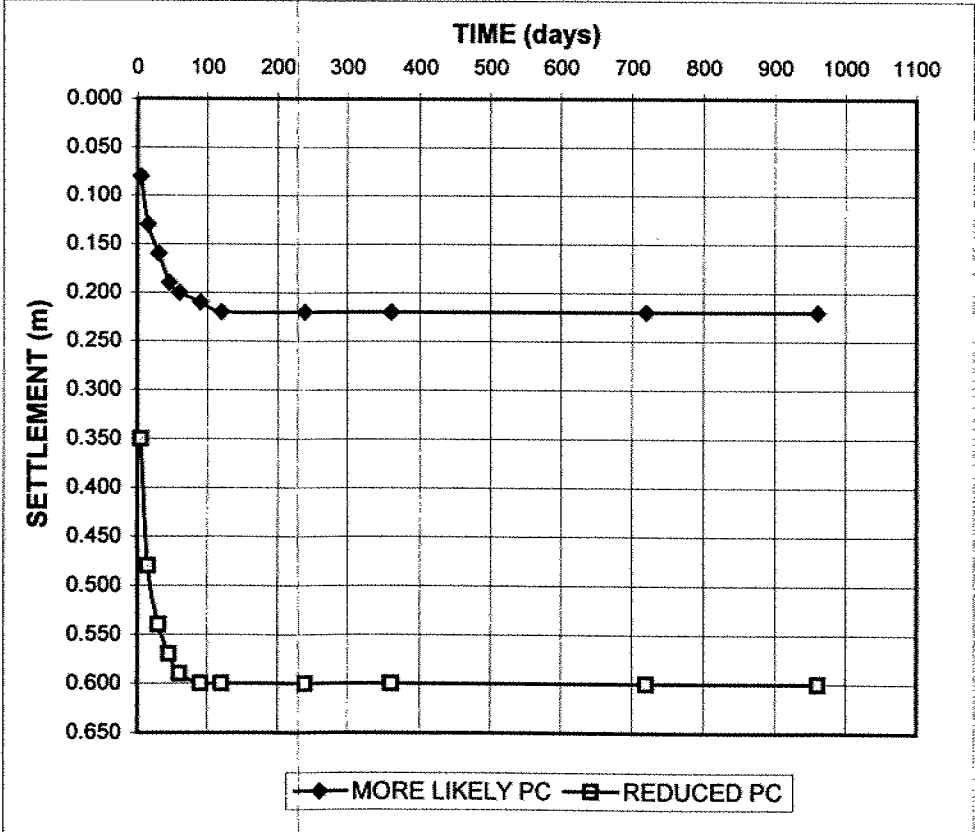
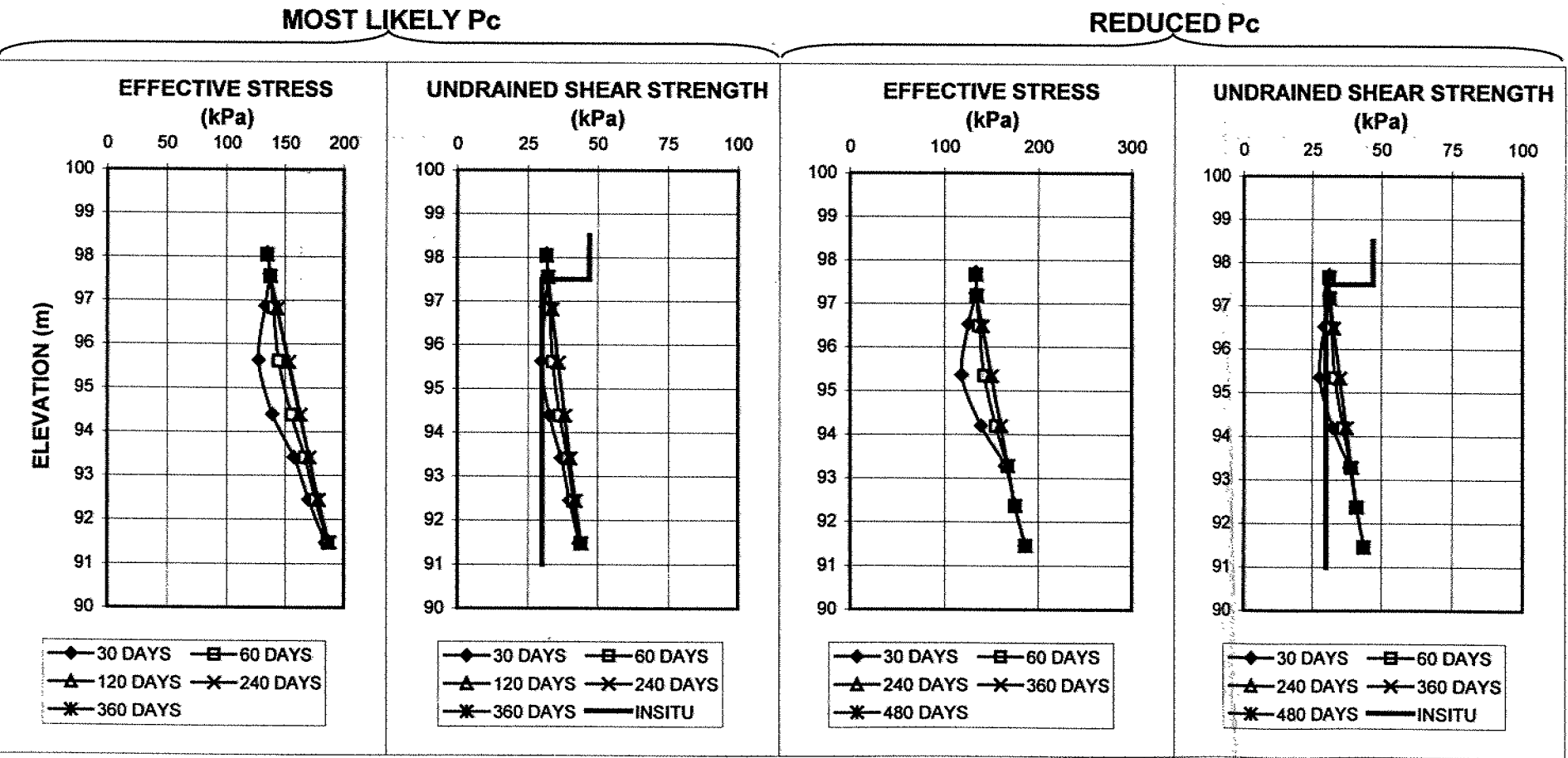
FIGURE A17-B

HIGHWAY 11 - TROUT CREEK BY-PASS  
 SOUTH INTERCHANGE - STATION 8+800, HIGHWAY 11 (BH23FP)  
 SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
 (AT THE CENTRELINE OF THE EMBANKMENT)



CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0

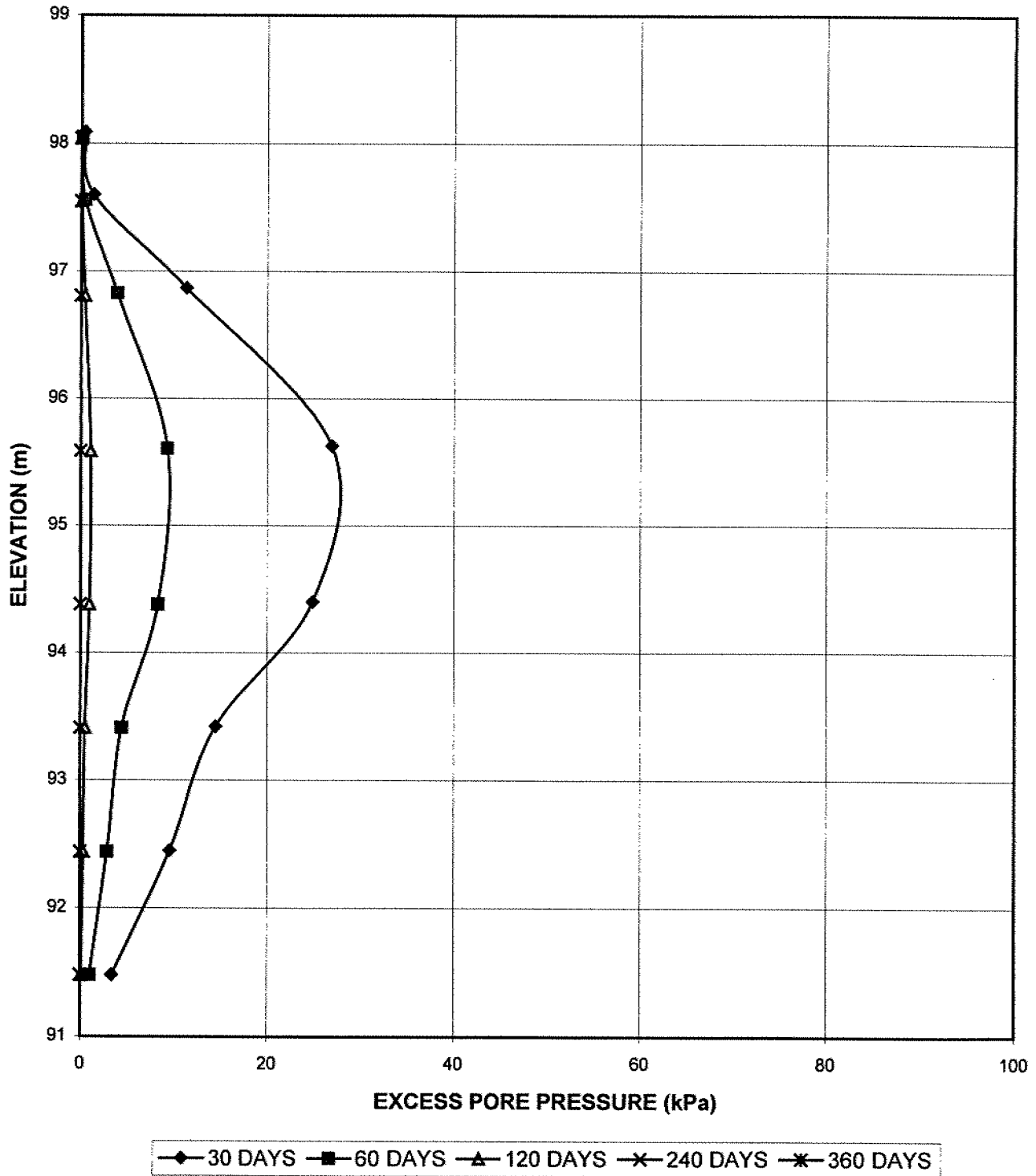
CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0



MASTER PLOT

FIGURE A18

HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+800 HIGHWAY 11 (BH23FP)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



EPP - CHART

FIGURE A18-B



**APPENDIX B**

**TABLES**

**Table B1 - Piezocone Test Locations and Depths**

Piezocone No.	Coordinates		Ground Surface Elevation (m)	Maximum Testing Depth (m)
	N	E		
CPTUS1	5091695	315187.5	313.3	13.05
CPTUS2	5091753	315239.7	313.1	9.75
CPTUS3	5091783.6	315289.1	313.2	16.93
CPTUS4	5091661.8	315234.3	313.2	15.28
CPTUS5	5091701.5	315407.5	312.3	22.08

TABLE B2

**HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE  
SOIL PROPERTIES FOR STABILITY AND SETTLEMENT ANALYSIS**

Location	Soil Layer	Depth Interval		Unit Weight (kN/m3)	Undrained Shear Strength (kPa)	Friction Angle (deg)	Poisson's Ratio	Young's Modulus (MPa)	Compression Ratio		Pre-consolidation Pressure		Coeff. Of Consolidation (m2/y)				Secondary Compression Ratio
		From (m)	To (m)						C <sub>h</sub> (1- $\alpha$ )	C <sub>v</sub> (1- $\alpha$ )	Most Likely (kPa)	Reduced (kPa)	C <sub>v</sub>		C <sub>h</sub>		
CPTUS1 West and East Abutments	Rock Fill	top of fill	1	20	---	42	0.3	150	N/A	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	N/A	N/A	N/A	---	---	---	---	---	---	---	---
	Upper Silt	1	1.5	18	---	28	0.3	22.5	0.2	0.02	---	---	---	---	---	---	---
	Clayey Silt	1.5	3.5	18	75	---	0.4	22.5	0.2	0.02	O.C.	O.C.	93	20	463	100	0.002
		3.5	5	18	50	---	0.4	15	0.2	0.02	319	150	93	20	463	100	0.002
		5	7	17.5	30	---	0.45	9	0.2	0.02	212	100	55	20	273	100	0.002
		7	8.5	18	50	---	0.4	15	0.2	0.02	128	60	36	20	179	100	0.002
	Lower Silt	8.5	9.5	18	---	30	0.35	22.5	0.2	0.02	212	100	80	20	399	100	0.002
	Silty Sand/Sandy Silt	9.5	13	19	---	32	0.3	30	---	---	600	300	120	20	600	100	0.002
Bedrock	13	>13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
CPTUS3 East Approach to Bridge	Rock Fill	top of fill	1.5	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1.5	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Sand	1.5	3	19	---	30	0.3	30	---	---	---	---	---	---	---	---	---
	Upper Silt	3	4	18	120	---	0.3	22.5	0.2	0.02	---	---	---	---	---	---	---
	Clayey Silt	4	9.5	18	30	---	0.45	9	0.2	0.02	500	250	139	20	694	100	0.002
	Lower Silt	9.5	12	18	65	---	0.3	20	0.2	0.02	128	N.C.	37	20	184	100	0.002
	Sandy Silt	12	13.5	18.5	---	30	0.3	20	0.2	0.02	277	140	54	20	268	100	0.002
	Silty Sand/Sand	13.5	17.5	19	---	33	0.3	30	0.2	0.02	277	140	---	---	925	---	---
	Bedrock	17.5	>17.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CPTUS5 EW-N Ramp	Rock Fill	top of fill	1	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Sand	1	4.5	19	---	33	0.3	30	---	---	---	---	---	---	---	---	---
	Upper Silt	4.5	5.5	18	120	---	0.3	22.5	0.2	0.02	---	---	---	---	---	---	---
	Clayey Silt	5.5	12.5	17.5	30	---	0.45	9	0.2	0.02	500	250	118	20	589	100	0.002
		12.5	16	18	40	---	0.45	12	0.2	0.02	128	N.C.	27	20	137	100	0.002
	Lower Silt	16	18	18	100	---	0.3	30	0.2	0.02	170	N.C.	67	20	336	100	0.002
	Sandy Silt	18	22	18.5	---	32	0.3	20	0.2	0.02	425	210	118	20	589	100	0.002
	Silty Sand/Sand	22	24	19	---	35	0.3	30	0.2	0.02	425	210	---	---	589	---	---
Bedrock	24	>24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
BH31FP EW-N Ramp	Rock Fill	top of fill	1	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Silty Sand	1	4	19	---	32	0.3	30	---	---	---	---	---	---	---	---	---
	Clayey Silt	4	12	17.5	30	---	0.45	9	0.2	0.02	---	---	---	---	---	---	---
		12	18.5	17.5	40	---	0.45	12	0.2	0.02	128	N.C.	27	20	137	100	0.002
	Lower Silt	18.5	21.5	18	40	---	0.3	12	0.2	0.02	170	N.C.	67	20	336	100	0.002
	Silt to Silty Sand	21.5	26.5	18.5	---	32	0.3	20	---	---	---	---	---	---	---	---	---
	Bedrock	26.5	>26.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BH23FP Hwy 11 - north of Bridge	Rock Fill	top of fill	1.5	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1.5	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Silt	1.5	2.5	18	---	32	0.3	30	---	---	200	100	263	20	1314	100	0.002
	Clayey Silt	2.5	6	18	30	---	0.45	9	0.2	0.02	128	N.C.	35	20	173	100	0.002
	Lower Silt	6	9	18	30	---	0.3	9	0.2	0.02	128	N.C.	263	20	1314	100	0.002
	Lower Sand	9	11	19	---	32	0.3	20	---	---	---	---	---	---	---	---	---
	Bedrock	11	>11	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes: O.C.: Over Consolidated Soil  
N.C.: Normally Consolidated Soil



**TABLE B3**  
**HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE**  
**SUMMARY OF STABILITY ANALYSIS**

Location	Design Height (m)	Target Height (m)	Berm Height (m)	Berm Width (m)	Height at this Stage (m)	Height at Previous Stage (m)	EPP dissipation before this stage	Factor of Safety	Reference Figure
CPTUS1 West and East Abutments	11.5	13	5.5	2	10	0	0%	1.37	
					13	10	50%	1.13	
					13	10	100%	1.18	
				7	10	0	0%	1.49	A7
					13	10	50%	1.29	A8
					13	13	100%	1.41	A9
CPTUS1-Head Slopes	11.5	13	0	0	13	10	50%	1.33	
(Final Configuration)	11.5	11.5	0	0	11.5	11.5	100%	1.55	
CPTUS3 East Approach to Bridge	10	11.5	4	2	7.5	0	0%	1.33	
					9.5	7.5	100%	1.31	
					11.5	9.5	100%	1.21	
				6	8.5	0	0%	1.32	
					9.5	8.5	40%	1.33	
					11.5	9.5	100%	1.32	
				8	9.5	0	0%	1.30	A10
					11.5	9.5	75%	1.32	A11
	9	10.5	3	8	9	0	0%	1.33	
	8	9.5	2	8	9.5	0	0%	1.21	
					8.5	0	0%	1.33	
					9.5	8.5	75%	1.33	
	7	8.5	1	8	8	0	0%	1.33	
	6	7.5	0	0	7.5	0	0%	1.28	
CPTUS5-EW-N Ramp	5	6	0	0	6	0	0%	1.70	A12

Note: EPP - Excess Pore Pressure

TABLE B4

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+500 - EW-N Ramp - CPTUS5  
Most Likely Pre-Consolidation Pressures - 14 m wide embankment top**

Initial Fill Height (m)		2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)		19 mm	29 mm	40 mm	51 mm	62 mm	73 mm
Primary Consol. Settl. (mm)		37 mm	71 mm	134 mm	236 mm	331 mm	418 mm
Total Settlement (mm) (*)		56 mm	100 mm	174 mm	287 mm	393 mm	491 mm
Final Height above O.G.S. (m)		1.944 m	2.9 m	3.826 m	4.713 m	5.607 m	6.509 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	6.3	21	1.979	33	2.967	48	3.952	66	4.934	83	5.917	99	6.901
15	0.50	9.4	22	1.978	36	2.964	53	3.947	73	4.927	93	5.907	112	6.888
30	1.00	15.6	25	1.975	40	2.960	61	3.939	88	4.912	114	5.886	138	6.862
45	1.50	18.8	26	1.974	42	2.958	65	3.935	95	4.905	124	5.876	152	6.848
60	2.00	21.9	27	1.973	45	2.955	69	3.931	103	4.897	134	5.866	165	6.835
120	4.00	31.3	31	1.969	51	2.949	82	3.918	125	4.875	166	5.834	204	6.796
240	8.00	56.3	40	1.960	69	2.931	115	3.885	184	4.816	248	5.752	308	6.692
360	12.00	68.8	44	1.956	78	2.922	132	3.868	213	4.787	290	5.710	361	6.639
480	16.00	78.1	48	1.952	84	2.916	145	3.855	235	4.765	321	5.679	399	6.601
600	20.00	84.4	50	1.950	89	2.911	153	3.847	250	4.750	341	5.659	426	6.574
720	24.00	87.5	51	1.949	91	2.909	157	3.843	258	4.743	352	5.648	439	6.561

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.944	> maximum time above	> 4.00	Approximate Time for 100% Consolidation (months)			
2.9		> maximum time above	> 0.50	#N/A	#N/A	#N/A
3.826			> 4.00	> 1.50	> 0.50	> 0.17
4.713			> maximum time above	> 4.00	> 4.00	> 2.00
5.607				> maximum time above	> 8.00	> 4.00
6.509					> maximum time above	> 12.00
						> maximum time above

TABLE B5

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
**Station 8+500 - EW-N Ramp - CPTUS5**  
**Reduced Pre-Consolidation Pressures - 14 m wide embankment top**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	19 mm	29 mm	40 mm	51 mm	62 mm	73 mm
Primary Consol. Settl. (mm)	272 mm	392 mm	505 mm	617 mm	733 mm	851 mm
Total Settlement (mm) (*)	291 mm	421 mm	545 mm	668 mm	795 mm	924 mm
Final Height above O.G.S. (m)	1.709 m	2.579 m	3.455 m	4.332 m	5.205 m	6.076 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	9.3	44	1.956	65	2.935	87	3.913	108	4.892	130	5.870	152	6.848
15	0.50	14.7	59	1.941	87	2.913	114	3.886	142	4.858	170	5.830	198	6.802
30	1.00	18.7	70	1.930	102	2.898	134	3.866	166	4.834	199	5.801	232	6.768
45	1.50	21.3	77	1.923	112	2.888	148	3.852	182	4.818	218	5.782	254	6.746
60	2.00	22.7	81	1.919	118	2.882	155	3.845	191	4.809	228	5.772	266	6.734
120	4.00	29.3	99	1.901	144	2.856	188	3.812	232	4.768	277	5.723	322	6.678
240	8.00	38.7	124	1.876	181	2.819	235	3.765	290	4.710	346	5.654	402	6.598
360	12.00	45.3	142	1.858	207	2.793	269	3.731	331	4.669	394	5.606	459	6.541
480	16.00	52	160	1.840	233	2.767	303	3.697	372	4.628	443	5.557	516	6.484
600	20.00	57.3	175	1.825	254	2.746	329	3.671	405	4.595	482	5.518	561	6.439
720	24.00	62.7	190	1.810	275	2.725	357	3.643	438	4.562	522	5.478	607	6.393

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.709	> maximum time above	> maximum time above	> 12.00	> 8.00	> 4.00	> 2.00
2.579		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
3.455			> maximum time above	> maximum time above	> maximum time above	> 16.00
4.332				> maximum time above	> maximum time above	> maximum time above
5.205					> maximum time above	> maximum time above
6.076						> maximum time above

TABLE B6

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+500 - EW-N Ramp - CPTUS5  
Most Likely Pre-Consolidation Pressures - 40 m wide embankment top**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	24 mm	36 mm	48 mm	61 mm	73 mm	85 mm
Primary Consol. Settl. (mm)	54 mm	116 mm	228 mm	334 mm	429 mm	516 mm
Total Settlement (mm) (*)	78 mm	152 mm	276 mm	395 mm	502 mm	601 mm
Final Height above O.G.S. (m)	1.922 m	2.848 m	3.724 m	4.605 m	5.498 m	6.399 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	8.3	27	1.973	43	2.957	62	3.938	82	4.918	100	5.900	118	6.882
15	0.50	9.4	29	1.971	47	2.953	69	3.931	92	4.908	113	5.887	134	6.866
30	1.00	15.6	32	1.968	54	2.946	84	3.916	113	4.887	140	5.860	165	6.835
45	1.50	18.8	34	1.966	58	2.942	91	3.909	124	4.876	154	5.846	182	6.818
60	2.00	21.9	36	1.964	61	2.939	98	3.902	134	4.866	167	5.833	198	6.802
120	4.00	31.3	41	1.959	72	2.928	119	3.881	166	4.834	207	5.793	247	6.753
240	8.00	56.3	54	1.948	101	2.899	176	3.824	249	4.751	315	5.685	376	6.624
360	12.00	68.8	61	1.939	116	2.884	205	3.795	291	4.709	368	5.632	440	6.560
480	16.00	78.1	66	1.934	127	2.875	226	3.774	322	4.678	408	5.592	488	6.512
600	20.00	84.4	70	1.930	134	2.866	240	3.760	343	4.657	435	5.565	521	6.479
720	24.00	87.5	71	1.929	138	2.863	248	3.753	353	4.647	448	5.552	537	6.464

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.922	> maximum time above	> 4.00	Approximate Time for 100% Consolidation (months)			
2.848		> maximum time above	> 0.50	#N/A	#N/A	#N/A
3.724			> 4.00	> 2.00	> 1.00	> 0.50
4.605			> maximum time above	> 8.00	> 4.00	> 4.00
5.498				> maximum time above	> 12.00	> 8.00
6.399					> maximum time above	> 16.00
						> maximum time above

TABLE B7

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+500 - EW-N Ramp - CPTUS5  
Reduced Pre-Consolidation Pressures - 40 m wide embankment top**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	24 mm	36 mm	48 mm	61 mm	73 mm	85 mm
Primary Consol. Settl. (mm)	344 mm	488 mm	629 mm	770 mm	899 mm	1018 mm
Total Settlement (mm) (*)	368 mm	524 mm	677 mm	831 mm	972 mm	1103 mm
Final Height above O.G.S. (m)	1.632 m	2.476 m	3.323 m	4.169 m	5.028 m	5.897 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	9.3	56	1.944	81	2.919	106	3.894	133	4.887	157	5.843	180	6.820
15	0.50	14.7	75	1.925	108	2.892	140	3.860	174	4.826	205	5.795	235	6.765
30	1.00	18.7	88	1.912	127	2.873	166	3.834	205	4.795	241	5.759	275	6.725
45	1.50	21.3	97	1.903	140	2.860	182	3.818	225	4.775	264	5.736	302	6.698
60	2.00	22.7	102	1.898	147	2.853	191	3.809	236	4.764	277	5.723	316	6.684
120	4.00	29.3	125	1.875	179	2.821	232	3.768	287	4.713	336	5.684	383	6.617
240	8.00	38.7	157	1.843	225	2.775	291	3.709	359	4.641	421	5.579	479	6.521
360	12.00	45.3	180	1.820	257	2.743	333	3.667	410	4.590	480	5.520	546	6.454
480	16.00	52	203	1.797	290	2.710	375	3.625	481	4.539	540	5.460	614	6.386
600	20.00	57.3	221	1.779	316	2.684	408	3.592	502	4.498	588	5.412	668	6.332
720	24.00	62.7	240	1.760	342	2.658	442	3.558	544	4.456	637	5.363	723	6.277

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.632	> maximum time above	> maximum time above	> 12.00	> 8.00	> 4.00	> 2.00
2.476		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
3.323			> maximum time above	> maximum time above	> maximum time above	> 20.00
4.169				> maximum time above	> maximum time above	> maximum time above
5.028					> maximum time above	> maximum time above
5.897						> maximum time above

TABLE B8

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+600 - S-EW Ramp - BH31FP  
Most Likely Pre-Consolidation Pressures**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	17 mm	25 mm	35 mm	44 mm	54 mm	64 mm
Primary Consol. Settl.(mm)	53 mm	86 mm	173 mm	311 mm	453 mm	585 mm
Total Settlement (mm) (*)	70 mm	111 mm	208 mm	355 mm	507 mm	649 mm
Final Height above O.G.S. (m)	1.93 m	2.889 m	3.792 m	4.645 m	5.493 m	6.351 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	11.8	23	1.977	35	2.965	55	3.945	81	4.919	107	5.893	133	6.867
15	0.50	17.6	28	1.974	40	2.960	65	3.935	99	4.901	134	5.866	167	6.833
30	1.00	23.5	29	1.971	45	2.955	76	3.924	117	4.883	160	5.840	201	6.799
45	1.50	29.4	33	1.967	50	2.950	86	3.914	135	4.865	187	5.813	236	6.764
60	2.00	35.3	36	1.964	55	2.945	96	3.904	154	4.846	214	5.786	271	6.729
120	4.00	41.2	39	1.961	60	2.940	106	3.894	172	4.828	241	5.759	305	6.695
240	8.00	52.9	45	1.955	70	2.930	127	3.873	209	4.791	294	5.706	373	6.627
360	12.00	64.7	51	1.949	81	2.919	147	3.853	245	4.755	347	5.653	442	6.558
480	16.00	70.6	54	1.946	86	2.914	157	3.843	264	4.736	374	5.626	477	6.523
600	20.00	82.4	61	1.939	96	2.904	178	3.822	300	4.700	427	5.573	546	6.454
720	24.00	82.4	61	1.939	96	2.904	178	3.822	300	4.700	427	5.573	546	6.454

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.93	> maximum time above	> 4.00	> 0.50	#N/A	#N/A	#N/A
2.889		> maximum time above	> 4.00	> 0.50	> 0.17	#N/A
3.792			> maximum time above	> 4.00	> 1.50	> 1.00
4.645				> maximum time above	> 12.00	> 4.00
5.493					> maximum time above	> 16.00
6.351						> maximum time above

TABLE B9

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+600 - S-EW Ramp - BH31FP  
Reduced Pre-Consolidation Pressures**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	17 mm	25 mm	35 mm	44 mm	54 mm	64 mm
Primary Consol. Settl. (mm)	378 mm	557 mm	723 mm	876 mm	1018 mm	1150 mm
Total Settlement (mm) (*)	393 mm	582 mm	758 mm	920 mm	1072 mm	1214 mm
Final Height above O.G.S. (m)	1.607 m	2.418 m	3.242 m	4.08 m	4.928 m	5.786 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	8.2	48	1.952	71	2.929	94	3.906	116	4.884	137	5.863	158	6.842
15	0.50	15.1	74	1.926	109	2.891	144	3.856	176	4.824	208	5.792	238	6.762
30	1.00	21.9	99	1.901	147	2.853	193	3.807	236	4.784	277	5.723	316	6.684
45	1.50	28	115	1.885	170	2.830	223	3.777	272	4.728	319	5.681	363	6.637
60	2.00	27.4	120	1.880	178	2.822	233	3.767	284	4.716	333	5.667	379	6.621
120	4.00	34.2	146	1.854	215	2.785	282	3.718	344	4.658	402	5.598	457	6.543
240	8.00	42.5	177	1.823	262	2.738	342	3.658	416	4.584	487	5.513	553	6.447
360	12.00	47.9	197	1.803	292	2.708	381	3.619	464	4.536	542	5.458	615	6.385
480	16.00	53.4	218	1.782	322	2.678	421	3.579	512	4.488	598	5.402	678	6.322
600	20.00	58.9	238	1.762	353	2.647	461	3.539	560	4.440	654	5.346	741	6.259
720	24.00	63	254	1.746	376	2.624	490	3.510	596	4.404	695	5.305	789	6.212

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.607	> maximum time above	> maximum time above	> 12.00	> 4.00	> 2.00	> 2.00
2.418		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
3.242			> maximum time above	> maximum time above	> maximum time above	> 20.00
4.08				> maximum time above	> maximum time above	> maximum time above
4.928					> maximum time above	> maximum time above
5.786						> maximum time above

TABLE B10

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
 Highway 11 - South of Interchange - 60m Wide Embankment Top - BH31FP  
 Most Likely Pre-Consolidation Pressures

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	6 m
Immediate Settlement (mm)	22 mm	33 mm	43 mm	54 mm	65 mm	65 mm
Primary Consol. Settl. (mm)	91 mm	191 mm	328 mm	490 mm	637 mm	637 mm
Total Settlement (mm) (*)	113 mm	224 mm	371 mm	544 mm	702 mm	702 mm
Final Height above O.G.S. (m)	1.887 m	2.776 m	3.629 m	4.456 m	5.298 m	5.298 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	11.6	33	1.967	56	2.944	82	3.918	112	4.888	140	5.860	140	5.860
15	0.50	17.6	38	1.962	67	2.933	101	3.899	140	4.860	177	5.823	177	5.823
30	1.00	23.5	43	1.957	78	2.922	120	3.880	169	4.831	215	5.785	215	5.785
45	1.50	29.4	49	1.951	89	2.911	139	3.861	198	4.802	252	5.748	252	5.748
60	2.00	35.3	54	1.946	100	2.900	159	3.841	227	4.773	290	5.710	290	5.710
120	4.00	41.2	59	1.941	112	2.888	178	3.822	256	4.744	327	5.673	327	5.673
240	8.00	52.9	70	1.930	134	2.866	217	3.783	313	4.687	402	5.598	402	5.598
360	12.00	64.7	81	1.919	157	2.843	255	3.745	371	4.629	477	5.523	477	5.523
480	16.00	70.6	86	1.914	168	2.832	275	3.725	400	4.600	515	5.485	515	5.485
600	20.00	82.4	97	1.903	190	2.810	313	3.687	458	4.542	590	5.410	590	5.410
720	24.00	82.4	97	1.903	190	2.810	313	3.687	458	4.542	590	5.410	590	5.410

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	6
Final Height above O.G.S. (m)						
1.887	> maximum time above	> 4.00	> 0.50	> 0.17	#N/A	#N/A
2.776		> maximum time above	> 8.00	> 1.50	> 1.00	> 1.00
3.629			> maximum time above	> 8.00	> 4.00	> 4.00
4.456				> maximum time above	> 16.00	> 16.00
5.298					> maximum time above	> maximum time above
5.298						> maximum time above



TABLE B11

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
Highway 11 - South of Interchange - 60m Wide Embankment Top - BH31FP  
Reduced Pre-Consolidation Pressures

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	6 m
Immediate Settlement (mm)	22 mm	33 mm	43 mm	54.3 mm	65 mm	65 mm
Primary Consol. Settl (mm)	501 mm	710 mm	893 mm	1056 mm	1202 mm	1202 mm
Total Settlement (mm) (*)	523 mm	743 mm	936 mm	1110.3 mm	1267 mm	1267 mm
Final Height above O.G.S. (m)	1.477 m	2.257 m	3.064 m	3.8897 m	4.733 m	4.733 m

Time	% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	8.2	63	1.837	91	2.909	118	3.884	141	4.859	164	5.836	164	5.836
15	0.50	15.1	98	1.902	140	2.860	178	3.822	214	4.786	247	5.753	247	5.753
30	1.00	21.9	132	1.868	188	2.812	239	3.761	286	4.714	328	5.672	328	5.672
45	1.50	26	152	1.848	218	2.782	275	3.725	329	4.671	378	5.622	378	5.622
60	2.00	27.4	159	1.841	228	2.772	288	3.712	344	4.656	394	5.606	394	5.606
120	4.00	34.2	193	1.807	276	2.724	348	3.652	415	4.585	476	5.524	476	5.524
240	8.00	42.5	235	1.765	335	2.665	423	3.577	503	4.497	576	5.424	576	5.424
360	12.00	47.9	262	1.738	373	2.627	471	3.529	560	4.440	641	5.359	641	5.359
480	16.00	53.4	290	1.710	412	2.588	520	3.480	618	4.382	707	5.293	707	5.293
600	20.00	58.9	317	1.683	451	2.549	569	3.431	676	4.324	773	5.227	773	5.227
720	24.00	63	338	1.662	480	2.520	606	3.394	720	4.280	822	5.178	822	5.178

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	6
Final Height above O.G.S. (m)						
1.477	> maximum time above	> maximum time above	> 16.00	> 8.00	> 4.00	> 4.00
2.257		> maximum time above	> maximum time above	> maximum time above	> 16.00	> 16.00
3.064			> maximum time above	> maximum time above	> maximum time above	> maximum time above
3.8897			> maximum time above	> maximum time above	> maximum time above	> maximum time above
4.733				> maximum time above	> maximum time above	> maximum time above
4.733					> maximum time above	> maximum time above

TABLE B12

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
Station 8+800 - Hwy 11 - BH23FP - W=60m  
Most Likely Pre-Consolidation Pressures

Initial Fill Height (m)	3 m	4 m	5 m	6 m	7 m	7 m
Immediate Settlement (mm)	21 mm	27 mm	34 mm	41 mm	48 mm	48 mm
Primary Consol. Settl.(mm)	60 mm	96 mm	116 mm	228 mm	293 mm	293 mm
Total Settlement (mm) (*)	81 mm	123 mm	150 mm	269 mm	341 mm	341 mm
Final Height above O.G.S. (m)	2.919 m	3.877 m	4.85 m	5.731 m	6.659 m	6.659 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	36.4	43	2.957	62	3.938	76	4.924	124	5.876	155	6.845	155	6.845
15	0.50	59.1	56	2.944	84	3.916	103	4.897	176	5.824	221	6.779	221	6.779
30	1.00	72.7	65	2.935	97	3.903	118	4.882	207	5.793	261	6.739	261	6.739
45	1.50	86.4	73	2.927	110	3.890	134	4.866	238	5.762	301	6.699	301	6.699
60	2.00	90.9	76	2.924	114	3.886	139	4.861	248	5.752	314	6.686	314	6.686
120	4.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
240	8.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
360	12.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
480	16.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
600	20.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
720	24.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	3	4	5	6	7	7
Final Height above O.G.S. (m)						
2.919	> 24.00	> 0.17	> 0.17	#N/A	#N/A	#N/A
3.877		> 24.00	> 1.00	#N/A	#N/A	#N/A
4.85			> 24.00	> 0.17	#N/A	#N/A
5.731				> 24.00	> 1.00	> 1.00
6.659					> 24.00	> 24.00
6.659						> 24.00

TABLE B13

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+800 - Hwy 11 - BH23FP - W=60m  
Reduced Pre-Consolidation Pressures**

Initial Fill Height (m)	3 m	4 m	5 m	6 m	7 m	7 m
Immediate Settlement (mm)	21 mm	27 mm	34 mm	41 mm	48 mm	48 mm
Primary Consol. Settl.(mm)	342 mm	440 mm	537 mm	622 mm	697 mm	697 mm
Total Settlement (mm) (*)	363 mm	467 mm	571 mm	663 mm	745 mm	745 mm
Final Height above O.G.S. (m)	2.637 m	3.533 m	4.429 m	5.337 m	6.255 m	6.255 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	58.3	220	2.780	284	3.716	347	4.653	404	5.596	454	6.546	454	6.546
15	0.50	80	295	2.705	379	3.621	464	4.536	539	5.461	606	6.394	606	6.394
30	1.00	90	329	2.671	423	3.577	517	4.483	601	5.399	675	6.325	675	6.325
45	1.50	95	346	2.654	445	3.555	544	4.456	632	5.368	710	6.290	710	6.290
60	2.00	98.3	357	2.643	460	3.540	562	4.438	652	5.348	733	6.267	733	6.267
120	4.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
240	8.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
360	12.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
480	16.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
600	20.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
720	24.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	3	4	5	6	7	7
Final Height above O.G.S. (m)						
2.637	> 24.00	> 0.17	> 0.17	#N/A	#N/A	#N/A
3.533		> 24.00	> 0.50	> 0.17	> 0.17	> 0.17
4.429			> 24.00	> 0.50	> 0.17	> 0.17
5.337				> 24.00	> 0.50	> 0.50
6.255					> 24.00	> 24.00
6.255						> 24.00

# Wick Drain Design Assumptions

TABLE B14

## HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE WICK DRAIN DESIGN ASSUMPTIONS

Site Location	Test Hole	C <sub>h</sub> (m <sup>2</sup> /y)	C <sub>v</sub> (m <sup>2</sup> /y)	Embankment Load (kPa)	Wick Drain Drainage Length (m)	Disturbance Ratios		Discharge Capacity q <sub>w</sub> (m <sup>3</sup> /s)
						Diameter Ratio (s)	Permeability Ratio (k <sub>c</sub> /k <sub>c</sub> )	
West & East Abutments	CPTUS1	173	35	260	8.5	3	3	1.00E-05
East Approach	CPTUS3	142	28	230	8	3	3	1.00E-05
EW-N Ramp	CPTUS5	137	27	120	12	3	3	1.00E-05

Site Location	Target Percentage Consolidation and Time					
	Schedule 1		Schedule 2		Schedule 3	
	After Stage 1	After Stage 2	After Stage 1	After Stage 2	After Stage 1	After Stage 2
West & East Abutments	50% in 1 month	100% in 12 months	50% before Stage 2	100% in 12 months	50% before Stage 2	100% in 6 months
East Approach	75% in one month	100% in 12 months	75% before Stage 2	100% in 12 months	75% before Stage 2	100% in 6 months
EW-N Ramp	100% in 12 months		100% in 12 months		100% in 6 months	

**Schedule 1:**  
 2 months: Site preparation (includes installation of wick drains)  
 3 months: Embankment Construction  
 12 months: Waiting period for stabilization of settlements

**Schedule 2:** Embankment construction and stabilization of settlements in 12 months

**Schedule 3:** Embankment construction and stabilization of settlements in 6 months

TABLE B15

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Most Likely Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_R$	5.49E-06	$m^2/s$	consider reducing $c_R$ to account for smear; $C_R/C_v$ is often 2 to 5		
$C_v$	1.10E-06	$m^2/s$	determined by the oedometer test		
$\lambda$	1.10E-06	$m^2/s$	$=k_w/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_u$	5.00E-08	m/s	undisturbed soil permeability		
$k'_e$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_e =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	well resistance cannot be ignored if $k_c/q_w > 3.33E-04$
l	8.50	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	260.00	kPa	$U_v$ target:	50 %	
Drainage Path (m)	4.00	m	Target Time (days):	30 days	
Settlement due to Primary Consolidation	492	mm	Time for Drainage Path:	30 days	
n	56				
$\alpha$	0.3759384				

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
50	0.31	0.67
75	0.67	1.17
90	1.17	1.83
98	2.17	3.00

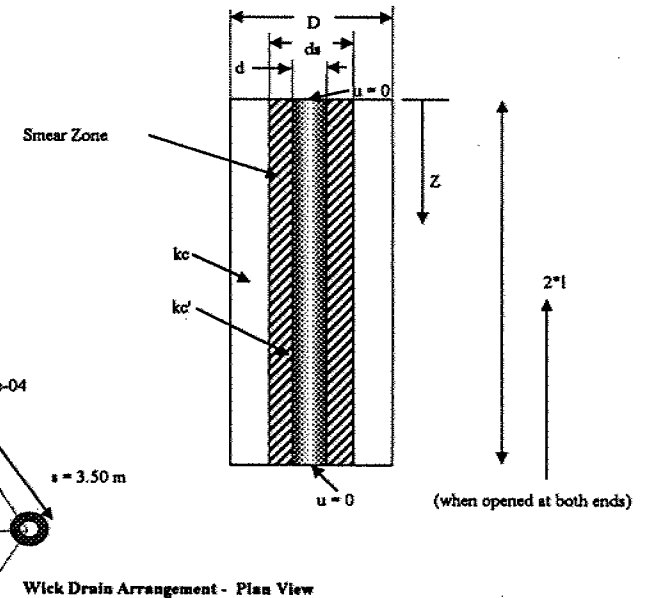


TABLE B16

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Most Likely Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_h$	5.49E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	1.10E-06	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	5.49E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	260.00	kPa		
Drainage Path (m)	4.00	m		
Settlement due to Primary Consolidation	492	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below = 0.17 month  
Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.83	1.33
90	1.50	2.83
98	3.00	8.00

TABLE B17

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Reduced Pc

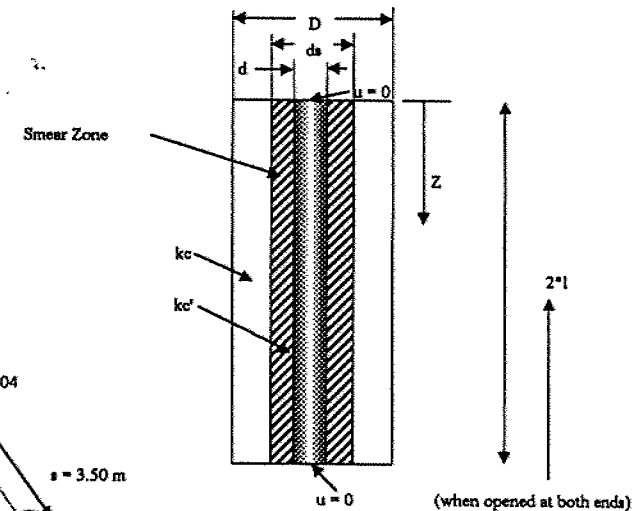
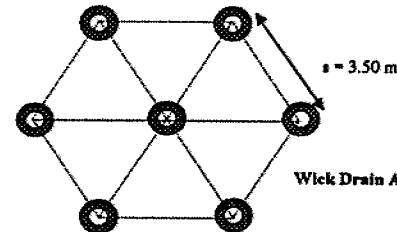
## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	5.49E-06	$m^2/s$	consider reducing $\alpha_s$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	1.10E-06	$m^2/s$	determined by the oedometer test		
$\lambda$	1.10E-06	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_s$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_0/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_0/q_w =$ 5.00E-03 ;well resistance cannot be ignored if $k_0/q_w > 3.33e-04$		
l	8.50	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL  
 260.00 kPa  
 4.00 m  
 890 mm  
 56 (D/d; should always be >12)  
 0.3759384 R(D/d); regression from Figure 3 of the paper

Uv target: 50 %  
 TargetTime (days): 30 days  
 Time for Drainage Path: 30 days



Time Increment for table below =  
 Resultant Maximum Time =

0.17 month  
 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.67	1.17
90	1.17	1.83
98	2.17	3.00

TABLE B18

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Reduced Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	5.49E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear, $C_h/C_v$ is often 2 to 5	
$C_v$	1.10E-06	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	5.49E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	260.00	kPa		
Drainage Path (m)	4.00	m		
Settlement due to Primary Consolidation	890	mm		
n	56	(D/d; should always be >12)		
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below =

0.17 month

Resultant Maximum Time =

10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.83	1.33
90	1.50	2.83
98	3.00	8.00



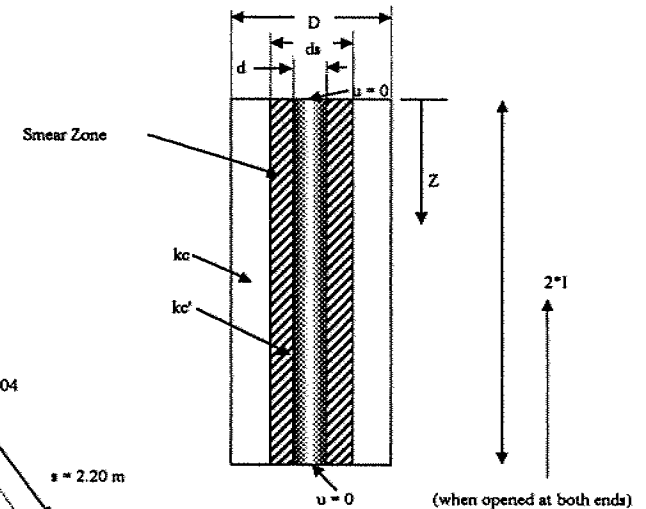
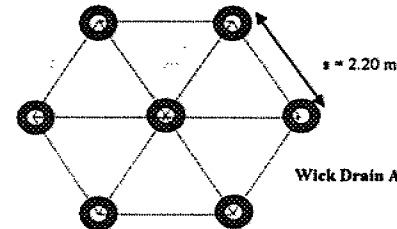
TABLE B19

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
 Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	2.20	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	35.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_h/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_c$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_c/q_w > 3.33e-04$
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	230.00	kPa	Uv target:	50 %	
Drainage Path (m)	4.50	m	Target Time (days):	50 days	
Settlement due to Primary Consolidation	480	mm	Time for Drainage Path:	50 days	
n	36	(D/d; should always be >12)			
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper)			



Time Increment for table below =  
 Resultant Maximum Time =

0.17 month  
 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.17	0.17
75	0.50	0.50
90	0.67	0.83
98	1.17	1.33

TABLE B20

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: Souht Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 2.20 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_H$ to account for smear, $C_H/C_V$ is often 2 to 5	
$C_V$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_t/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_H$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	480	mm		
n	36	(D/d; should always be >12)		
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below = 0.17 month  
Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	U <sub>v</sub> and U <sub>h</sub>	U <sub>h</sub> only
40	0.17	0.17
75	0.50	0.50
90	0.83	1.17
98	2.00	3.00

TABLE B21

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
 Consolidation Requirement: 75% in 1 month

**INPUT PARAMETERS**

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_c$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	well resistance cannot be ignored if $k_c/q_w > 3.33e-04$
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	230.00	kPa	$U_v$ target:	50 %	
Drainage Path (m)	4.50	m	TargetTime (days):	50 days	
Settlement due to Primary Consolidation	480	mm	Time for Drainage Path:	50 days	
n	56	(D/d; should always be >12)			
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)			

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
40	0.33	0.50
75	0.83	1.33
90	1.50	2.17
98	2.67	3.50

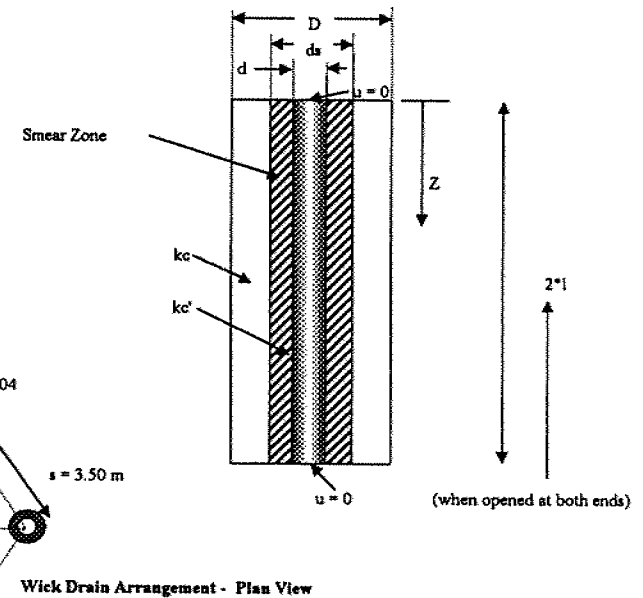


TABLE B22

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: Souht Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
Consolidation Requirement: 75% in 1 month

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_v/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	480	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below =  
Resultant Maximum Time =

0.17 month  
10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.33	0.50
75	1.00	1.83
90	2.00	3.67
98	4.33	more than maximum time entered

TABLE B23

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced  $P_c$   
 Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	2.20	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	35.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_w/(\gamma_w \cdot m_v)$ , or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_u$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_u/k'_s =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_u/q_w =$ 5.00E-03 ; well resistance cannot be ignored if $k_u/q_w > 3.33e-04$		
l	8.00	m	length of the drain when open at one end only		
Layer	ML-CL		half length of the drain when open at both ends		
Surcharge (kPa)	230.00	kPa	$U_v$ target:	50 %	
Drainage Path (m)	4.50	m	TargetTime (days):	50 days	
Settlement due to Primary Consolidation	1030	mm	Time for Drainage Path:	50 days	
n	36	(D/d; should always be >12)			
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper			

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
40	0.37	0.17
75	0.50	0.50
90	0.67	0.83
98	1.37	1.33

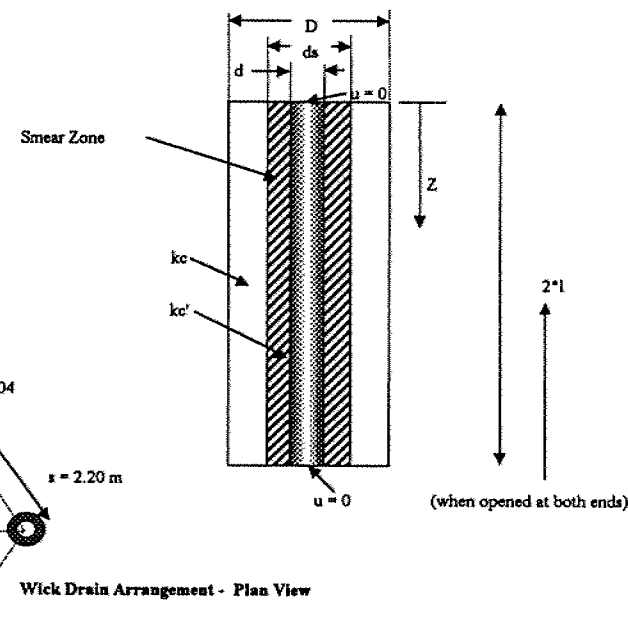


TABLE B24

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 2.20 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_H$ to account for smear; $C_H/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_H/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_H$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	1030	mm		
n	36	(D/d; should always be >12)		
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below =  
Resultant Maximum Time =

0.17 month  
10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.17	0.17
75	0.50	0.50
90	0.83	1.17
98	2.00	3.00

TABLE B25

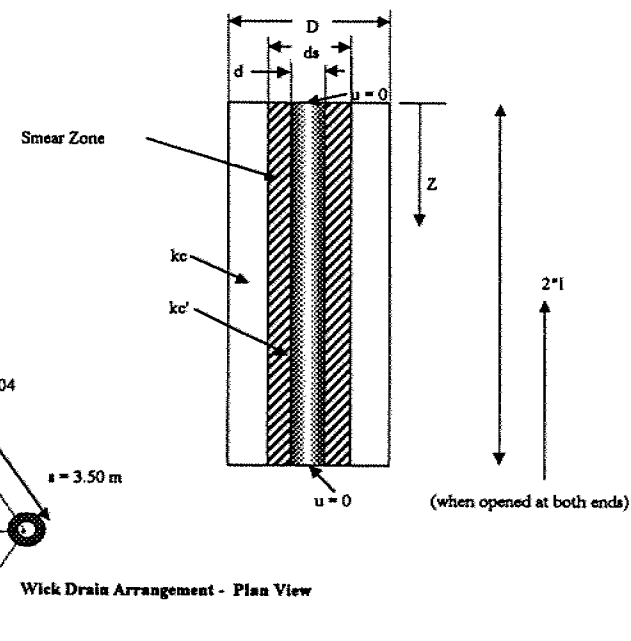
**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced  $P_c$   
 Consolidation Requirement: 75% in 1 month and 100% in 12 months

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $C_H$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$\approx k_v/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_v$	5.00E-08	$m/s$	undisturbed soil permeability		
$k'_s$	1.67E-08	$m/s$	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^2/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_c/q_w > 3.33E-04$
l	8.00	m	length of the drain when open at one end only		
Layer			half length of the drain when open at both ends		
Surcharge (kPa)	230.00	kPa			
Drainage Path (m)	4.50	m	Uv target:	50 %	
Settlement due to Primary Consolidation	1030	mm	Target Time (days):	50 days	
n	56	(D/d; should always be >12)	Time for Drainage Path:	50 days	
$\alpha$	0.3759384	(D/d); regression from Figure 3 of the paper)			

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months



% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.33	0.50
75	0.83	1.43
90	1.50	2.17
98	2.67	3.50

TABLE B26

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
Consolidation Requirement: 75% in 1 month and 100% in 12 months

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_h$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	1030	mm		
n	56	(D/d; should always be >12)		
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)		
Time Increment for table below =	0.17	month		
Resultant Maximum Time =	10.17	months		

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.33	0.50
75	1.00	1.83
90	2.00	3.67
98	4.33	more than maximum time entered



TABLE B27

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Most Likely Pc  
 Consolidation Requirement: 100% in one year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+1)/\pi$ ; $n =$	56.5	
$C_H$	4.34E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	8.69E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	8.69E-07	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_s$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_s/k'_s =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_s/q_w =$	5.00E-03	well resistance cannot be ignored if $k_s/q_w > 3.33E-04$
l	12.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL	120.00	kPa	Uv target:	50 %
	9.30	m	TargetTime (days):	220 days
	331	mm	Time for Drainage Path:	220 days
	56	(D/d; should always be >12)		
	0.3759384	(D/d); regression from Figure 3 of the paper)		

Time Increment for table below = 0.33 month  
 Resultant Maximum Time = 20.33 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.67	0.67
75	1.33	1.67
90	2.33	2.67
98	3.67	4.33

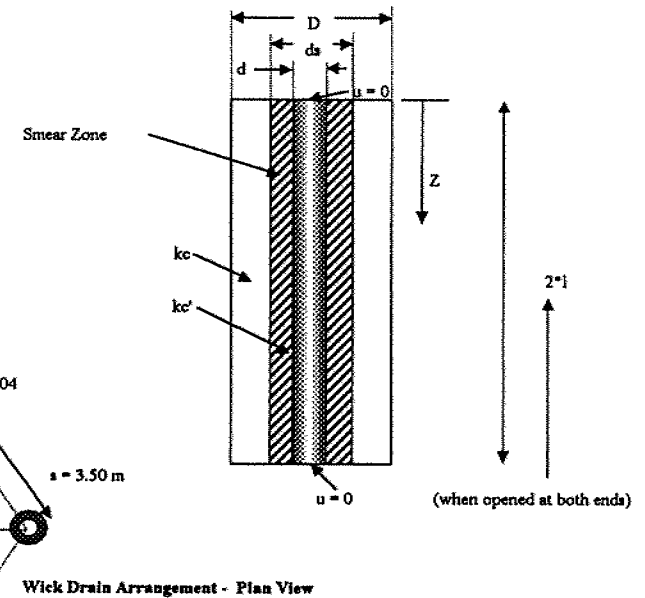


TABLE B28

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Most Likely Pc  
Consolidation Requirement: 100% in one year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	$s = 3.50$ m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.34E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	8.69E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.34E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	120.00	kPa		
Drainage Path (m)	9.30	m		
Settlement due to Primary Consolidation	331	mm		
n	56	(D/d; should always be >12)		
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)		
Time Increment for table below =	0.25	month		
Resultant Maximum Time =	15.25	months		

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.50	0.75
75	2.00	2.50
90	3.75	5.50
98	9.25	14.75

TABLE B29

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Reduced Pc  
 Consolidation Requirement: 100% in 1 year

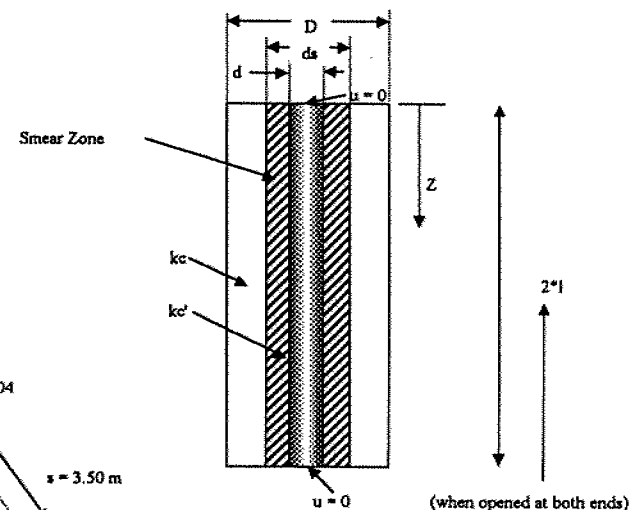
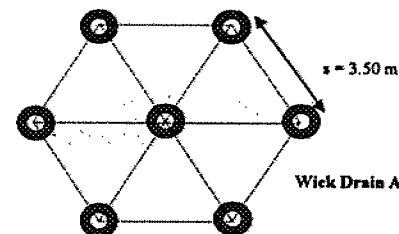
## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.34E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	8.69E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	8.69E-07	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_s$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_s/k'_s =$	3.00	
$q_w$	1.00E-05	$m^2/s$	drain discharge capacity; $k_s/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_s/q_w > 3.33E-04$
l	12.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL  
 120.00 kPa  
 11.80 m  
 734 mm  
 56 (D/d; should always be  $>12$ )  
 0.3759384  $(D/d)$ ; regression from Figure 3 of the paper

$U_v$  target: 50 %  
 Target Time (days): 350 days  
 Time for Drainage Path: 352.5 days



Time Increment for table below =  
 Resultant Maximum Time =

0.25 month  
 15.25 months

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
40	0.50	0.75
75	1.25	1.50
90	2.25	2.50
98	3.75	4.25

TABLE B30

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: Souht Interchange  
Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Reduced Pc  
Consolidation Requirement: 100% in 1 year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_h$	4.34E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	8.69E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.34E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	120.00	kPa		
Drainage Path (m)	11.80	m		
Settlement due to Primary Consolidation	734	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	
Time Increment for table below =	0.25	month		
Resultant Maximum Time =	15.25	months		

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.75	0.75
75	2.00	2.50
90	4.25	5.50
98	10.25	14.75

**TABLE B31**  
**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE**  
**DESIGN RECOMMENDATIONS FOR DIFFERENT CONSTRUCTION SCHEDULES**

**Schedule 1:** 2 months: Site preparation (includes installation of wick drains)  
 3 months: Embankment Construction  
 12 months: Waiting period for stabilization of settlements

**Schedule 2:** Embankment construction and stabilization of settlements in 12 months

**Schedule 3:** Embankment construction and stabilization of settlements in 6 months

**Location:** H>6 m plus surcharge: Boundary Road: St. 9+800 to 12 m east of West Abutment and 12 m west of East Abutment to 10+140; E-S Ramp: 9+100 to 9+160  
 EW-N Ramp: Station < 8+380; SE-W Ramp: Station > 8+780; High embankments along Hwy 11, north of Sta. 8+960, do not require surcharge or wick drains  
**Surcharge:** 1.5 m  
**Berm Width:** 8 m  
**Berm Height:** 6 m below the pavement final design elevation

Construction Sequence	Height of embankment at this stage (H) for a certain Berm Height (BH)	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = 3.5 m	Wick Spacing = N/A	Wick Spacing = 3.0 m	
Stage 1	H=0 to 9.5 m for BH>4m H=0 to 9.0 for BH=3m H=0 to 8.5 for BH=2m H=0 to 8.0 for BH=1m H=0 to 7.5 for BH=0m	0 to 5 weeks	0 to 5 weeks	0 to 5 weeks	No EPP Requirement
Stage 2	Wait - No construction	5 to 9 weeks	5 to 13 weeks	5 to 7 weeks	-
Stage 3	Complete Embankment to top of surcharge	9 to 10 weeks	13 to 14 weeks	7 to 8 weeks	40 kPa
Stage 4	Wait - No construction	10 to 28 weeks	14 to 52 weeks	8 to 21 weeks	-
Stage 5	Trim to Final Elevation	Start after 28 weeks	Start after 52 weeks	Start after 21 weeks	0 kPa

**Location:** 6m>H>4m plus surcharge: Boundary Road: 10+140 to 10+210; EW-N Ramp: 8+380 to 8+450; SE-W Ramp: 8+780 to 8+720  
 Embankments 4 m to 6 m high in the area north of the bridge along Hwy 11 should include surcharge but no wick drains  
**Surcharge:** 1.2 m  
**Berm Height:** None

Construction Sequence	Description	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = 3.5 m	Wick Spacing = 3.5 m	Wick Spacing = 2.5 m	
Stage 1	Complete Embankment to top of surcharge	0 to 4 weeks	0 to 4 weeks	0 to 4 weeks	No EPP Requirement
Stage 2	Wait - No construction	4 to 45 weeks	4 to 45 weeks	4 to 24 weeks	-
Stage 3	Trim to Final Elevation	Start after 45 weeks	Start after 45 weeks	Start after 24 weeks	0 kPa

**Location:** H<4m plus surcharge: Boundary Road: Stations < 10+210; EW-N Ramp: > 8+450; SE-W Ramp: < 8+720  
**Surcharge:** Refer to table below  
**Berm Height:** None

Construction Sequence	Description	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = N/A	Wick Spacing = N/A	Wick Spacing = N/A	
		Surcharge = 1.2 m	Surcharge = 1.2 m	Surcharge = 2.2 m	
Stage 1	Complete Embankment to top of surcharge	0 to 2 weeks	0 to 2 weeks	0 to 2 weeks	No EPP Requirement
Stage 2	Wait - No construction	2 to 52 weeks	2 to 52 weeks	2 to 10 weeks	-
Stage 3	Trim to Final Elevation	Start after 52 weeks	Start after 52 weeks	Start after 10 weeks	0 kPa

Note: (\*) Trimming to final elevation can only be carried out after both EPP and settlements due to primary consolidation have stabilized within 2% of the value assessed according to the Rectangular Hyperbola Method (refer to text)



**APPENDIX C**

**ConeTec Report**

**(South Interchange Testholes Only)**

**PRESENTATION OF CONE PENETRATION TEST DATA,  
Trout Creek Interchanges**

**Trout Creek, Ontario**

**Prepared for:**

**Thurber Engineering Ltd.  
Etobicoke, Ontario**

**Prepared by:**

**CONETEC INVESTIGATIONS LTD.**

**March 31, 1999**



## **TABLE OF CONTENTS**

- 1.0 INTRODUCTION**
- 2.0 FIELD EQUIPMENT AND PROCEDURES**
- 3.0 CONE PENETRATION TEST DATA**
  - 3.1 CPT Data**
  - 3.2 Pore Pressure Dissipation Data**

## **APPENDICES**

- |                   |  |
|-------------------|--|
| <b>Appendix A</b> | <b>CPT Plots</b>                                       |
| <b>Appendix B</b> | <b>CPT Interpretations</b>                             |
| <b>Appendix C</b> | <b>Summary of Dissipations and Pore Pressure Plots</b> |

## 1.0 INTRODUCTION

This report presents the results of a cone penetration testing (CPT) program carried out at the location of the South and North Trout Creek Interchanges, near Trout Creek, Ontario. A total of 10 CPT's with pore pressure dissipation tests were performed for this investigation, with 5 CPTs at each of the south and north interchange sites between the period of March 25<sup>th</sup> and March 26<sup>th</sup>, 1999.

## 2.0 FIELD EQUIPMENT AND PROCEDURES

### 2.1 CPT Procedures

The cone penetration tests (CPT's) were carried out by **ConeTec Investigations Ltd.** of Vancouver, B.C. using an integrated electronic cone system. A 20 ton compression type cone was used for all of the soundings. The 20 ton cone has a tip area of 15 sq cm and friction sleeve area of 225 sq cm. A piezometer element 6 mm thick is located immediately behind the cone tip. The compression cones are designed with an equal end area friction sleeve and a tip end area ratio of 0.85. The cone system used during the program recorded the following parameters at 2.5 cm depth increments:

- Tip Resistance ( $Q_c$ ) in bars
- Sleeve Friction ( $F_s$ ) in bars
- Dynamic Pore Pressure ( $U_t$ ) in metres of water

The above parameters were printed simultaneously on a printer and stored on digital media for future analysis and reference.

The porous plastic pore pressure element was located directly behind the cone tip. Each of the elements were saturated in glycerin under vacuum pressure prior to penetration. Pore pressure dissipations were recorded at 5 second intervals during all pauses in the penetration.

A complete set of baseline readings were taken prior to and after each sounding to determine if any zero load offsets had occurred due a temperature change of the probe. Establishing the presence of temperature shifts and load offsets enables the operator to make corrections to the cone data if necessary. These corrections can be important, especially where the load conditions are relatively low, and generally are the single largest source of error with respect to the accuracy of cone data. Since the probes are temperature compensated, load shifts due to changes in probe

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temperature are only a problem when there are extreme temperature changes from before the test is started and while the probe is in situ. For the testing done on this project keeping the cone within an operating temperature range that did not produce load offsets was not a problem. The cone was pushed using track mounted CME 75 provided by All Terrain Drilling. All CPTs where pushed to refusal.

The following is a list of the CPT names, test depths and water tables. The bracketed values in the water table column are from dissipation tests at refusal.

CPT File	CPT Test Name	Depth (m)	Water Table (m)
141cps1	CPT-S1	13.05	0.0 (-0.3)
141cps2	CPT-S2	9.75	0.0 (-0.05)
141cps3	CPT-S3	16.925	0.0 (-0.2)
141cps4	CPT-S4	15.275	0.0
141cps5	CPT-S5	22.075	0.0 (-0.3)
141cpn1	CPT-N1	12.10	0.0 (-0.3)
141cpn2	CPT-N2	17.325	0.0 (0.1)
141cpn3	CPT-N3	15.125	0.0 (0.0)
141cpn4	CPT-N4	19.925 (20.6) *	0.0 (-0.4)
141cpn5	CPT-N5	11.85 (12.55) *	0.0 (-0.45)

\* Pore pressure data at depths below recorded CPT Data (CPT data not recorded)

### 3.0 CONE PENETRATION TEST DATA

#### 3.1 CPT Data

The cone penetration test data is presented in graphical form in Appendix A following the text of this report. For each test there are two sets of plots. The first plot consists of Tip Resistance (Qt) in bars, Sleeve Friction (Fs) in bars, Pore Pressure (U) in metres of water, and Friction Ratio (Rf) plotted versus depth. The second plot consists of Qt, SPT N60, SPT (N1)60, and Undrained Strength (Su) in kPa. The CPT data is also stored as ASCII text on the accompanying data disk. Penetration data is referenced to existing ground. Stratigraphic interpretations appears on the right side of both plot

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sets. The stratigraphic interpretation is based on a chart relating cone bearing  $Q_c$ , and sleeve friction  $F_s$  developed by Robertson et al, 1986 as shown in Figure 1. Detailed interpretations of the CPT data are included in Appendix B. A description of the interpretation methods is included at the end of Appendix B.

### 3.2 Pore Pressure Dissipation Test Results

Pore pressure dissipations were recorded during selected pauses in penetration for all CPTs tests. The pore pressure data was recorded at 5 second intervals. The pore pressure dissipation data for each CPT is included on the data disk. Pore pressure dissipation data in fine grained soils provides a good indication of the consolidation characteristics. Data from pore pressure dissipation tests in tabular format is presented in Appendix C. The coefficient of consolidation in the horizontal direction,  $c_h$ , was calculated using the equation following equation.

$$c_h = \frac{T^* r^2 \sqrt{I_r}}{t}$$

where:

$T^*$	-	time constant = 0.245 for 50% dissipation
$r$	-	radius of the cone
$I_r$	-	Rigidity Index = $G/S_u$
$t$	-	time for dissipation

For all the dissipations the time for 50 percent dissipation was used to calculate  $c_h$ . A value of 200 for the rigidity index was used in all calculations. The resulting values of  $c_h$  ranged from 1.8  $\text{cm}^2/\text{min}$  to 110  $\text{cm}^2/\text{min}$ , with most values falling between 2  $\text{cm}^2/\text{min}$  to 9  $\text{cm}^2/\text{min}$ . Pore pressure dissipation tests in the highly permeable sand layer below the clayey silt reached equilibrium almost instantaneously. The equilibrium values of pore pressure indicate the water table was at the surface to about 0.3 above the surface.

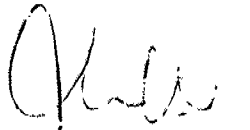
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We trust that the information presented in this report is sufficient for your purposes. If you have any questions regarding the contents of this report, please do not hesitate to contact our office.

Yours truly,

**ConeTec Investigations Ltd.**

Per:



**Ilmar Weemees, P.Eng.**

ref: 99-141.wpd

**ConeTec Investigations Ltd.**

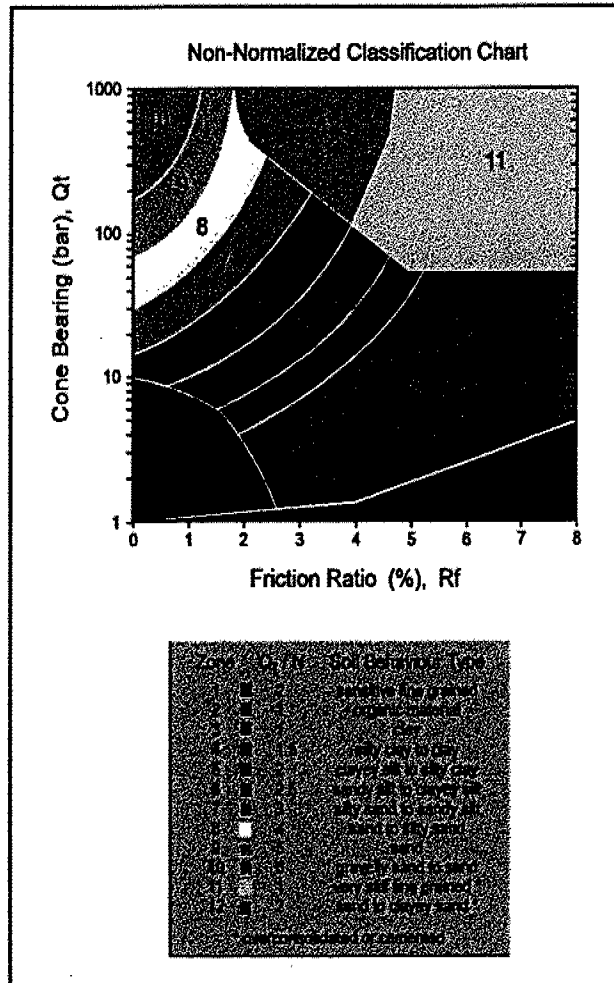


Figure 1. Soil Behaviour Type Classification Chart

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## **APPENDIX A**

### **CPT Plots**

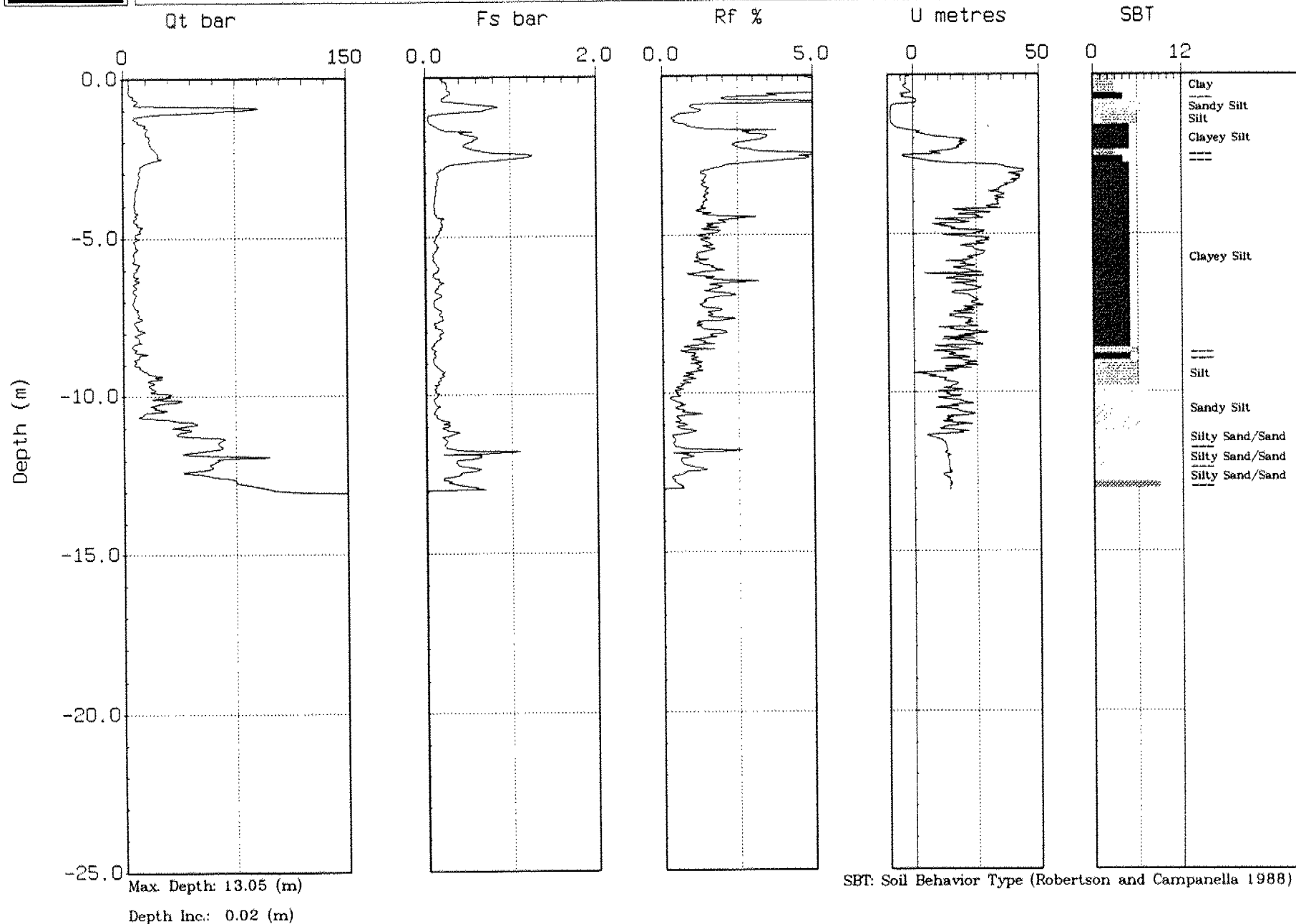
**ConeTec Investigations Ltd.**



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Site: 99-141 CPT-S1  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11



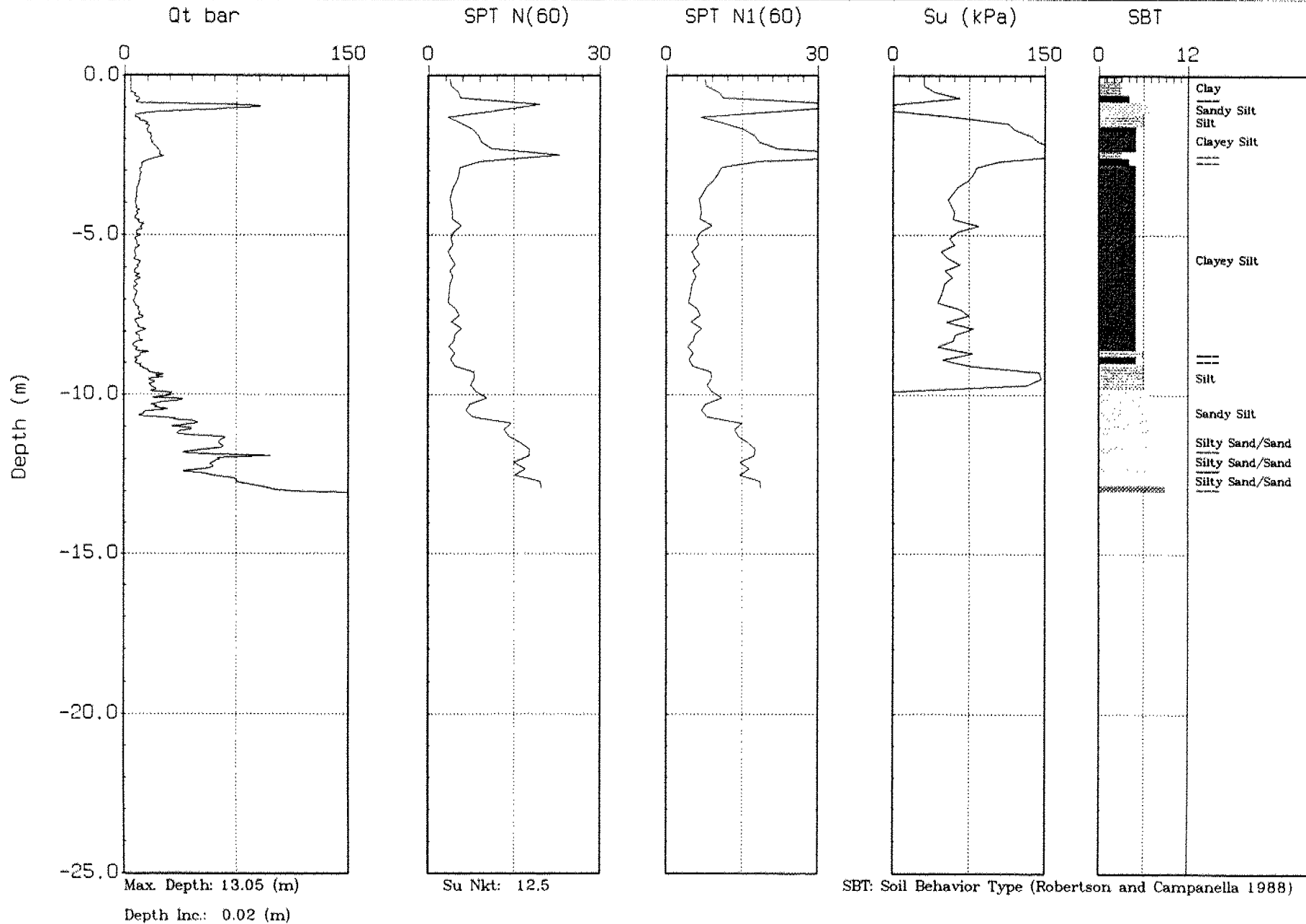




Thurber Engineering

Site: 99-141 CPT-S1  
Location: S.INTERCHANGE

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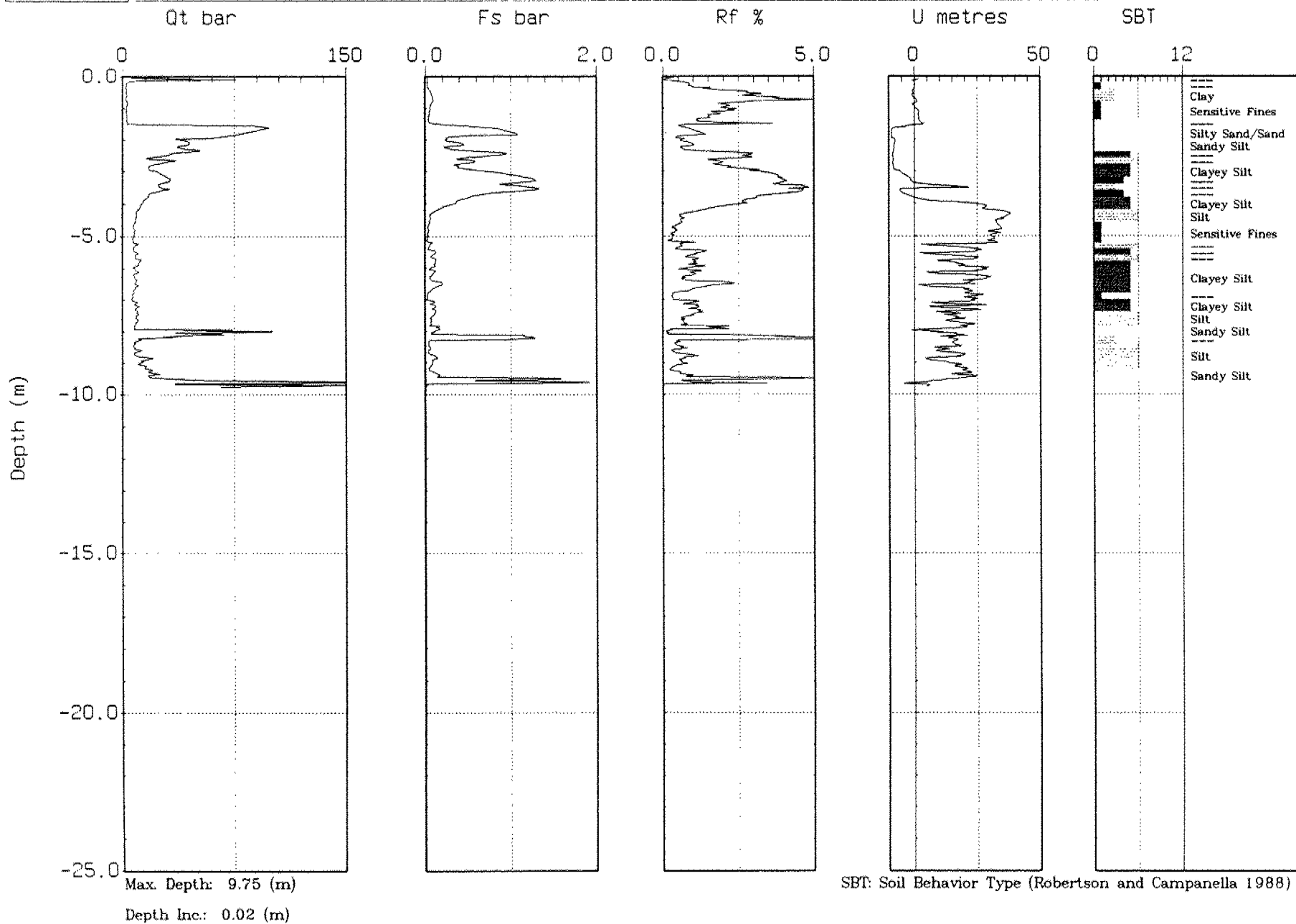




Thurber Engineering

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Location: SINTERCHANGE

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Date: 03:25:99 11:29

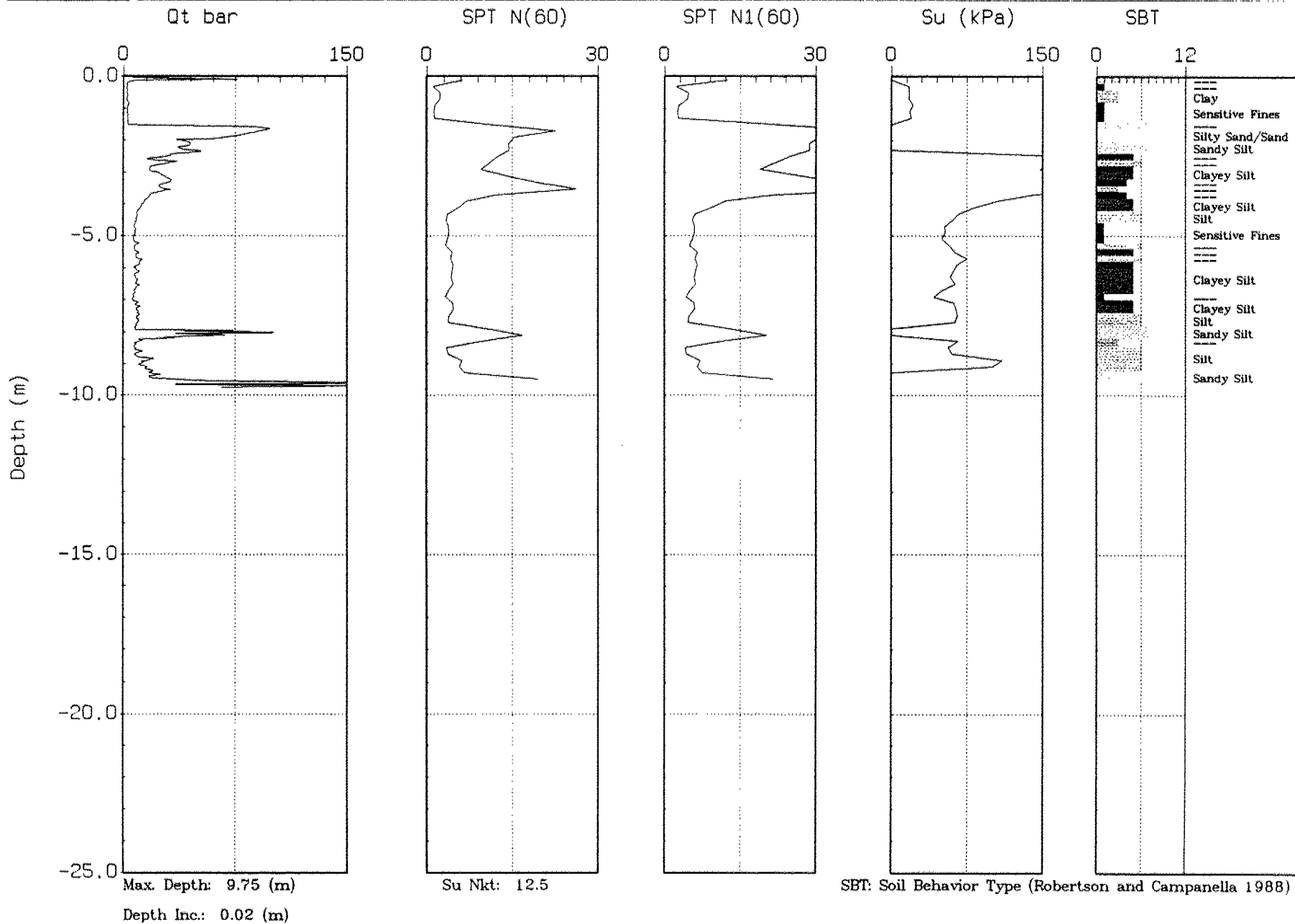




Thurber Engineering

Site: 99-141 CPT-S2  
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Cone: 20 TON A 058  
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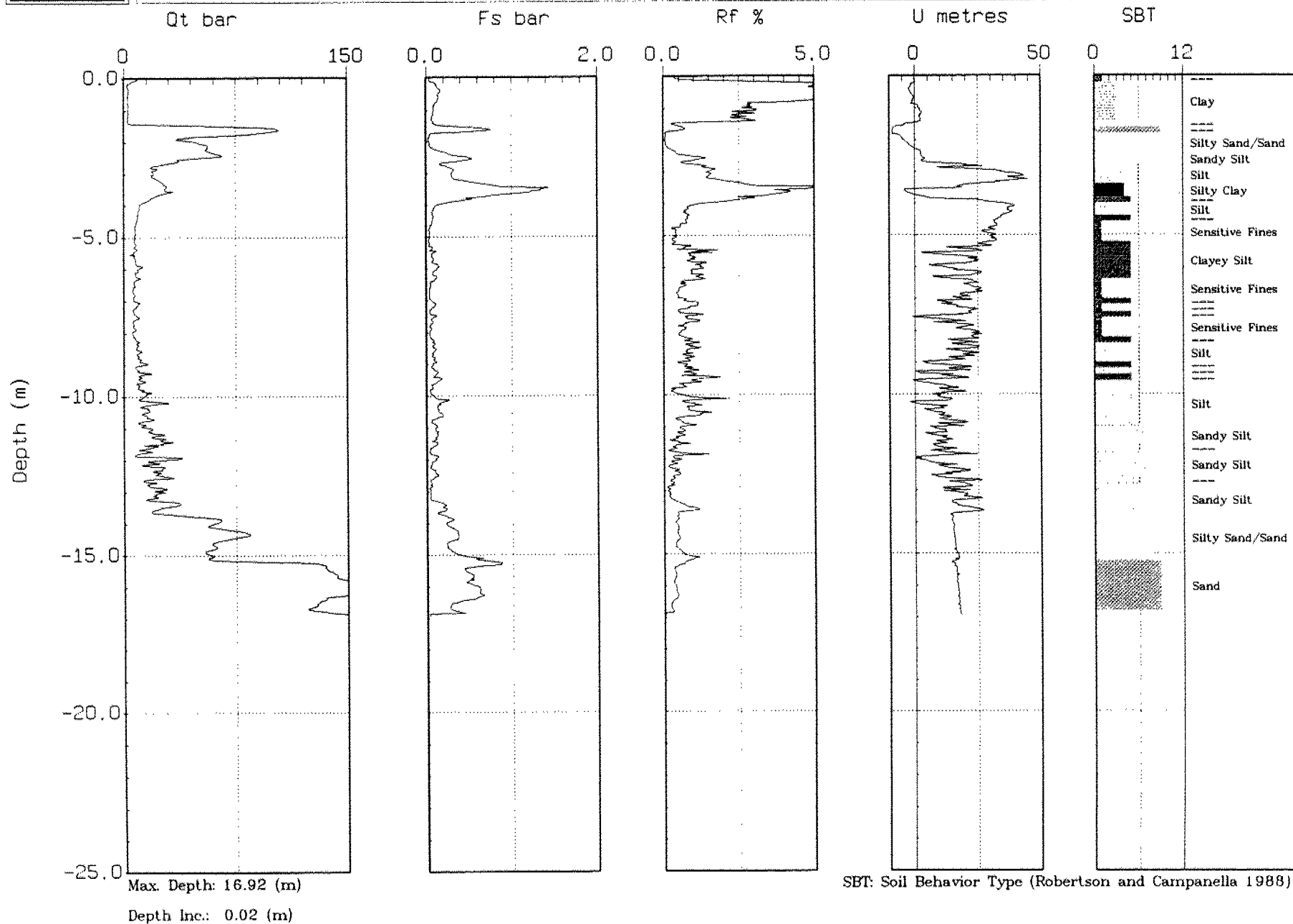




Thurber Engineering

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Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 13:21



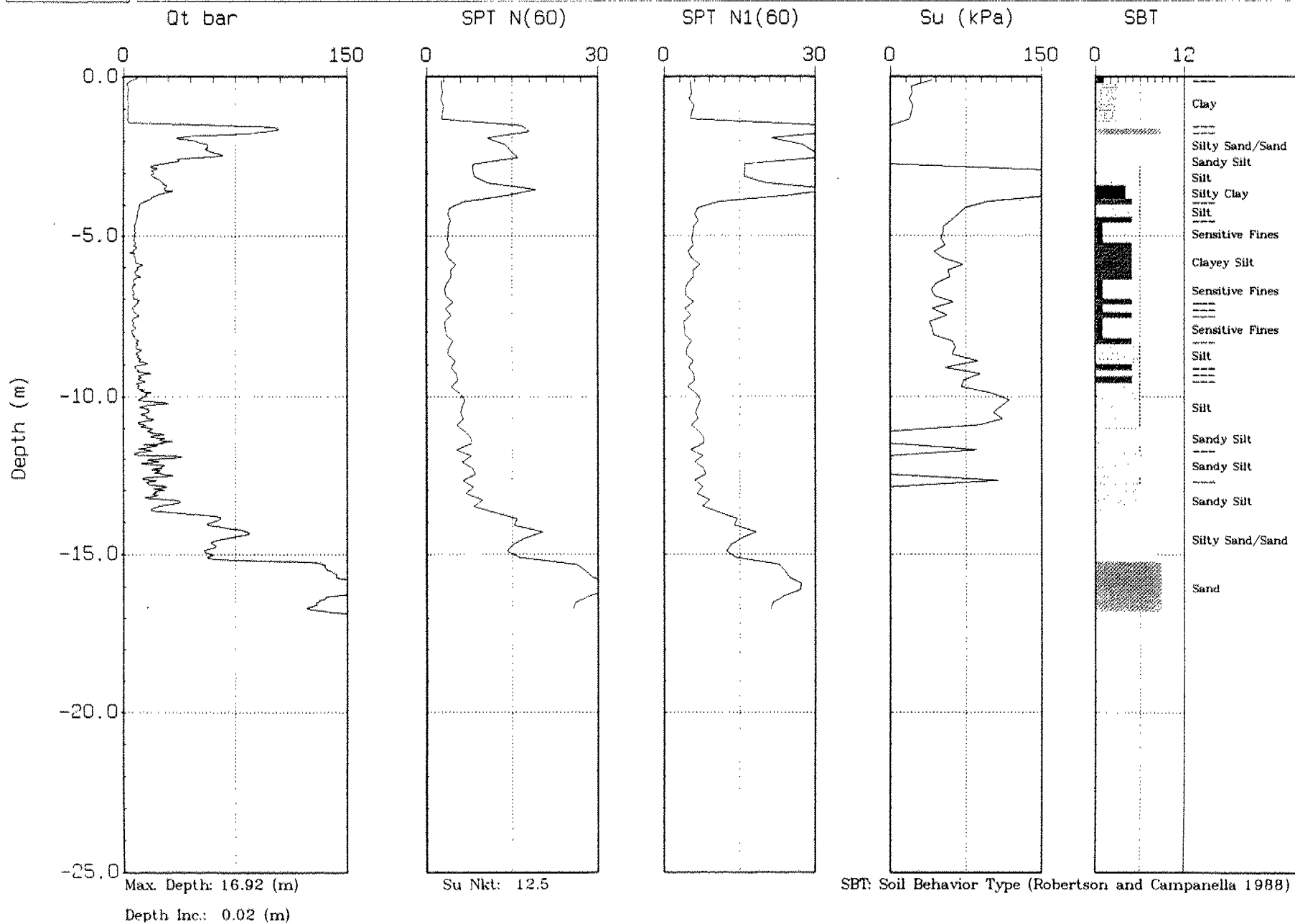
SBT: Soil Behavior Type (Robertson and Campanella 1988)



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Site: 99-141 CPT-S3  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 13:21

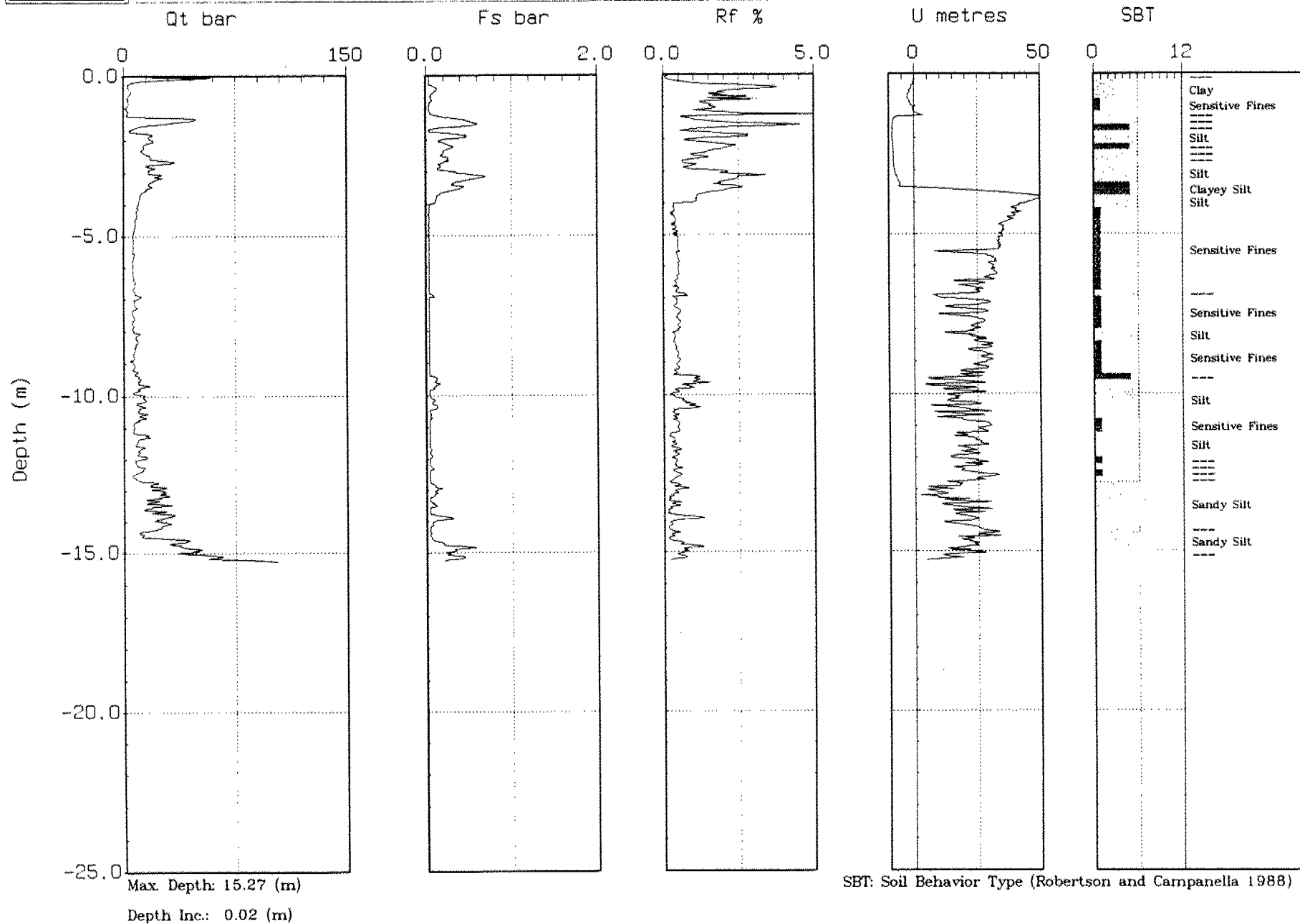




Thurber Engineering

Site: 99-141 CPT-S4  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 15:35



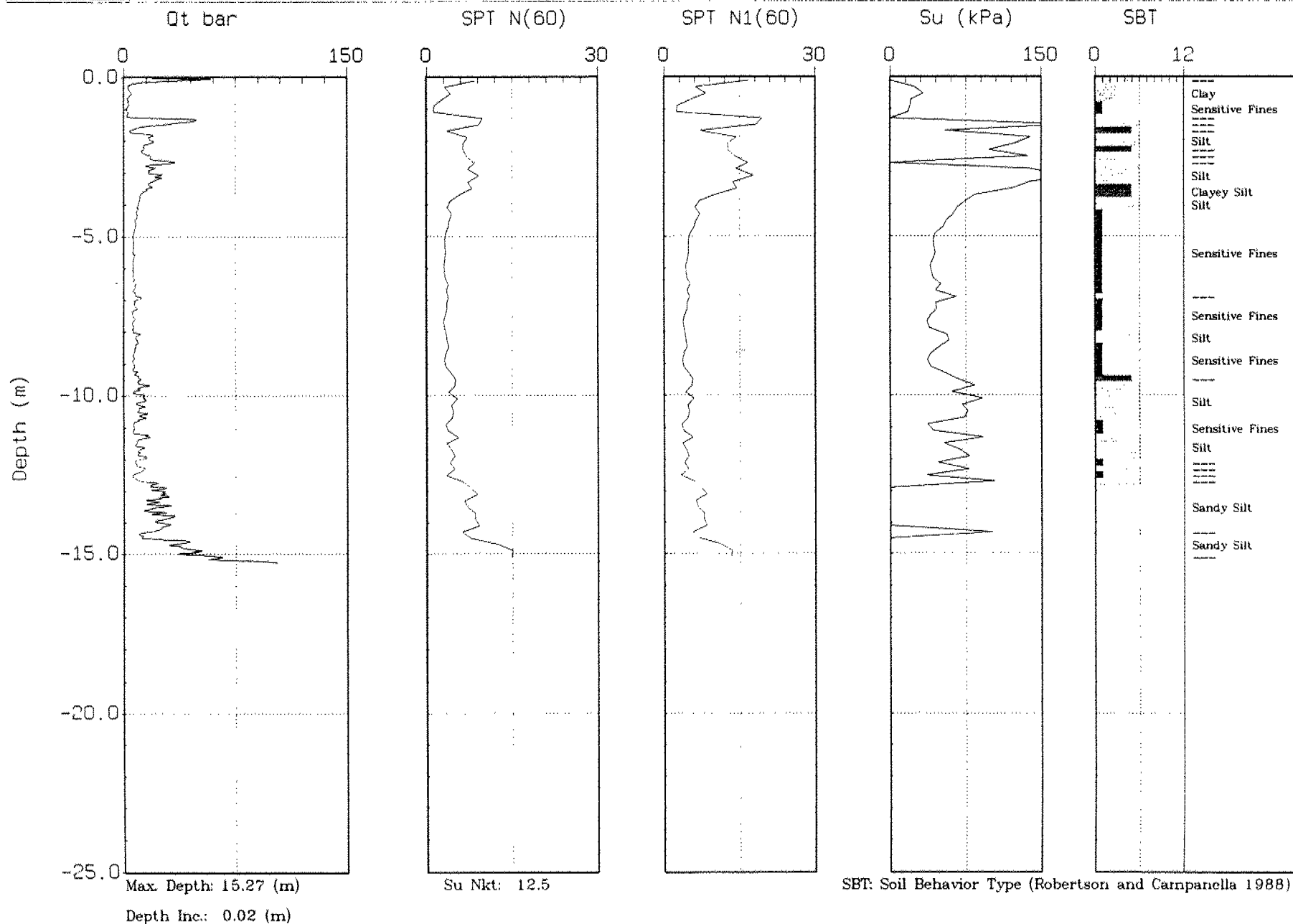
SBT: Soil Behavior Type (Robertson and Campanella 1988)



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Site: 99-141 OPT-S4  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 15:35

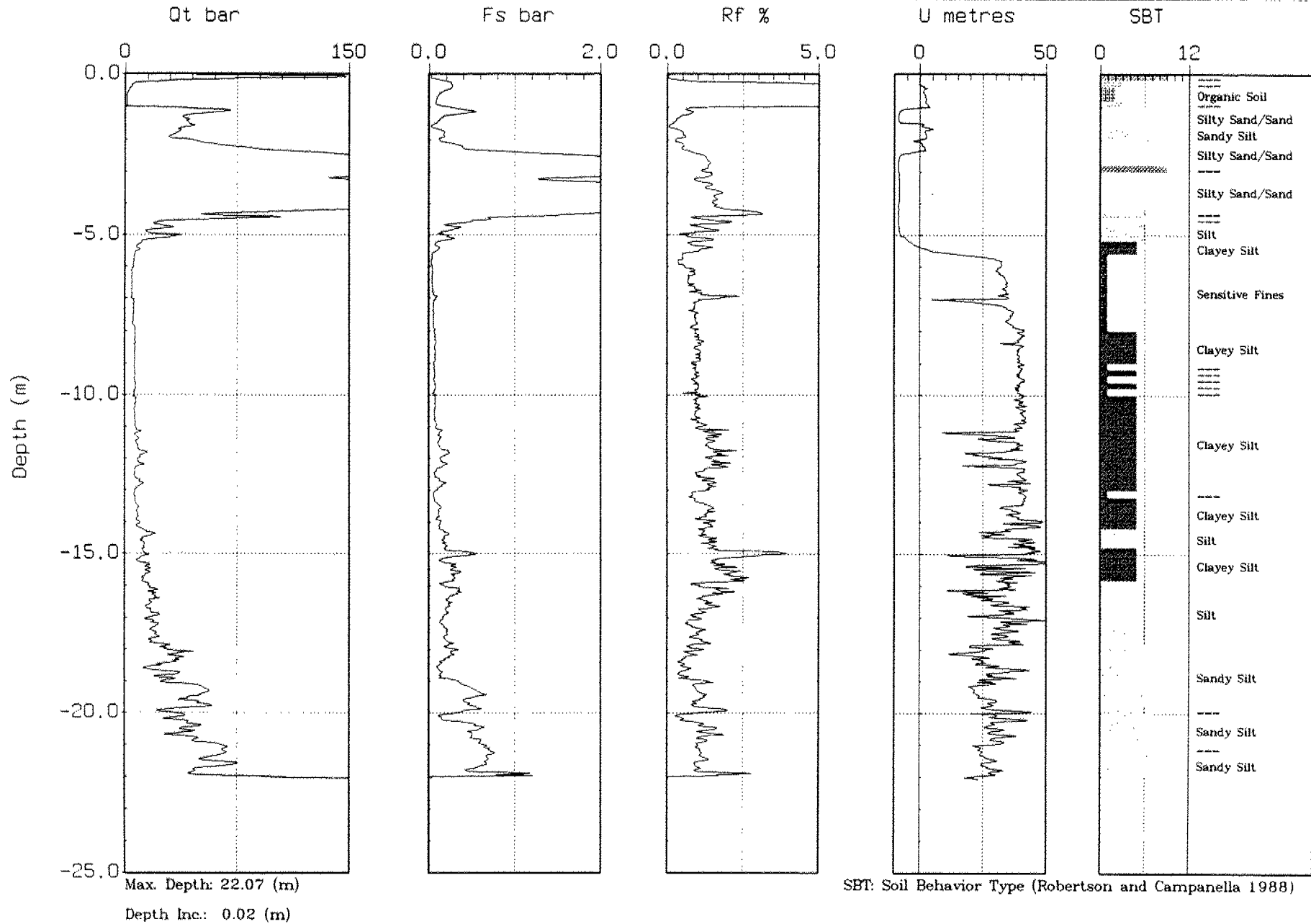




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Site: 99-141 OPT-S5  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 17:56



SBT: Soil Behavior Type (Robertson and Campanella 1988)

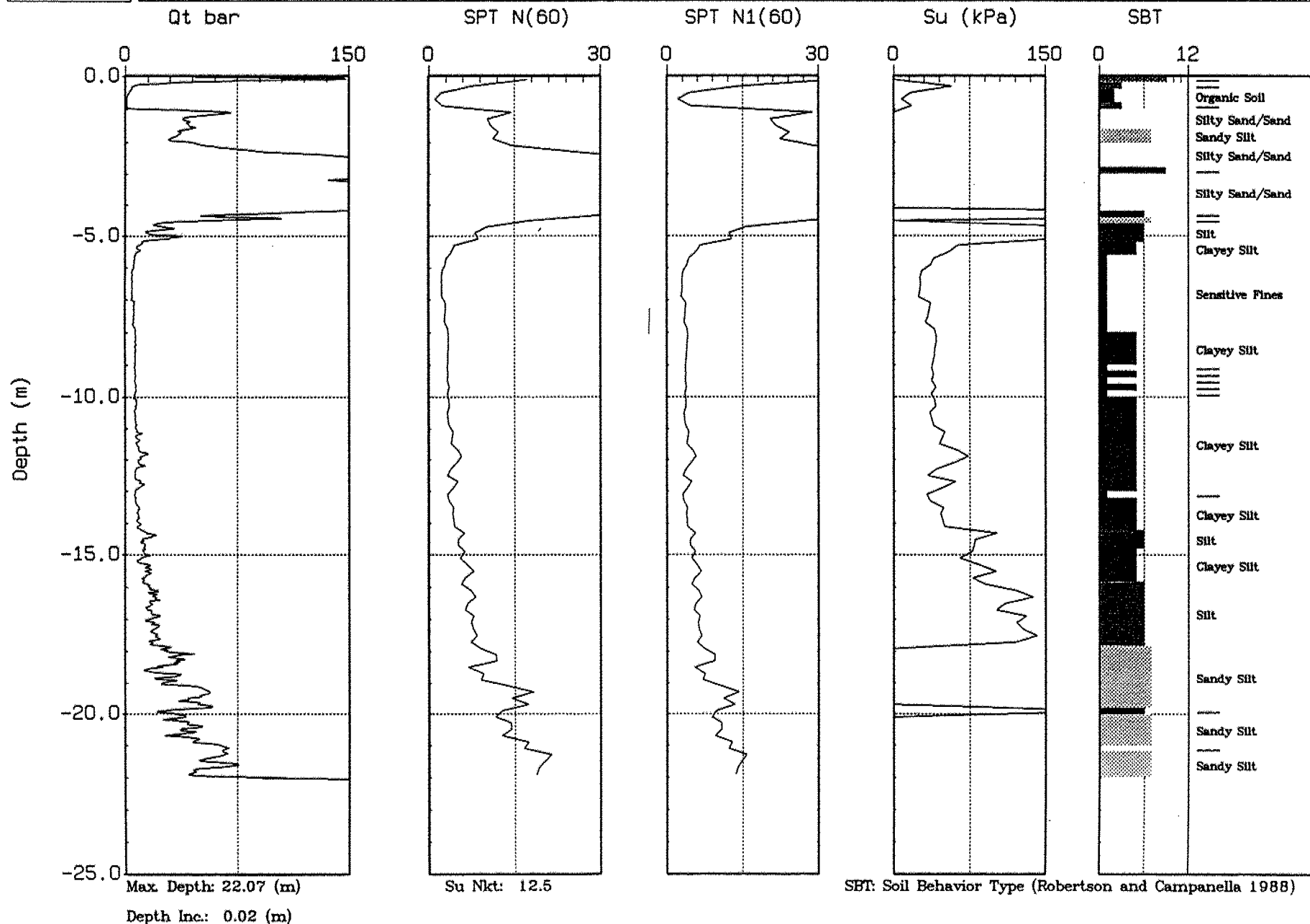




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Site: 99-141 CPT-S5  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 17:56



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**APPENDIX B**  
**CPT Interpretations**

**ConeTec Investigations Ltd.**



# ConeTec

Geotechnical and Environmental Site Investigation Contractors

## ConeTec CPT Interpretations as of January 7, 1999 (Release 1.00.19)

ConeTec's interpretation routine should be considered a calculator of current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (typically 0.25m). Note that  $Q_t$  is the recorded tip value,  $Q_c$ , corrected for pore pressure effects. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction,  $F_s$ , are not required.

The tip correction is:  $Q_t = Q_c + (1-a) \cdot U_d$

where:  $Q_t$  is the corrected tip load

$Q_c$  is the recorded tip load

$U_d$  is the recorded dynamic pore pressure

$a$  is the Net Area Ratio for the cone (typically 0.85 for ConeTec cones)

Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). The stress calculations use unit weights assigned to the Soil Behaviour Type zones or from a user defined unit weight profile.

Details regarding the interpretation methods for all of the interpreted parameters is given in table 1. The appropriate references referred to in table 1 are listed in table 2.

The estimated Soil Behaviour Type is based on the charts developed by Robertson and Campanella shown in figure 1.

**Table 1 CPT Interpretation Methods**

Interpreted Parameter	Description	Equation	Ref
Depth	mid layer depth		
AvgQt	Averaged corrected tip ( $Q_t$ )	$AvgQt = \frac{1}{n} \sum_{i=1}^n Q_{t_i}$	
AvgFs	Averaged sleeve friction ( $F_s$ )	$AvgFs = \frac{1}{n} \sum_{i=1}^n F_{s_i}$	
AvgRf	Averaged friction ratio ( $R_f$ )	$AvgRf = 100\% \cdot \frac{AvgFs}{AvgQt}$	
AvgUd	Averaged dynamic pore pressure ( $U_d$ )	$AvgUd = \frac{1}{n} \sum_{i=1}^n U_{d_i}$	
SBT	Soil Behavior Type as defined by Robertson and Campanella		1

# CPT Interpretations

U.Wt.	Unit Weight of soil determined from: 1) uniform value or 2) value assigned to each SBT zone 3) user supplied unit weight profile		
TStress	Total vertical overburden stress at mid layer depth	$TStress = \sum_{i=1}^n \gamma_i \cdot h_i$ where $\gamma_i$ is layer unit weight $h_i$ is layer thickness	
EStress	Effective vertical overburden stress at mid layer depth	$EStress = TStress - Ueq$	
Ueq	Equilibrium pore pressure determined from: 1) hydrostatic from water table depth 2) user supplied profile		
Cn	SPT $N_{60}$ overburden correction factor	$Cn = (\sigma_v')^{0.5}$ where $\sigma_v'$ is in tsf $0.5 < Cn < 2.0$	
$N_{60}$	SPT N value at 60% energy calculated from Q/N ratios assigned to each SBT zone		3
$(N1)_{60}$	SPT $N_{60}$ value corrected for overburden pressure	$N1_{60} = Cn \cdot N_{60}$	3
$\Delta(N1)_{60}$	Equivalent Clean Sand Correction to $(N1)_{60}$	$\Delta(N1)_{60} = \frac{K_{SPT}}{1 - K_{SPT}} \cdot (N1)_{60}$  Where: $K_{SPT}$ is defined as:  0.0 for FC < 5% 0.0167 • (FC - 5) for 5% < FC < 35% 0.5 for FC > 35%  FC - Fines Content in %	7
$(N1)_{60cs}$	Equivalent Clean Sand $(N1)_{60}$	$(N1)_{60cs} = (N1)_{60} + \Delta(N1)_{60}$	7
Su	Undrained shear strength - Nkt is use selectable	$Su = \frac{Q_t - \sigma_v}{N_{kt}}$	2
k	Coefficient of permeability (assigned to each SBT zone)		6
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{Q_t - \sigma_v}$	2
Qtn	Normalized Qt for Soil Behavior Type classification as defined by Robertson, 1990	$Qtn = \frac{Q_t - \sigma_v}{\sigma_v}$	4
Rfn	Normalized Rf for Soil Behavior Type classification as defined by Robertson, 1990	$Rfn = 100\% \cdot \frac{f_s}{Q_t - \sigma_v}$	4
SBTn	Normalized Soil Behavior Type (slightly modified from that published by Robertson, 1990. This version includes all the soil zones of the original non-normalized SBT chart - see figure 1)		4
Qc1	Normalized Qt for seismic analysis	$qc1 = qc \cdot (Pa/\sigma_v')^{0.5}$ where: Pa = atm. pressure	5
Qc1N	Dimensionless Normalized Qt1	$qc1N = qc1 / Pa$ where: Pa = atm. pressure	

# CPT Interpretations

$\Delta q_{c1N1}$	Equivalent clean sand correction	$\Delta q_{c1N} = \frac{K_{CPT}}{1 - K_{CPT}} \cdot q_{c1N}$ <p>Where: <math>K_{CPT}</math> is defined as:</p> <p>0.0 for <math>FC &lt; 5\%</math>  <math>0.0267 \cdot (FC - 5)</math> for <math>5\% &lt; FC &lt; 35\%</math>  0.5 for <math>FC &gt; 35\%</math></p> <p>FC - Fines Content in %</p>	5
$q_{c1Ncs}$	Clean Sand equivalent $q_{c1N}$	$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$	5
$I_c$	Soil index for estimating grain characteristics	$I_c = [(3.47 - \log Q)^2 + (\log F + 1.22)^2]^{0.5}$	5
FC	Fines content (%)	$FC = 1.75(I_c^{3.25}) - 3.7$ $FC = 100$ for $I_c > 3.5$ $FC = 0$ for $I_c < 1.26$ $FC = 5\%$ if $1.64 < I_c < 2.6$ AND $R_{fh} < 0.5$	8
PHI	Friction Angle	Campanella and Robertson Durunoglu and Mitchel Janbu	1
Dr	Relative Density	Ticino Sand Hokksund Sand Schmertmann 1976 Jamiołkowski - All Sands	1
OCR	Over Consolidation Ratio		1
State Parameter			9
CRR	Cyclic Resistance Ratio		7

# CPT Interpretations

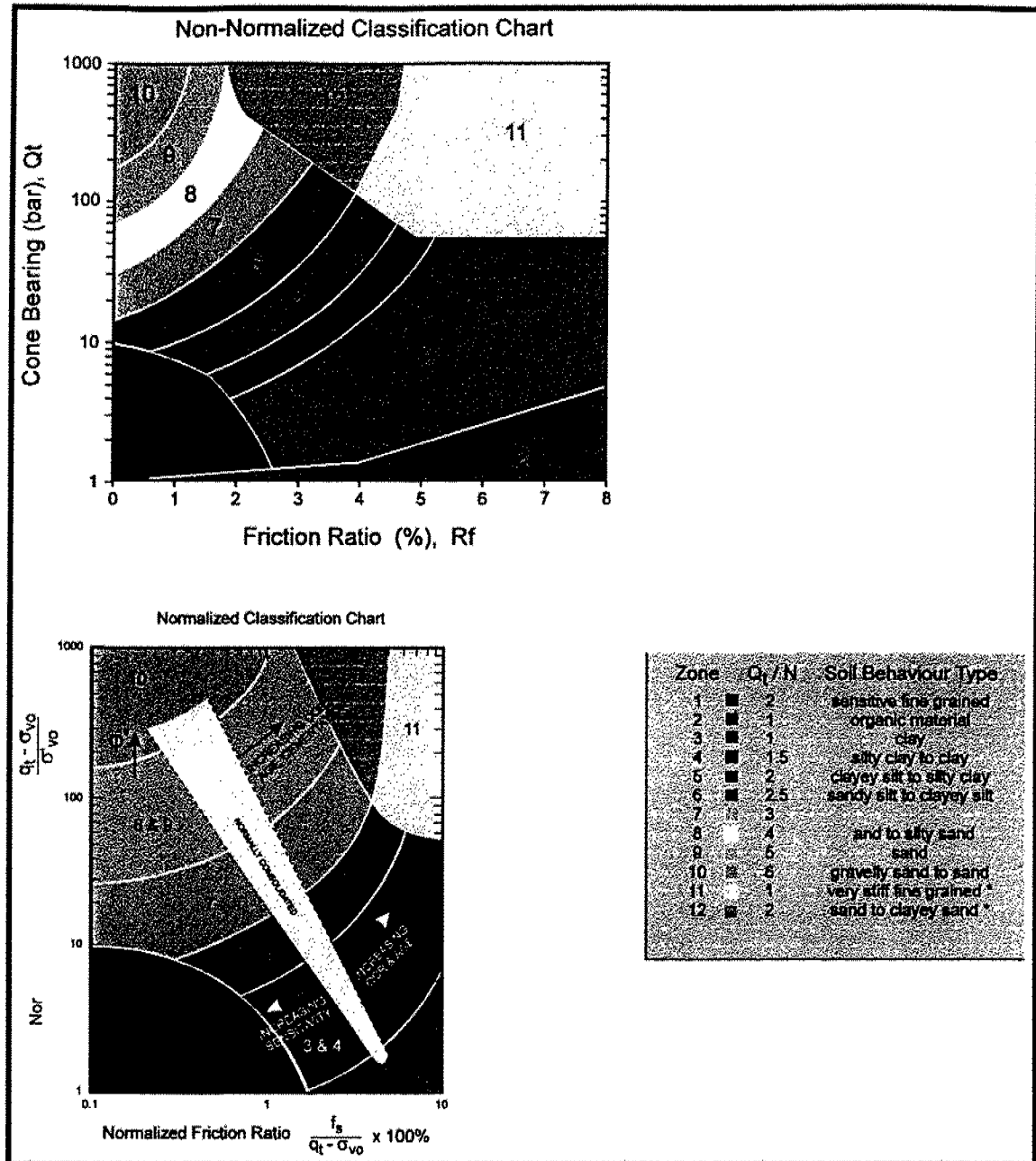


Figure 1 Non-Normalized and Normalized Soil Behaviour Type Classification Charts

## CPT Interpretations

**Table 2    References**

No.	Reference
1	Robertson, P.K. and Campanella, R.G., 1986, "Guidelines for Use, Interpretation and Application of the CPT and CPTU", UBC, Soil Mechanics Series No. 105, Civil Eng. Dept., Vancouver, B.C., Canada
2	Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.
3	Robertson, P.K. and Campanella, R.G., 1989, "Guidelines for Geotechnical Design Using CPT and CPTU", UBC, Soil Mechanics Series No. 120, Civil Eng. Dept., Vancouver, B.C., Canada
4	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
5	Robertson, P.K. and Fear, C.E., 1995, "Liquefaction of Sands and its Evaluation", Keynote Lecture, First International Conference on Earthquake Geotechnical Engineering, Tokyo, Japan.
6	ConeTec Internal Report
7	Robertson, P.K. and Wride, C.E., 1997, "Cyclic Liquefaction and its Evaluation Based on SPT and CPT", NCEER Workshop Paper, January 22, 1997
8	Wride, C.E. and Robertson, P.K., 1997, "Phase II Data Review Report (Massey and Kidd Sites, Fraser River Delta)", Volume 1 - Data Report (June 1997), University of Alberta.
9	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.

ConeTec Investigations Ltd. - CPT Interpretation  
Interpretation Output - Release 1.00.17

Page: 1a

Run No: 99-0331-0827-4079  
Job No: 99-141  
Client: Thurber Engineering  
Project: Trout Lake By-Pass  
Site: 99-141 CPT-S1  
Location: S.INTERCHANGE  
Cone: 20 TON A 058  
CPT Date: 99/25/03  
CPT Time: 09:11  
CPT File: 141CPS1.COR  
Northing (m): 0.000  
Easting (m): 0.000  
Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0  
Su Nkt used: 12.50  
Averaging Increment (m): 0.25  
Phi Method: Robertson and Campanella, 1983  
Dr Method: Jamiolkowski - All Sands  
State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60	Su (kPa)	CRR
0.12	3.8	0.22	5.81	-2.91	3	17.5	2.2	1.0	1.23	2.00	3.8	7.6	30.2	0.00
0.38	3.8	0.27	7.08	-2.94	2	12.5	5.9	2.3	3.68	2.00	3.8	7.6	29.8	0.00
0.62	7.6	0.22	2.92	-2.78	4	18.0	9.8	3.6	6.13	2.00	5.1	10.2	60.4	0.00
0.88	48.4	0.64	1.31	-3.14	7	18.5	14.3	5.7	8.58	2.00	16.1	32.3	UnDef	0.16
1.12	29.6	0.33	1.10	-9.00	7	18.5	18.9	7.9	11.04	2.00	9.9	19.7	UnDef	0.10
1.38	10.8	0.04	0.41	-8.99	6	18.0	23.5	10.0	13.49	2.00	4.3	8.6	84.4	0.00
1.62	15.3	0.23	1.47	-6.28	6	18.0	28.0	12.1	15.94	2.00	6.1	12.2	119.9	0.08
1.88	16.9	0.54	3.22	5.88	5	18.0	32.5	14.1	18.39	2.00	8.5	16.9	132.7	0.10
2.12	18.8	0.49	2.60	19.39	5	18.0	37.0	16.2	20.85	2.00	9.4	18.8	147.4	0.10
2.38	22.8	0.88	3.86	13.32	4	18.0	41.5	18.2	23.30	2.00	15.2	30.4	179.2	0.00
2.62	17.7	0.75	4.28	1.19	3	17.5	45.9	20.2	25.75	2.00	17.7	35.3	137.6	0.00
2.88	10.9	0.20	1.87	32.38	5	18.0	50.4	22.2	28.20	2.00	5.5	10.9	83.5	0.09
3.12	10.4	0.14	1.37	41.58	5	18.0	54.9	24.2	30.66	1.99	5.2	10.4	78.9	0.09
3.38	9.5	0.13	1.35	39.21	5	18.0	59.4	26.3	33.11	1.91	4.7	9.1	71.2	0.09
3.62	8.1	0.12	1.47	34.06	5	18.0	63.9	28.3	35.56	1.84	4.0	7.4	59.6	0.09
3.88	7.6	0.11	1.41	33.95	5	18.0	68.4	30.4	38.01	1.78	3.8	6.7	55.1	0.09
4.12	8.2	0.11	1.29	29.24	5	18.0	72.9	32.4	40.47	1.72	4.1	7.0	59.5	0.09
4.38	7.7	0.15	1.98	25.14	5	18.0	77.4	34.5	42.92	1.67	3.9	6.5	55.7	0.11
4.62	10.6	0.18	1.75	14.05	5	18.0	81.9	36.5	45.37	1.62	5.3	8.6	78.2	0.10
4.88	9.3	0.14	1.56	21.67	5	18.0	86.4	38.6	47.82	1.58	4.7	7.3	67.5	0.11
5.12	7.9	0.11	1.42	24.69	5	18.0	90.9	40.6	50.28	1.54	4.0	6.1	56.2	0.10
5.38	7.9	0.12	1.55	24.01	5	18.0	95.4	42.6	52.73	1.50	3.9	5.9	55.5	0.10
5.62	7.0	0.08	1.20	25.66	5	18.0	99.9	44.7	55.18	1.46	3.5	5.1	48.0	0.09
5.88	9.4	0.13	1.37	20.46	5	18.0	104.4	46.7	57.63	1.43	4.7	6.7	66.9	0.11
6.12	7.6	0.10	1.38	18.95	5	18.0	108.9	48.8	60.09	1.40	3.8	5.3	52.3	0.10
6.38	8.0	0.16	1.95	20.87	5	18.0	113.4	50.8	62.54	1.37	4.0	5.5	55.2	0.10
6.62	7.3	0.12	1.67	22.86	5	18.0	117.9	52.9	64.99	1.35	3.7	4.9	49.0	0.09
6.88	7.4	0.14	1.93	19.94	5	18.0	122.4	54.9	67.44	1.32	3.7	4.9	49.0	0.09
7.12	7.3	0.10	1.32	24.78	5	18.0	126.9	57.0	69.90	1.30	3.7	4.8	48.5	0.09
7.38	9.8	0.16	1.69	21.07	5	18.0	131.4	59.0	72.35	1.27	4.9	6.2	67.5	0.10
7.62	9.0	0.15	1.69	18.76	5	18.0	135.9	61.1	74.80	1.25	4.5	5.6	61.3	0.10
7.88	10.9	0.15	1.35	18.87	5	18.0	140.4	63.1	77.25	1.23	5.4	6.7	75.8	0.11
8.12	9.3	0.16	1.73	22.34	5	18.0	144.9	65.2	79.71	1.21	4.6	5.6	62.6	0.10
8.38	7.6	0.09	1.20	22.03	5	18.0	149.4	67.2	82.16	1.19	3.8	4.5	48.8	0.09
8.62	10.3	0.09	0.90	14.19	6	18.0	153.9	69.3	84.61	1.18	4.1	4.8	69.9	0.10
8.88	8.1	0.08	1.04	17.15	5	18.0	158.4	71.3	87.06	1.16	4.1	4.7	52.4	0.09
9.12	12.3	0.14	1.15	20.44	6	18.0	162.9	73.4	89.52	1.14	4.9	5.6	85.3	0.11
9.38	21.2	0.19	0.88	8.46	6	18.0	167.4	75.4	91.97	1.13	8.5	9.6	156.1	0.09
9.62	17.9	0.14	0.75	13.80	6	18.0	171.9	77.5	94.42	1.11	7.2	8.0	129.5	0.09



Run No: 99-0331-0827-4079

CPT File: 141CPS1.COR

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	23.7	0.11	0.48	14.77	7	18.5	176.4	79.6	96.87	1.10	7.9	8.7	UnDef	0.09
10.12	29.6	0.10	0.34	14.00	7	18.5	181.1	81.7	99.33	1.08	9.9	10.7	UnDef	0.08
10.38	22.6	0.12	0.51	17.20	7	18.5	185.7	83.9	101.78	1.07	7.5	8.0	UnDef	0.09
10.62	16.7	0.11	0.65	18.98	6	18.0	190.2	86.0	104.23	1.06	6.7	7.1	118.5	0.09
10.88	41.7	0.23	0.55	15.35	7	18.5	194.8	88.1	106.68	1.04	13.9	14.5	UnDef	0.10
11.12	39.1	0.28	0.71	15.35	7	18.5	199.4	90.3	109.14	1.03	13.0	13.4	UnDef	0.10
11.38	63.0	0.22	0.36	9.56	8	19.0	204.1	92.5	111.59	1.02	15.8	16.0	UnDef	0.11
11.62	60.2	0.29	0.48	12.27	8	19.0	208.9	94.8	114.04	1.01	15.1	15.1	UnDef	0.10
11.88	64.4	0.65	1.01	12.97	8	19.0	213.6	97.1	116.49	0.99	16.1	16.0	UnDef	0.15
12.12	59.5	0.37	0.63	13.55	8	19.0	218.4	99.4	118.95	0.98	14.9	14.6	UnDef	0.12
12.38	50.5	0.50	0.99	14.04	7	18.5	223.1	101.7	121.40	0.97	16.8	16.3	UnDef	0.12
12.62	72.4	0.25	0.35	12.91	8	19.0	227.8	103.9	123.85	0.96	18.1	17.4	UnDef	0.11
12.88	96.0	0.40	0.42	14.27	9	19.5	232.6	106.3	126.30	0.95	19.2	18.2	UnDef	0.16

Run No: 99-0331-0827-4079  
 Job No: 99-141  
 Client: Thurber Engineering  
 Project: Trout Lake By-Pass  
 Site: 99-141 CPT-S1  
 Location: S.INTERCHANGE  
 Cone: 20 TON A 058  
 CPT Date: 99/25/03  
 CPT Time: 09:11  
 CPT File: 141CPS1.COR  
 Northing (m): 0.000  
 Easting (m): 0.000  
 Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0  
 Su Nkt used: 12.50  
 Averaging Increment (m): 0.25  
 Phi Method: Robertson and Campanella, 1983  
 Dr Method: Jamiolkowski - All Sands  
 State Parameter M: 1.20  
 Used Unit Weights Assigned to Soil Zones  
 Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param
0.12	5.0E-08	-0.08	393.2	5.85	11	7.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.38	1.0E-15	-0.09	164.9	7.19	11	7.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.62	5.0E-07	-0.04	208.6	2.95	12	15.3	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.88	5.0E-04	-0.01	842.7	1.32	9	96.8	0.0	96.8	2.1	50	87.5	1.0	-0.43
1.12	5.0E-04	-0.03	372.4	1.11	9	59.2	0.0	59.2	3.6	48	68.8	1.0	-0.33
1.38	5.0E-05	-0.10	105.4	0.42	9	21.6	0.0	21.6	5.0	42	36.4	10.0	-0.12
1.62	5.0E-05	-0.05	124.3	1.50	9	30.5	6.9	37.4	11.9	44	43.7	10.0	-0.26
1.88	5.0E-06	0.02	117.6	3.28	7	33.8	22.6	56.4	20.0	UnDef	UnDef	10.0	UnDef
2.12	5.0E-06	0.09	114.1	2.65	7	37.6	19.8	57.4	17.9	UnDef	UnDef	10.0	UnDef
2.38	5.0E-07	0.05	123.1	3.93	12	45.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
2.62	5.0E-08	-0.01	85.2	4.39	11	35.3	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
2.88	5.0E-06	0.28	47.1	1.97	7	21.9	23.5	45.4	24.4	UnDef	UnDef	6.0	UnDef
3.12	5.0E-06	0.38	40.7	1.45	7	20.8	19.6	40.4	23.1	UnDef	UnDef	6.0	UnDef
3.38	5.0E-06	0.40	33.9	1.44	7	18.5	22.6	41.1	25.6	UnDef	UnDef	6.0	UnDef
3.62	5.0E-06	0.40	26.3	1.60	7	15.2	32.3	47.5	30.5	UnDef	UnDef	6.0	UnDef
3.88	5.0E-06	0.43	22.7	1.55	7	13.8	38.4	52.1	32.6	UnDef	UnDef	6.0	UnDef
4.12	5.0E-06	0.33	23.0	1.41	7	14.3	34.0	48.4	31.3	UnDef	UnDef	6.0	UnDef
4.38	5.0E-06	0.29	20.2	2.20	6	13.2	52.8	65.9	38.8	UnDef	UnDef	6.0	UnDef
4.62	5.0E-06	0.09	26.8	1.89	7	17.5	46.1	63.6	32.1	UnDef	UnDef	6.0	UnDef
4.88	5.0E-06	0.20	21.9	1.72	6	15.0	54.3	69.3	34.4	UnDef	UnDef	6.0	UnDef
5.12	5.0E-06	0.27	17.3	1.61	6	12.4	49.8	62.2	37.8	UnDef	UnDef	6.0	UnDef
5.38	5.0E-06	0.26	16.3	1.76	6	12.1	48.4	60.5	40.0	UnDef	UnDef	6.0	UnDef
5.62	5.0E-06	0.33	13.4	1.40	6	10.5	41.9	52.4	41.0	UnDef	UnDef	6.0	UnDef
5.88	5.0E-06	0.17	17.9	1.54	6	13.8	55.0	68.8	36.7	UnDef	UnDef	6.0	UnDef
6.12	5.0E-06	0.19	13.4	1.60	6	10.9	43.7	54.6	42.7	UnDef	UnDef	6.0	UnDef
6.38	5.0E-06	0.21	13.6	2.27	6	11.3	45.1	56.3	47.1	UnDef	UnDef	6.0	UnDef
6.62	5.0E-06	0.26	11.6	1.99	6	10.0	40.2	50.2	48.7	UnDef	UnDef	3.0	UnDef
6.88	5.0E-06	0.21	11.2	2.32	6	9.9	39.7	49.6	51.7	UnDef	UnDef	3.0	UnDef
7.12	5.0E-06	0.29	10.6	1.60	6	9.7	38.8	48.5	47.6	UnDef	UnDef	3.0	UnDef
7.38	5.0E-06	0.16	14.3	1.96	6	12.7	50.8	63.5	44.0	UnDef	UnDef	6.0	UnDef
7.62	5.0E-06	0.14	12.5	1.98	6	11.5	46.2	57.7	46.9	UnDef	UnDef	6.0	UnDef
7.88	5.0E-06	0.11	15.0	1.55	6	13.7	54.8	68.5	40.1	UnDef	UnDef	6.0	UnDef
8.12	5.0E-06	0.18	12.0	2.04	6	11.5	45.9	57.4	48.3	UnDef	UnDef	3.0	UnDef
8.38	5.0E-06	0.22	9.1	1.49	6	9.3	37.0	46.3	50.3	UnDef	UnDef	3.0	UnDef
8.62	5.0E-05	0.06	12.6	1.06	6	12.4	49.4	61.8	39.2	32	30.0	6.0	0.01
8.88	5.0E-06	0.12	9.2	1.30	6	9.6	38.5	48.2	48.3	UnDef	UnDef	3.0	UnDef
9.12	5.0E-05	0.10	14.5	1.32	6	14.4	57.4	71.8	38.8	32	30.0	6.0	-0.01
9.38	5.0E-05	0.00	25.9	0.95	7	24.4	30.0	54.4	25.6	36	30.0	6.0	-0.06
9.62	5.0E-05	0.03	20.9	0.83	7	20.3	31.7	52.1	27.8	34	30.0	6.0	-0.02

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param	
9.88	5.0E-04	0.02	27.5	0.52	7	26.5	18.0	44.6	20.2	36	30.0	1.0	-0.01	2.9
10.12	5.0E-04	0.01	34.0	0.36	9	32.7	0.0	32.7	5.0	38	35.3	1.0	0.00	0.0
10.38	5.0E-04	0.03	24.7	0.56	7	24.6	21.0	45.6	22.2	34	30.0	1.0	-0.01	3.2
10.62	5.0E-05	0.06	17.2	0.73	7	18.0	35.8	53.8	29.9	32	30.0	6.0	0.01	5.0
10.88	5.0E-04	0.01	45.1	0.58	9	44.4	15.6	60.1	14.8	38	44.0	1.0	-0.07	2.8
11.12	5.0E-04	0.01	41.1	0.74	7	41.1	20.5	61.7	17.5	38	41.8	1.0	-0.08	3.5
11.38	5.0E-03	0.00	65.9	0.37	9	65.5	0.0	65.5	5.0	40	55.2	1.0	-0.07	0.0
11.62	5.0E-03	0.00	61.3	0.49	9	61.8	0.0	61.8	5.0	40	53.5	1.0	-0.08	0.0
11.88	5.0E-03	0.00	64.1	1.05	7	65.4	24.0	89.4	15.1	40	55.1	1.0	-0.15	3.2
12.12	5.0E-03	0.00	57.7	0.65	9	59.7	15.9	75.6	12.9	40	52.5	1.0	-0.10	2.2
12.38	5.0E-04	0.00	47.5	1.04	7	50.1	27.5	77.6	18.3	38	47.5	1.0	-0.12	4.7
12.62	5.0E-03	0.00	67.5	0.36	9	71.0	0.0	71.0	5.0	40	57.5	1.0	-0.07	0.0
12.88	5.0E-02	0.00	88.1	0.43	9	93.1	0.0	93.1	5.0	42	65.2	1.0	-0.10	0.0

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-4700

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S2

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 11:29

CPT File: 141CPS2.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method : Robertson and Campanella, 1983

Dr Method : Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	15.4	0.02	0.13	0.17	6	18.0	2.2	1.0	1.23	2.00	6.2	12.3	123.0	0.08
0.38	2.2	0.04	1.78	-0.25	1	17.5	6.7	3.0	3.68	2.00	1.1	2.2	17.0	0.00
0.62	2.2	0.08	3.51	-0.25	3	17.5	11.1	4.9	6.13	2.00	2.2	4.4	16.9	0.00
0.88	2.8	0.06	2.22	0.12	3	17.5	15.4	6.9	8.58	2.00	2.8	5.6	21.1	0.00
1.12	2.5	0.05	1.88	1.58	1	17.5	19.8	8.8	11.04	2.00	1.2	2.5	18.4	0.00
1.38	2.7	0.04	1.65	2.08	1	17.5	24.2	10.7	13.49	2.00	1.3	2.7	19.4	0.00
1.62	81.4	0.67	0.82	-5.32	8	19.0	28.8	12.8	15.94	2.00	20.4	40.7	UnDef	0.00
1.88	65.5	0.61	0.93	-8.90	8	19.0	33.5	15.1	18.39	2.00	16.4	32.7	UnDef	0.29
2.12	41.7	0.33	0.80	-7.93	7	18.5	38.2	17.3	20.85	2.00	13.9	27.8	UnDef	0.13
2.38	39.3	0.65	1.65	-8.39	7	18.5	42.8	19.5	23.30	2.00	13.1	26.2	UnDef	0.15
2.62	25.2	0.51	2.02	-8.54	6	18.0	47.4	21.6	25.75	2.00	10.1	20.1	197.6	0.11
2.88	19.1	0.47	2.44	-7.87	5	18.0	51.9	23.7	28.20	2.00	9.5	19.1	148.5	0.11
3.12	28.6	1.08	3.77	-3.31	5	18.0	56.4	25.7	30.66	1.93	14.3	27.6	224.3	0.00
3.38	26.6	1.12	4.22	6.19	4	18.0	60.9	27.8	33.11	1.86	17.8	33.0	208.2	0.00
3.62	22.0	0.93	4.20	-4.58	3	17.5	65.3	29.8	35.56	1.79	22.0	39.5	170.8	0.21
3.88	14.4	0.41	2.83	7.85	5	18.0	69.8	31.7	38.01	1.74	7.2	12.5	109.4	0.13
4.12	10.7	0.18	1.66	29.74	5	18.0	74.2	33.8	40.47	1.68	5.4	9.0	79.9	0.10
4.38	9.0	0.06	0.62	36.09	6	18.0	78.8	35.8	42.92	1.64	3.6	5.9	65.4	0.08
4.62	7.6	0.04	0.48	33.26	1	17.5	83.2	37.8	45.37	1.59	3.8	6.0	53.9	0.00
4.88	7.7	0.03	0.35	31.58	1	17.5	87.6	39.7	47.82	1.55	3.8	6.0	54.5	0.00
5.12	7.7	0.04	0.48	28.28	1	17.5	91.9	41.7	50.28	1.52	3.9	5.9	54.5	0.08
5.38	7.9	0.07	0.83	20.01	5	18.0	96.4	43.6	52.73	1.48	4.0	5.9	55.7	0.09
5.62	9.7	0.09	0.97	15.84	6	18.0	100.9	45.7	55.18	1.45	3.9	5.6	69.7	0.09
5.88	9.5	0.10	1.03	19.28	5	18.0	105.4	47.7	57.63	1.42	4.7	6.7	67.5	0.10
6.12	8.6	0.08	0.96	20.07	5	18.0	109.9	49.8	60.09	1.39	4.3	5.9	59.8	0.10
6.38	8.7	0.11	1.30	24.59	5	18.0	114.4	51.8	62.54	1.36	4.3	5.9	60.3	0.10
6.62	8.3	0.10	1.18	14.72	5	18.0	118.9	53.9	64.99	1.33	4.2	5.5	57.0	0.10
6.88	6.6	0.02	0.32	22.93	1	17.5	123.3	55.9	67.44	1.31	3.3	4.3	43.1	0.09
7.12	9.1	0.10	1.07	17.39	5	18.0	127.8	57.9	69.90	1.29	4.5	5.8	62.3	0.10
7.38	9.5	0.10	1.08	16.44	5	18.0	132.2	59.9	72.35	1.26	4.8	6.0	65.5	0.10
7.62	9.4	0.06	0.67	16.48	6	18.0	136.8	61.9	74.80	1.24	3.7	4.7	64.0	0.10
7.88	27.3	0.12	0.42	14.88	7	18.5	141.3	64.1	77.25	1.22	9.1	11.1	UnDef	0.08
8.12	42.4	0.75	1.76	14.45	7	18.5	145.9	66.2	79.71	1.20	14.1	17.0	UnDef	0.14
8.38	8.5	0.13	1.50	16.63	5	18.0	150.5	68.3	82.16	1.18	4.2	5.0	55.9	0.09
8.62	9.2	0.04	0.48	13.14	6	18.0	155.0	70.4	84.61	1.17	3.7	4.3	60.9	0.10
8.88	14.3	0.10	0.70	11.24	6	18.0	159.5	72.4	87.06	1.15	5.7	6.6	101.6	0.09
9.12	15.2	0.05	0.35	18.00	6	18.0	164.0	74.5	89.52	1.13	6.1	6.9	108.7	0.00
9.38	20.5	0.34	1.64	20.45	6	18.0	168.5	76.5	91.97	1.12	8.2	9.2	150.5	0.15

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-4700

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S2

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 11:29

CPT File: 141CPS2.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method : Robertson and Campanella, 1983

Dr Method : Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1) Param
0.12	5.0E-05	0.00	1000.0	0.13	10	30.8	0.0	30.8	0.0	50	79.3	10.0	-0.21 0.0
0.38	1.0E-07	-0.03	70.5	1.84	7	4.4	2.6	7.0	19.0	UnDef	UnDef	10.0	UnDef 0.7
0.62	5.0E-08	-0.04	42.8	3.69	6	4.4	14.4	18.8	33.6	UnDef	UnDef	6.0	UnDef 4.1
0.88	5.0E-08	-0.03	38.5	2.35	7	5.6	10.2	15.8	29.2	UnDef	UnDef	6.0	UnDef 3.8
1.12	1.0E-07	0.02	26.2	2.05	6	5.0	15.7	20.7	33.4	UnDef	UnDef	6.0	UnDef 2.3
1.38	1.0E-07	0.03	22.7	1.81	6	5.3	19.5	24.8	34.4	UnDef	UnDef	6.0	UnDef 2.6
1.62	5.0E-03	-0.01	633.3	0.82	10	162.8	0.0	162.8	0.6	50	90.8	1.0	-0.34 0.0
1.88	5.0E-03	-0.02	431.3	0.93	9	131.0	0.0	131.0	2.2	48	82.2	1.0	-0.32 0.0
2.12	5.0E-04	-0.02	238.2	0.81	9	83.4	0.0	83.4	3.9	46	67.3	1.0	-0.25 0.0
2.38	5.0E-04	-0.03	199.5	1.66	9	78.7	10.4	89.1	9.4	46	64.0	1.0	-0.31 2.1
2.62	5.0E-05	-0.04	114.2	2.06	7	50.4	19.2	69.6	15.3	42	49.7	10.0	-0.29 4.2
2.88	5.0E-06	-0.06	78.4	2.51	7	38.2	28.6	66.8	21.1	UnDef	UnDef	10.0	UnDef 7.0
3.12	5.0E-06	-0.02	109.0	3.84	12	56.4	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef UnDef
3.38	5.0E-07	0.01	93.7	4.32	11	50.5	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef UnDef
3.62	5.0E-08	-0.04	71.7	4.33	6	40.3	71.5	111.8	28.9	UnDef	UnDef	10.0	UnDef 26.3
3.88	5.0E-06	0.03	43.1	2.98	6	25.5	55.0	80.5	30.6	UnDef	UnDef	6.0	UnDef 9.3
4.12	5.0E-06	0.25	29.6	1.78	7	18.5	36.5	55.0	29.9	UnDef	UnDef	6.0	UnDef 6.4
4.38	5.0E-05	0.38	22.8	0.68	7	15.0	16.9	31.8	24.8	34	30.0	6.0	0.02 2.9
4.62	1.0E-07	0.42	17.8	0.53	7	12.3	17.4	29.7	26.9	UnDef	UnDef	6.0	UnDef 3.5
4.88	1.0E-07	0.38	17.1	0.40	7	12.2	0.0	12.2	5.0	UnDef	UnDef	6.0	UnDef 0.0
5.12	1.0E-07	0.33	16.3	0.54	7	12.0	20.2	32.2	28.5	UnDef	UnDef	6.0	UnDef 3.8
5.38	5.0E-06	0.21	16.0	0.95	7	12.0	38.8	50.8	33.6	UnDef	UnDef	6.0	UnDef 5.4
5.62	5.0E-05	0.12	19.1	1.08	7	14.4	35.8	50.2	31.7	34	30.0	6.0	-0.02 4.5
5.88	5.0E-06	0.16	17.7	1.16	7	13.7	45.5	59.3	33.8	UnDef	UnDef	6.0	UnDef 6.2
6.12	5.0E-06	0.18	15.0	1.10	6	12.2	48.6	60.8	36.2	UnDef	UnDef	6.0	UnDef 5.9
6.38	5.0E-06	0.24	14.5	1.50	6	12.1	48.2	60.3	40.3	UnDef	UnDef	6.0	UnDef 5.9
6.62	5.0E-06	0.11	13.2	1.38	6	11.3	45.3	56.6	41.2	UnDef	UnDef	6.0	UnDef 5.5
6.88	1.0E-07	0.29	9.6	0.39	7	8.8	35.4	44.2	36.1	UnDef	UnDef	3.0	UnDef 4.3
7.12	5.0E-06	0.13	13.5	1.25	6	11.9	47.6	59.5	39.7	UnDef	UnDef	6.0	UnDef 5.8
7.38	5.0E-06	0.11	13.7	1.26	6	12.3	49.1	61.4	39.5	UnDef	UnDef	6.0	UnDef 6.0
7.62	5.0E-05	0.11	12.9	0.79	6	11.9	47.6	59.5	35.8	32	30.0	6.0	0.03 4.7
7.88	5.0E-04	0.03	40.4	0.45	9	34.1	0.0	34.1	5.0	38	36.4	1.0	-0.04 0.0
8.12	5.0E-04	0.02	61.9	1.82	7	52.1	36.0	88.2	20.3	40	48.6	1.0	-0.20 5.8
8.38	5.0E-06	0.12	10.2	1.82	6	10.3	41.1	51.4	50.2	UnDef	UnDef	3.0	UnDef 5.0
8.62	5.0E-05	0.06	10.8	0.58	6	10.9	43.7	54.6	36.7	30	30.0	3.0	0.07 4.3
8.88	5.0E-05	0.02	17.5	0.79	7	16.8	34.8	51.5	30.2	32	30.0	6.0	0.00 4.8
9.12	5.0E-05	0.06	18.2	0.40	7	17.6	0.0	17.6	5.0	32	30.0	6.0	0.05 0.0
9.38	5.0E-05	0.06	24.6	1.79	6	23.4	68.4	91.8	32.9	34	30.0	6.0	-0.10 8.0

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5304

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S3

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 13:21

CPT File: 141CPS3.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method : Robertson and Campanella, 1983

Dr Method : Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60	Su (kPa)	CRR
0.12	4.5	0.07	1.59	-0.42	1	17.5	2.2	1.0	1.23	2.00	2.3	4.5	36.1	0.00
0.38	2.8	0.14	5.18	-2.00	3	17.5	6.6	2.9	3.68	2.00	2.8	5.6	21.9	0.00
0.62	2.5	0.13	5.30	-0.89	3	17.5	10.9	4.8	6.13	2.00	2.5	5.0	19.2	0.00
0.88	2.8	0.09	3.07	0.17	3	17.5	15.3	6.7	8.58	2.00	2.8	5.7	21.5	0.00
1.12	2.7	0.07	2.67	2.16	3	17.5	19.7	8.7	11.04	2.00	2.7	5.4	20.0	0.00
1.38	16.3	0.09	0.58	0.73	6	18.0	24.1	10.6	13.49	2.00	6.5	13.0	128.1	0.08
1.62	95.8	0.48	0.50	-7.81	9	19.5	28.8	12.9	15.94	2.00	19.2	38.3	UnDef	0.00
1.88	48.5	0.03	0.05	-6.01	8	19.0	33.6	15.2	18.39	2.00	12.1	24.3	UnDef	0.16
2.12	54.9	0.05	0.09	-2.31	8	19.0	38.4	17.5	20.85	2.00	13.7	27.4	UnDef	0.20
2.38	59.6	0.30	0.50	2.09	8	19.0	43.1	19.8	23.30	2.00	14.9	29.8	UnDef	0.24
2.62	30.5	0.31	1.02	6.00	7	18.5	47.8	22.1	25.75	2.00	10.2	20.3	UnDef	0.11
2.88	19.7	0.29	1.46	23.30	6	18.0	52.4	24.2	28.20	1.99	7.9	15.7	153.4	0.10
3.12	21.6	0.35	1.60	40.73	6	18.0	56.9	26.2	30.66	1.91	8.7	16.5	168.5	0.10
3.38	27.4	0.92	3.35	24.82	5	18.0	61.4	28.3	33.11	1.84	13.7	25.3	214.6	0.17
3.62	25.0	0.99	3.94	-1.30	4	18.0	65.9	30.3	35.56	1.78	16.7	29.6	194.6	0.20
3.88	13.9	0.32	2.31	19.45	5	18.0	70.4	32.4	38.01	1.72	6.9	11.9	105.3	0.11
4.12	9.9	0.08	0.81	37.83	6	18.0	74.9	34.4	40.47	1.67	3.9	6.6	72.9	0.08
4.38	9.0	0.07	0.77	35.10	6	18.0	79.4	36.5	42.92	1.62	3.6	5.8	65.6	0.08
4.62	7.6	0.05	0.60	31.75	5	18.0	83.9	38.5	45.37	1.58	3.8	6.0	54.3	0.08
4.88	7.4	0.03	0.38	29.61	1	17.5	88.3	40.5	47.82	1.54	3.7	5.7	52.3	0.00
5.12	7.3	0.02	0.34	30.39	1	17.5	92.7	42.4	50.28	1.50	3.7	5.5	51.2	0.00
5.38	7.3	0.06	0.84	23.67	5	18.0	97.1	44.4	52.73	1.47	3.6	5.4	50.6	0.10
5.62	7.0	0.07	0.96	15.24	5	18.0	101.6	46.4	55.18	1.44	3.5	5.0	47.6	0.09
5.88	9.6	0.11	1.16	16.49	5	18.0	106.1	48.5	57.63	1.41	4.8	6.7	68.2	0.11
6.12	8.4	0.09	1.05	20.97	5	18.0	110.6	50.5	60.09	1.38	4.2	5.8	58.3	0.10
6.38	7.8	0.07	0.95	18.20	5	18.0	115.1	52.6	62.54	1.35	3.9	5.3	53.1	0.09
6.62	6.2	0.04	0.58	23.22	1	17.5	119.6	54.6	64.99	1.32	3.1	4.1	40.4	0.09
6.88	6.8	0.04	0.52	20.10	1	17.5	123.9	56.5	67.44	1.30	3.4	4.4	44.2	0.09
7.12	8.6	0.08	0.97	14.15	5	18.0	128.4	58.5	69.90	1.28	4.3	5.5	58.5	0.10
7.38	7.4	0.06	0.78	21.31	5	18.0	132.9	60.5	72.35	1.26	3.7	4.7	48.6	0.09
7.62	6.9	0.06	0.85	8.97	5	18.0	137.4	62.6	74.80	1.24	3.5	4.3	44.2	0.09
7.88	6.5	0.04	0.65	19.99	1	17.5	141.8	64.6	77.25	1.22	3.2	3.9	40.3	0.09
8.12	7.2	0.05	0.64	24.08	1	17.5	146.2	66.5	79.71	1.20	3.6	4.3	45.9	0.09
8.38	8.9	0.08	0.89	19.15	5	18.0	150.6	68.5	82.16	1.18	4.4	5.2	58.8	0.09
8.62	9.8	0.08	0.78	20.19	6	18.0	155.1	70.5	84.61	1.17	3.9	4.6	66.1	0.10
8.88	11.9	0.09	0.73	14.34	6	18.0	159.6	72.6	87.06	1.15	4.8	5.5	82.2	0.11
9.12	9.5	0.08	0.87	15.79	6	18.0	164.1	74.6	89.52	1.13	3.8	4.3	62.5	0.10
9.38	11.7	0.12	1.06	10.80	6	18.0	168.6	76.7	91.97	1.12	4.7	5.2	80.0	0.11
9.62	10.3	0.08	0.82	5.71	6	18.0	173.1	78.7	94.42	1.10	4.1	4.5	68.5	0.10

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	14.1	0.05	0.36	13.39	6	18.0	177.6	80.8	96.87	1.09	5.7	6.2	99.0	0.00
10.12	17.4	0.16	0.90	8.93	6	18.0	182.1	82.8	99.33	1.08	7.0	7.5	124.6	0.10
10.38	14.7	0.13	0.88	6.54	6	18.0	186.6	84.8	101.78	1.06	5.9	6.3	103.0	0.13
10.62	15.3	0.14	0.94	10.49	6	18.0	191.1	86.9	104.23	1.05	6.1	6.4	107.5	0.13
10.88	12.8	0.08	0.65	15.24	6	18.0	195.6	88.9	106.68	1.04	5.1	5.3	87.0	0.11
11.12	19.9	0.11	0.56	8.90	7	18.5	200.2	91.1	109.14	1.03	6.6	6.8	UnDef	0.09
11.38	25.5	0.10	0.40	10.83	7	18.5	204.8	93.2	111.59	1.01	8.5	8.6	UnDef	0.00
11.62	15.9	0.06	0.36	10.11	6	18.0	209.4	95.3	114.04	1.00	6.4	6.4	110.8	0.00
11.88	20.4	0.09	0.43	10.46	7	18.5	213.9	97.4	116.49	0.99	6.8	6.7	UnDef	0.00
12.12	20.0	0.05	0.26	7.32	7	18.5	218.6	99.6	118.95	0.98	6.7	6.5	UnDef	0.00
12.38	23.0	0.09	0.40	16.14	7	18.5	223.2	101.8	121.40	0.97	7.7	7.4	UnDef	0.00
12.62	20.2	0.06	0.28	14.57	7	18.5	227.8	104.0	123.85	0.96	6.7	6.5	UnDef	0.00
12.88	22.6	0.04	0.16	18.43	7	18.5	232.4	106.1	126.30	0.95	7.5	7.1	UnDef	0.00
13.12	19.2	0.03	0.17	19.02	7	18.5	237.1	108.3	128.76	0.94	6.4	6.0	UnDef	0.00
13.38	31.8	0.16	0.51	17.09	7	18.5	241.7	110.5	131.21	0.93	10.6	9.9	UnDef	0.09
13.62	25.5	0.18	0.70	21.70	7	18.5	246.3	112.7	133.66	0.92	8.5	7.8	UnDef	0.10
13.88	61.0	0.25	0.42	14.50	8	19.0	251.0	114.9	136.11	0.91	15.3	13.9	UnDef	0.10
14.12	64.4	0.28	0.44	15.04	8	19.0	255.8	117.2	138.57	0.90	16.1	14.5	UnDef	0.10
14.38	78.9	0.36	0.45	15.14	8	19.0	260.5	119.5	141.02	0.90	19.7	17.7	UnDef	0.11
14.62	61.2	0.25	0.40	15.58	8	19.0	265.2	121.8	143.47	0.89	15.3	13.6	UnDef	0.10
14.88	57.0	0.29	0.51	15.91	8	19.0	270.0	124.1	145.92	0.88	14.3	12.5	UnDef	0.11
15.12	76.4	0.63	0.83	16.47	8	19.0	274.8	126.4	148.38	0.87	19.1	16.6	UnDef	0.15
15.38	135.3	0.58	0.43	15.64	9	19.5	279.6	128.7	150.83	0.86	27.1	23.3	UnDef	0.24
15.62	142.6	0.51	0.36	16.34	9	19.5	284.4	131.2	153.28	0.85	28.5	24.4	UnDef	0.26
15.88	158.4	0.51	0.32	16.36	9	19.5	289.3	133.6	155.73	0.85	31.7	26.8	UnDef	0.32
16.12	159.8	0.61	0.38	16.78	9	19.5	294.2	136.0	158.19	0.84	32.0	26.8	UnDef	0.32
16.38	135.4	0.50	0.37	16.98	9	19.5	299.1	138.4	160.64	0.83	27.1	22.5	UnDef	0.22
16.62	126.9	0.27	0.21	17.13	9	19.5	303.9	140.8	163.09	0.82	25.4	20.9	UnDef	0.19

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5304

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S3

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 13:21

CPT File: 141CPS3.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Param	Del(n1)60 (N1)	
0.12	1.0E-07	-0.01	470.0	1.59	9	9.1	0.0	9.1	4.9	UnDef	UnDef	10.0	UnDef	0.0
0.38	5.0E-08	-0.09	94.8	5.31	11	5.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef	UnDef
0.62	5.0E-08	-0.06	49.9	5.54	1	5.0	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef	UnDef
0.88	5.0E-08	-0.03	39.9	3.24	6	5.7	16.5	22.1	32.9	UnDef	UnDef	6.0	UnDef	4.9
1.12	5.0E-08	0.04	28.9	2.88	6	5.4	21.6	27.0	36.2	UnDef	UnDef	6.0	UnDef	5.4
1.38	5.0E-05	0.00	150.5	0.59	9	32.5	0.0	32.5	4.8	44	47.3	10.0	-0.18	0.0
1.62	5.0E-02	-0.01	742.0	0.50	10	191.6	0.0	191.6	0.0	50	95.0	1.0	-0.31	0.0
1.88	5.0E-03	-0.02	316.3	0.05	10	97.0	0.0	97.0	0.0	46	73.5	1.0	-0.04	0.0
2.12	5.0E-03	-0.01	310.7	0.09	10	109.7	0.0	109.7	0.0	46	75.0	1.0	-0.09	0.0
2.38	5.0E-03	0.00	298.5	0.50	10	119.2	0.0	119.2	1.0	46	75.6	1.0	-0.23	0.0
2.62	5.0E-04	0.01	136.0	1.04	9	61.0	6.4	67.4	8.6	44	54.9	1.0	-0.22	1.3
2.88	5.0E-05	0.10	79.4	1.50	7	39.4	16.1	55.5	15.9	42	41.1	10.0	-0.19	3.5
3.12	5.0E-05	0.18	80.3	1.65	7	42.2	18.9	61.1	16.6	42	42.6	10.0	-0.20	4.0
3.38	5.0E-06	0.08	94.9	3.43	7	51.6	46.1	97.7	22.7	UnDef	UnDef	10.0	UnDef	10.6
3.62	5.0E-07	-0.02	80.2	4.05	6	45.4	62.3	107.7	26.7	UnDef	UnDef	10.0	UnDef	16.8
3.88	5.0E-06	0.12	40.7	2.44	7	24.4	42.8	67.2	28.9	UnDef	UnDef	6.0	UnDef	7.9
4.12	5.0E-05	0.36	26.5	0.88	7	16.8	18.4	35.3	24.6	36	30.0	6.0	-0.01	3.2
4.38	5.0E-05	0.37	22.5	0.84	7	14.9	20.6	35.5	26.7	34	30.0	6.0	0.01	3.3
4.62	5.0E-06	0.39	17.6	0.68	7	12.3	21.7	34.0	28.9	UnDef	UnDef	6.0	UnDef	4.0
4.88	1.0E-07	0.37	16.1	0.43	7	11.7	0.0	11.7	5.0	UnDef	UnDef	6.0	UnDef	0.0
5.12	1.0E-07	0.39	15.1	0.39	7	11.3	0.0	11.3	5.0	UnDef	UnDef	6.0	UnDef	0.0
5.38	5.0E-06	0.28	14.2	0.96	6	10.9	43.8	54.7	35.9	UnDef	UnDef	6.0	UnDef	5.4
5.62	5.0E-06	0.16	12.8	1.12	6	10.2	40.9	51.2	39.5	UnDef	UnDef	6.0	UnDef	5.0
5.88	5.0E-06	0.12	17.6	1.30	6	13.8	55.1	68.9	35.1	UnDef	UnDef	6.0	UnDef	6.7
6.12	5.0E-06	0.20	14.4	1.21	6	11.8	47.2	59.0	38.0	UnDef	UnDef	6.0	UnDef	5.8
6.38	5.0E-06	0.17	12.6	1.11	6	10.7	43.0	53.7	39.7	UnDef	UnDef	6.0	UnDef	5.3
6.62	1.0E-07	0.32	9.2	0.71	6	8.4	33.8	42.2	41.8	UnDef	UnDef	3.0	UnDef	4.1
6.88	1.0E-07	0.23	9.8	0.63	6	9.0	36.0	45.0	39.5	UnDef	UnDef	3.0	UnDef	4.4
7.12	5.0E-06	0.09	12.5	1.14	6	11.2	45.0	56.2	40.1	UnDef	UnDef	6.0	UnDef	5.5
7.38	5.0E-06	0.22	10.0	0.95	6	9.5	38.1	47.6	42.8	UnDef	UnDef	3.0	UnDef	4.7
7.62	5.0E-06	0.02	8.8	1.07	6	8.7	34.9	43.6	46.9	UnDef	UnDef	3.0	UnDef	4.3
7.88	1.0E-07	0.24	7.8	0.83	6	8.0	32.1	40.2	47.1	UnDef	UnDef	3.0	UnDef	3.9
8.12	1.0E-07	0.27	8.6	0.80	6	8.8	35.3	44.2	44.4	UnDef	UnDef	3.0	UnDef	4.3
8.38	5.0E-06	0.14	10.7	1.07	6	10.7	42.8	53.5	42.7	UnDef	UnDef	3.0	UnDef	5.2
8.62	5.0E-05	0.14	11.7	0.93	6	11.7	46.7	58.4	39.4	30	30.0	3.0	0.03	4.6
8.88	5.0E-05	0.05	14.2	0.85	6	13.9	53.7	67.6	34.7	32	30.0	6.0	0.01	5.4
9.12	5.0E-05	0.08	10.5	1.05	6	10.9	43.8	54.7	43.0	30	30.0	3.0	0.03	4.3
9.38	5.0E-05	0.01	13.1	1.24	6	13.4	53.4	66.8	40.2	32	30.0	6.0	-0.01	5.2
9.62	5.0E-05	-0.04	10.9	0.98	6	11.6	46.4	58.0	41.4	30	30.0	3.0	0.02	4.5



Run No: 99-0331-0827-5304

CPT File: 141CPS3.COR

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param	
9.88	5.0E-05	0.03	15.3	0.41	7	15.7	0.0	15.7	5.0	32	30.0	6.0	0.06	0.0
10.12	5.0E-05	-0.01	18.8	1.01	7	19.1	45.0	64.1	31.3	34	30.0	6.0	-0.03	5.9
10.38	5.0E-05	-0.03	15.2	1.01	6	16.0	64.0	80.0	35.2	32	30.0	6.0	-0.01	6.3
10.62	5.0E-05	0.00	15.5	1.07	6	16.5	65.8	82.3	35.4	32	30.0	6.0	-0.02	6.4
10.88	5.0E-05	0.04	12.2	0.77	6	13.6	54.4	68.0	36.7	32	30.0	3.0	0.03	5.3
11.12	5.0E-04	-0.01	19.7	0.63	7	20.9	28.1	48.9	26.5	34	30.0	1.0	0.00	3.8
11.38	5.0E-04	0.00	25.2	0.43	7	26.4	0.0	26.4	5.0	34	30.0	1.0	0.01	0.0
11.62	5.0E-05	-0.01	14.5	0.42	7	16.3	0.0	16.3	5.0	32	30.0	6.0	0.06	0.0
11.88	5.0E-04	-0.01	18.7	0.48	7	20.6	0.0	20.6	5.0	34	30.0	1.0	0.02	0.0
12.12	5.0E-04	-0.03	17.9	0.30	7	20.1	0.0	20.1	5.0	32	30.0	1.0	0.06	0.0
12.38	5.0E-04	0.02	20.4	0.45	7	22.8	0.0	22.8	5.0	34	30.0	1.0	0.02	0.0
12.62	5.0E-04	0.01	17.3	0.31	7	19.8	0.0	19.8	5.0	32	30.0	1.0	0.07	0.0
12.88	5.0E-04	0.03	19.1	0.18	7	21.9	0.0	21.9	5.0	34	30.0	1.0	0.10	0.0
13.12	5.0E-04	0.03	15.6	0.20	7	18.5	0.0	18.5	5.0	32	30.0	1.0	0.11	0.0
13.38	5.0E-04	0.01	26.6	0.55	7	30.3	22.7	53.0	21.1	36	33.0	1.0	-0.02	3.6
13.62	5.0E-04	0.03	20.4	0.77	7	24.0	36.2	60.2	27.5	34	30.0	1.0	-0.01	4.7
13.88	5.0E-03	0.00	50.9	0.43	9	56.9	0.0	56.9	5.0	38	51.1	1.0	-0.06	0.0
14.12	5.0E-03	0.00	52.7	0.46	9	59.5	0.0	59.5	5.0	40	52.4	1.0	-0.06	0.0
14.38	5.0E-03	0.00	63.8	0.47	9	72.2	0.0	72.2	5.0	40	57.9	1.0	-0.08	0.0
14.62	5.0E-03	0.00	48.0	0.42	9	55.4	0.0	55.4	5.0	38	50.4	1.0	-0.05	0.0
14.88	5.0E-03	0.00	43.8	0.53	9	51.2	17.7	68.9	14.6	38	48.1	1.0	-0.06	2.4
15.12	5.0E-03	0.00	58.3	0.86	9	67.9	23.3	91.3	14.6	40	56.2	1.0	-0.12	3.2
15.38	5.0E-02	0.00	102.9	0.44	9	119.3	0.0	119.3	5.0	42	72.3	1.0	-0.12	0.0
15.62	5.0E-02	0.00	106.5	0.36	9	124.5	0.0	124.5	5.0	42	73.6	1.0	-0.11	0.0
15.88	5.0E-02	0.00	116.5	0.33	9	137.1	0.0	137.1	4.1	42	76.3	1.0	-0.11	0.0
16.12	5.0E-02	0.00	115.3	0.39	9	137.0	0.0	137.0	4.8	42	76.3	1.0	-0.12	0.0
16.38	5.0E-02	0.00	95.6	0.38	9	115.1	0.0	115.1	5.0	42	71.3	1.0	-0.10	0.0
16.62	5.0E-02	0.00	87.9	0.22	9	106.9	0.0	106.9	4.8	42	69.2	1.0	-0.05	0.0

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5760

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S4

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 15:35

CPT File: 141CPS4.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	20.9	0.03	0.14	-0.07	7	18.5	2.3	1.1	1.23	2.00	7.0	13.9	UnDef	0.09
0.38	3.6	0.10	2.70	-1.23	3	17.5	6.8	3.1	3.68	2.00	3.6	7.1	27.9	0.00
0.62	3.2	0.06	1.90	-2.45	1	17.5	11.2	5.1	6.13	2.00	1.6	3.2	24.3	0.00
0.88	2.6	0.04	1.62	-1.80	1	17.5	15.6	7.0	8.58	2.00	1.3	2.6	19.4	0.00
1.12	2.3	0.05	2.00	-0.08	1	17.5	19.9	8.9	11.04	2.00	1.2	2.3	16.8	0.00
1.38	35.9	0.40	1.12	-5.74	7	18.5	24.4	10.9	13.49	2.00	12.0	23.9	UnDef	0.11
1.62	8.2	0.24	2.92	-8.75	4	18.0	29.0	13.1	15.94	2.00	5.5	10.9	63.2	0.09
1.88	16.9	0.34	1.98	-8.77	6	18.0	33.5	15.1	18.39	2.00	6.8	13.6	132.8	0.09
2.12	15.3	0.23	1.53	-8.59	6	18.0	38.0	17.2	20.85	2.00	6.1	12.3	119.6	0.09
2.38	14.1	0.20	1.44	-8.40	6	18.0	42.5	19.2	23.30	2.00	5.6	11.3	109.1	0.09
2.62	24.3	0.22	0.89	-8.29	7	18.5	47.1	21.3	25.75	2.00	8.1	16.2	UnDef	0.10
2.88	17.2	0.19	1.13	-8.05	6	18.0	51.6	23.4	28.20	2.00	6.9	13.8	133.4	0.09
3.12	22.2	0.55	2.47	-7.29	6	18.0	56.1	25.5	30.66	1.94	8.9	17.3	173.4	0.12
3.38	17.3	0.37	2.12	-6.04	5	18.0	60.6	27.5	33.11	1.87	8.6	16.1	133.2	0.10
3.62	12.4	0.21	1.69	25.20	5	18.0	65.1	29.6	35.56	1.80	6.2	11.2	94.0	0.09
3.88	10.2	0.10	1.00	48.41	6	18.0	69.6	31.6	38.01	1.74	4.1	7.1	76.1	0.09
4.12	8.9	0.03	0.34	40.88	6	18.0	74.1	33.7	40.47	1.69	3.6	6.0	65.3	0.00
4.38	8.3	0.03	0.32	39.42	1	17.5	78.6	35.6	42.92	1.64	4.2	6.8	60.2	0.00
4.62	7.6	0.03	0.37	35.90	1	17.5	82.9	37.6	45.37	1.60	3.8	6.1	54.1	0.00
4.88	6.6	0.03	0.39	34.87	1	17.5	87.3	39.5	47.82	1.56	3.3	5.1	45.8	0.00
5.12	6.3	0.03	0.46	33.84	1	17.5	91.7	41.4	50.28	1.52	3.2	4.8	43.3	0.08
5.38	6.3	0.03	0.48	33.64	1	17.5	96.1	43.3	52.73	1.49	3.1	4.7	42.5	0.09
5.62	6.6	0.03	0.45	23.14	1	17.5	100.4	45.3	55.18	1.45	3.3	4.8	44.9	0.09
5.88	6.0	0.03	0.50	31.32	1	17.5	104.8	47.2	57.63	1.42	3.0	4.3	39.7	0.09
6.12	6.1	0.03	0.49	31.54	1	17.5	109.2	49.1	60.09	1.40	3.1	4.3	40.2	0.09
6.38	7.0	0.03	0.43	27.51	1	17.5	113.6	51.0	62.54	1.37	3.5	4.8	46.7	0.09
6.62	6.9	0.03	0.42	23.86	1	17.5	117.9	52.9	64.99	1.35	3.4	4.6	45.5	0.09
6.88	9.0	0.05	0.52	17.57	6	18.0	122.4	54.9	67.44	1.32	3.6	4.7	61.9	0.09
7.12	7.2	0.03	0.42	25.06	1	17.5	126.8	56.9	69.90	1.30	3.6	4.7	47.6	0.09
7.38	6.3	0.03	0.48	21.94	1	17.5	131.2	58.8	72.35	1.28	3.1	4.0	39.5	0.09
7.62	6.3	0.03	0.47	21.48	1	17.5	135.6	60.8	74.80	1.26	3.2	4.0	39.8	0.09
7.88	6.1	0.03	0.49	24.88	1	17.5	139.9	62.7	77.25	1.24	3.1	3.8	37.7	0.09
8.12	8.4	0.03	0.36	20.78	6	18.0	144.4	64.7	79.71	1.22	3.4	4.1	55.9	0.00
8.38	8.4	0.03	0.36	26.79	6	18.0	148.9	66.7	82.16	1.20	3.4	4.0	55.6	0.00
8.62	6.9	0.03	0.44	26.75	1	17.5	153.3	68.7	84.61	1.18	3.4	4.1	42.8	0.09
8.88	6.2	0.03	0.48	29.01	1	17.5	157.7	70.6	87.06	1.16	3.1	3.6	37.1	0.08
9.12	6.9	0.03	0.44	26.96	1	17.5	162.1	72.5	89.52	1.15	3.4	4.0	42.2	0.09
9.38	9.2	0.06	0.69	21.19	6	18.0	166.5	74.5	91.97	1.13	3.7	4.2	60.1	0.09
9.62	11.7	0.11	0.95	14.35	6	18.0	171.0	76.6	94.42	1.12	4.7	5.2	79.6	0.11

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	9.4	0.04	0.46	19.87	6	18.0	175.5	78.6	96.87	1.10	3.7	4.1	60.9	0.09
10.12	12.3	0.07	0.54	15.13	6	18.0	180.0	80.7	99.33	1.09	4.9	5.4	84.0	0.10
10.38	10.7	0.09	0.81	19.24	6	18.0	184.5	82.7	101.78	1.08	4.3	4.6	70.9	0.10
10.62	12.2	0.04	0.35	18.92	6	18.0	189.0	84.8	104.23	1.06	4.9	5.2	82.6	0.00
10.88	7.1	0.03	0.42	25.25	1	17.5	193.4	86.8	106.68	1.05	3.5	3.7	41.2	0.09
11.12	8.9	0.03	0.34	25.20	6	18.0	197.9	88.7	109.14	1.04	3.5	3.7	55.2	0.09
11.38	11.2	0.03	0.26	22.11	6	18.0	202.4	90.8	111.59	1.03	4.5	4.6	73.2	0.00
11.62	9.9	0.04	0.36	23.57	6	18.0	206.9	92.8	114.04	1.02	4.0	4.0	62.8	0.09
11.88	11.6	0.04	0.36	19.70	6	18.0	211.4	94.9	116.49	1.00	4.6	4.7	75.9	0.10
12.12	8.8	0.03	0.38	23.66	6	18.0	215.9	96.9	118.95	0.99	3.5	3.5	52.8	0.09
12.38	9.9	0.04	0.42	19.92	6	18.0	220.4	99.0	121.40	0.98	4.0	3.9	61.8	0.09
12.62	11.1	0.03	0.29	27.06	6	18.0	224.9	101.0	123.85	0.97	4.4	4.3	70.5	0.10
12.88	21.8	0.10	0.47	13.99	7	18.5	229.4	103.1	126.30	0.96	7.3	7.0	UnDef	0.09
13.12	26.0	0.08	0.32	7.97	7	18.5	234.1	105.3	128.76	0.95	8.7	8.3	UnDef	0.00
13.38	20.7	0.06	0.28	16.88	7	18.5	238.7	107.5	131.21	0.94	6.9	6.5	UnDef	0.00
13.62	20.2	0.04	0.19	19.84	7	18.5	243.3	109.7	133.66	0.93	6.7	6.3	UnDef	0.00
13.88	27.0	0.16	0.60	20.84	7	18.5	247.9	111.8	136.11	0.93	9.0	8.3	UnDef	0.10
14.12	26.4	0.05	0.19	18.31	7	18.5	252.6	114.0	138.57	0.92	8.8	8.1	UnDef	0.00
14.38	12.6	0.03	0.27	28.40	6	18.0	257.1	116.1	141.02	0.91	5.0	4.6	80.0	0.10
14.62	35.6	0.11	0.31	22.61	7	18.5	261.7	118.2	143.47	0.90	11.9	10.7	UnDef	0.08
14.88	43.4	0.36	0.83	19.93	7	18.5	266.3	120.4	145.92	0.89	14.5	12.9	UnDef	0.11
15.12	65.8	0.32	0.49	16.69	8	19.0	271.0	122.6	148.38	0.88	16.4	14.5	UnDef	0.12

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5760

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S4

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 15:35

CPT File: 141CPS4.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 Param	60 (N1)
0.12	5.0E-04	0.00	1000.0	0.14	10	41.8	0.0	41.8	0.0	50	87.2	1.0	-0.22	0.0
0.38	5.0E-08	-0.05	111.2	2.76	7	7.1	4.0	11.1	18.6	UnDef	UnDef	10.0	UnDef	2.1
0.62	1.0E-07	-0.10	60.1	1.97	7	6.3	4.9	11.2	21.5	UnDef	UnDef	10.0	UnDef	1.2
0.88	1.0E-07	-0.11	34.8	1.73	7	5.2	7.5	12.6	27.1	UnDef	UnDef	6.0	UnDef	1.5
1.12	1.0E-07	-0.06	23.6	2.19	6	4.6	18.4	23.0	36.0	UnDef	UnDef	6.0	UnDef	2.3
1.38	5.0E-04	-0.02	325.8	1.13	9	71.8	0.0	71.8	4.3	48	69.6	1.0	-0.31	0.0
1.62	5.0E-07	-0.13	60.5	3.02	7	16.4	21.5	37.9	26.3	UnDef	UnDef	10.0	UnDef	6.0
1.88	5.0E-05	-0.06	109.9	2.02	7	33.9	13.2	47.1	15.5	42	43.5	10.0	-0.28	2.9
2.12	5.0E-05	-0.07	87.1	1.57	7	30.7	11.7	42.3	15.3	42	38.8	10.0	-0.23	2.6
2.38	5.0E-05	-0.08	71.0	1.49	7	28.1	13.1	41.2	16.9	40	34.7	10.0	-0.20	2.8
2.62	5.0E-04	-0.04	112.0	0.91	9	48.7	6.0	54.7	9.1	42	48.9	1.0	-0.19	1.2
2.88	5.0E-05	-0.06	71.2	1.16	7	34.4	12.2	46.6	14.8	40	37.6	10.0	-0.18	2.7
3.12	5.0E-05	-0.05	85.1	2.53	7	44.1	30.4	74.4	20.3	42	43.8	10.0	-0.29	5.9
3.38	5.0E-06	-0.06	60.5	2.20	7	32.9	28.9	61.8	22.5	UnDef	UnDef	10.0	UnDef	6.7
3.62	5.0E-06	0.18	39.7	1.79	7	22.8	28.0	50.8	25.6	UnDef	UnDef	6.0	UnDef	5.9
3.88	5.0E-05	0.46	30.1	1.07	7	18.2	19.7	37.8	24.5	36	30.0	6.0	-0.02	3.4
4.12	5.0E-05	0.44	24.3	0.37	7	15.4	0.0	15.4	5.0	34	30.0	6.0	0.07	0.0
4.38	1.0E-07	0.46	21.1	0.36	7	13.9	0.0	13.9	5.0	UnDef	UnDef	6.0	UnDef	0.0
4.62	1.0E-07	0.45	18.0	0.41	7	12.4	0.0	12.4	5.0	UnDef	UnDef	6.0	UnDef	0.0
4.88	1.0E-07	0.51	14.5	0.45	7	10.5	0.0	10.5	5.0	UnDef	UnDef	6.0	UnDef	0.0
5.12	1.0E-07	0.52	13.1	0.54	7	9.8	26.8	36.6	32.4	UnDef	UnDef	6.0	UnDef	4.1
5.38	1.0E-07	0.52	12.3	0.56	7	9.5	32.7	42.3	34.0	UnDef	UnDef	3.0	UnDef	4.4
5.62	1.0E-07	0.31	12.4	0.53	7	9.8	30.7	40.5	33.4	UnDef	UnDef	3.0	UnDef	4.3
5.88	1.0E-07	0.50	10.5	0.60	6	8.8	35.0	43.8	37.6	UnDef	UnDef	3.0	UnDef	4.3
6.12	1.0E-07	0.50	10.2	0.60	6	8.7	34.9	43.7	38.0	UnDef	UnDef	3.0	UnDef	4.3
6.38	1.0E-07	0.36	11.4	0.51	7	9.8	37.0	46.7	34.6	UnDef	UnDef	3.0	UnDef	4.7
6.62	1.0E-07	0.30	10.8	0.51	7	9.4	37.8	47.2	35.8	UnDef	UnDef	3.0	UnDef	4.6
6.88	5.0E-05	0.14	14.1	0.61	7	12.1	31.1	43.2	32.0	32	30.0	6.0	0.05	3.9
7.12	1.0E-07	0.30	10.5	0.50	6	9.6	38.3	47.9	36.3	UnDef	UnDef	3.0	UnDef	4.7
7.38	1.0E-07	0.29	8.4	0.61	6	8.1	32.6	40.7	42.4	UnDef	UnDef	3.0	UnDef	4.0
7.62	1.0E-07	0.27	8.2	0.60	6	8.1	32.5	40.6	42.9	UnDef	UnDef	3.0	UnDef	4.0
7.88	1.0E-07	0.35	7.5	0.64	6	7.7	30.9	38.6	45.3	UnDef	UnDef	3.0	UnDef	3.8
8.12	5.0E-05	0.18	10.8	0.43	7	10.5	0.0	10.5	5.0	30	30.0	3.0	0.10	0.0
8.38	5.0E-05	0.26	10.4	0.43	7	10.3	0.0	10.3	5.0	30	30.0	3.0	0.11	0.0
8.62	1.0E-07	0.33	7.8	0.56	6	8.3	33.2	41.5	43.4	UnDef	UnDef	3.0	UnDef	4.1
8.88	1.0E-07	0.43	6.6	0.65	6	7.4	29.6	37.0	48.7	UnDef	UnDef	3.0	UnDef	3.6
9.12	1.0E-07	0.33	7.3	0.57	6	8.1	32.4	40.5	45.1	UnDef	UnDef	3.0	UnDef	4.0
9.38	5.0E-05	0.15	10.1	0.84	6	10.6	42.5	53.1	41.5	30	30.0	3.0	0.06	4.2
9.62	5.0E-05	0.05	13.0	1.12	6	13.3	53.3	66.6	39.2	32	30.0	6.0	0.00	5.2

Run No: 99-0331-0827-5760

CPT File: 141CPS4.COR

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param	
9.88	5.0E-05	0.13	9.7	0.57	6	10.6	42.2	52.8	38.8	30	30.0	3.0	0.08	4.1
10.12	5.0E-05	0.05	13.0	0.63	7	13.7	45.1	58.8	33.7	32	30.0	6.0	0.04	4.9
10.38	5.0E-05	0.10	10.7	0.98	6	11.8	47.1	58.8	41.8	30	30.0	3.0	0.03	4.6
10.62	5.0E-05	0.08	12.2	0.42	7	13.3	0.0	13.3	5.0	32	30.0	3.0	0.08	0.0
10.88	1.0E-07	0.27	5.9	0.58	6	7.6	30.4	38.1	50.2	UnDef	UnDef	1.5	UnDef	3.7
11.12	5.0E-05	0.20	7.8	0.44	6	9.4	37.7	47.1	41.5	30	30.0	3.0	0.13	3.7
11.38	5.0E-05	0.11	10.1	0.32	7	11.7	0.0	11.7	5.0	30	30.0	3.0	0.12	0.0
11.62	5.0E-05	0.15	8.5	0.46	6	10.3	41.2	51.5	40.0	30	30.0	3.0	0.11	4.0
11.88	5.0E-05	0.08	10.0	0.44	6	11.9	47.6	59.5	36.2	30	30.0	3.0	0.09	4.7
12.12	5.0E-05	0.17	6.8	0.50	6	8.9	35.6	44.5	45.6	30	30.0	3.0	0.13	3.5
12.38	5.0E-05	0.10	7.8	0.54	6	10.0	39.9	49.9	43.1	30	30.0	3.0	0.10	3.9
12.62	5.0E-05	0.16	8.7	0.36	6	11.0	44.0	55.0	37.7	30	30.0	3.0	0.13	4.3
12.88	5.0E-04	0.01	18.9	0.52	7	21.5	26.9	48.3	25.8	34	30.0	1.0	0.02	3.7
13.12	5.0E-04	-0.02	22.4	0.35	7	25.3	0.0	25.3	5.0	34	30.0	1.0	0.03	0.0
13.38	5.0E-04	0.02	17.0	0.32	7	19.9	0.0	19.9	5.0	32	30.0	1.0	0.07	0.0
13.62	5.0E-04	0.03	16.2	0.21	7	19.3	0.0	19.3	5.0	32	30.0	1.0	0.10	0.0
13.88	5.0E-04	0.03	21.9	0.66	7	25.5	29.9	55.4	25.2	34	30.0	1.0	-0.01	4.2
14.12	5.0E-04	0.02	20.9	0.21	7	24.7	0.0	24.7	5.0	34	30.0	1.0	0.08	0.0
14.38	5.0E-05	0.14	8.6	0.34	6	11.7	46.7	58.3	37.6	30	30.0	3.0	0.13	4.6
14.62	5.0E-04	0.02	27.9	0.34	7	32.7	0.0	32.7	5.0	36	35.3	1.0	0.02	0.0
14.88	5.0E-04	0.01	33.8	0.88	7	39.5	30.1	69.6	21.2	38	40.7	1.0	-0.07	4.8
15.12	5.0E-03	0.00	51.4	0.51	9	59.4	15.1	74.5	12.6	38	52.3	1.0	-0.07	2.1

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0828-0150

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S5

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 17:56

CPT File: 141CPS5.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	71.8	0.09	0.13	-0.06	8	19.0	2.4	1.1	1.23	2.00	17.9	35.9	UnDef	0.36
0.38	3.8	0.25	6.58	1.13	3	17.5	6.9	3.3	3.68	2.00	3.8	7.5	29.6	0.00
0.62	1.2	0.12	9.58	1.80	2	12.5	10.7	4.6	6.13	2.00	1.2	2.5	9.1	0.00
0.88	2.0	0.10	5.09	2.69	2	12.5	13.8	5.2	8.58	2.00	2.0	4.0	15.1	0.00
1.12	54.8	0.39	0.71	-6.73	8	19.0	17.8	6.7	11.04	2.00	13.7	27.4	UnDef	0.20
1.38	40.9	0.12	0.29	-7.45	8	19.0	22.5	9.0	13.49	2.00	10.2	20.4	UnDef	0.13
1.62	39.8	0.08	0.19	2.46	8	19.0	27.2	11.3	15.94	2.00	10.0	19.9	UnDef	0.13
1.88	33.9	0.16	0.46	2.04	7	18.5	31.9	13.5	18.39	2.00	11.3	22.6	UnDef	0.11
2.12	62.4	0.28	0.45	0.41	8	19.0	36.6	15.8	20.85	2.00	15.6	31.2	UnDef	0.26
2.38	126.9	1.15	0.91	-3.03	9	19.5	41.4	18.1	23.30	2.00	25.4	50.8	UnDef	0.00
2.62	185.1	2.49	1.34	-8.38	8	19.0	46.2	20.5	25.75	2.00	46.3	92.5	UnDef	0.00
2.88	238.0	3.02	1.27	-8.55	8	19.0	51.0	22.8	28.20	2.00	59.5	119.0	UnDef	0.00
3.12	166.4	2.12	1.27	-8.24	8	19.0	55.8	25.1	30.66	1.95	41.6	81.3	UnDef	0.00
3.38	193.9	2.50	1.29	-8.16	8	19.0	60.5	27.4	33.11	1.87	48.5	90.6	UnDef	0.00
3.62	224.8	3.61	1.60	-8.10	8	19.0	65.2	29.7	35.56	1.80	56.2	100.9	UnDef	0.00
3.88	226.8	3.55	1.56	-8.16	8	19.0	70.0	32.0	38.01	1.73	56.7	98.1	UnDef	0.00
4.12	161.3	3.00	1.86	-8.44	8	19.0	74.8	34.3	40.47	1.67	40.3	67.4	UnDef	0.00
4.38	74.4	1.38	1.85	-8.46	7	18.5	79.4	36.5	42.92	1.62	24.8	40.2	UnDef	0.35
4.62	26.0	0.36	1.37	-8.42	6	18.0	84.0	38.6	45.37	1.57	10.4	16.4	201.1	0.10
4.88	21.0	0.21	0.99	-8.02	6	18.0	88.5	40.7	47.82	1.53	8.4	12.9	161.0	0.09
5.12	19.3	0.18	0.94	-5.14	6	18.0	93.0	42.7	50.28	1.50	7.7	11.5	146.7	0.09
5.38	8.4	0.09	1.09	0.39	5	18.0	97.5	44.8	52.73	1.46	4.2	6.2	59.8	0.10
5.62	6.3	0.04	0.59	18.16	1	17.5	101.9	46.8	55.18	1.43	3.2	4.5	42.4	0.09
5.88	5.6	0.02	0.43	31.96	1	17.5	106.3	48.7	57.63	1.40	2.8	4.0	36.6	0.09
6.12	4.5	0.04	0.82	31.09	1	17.5	110.7	50.6	60.09	1.38	2.3	3.1	27.2	0.08
6.38	4.4	0.03	0.68	33.80	1	17.5	115.1	52.5	62.54	1.35	2.2	3.0	26.2	0.08
6.62	4.4	0.04	0.85	33.88	1	17.5	119.4	54.4	64.99	1.33	2.2	2.9	26.0	0.08
6.88	4.3	0.06	1.41	34.00	1	17.5	123.8	56.4	67.44	1.30	2.2	2.8	24.7	0.00
7.12	5.7	0.06	0.98	22.53	1	17.5	128.2	58.3	69.90	1.28	2.9	3.7	35.7	0.08
7.38	5.6	0.05	0.89	35.91	1	17.5	132.6	60.2	72.35	1.26	2.8	3.6	34.5	0.08
7.62	5.4	0.05	0.92	35.14	1	17.5	136.9	62.1	74.80	1.24	2.7	3.4	32.6	0.08
7.88	6.2	0.05	0.89	38.49	1	17.5	141.3	64.1	77.25	1.22	3.1	3.8	38.1	0.09
8.12	6.7	0.07	0.98	39.92	5	18.0	145.8	66.0	79.71	1.20	3.4	4.0	42.1	0.09
8.38	6.6	0.07	1.04	38.27	5	18.0	150.2	68.1	82.16	1.19	3.3	3.9	40.9	0.09
8.62	6.6	0.07	1.02	38.86	5	18.0	154.8	70.1	84.61	1.17	3.3	3.9	40.4	0.09
8.88	6.5	0.06	0.99	39.27	5	18.0	159.2	72.2	87.06	1.15	3.2	3.7	39.0	0.09
9.12	6.3	0.06	0.92	39.95	1	17.5	163.7	74.2	89.52	1.14	3.2	3.6	37.5	0.08
9.38	6.4	0.06	0.95	39.58	5	18.0	168.1	76.2	91.97	1.12	3.2	3.6	38.1	0.08
9.62	6.7	0.06	0.95	39.69	5	18.0	172.6	78.2	94.42	1.11	3.4	3.7	40.2	0.09

Run No: 99-0331-0828-0150

CPT File: 141CPS5.COR

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgJd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	6.5	0.06	0.94	39.25	5	18.0	177.1	80.3	96.87	1.09	3.3	3.6	38.0	0.08
10.12	7.0	0.07	0.98	39.71	5	18.0	181.6	82.3	99.33	1.08	3.5	3.8	41.1	0.09
10.38	6.5	0.06	0.99	40.33	5	18.0	186.1	84.3	101.78	1.07	3.3	3.5	37.4	0.08
10.62	6.5	0.06	0.94	41.00	5	18.0	190.6	86.4	104.23	1.05	3.3	3.4	36.8	0.08
10.88	6.8	0.07	1.05	40.03	5	18.0	195.1	88.4	106.68	1.04	3.4	3.6	39.1	0.08
11.12	8.0	0.11	1.41	29.83	5	18.0	199.6	90.5	109.14	1.03	4.0	4.1	47.6	0.09
11.38	7.9	0.12	1.46	32.70	5	18.0	204.1	92.5	111.59	1.02	4.0	4.0	47.1	0.09
11.62	8.6	0.13	1.48	38.46	5	18.0	208.6	94.6	114.04	1.01	4.3	4.3	52.0	0.09
11.88	11.6	0.19	1.63	26.29	5	18.0	213.1	96.6	116.49	1.00	5.8	5.8	75.4	0.10
12.12	9.5	0.16	1.64	35.11	5	18.0	217.6	98.7	118.95	0.99	4.8	4.7	58.8	0.09
12.38	6.7	0.08	1.27	39.64	5	18.0	222.1	100.7	121.40	0.98	3.3	3.3	35.7	0.08
12.62	8.0	0.10	1.27	40.21	5	18.0	226.6	102.8	123.85	0.97	4.0	3.9	45.9	0.09
12.88	9.0	0.13	1.43	37.83	5	18.0	231.1	104.8	126.30	0.96	4.5	4.3	53.7	0.09
13.12	6.4	0.05	0.84	41.00	1	17.5	235.6	106.8	128.76	0.95	3.2	3.0	32.6	0.08
13.38	7.4	0.08	1.13	39.57	5	18.0	240.0	108.8	131.21	0.94	3.7	3.5	40.3	0.08
13.62	8.4	0.12	1.41	35.87	5	18.0	244.5	110.8	133.66	0.93	4.2	3.9	47.4	0.09
13.88	8.5	0.11	1.26	42.01	5	18.0	249.0	112.9	136.11	0.92	4.2	3.9	47.8	0.09
14.12	9.3	0.12	1.29	39.82	5	18.0	253.5	114.9	138.57	0.91	4.6	4.2	54.0	0.09
14.38	15.6	0.19	1.21	29.38	6	18.0	258.0	117.0	141.02	0.90	6.2	5.7	104.2	0.11
14.62	12.0	0.17	1.44	42.24	5	18.0	262.5	119.0	143.47	0.90	6.0	5.4	75.1	0.10
14.88	12.3	0.31	2.48	43.41	5	18.0	267.0	121.1	145.92	0.89	6.2	5.5	77.3	0.10
15.12	10.4	0.23	2.24	35.15	5	18.0	271.5	123.1	148.38	0.88	5.2	4.6	61.5	0.00
15.38	14.9	0.27	1.78	31.70	6	18.0	276.0	125.2	150.83	0.87	6.0	5.2	97.4	0.11
15.62	13.7	0.30	2.21	35.03	5	18.0	280.5	127.2	153.28	0.87	6.8	5.9	87.1	0.10
15.88	13.7	0.20	1.49	34.36	6	18.0	285.0	129.3	155.73	0.86	5.5	4.7	87.0	0.10
16.12	18.3	0.31	1.72	25.03	6	18.0	289.5	131.3	158.19	0.85	7.3	6.3	123.4	0.13
16.38	18.8	0.23	1.22	28.10	6	18.0	294.0	133.4	160.64	0.85	7.5	6.4	126.9	0.13
16.62	15.8	0.22	1.36	36.43	6	18.0	298.5	135.4	163.09	0.84	6.3	5.3	102.8	0.11
16.88	18.9	0.19	0.99	31.77	6	18.0	303.0	137.5	165.54	0.83	7.6	6.3	127.3	0.13
17.12	18.8	0.14	0.75	38.73	6	18.0	307.5	139.5	168.00	0.83	7.5	6.2	125.6	0.13
17.38	19.0	0.19	1.01	32.96	6	18.0	312.0	141.6	170.45	0.82	7.6	6.3	127.2	0.13
17.62	19.6	0.19	0.96	33.77	6	18.0	316.5	143.6	172.90	0.82	7.8	6.4	131.3	0.13
17.88	25.0	0.23	0.94	28.52	7	18.5	321.1	145.7	175.35	0.81	8.3	6.8	UnDef	0.18
18.12	35.7	0.26	0.72	20.76	7	18.5	325.7	147.9	177.81	0.80	11.9	9.6	UnDef	0.11
18.38	30.4	0.14	0.47	24.74	7	18.5	330.3	150.1	180.26	0.80	10.1	8.1	UnDef	0.10
18.62	22.0	0.11	0.52	33.83	7	18.5	334.9	152.2	182.71	0.79	7.3	5.8	UnDef	0.14
18.88	28.4	0.19	0.65	28.72	7	18.5	339.6	154.4	185.16	0.79	9.5	7.5	UnDef	0.12
19.12	43.4	0.42	0.97	23.45	7	18.5	344.2	156.6	187.62	0.78	14.5	11.3	UnDef	0.13
19.38	51.8	0.58	1.12	22.41	7	18.5	348.8	158.7	190.07	0.78	17.3	13.4	UnDef	0.15
19.62	45.8	0.43	0.95	28.76	7	18.5	353.4	160.9	192.52	0.77	15.3	11.8	UnDef	0.13
19.88	37.0	0.47	1.28	31.17	7	18.5	358.1	163.1	194.97	0.77	12.3	9.4	UnDef	0.24
20.12	35.3	0.16	0.45	33.45	7	18.5	362.7	165.3	197.43	0.76	11.8	9.0	UnDef	0.10
20.38	43.7	0.52	1.18	28.47	7	18.5	367.3	167.4	199.88	0.76	14.6	11.0	UnDef	0.17
20.62	37.9	0.50	1.33	31.82	7	18.5	371.9	169.6	202.33	0.75	12.6	9.5	UnDef	0.28
20.88	51.3	0.56	1.10	30.19	7	18.5	376.6	171.8	204.78	0.75	17.1	12.8	UnDef	0.15
21.12	66.5	0.69	1.03	23.50	8	19.0	381.2	174.0	207.24	0.74	16.6	12.3	UnDef	0.16
21.38	58.1	0.69	1.19	26.46	7	18.5	385.9	176.2	209.69	0.74	19.4	14.3	UnDef	0.17
21.62	64.8	0.61	0.95	26.20	8	19.0	390.6	178.5	212.14	0.73	16.2	11.9	UnDef	0.15
21.88	54.2	0.69	1.28	28.23	7	18.5	395.3	180.7	214.59	0.73	18.1	13.2	UnDef	0.19

Interpretation Output - Release 1.00.17

Run No: 99-0331-0828-0150

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S5

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 17:56

CPT File: 141CPS5.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param
0.12	5.0E-03	0.00	1000.0	0.13	10	143.5	0.0	143.5	0.0	50	95.0	1.0	-0.21 0.0
0.38	5.0E-08	0.02	113.5	6.71	11	7.5	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef UnDef
0.62	1.0E-15	0.10	24.9	10.00	1	2.5	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef UnDef
0.88	1.0E-15	0.09	36.0	5.47	1	4.0	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef UnDef
1.12	5.0E-03	-0.01	813.8	0.71	10	109.6	0.0	109.6	0.0	50	88.8	1.0	-0.35 0.0
1.38	5.0E-03	-0.02	451.3	0.30	10	81.8	0.0	81.8	0.0	48	76.1	1.0	-0.22 0.0
1.62	5.0E-03	0.00	349.5	0.19	10	79.6	0.0	79.6	0.0	48	72.1	1.0	-0.16 0.0
1.88	5.0E-04	0.00	247.6	0.47	9	67.7	0.0	67.7	1.5	46	64.9	1.0	-0.20 0.0
2.12	5.0E-03	0.00	393.2	0.45	10	124.8	0.0	124.8	0.0	48	80.2	1.0	-0.24 0.0
2.38	5.0E-02	0.00	697.5	0.91	9	253.9	0.0	253.9	0.8	50	95.0	1.0	-0.36 0.0
2.62	5.0E-03	-0.01	900.5	1.35	9	370.1	0.0	370.1	2.1	50	95.0	1.0	-0.43 0.0
2.88	5.0E-03	0.00	1000.0	1.27	9	476.1	0.0	476.1	1.6	50	95.0	1.0	-0.44 0.0
3.12	5.0E-03	-0.01	660.8	1.28	9	332.1	0.0	332.1	2.5	50	95.0	1.0	-0.40 0.0
3.38	5.0E-03	-0.01	705.6	1.29	9	370.5	0.0	370.5	2.4	50	95.0	1.0	-0.40 0.0
3.62	5.0E-03	-0.01	754.8	1.61	12	412.5	UnDef	UnDef	0.0	50	95.0	1.0	-0.44 UnDef
3.88	5.0E-03	-0.01	706.9	1.57	9	401.0	0.0	401.0	3.5	50	95.0	1.0	-0.43 0.0
4.12	5.0E-03	-0.01	468.3	1.87	9	275.5	7.4	282.8	6.0	48	95.0	1.0	-0.42 1.1
4.38	5.0E-04	-0.02	201.6	1.87	9	123.1	20.0	143.1	10.2	46	73.2	1.0	-0.33 3.8
4.62	5.0E-05	-0.05	65.1	1.42	7	41.8	20.7	62.5	17.4	40	42.3	10.0	-0.18 4.3
4.88	5.0E-05	-0.06	49.5	1.03	7	32.9	16.9	49.9	17.7	38	35.4	6.0	-0.13 3.5
5.12	5.0E-05	-0.05	42.9	0.99	7	29.5	17.8	47.3	19.1	38	32.3	6.0	-0.11 3.6
5.38	5.0E-06	-0.07	16.7	1.23	6	12.6	50.5	63.1	35.4	UnDef	UnDef	6.0	UnDef 6.2
5.62	1.0E-07	0.23	11.3	0.70	6	9.2	37.0	46.2	37.3	UnDef	UnDef	3.0	UnDef 4.5
5.88	1.0E-07	0.56	9.4	0.53	6	8.1	32.3	40.4	38.8	UnDef	UnDef	3.0	UnDef 4.0
6.12	1.0E-07	0.72	6.7	1.09	6	6.3	25.4	31.7	53.6	UnDef	UnDef	3.0	UnDef 3.1
6.38	1.0E-07	0.82	6.2	0.92	6	6.1	24.4	30.5	53.6	UnDef	UnDef	1.5	UnDef 3.0
6.62	1.0E-07	0.82	6.0	1.17	4	6.0	24.1	30.1	57.6	UnDef	UnDef	1.5	UnDef 2.9
6.88	1.0E-07	0.86	5.5	1.98	4	5.8	23.0	28.8	67.3	UnDef	UnDef	1.5	UnDef 2.8
7.12	1.0E-07	0.34	7.6	1.26	6	7.5	30.1	37.6	52.2	UnDef	UnDef	3.0	UnDef 3.7
7.38	1.0E-07	0.65	7.2	1.16	6	7.3	29.1	36.4	52.8	UnDef	UnDef	3.0	UnDef 3.6
7.62	1.0E-07	0.66	6.5	1.23	6	6.9	27.6	34.5	55.8	UnDef	UnDef	3.0	UnDef 3.4
7.88	1.0E-07	0.63	7.4	1.16	6	7.7	30.8	38.6	51.9	UnDef	UnDef	3.0	UnDef 3.8
8.12	5.0E-06	0.59	8.0	1.25	6	8.3	33.1	41.3	51.2	UnDef	UnDef	3.0	UnDef 4.0
8.38	5.0E-06	0.57	7.5	1.35	6	8.0	32.1	40.1	53.5	UnDef	UnDef	3.0	UnDef 3.9
8.62	5.0E-06	0.59	7.2	1.33	6	7.9	31.5	39.4	54.4	UnDef	UnDef	3.0	UnDef 3.9
8.88	5.0E-06	0.61	6.7	1.31	6	7.6	30.4	38.0	55.9	UnDef	UnDef	3.0	UnDef 3.7
9.12	1.0E-07	0.64	6.3	1.24	4	7.3	29.4	36.7	56.7	UnDef	UnDef	3.0	UnDef 3.6
9.38	5.0E-06	0.62	6.3	1.28	4	7.4	29.5	36.9	57.5	UnDef	UnDef	3.0	UnDef 3.6
9.62	5.0E-06	0.59	6.4	1.27	4	7.6	30.5	38.1	56.8	UnDef	UnDef	3.0	UnDef 3.7



Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Param	Del(n1)60 (N1)
9.88	5.0E-06	0.61	5.9	1.29	4	7.3	29.1	36.4	59.0	UnDef	UnDef	1.5	UnDef	3.6
10.12	5.0E-06	0.56	6.2	1.32	4	7.7	30.7	38.4	57.9	UnDef	UnDef	1.5	UnDef	3.8
10.38	5.0E-06	0.63	5.5	1.39	4	7.1	28.5	35.6	61.8	UnDef	UnDef	1.5	UnDef	3.5
10.62	5.0E-06	0.65	5.3	1.33	4	7.0	28.0	35.0	62.3	UnDef	UnDef	1.5	UnDef	3.4
10.88	5.0E-06	0.59	5.5	1.47	4	7.3	29.1	36.3	62.7	UnDef	UnDef	1.5	UnDef	3.6
11.12	5.0E-06	0.31	6.6	1.88	4	8.4	33.4	41.8	61.5	UnDef	UnDef	3.0	UnDef	4.1
11.38	5.0E-06	0.36	6.4	1.97	4	8.2	33.0	41.2	63.1	UnDef	UnDef	3.0	UnDef	4.0
11.62	5.0E-06	0.40	6.9	1.95	4	8.8	35.3	44.1	60.9	UnDef	UnDef	3.0	UnDef	4.3
11.88	5.0E-06	0.15	9.7	2.00	6	11.8	47.0	58.8	52.6	UnDef	UnDef	3.0	UnDef	5.8
12.12	5.0E-06	0.31	7.4	2.12	4	9.6	38.4	48.0	60.1	UnDef	UnDef	3.0	UnDef	4.7
12.38	5.0E-06	0.60	4.4	1.90	4	6.7	26.6	33.3	72.8	UnDef	UnDef	1.5	UnDef	3.3
12.62	5.0E-06	0.47	5.6	1.78	4	7.9	31.6	39.5	65.1	UnDef	UnDef	1.5	UnDef	3.9
12.88	5.0E-06	0.36	6.4	1.92	4	8.8	35.3	44.1	62.5	UnDef	UnDef	3.0	UnDef	4.3
13.12	1.0E-07	0.67	3.8	1.33	4	6.2	24.9	31.1	71.9	UnDef	UnDef	1.5	UnDef	3.0
13.38	5.0E-06	0.51	4.6	1.67	4	7.1	28.5	35.7	69.4	UnDef	UnDef	1.5	UnDef	3.5
13.62	5.0E-06	0.37	5.3	1.99	4	7.9	31.8	39.7	68.1	UnDef	UnDef	1.5	UnDef	3.9
13.88	5.0E-06	0.46	5.3	1.79	4	8.0	31.9	39.8	66.7	UnDef	UnDef	1.5	UnDef	3.9
14.12	5.0E-06	0.37	5.9	1.78	4	8.7	34.6	43.3	63.7	UnDef	UnDef	1.5	UnDef	4.2
14.38	5.0E-05	0.11	11.1	1.45	6	14.4	57.7	72.2	45.4	30	30.0	3.0	0.01	5.7
14.62	5.0E-06	0.29	7.9	1.84	4	11.0	44.0	55.0	56.6	UnDef	UnDef	3.0	UnDef	5.4
14.88	5.0E-06	0.29	8.0	3.17	4	11.2	44.8	56.0	64.8	UnDef	UnDef	3.0	UnDef	5.5
15.12	5.0E-06	0.26	6.2	3.03	1	9.4	UnDef	UnDef	100.0	UnDef	UnDef	1.5	UnDef	UnDef
15.38	5.0E-05	0.13	9.7	2.18	4	13.3	53.4	66.7	54.0	30	30.0	3.0	0.00	5.2
15.62	5.0E-06	0.17	8.6	2.78	4	12.1	48.5	60.7	60.9	UnDef	UnDef	3.0	UnDef	5.9
15.88	5.0E-05	0.17	8.4	1.89	4	12.1	48.3	60.3	55.3	30	30.0	3.0	0.03	4.7
16.12	5.0E-05	0.06	11.7	2.04	6	16.0	64.0	80.0	48.7	30	30.0	3.0	-0.03	6.3
16.38	5.0E-05	0.07	11.9	1.44	6	16.3	65.1	81.4	43.9	30	30.0	3.0	0.00	6.4
16.62	5.0E-05	0.15	9.5	1.67	6	13.6	54.4	68.0	50.8	30	30.0	3.0	0.02	5.3
16.88	5.0E-05	0.09	11.6	1.17	6	16.2	64.6	80.8	42.1	30	30.0	3.0	0.02	6.3
17.12	5.0E-05	0.13	11.3	0.89	6	15.9	63.6	79.5	39.8	30	30.0	3.0	0.04	6.2
17.38	5.0E-05	0.10	11.2	1.21	6	16.0	64.0	79.9	43.1	30	30.0	3.0	0.02	6.3
17.62	5.0E-05	0.10	11.4	1.15	6	16.3	65.3	81.7	42.1	30	30.0	3.0	0.02	6.4
17.88	5.0E-04	0.05	15.0	1.07	6	20.7	82.8	103.6	36.0	32	30.0	1.0	-0.01	6.8
18.12	5.0E-04	0.01	22.0	0.79	7	29.4	40.1	69.5	26.6	34	32.2	1.0	-0.03	5.4
18.38	5.0E-04	0.02	18.0	0.53	7	24.8	34.2	59.0	26.7	32	30.0	1.0	0.02	4.6
18.62	5.0E-04	0.08	12.3	0.61	7	17.8	67.6	85.4	34.6	32	30.0	1.0	0.05	5.7
18.88	5.0E-04	0.04	16.2	0.74	7	22.9	52.5	75.3	31.1	32	30.0	1.0	0.01	5.8
19.12	5.0E-04	0.01	25.5	1.05	7	34.6	48.2	82.8	26.8	36	36.9	1.0	-0.06	6.5
19.38	5.0E-04	0.01	30.4	1.20	7	41.1	48.9	90.0	25.3	36	41.8	1.0	-0.09	6.9
19.62	5.0E-04	0.02	26.2	1.03	7	36.1	46.6	82.7	26.1	36	38.0	1.0	-0.06	6.4
19.88	5.0E-04	0.03	20.5	1.42	7	28.9	89.8	118.8	33.3	34	31.7	1.0	-0.06	8.5
20.12	5.0E-04	0.04	19.2	0.50	7	27.5	32.7	60.2	25.3	34	30.3	1.0	0.02	4.6
20.38	5.0E-04	0.02	23.9	1.29	7	33.8	66.0	99.8	29.8	34	36.2	1.0	-0.07	7.8
20.62	5.0E-04	0.03	20.2	1.47	6	29.1	100.2	129.3	34.0	34	31.9	1.0	-0.06	8.9
20.88	5.0E-04	0.02	27.6	1.19	7	39.1	53.7	92.8	26.7	36	40.4	1.0	-0.08	7.2
21.12	5.0E-03	0.00	36.0	1.09	7	50.4	42.7	93.1	22.2	38	47.6	1.0	-0.10	5.0
21.38	5.0E-04	0.01	30.7	1.28	7	43.7	54.5	98.3	25.8	36	43.6	1.0	-0.09	7.6
21.62	5.0E-03	0.01	34.1	1.01	7	48.5	41.1	89.7	22.2	38	46.5	1.0	-0.09	4.8
21.88	5.0E-04	0.01	27.8	1.38	7	40.3	64.6	104.9	28.1	36	41.2	1.0	-0.09	8.2

**Thurber Engineering**

## **APPENDIX C**

### **Summary of Dissipations and Pore Pressure Plots**

**ConeTec Investigations Ltd.**

### Summary of Pore Pressure Dissipation Plots

Test CPT - S1

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo (m)
2.5	8.8	115	---
4.5	5.2	196	---
6.5	3.4	295	---
8.5	7.6	134	---
10.5	25.0	41	---
13.0	---	---	13.3

Test CPT - S2

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	8.3	121	---
5.5	2.4	415	---
6.5	4.5	225	---
8.5	4.8	213	---
9.75	---	---	9.8

Test CPT - S3

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	13.2	77	---
5.5	3.5	290	---
7.7	2.7	860	---
9.5	5.1	200	---
11.5	17.6	58	---
16.93	---	---	17.1

Test CPT - S4

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	3.5	290	---
5.5	2.5	398	---
7.5	2.6	383	---
9.5	2.4	423	---
11.3	11.3	90	---

Test CPT - S5

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
7.0	11.2	91	---
15.0	6.4	159	---
22.08	---	---	22.4

Test CPT - N1

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
5.0	3.2	316	---
7.0	4.9	205	---
9.0	27.0	38	---
12.1	---	---	12.4

Test CPT - N2

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
8.0	1.8	560	---
10.0	4.0	253	---
12.0	12.7	80	---
16.0	110	9	---
17.3	---	---	17.2

Test CPT - N3

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
5.0	1.4	703	---
7.0	1.7	603	---
12.0	68.0	15	---
15.12	---	---	15.1

Test CPT - N4

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
7.5	4.4	230	---
10.0	1.9	534	---
13.0	2.5	403	---
20.6	---	---	21.0

Test CPT - N5

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
4.0	2.7	373	---
9.0	60.3	17	---
12.55	---	---	13.0

Thurber Engineering

Hole: CPTUS1

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 09:11

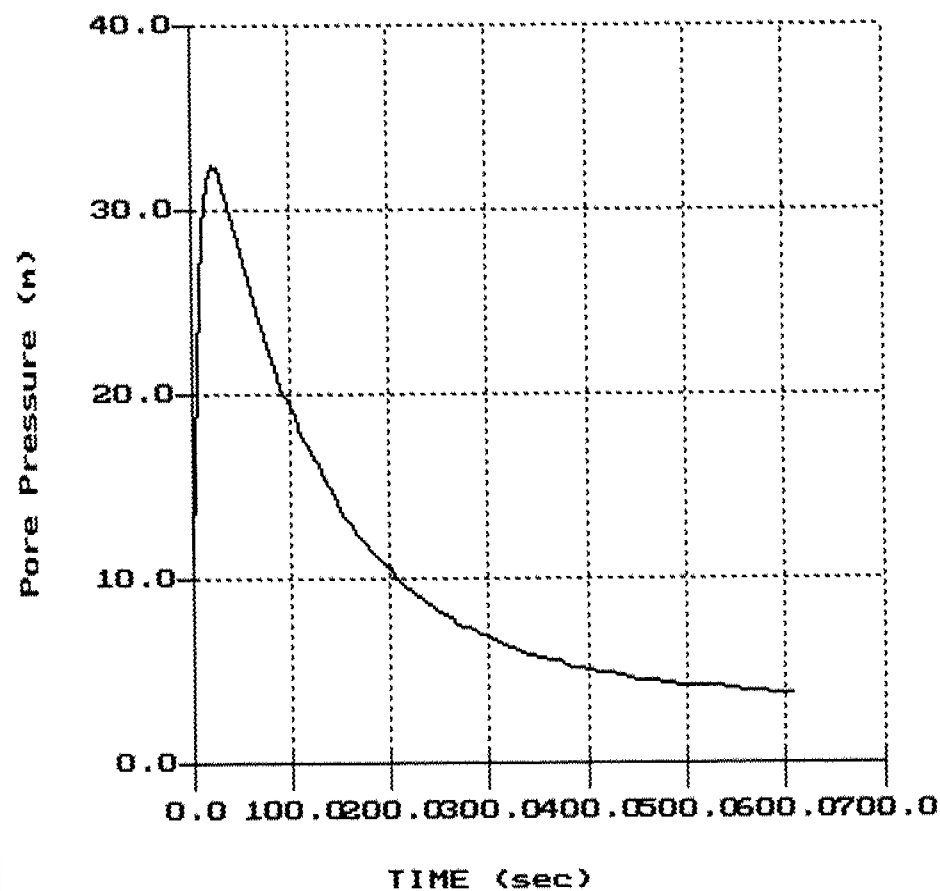
File: 141CPS1.PPD

Depth (m): 2.50

(ft): 8.20

Duration: 605.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS1

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 09:11

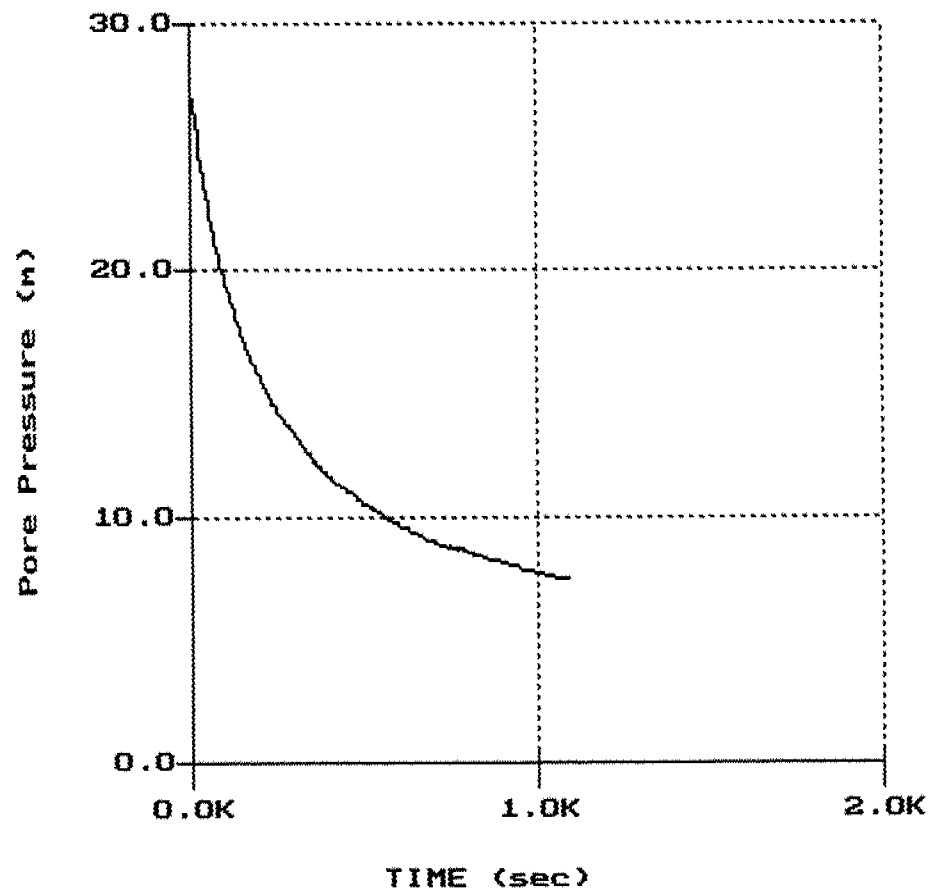
File: 141CPS1.PPD

Depth (m): 4.50

(ft): 14.76

Duration: 1090.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS1

Location: S. INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 09:11

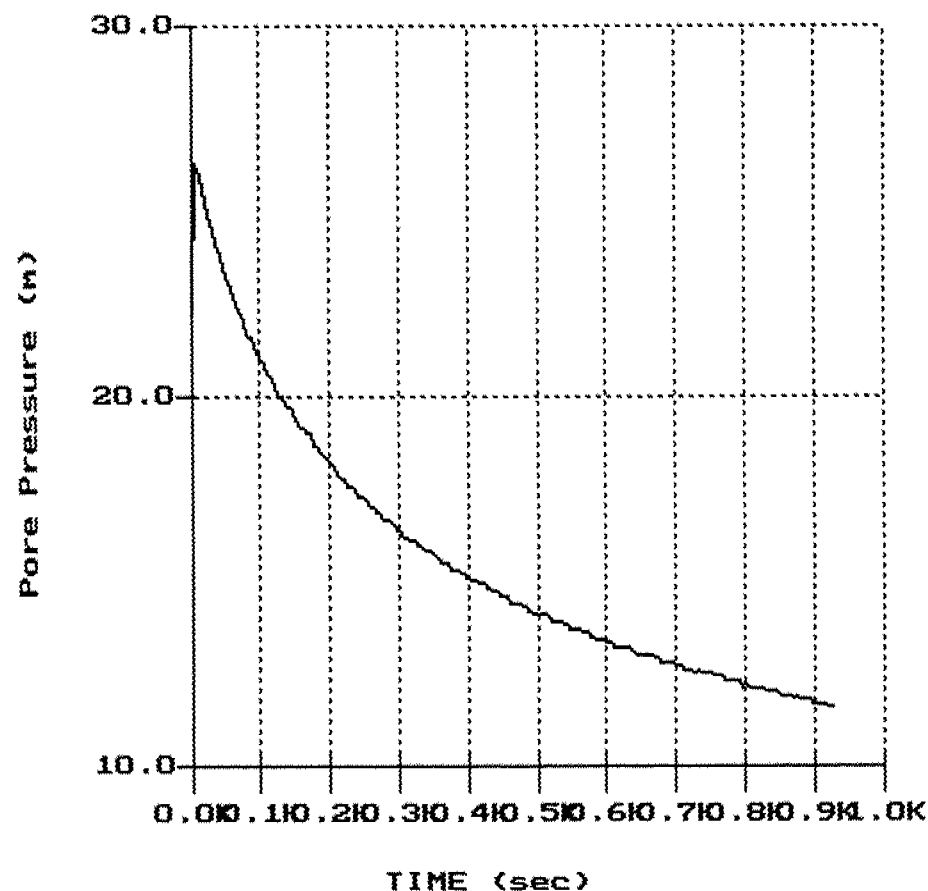
File: 141CPS1.PPD

Depth (m): 6.50

(ft): 21.33

Duration: 925.0s

PORE PRESSURE DISSIPATION RECORD



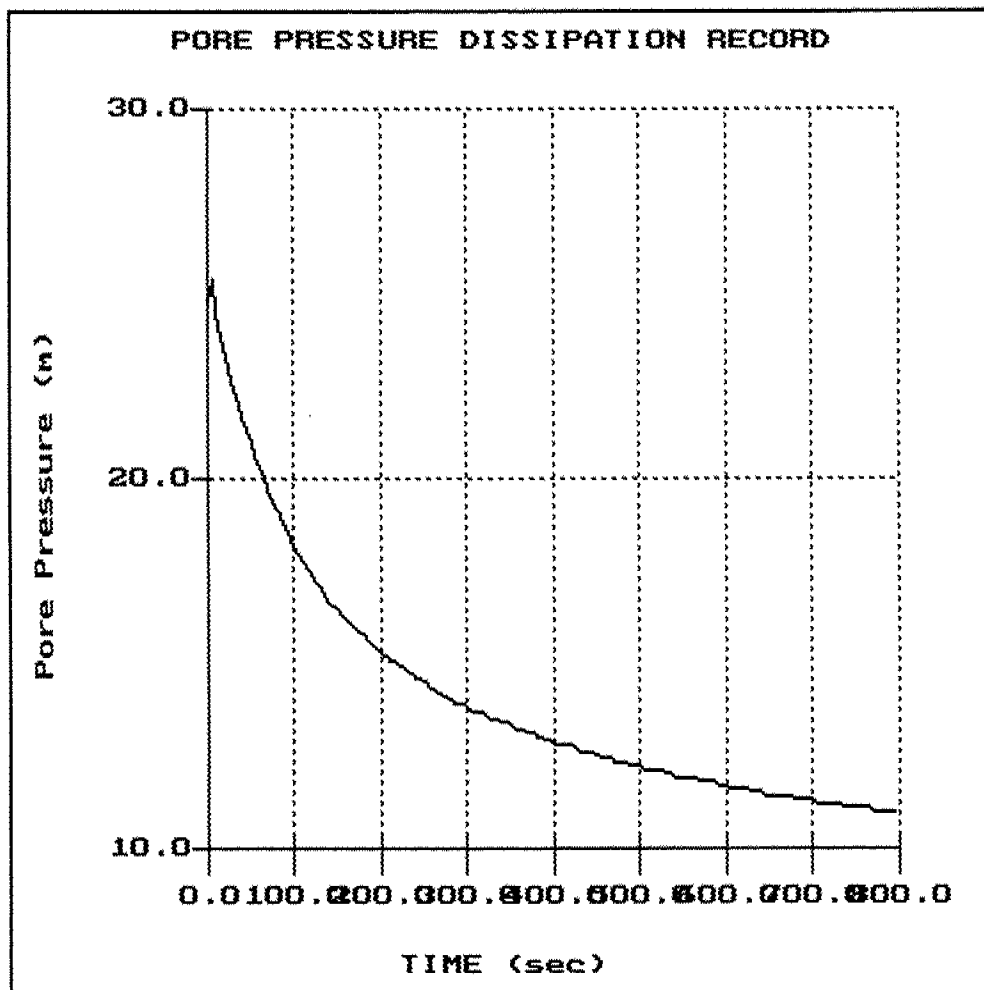


Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 8.50  
(ft): 27.89  
Duration: 795.0s



Thurber Engineering

Hole: CPTUS1

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 09:11

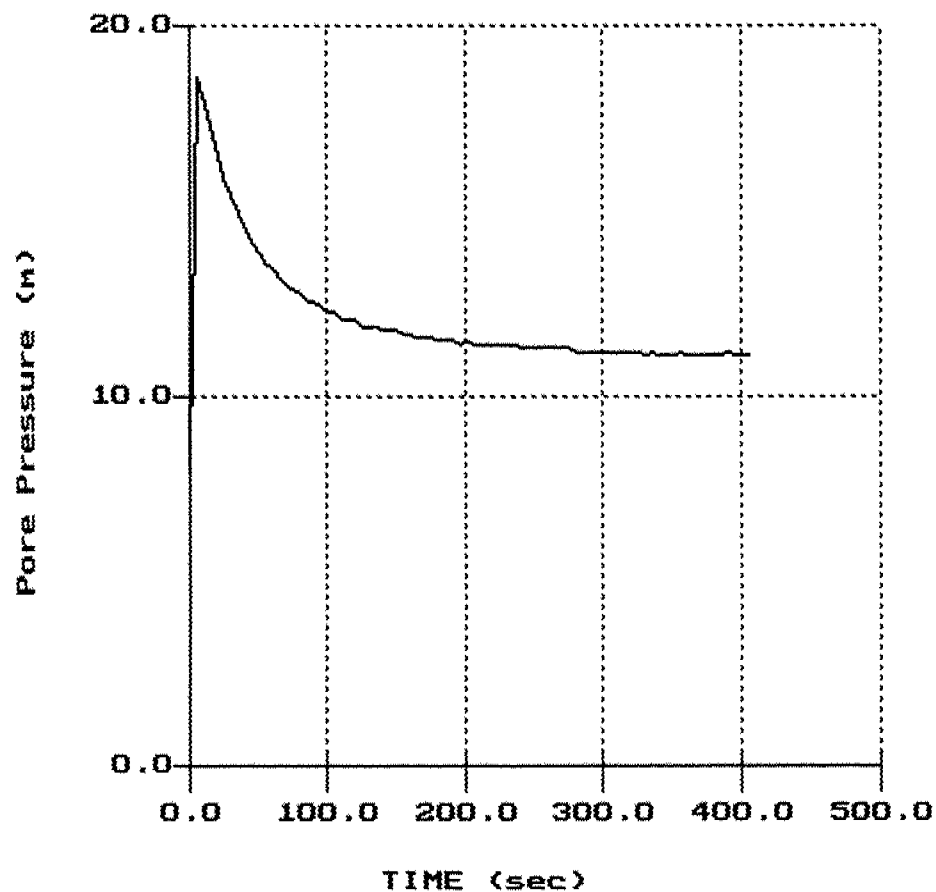
File: 141CPS1.PPD

Depth (m): 10.50

(ft): 34.45

Duration : 405.0s

PORE PRESSURE DISSIPATION RECORD



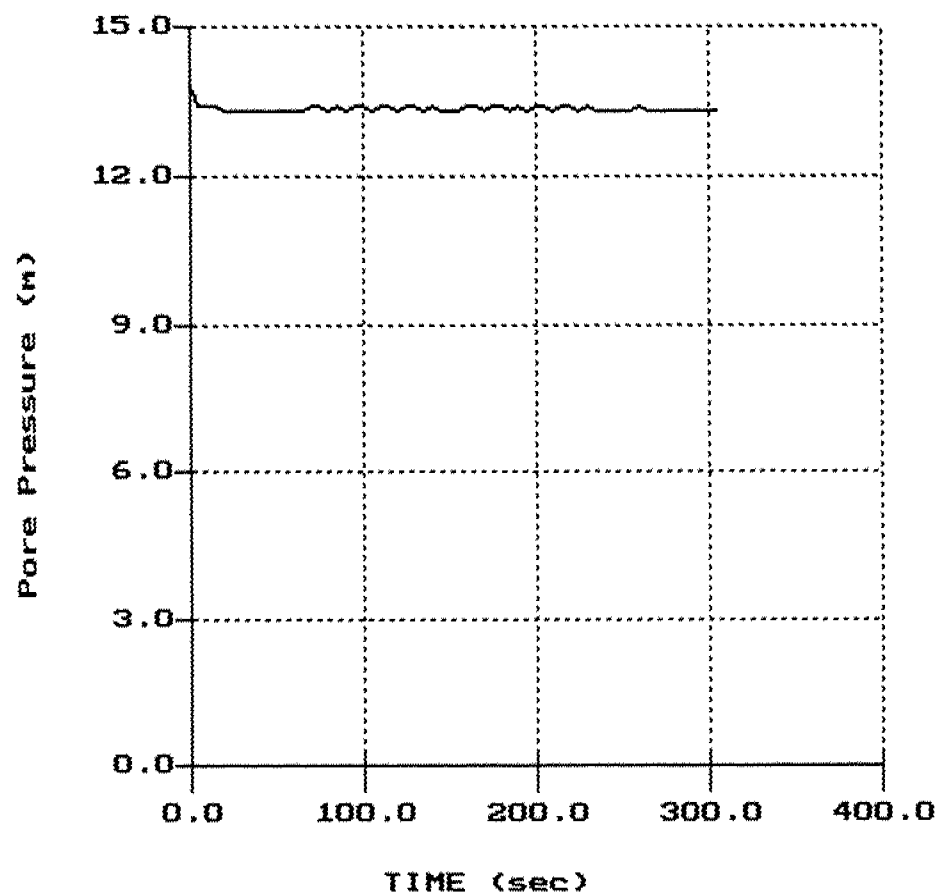
Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 13.00  
(ft): 42.65  
Duration : 305.0s

PORE PRESSURE DISSIPATION RECORD

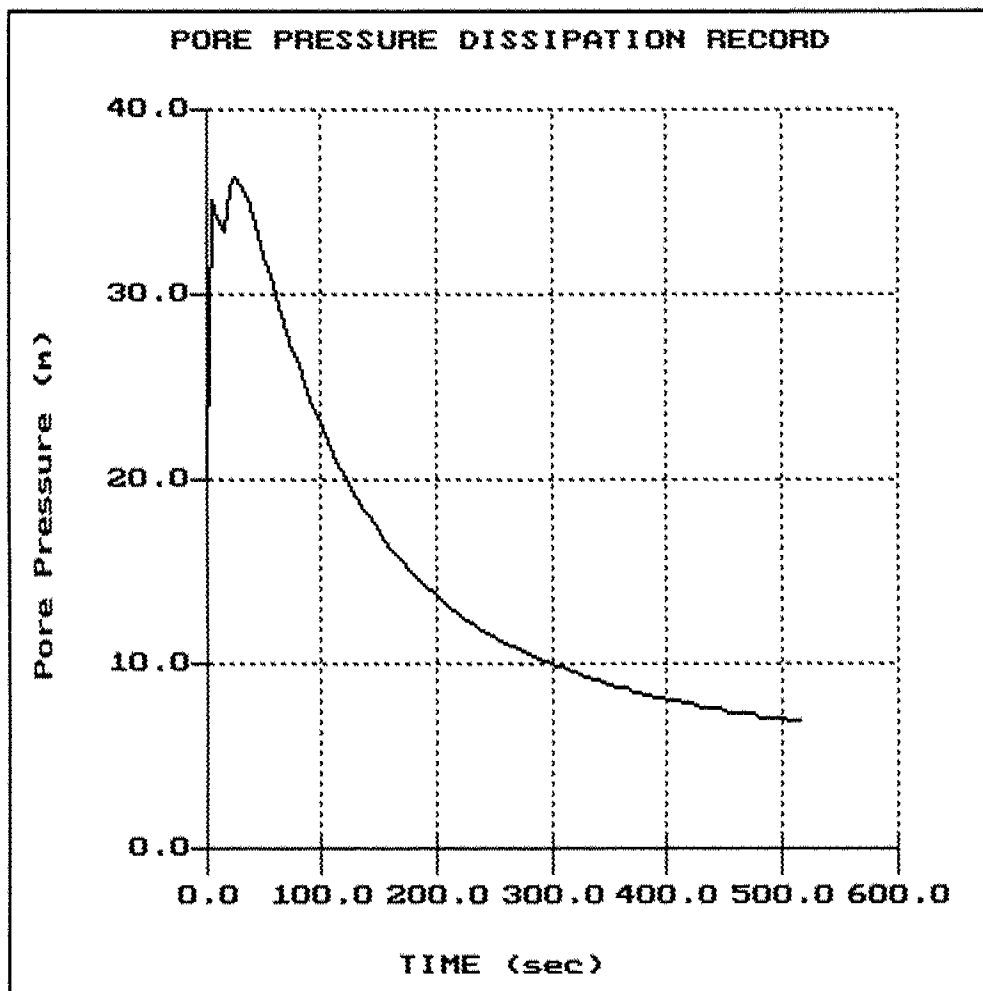


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 3.50  
(ft): 11.48  
Duration: 515.0s



Thurber Engineering

Hole: CPTUS2

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 11:29

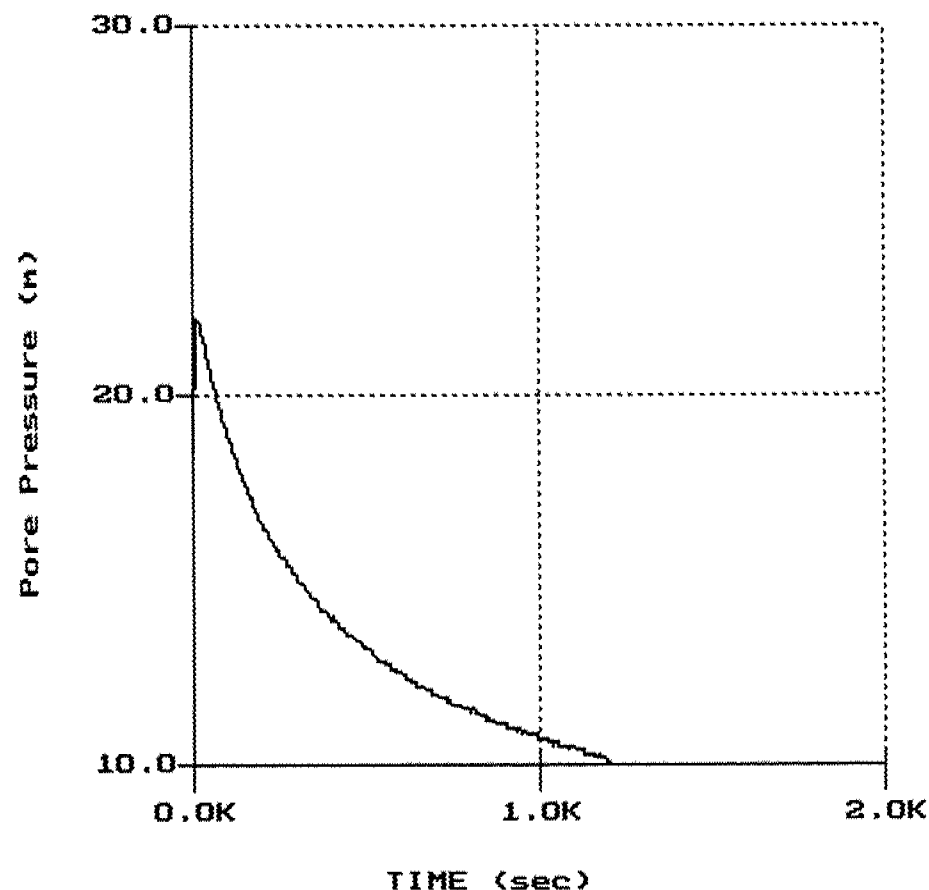
File: 141CPS2.PPD

Depth (m): 5.50

(ft): 18.04

Duration : 1205.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS2

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 11:29

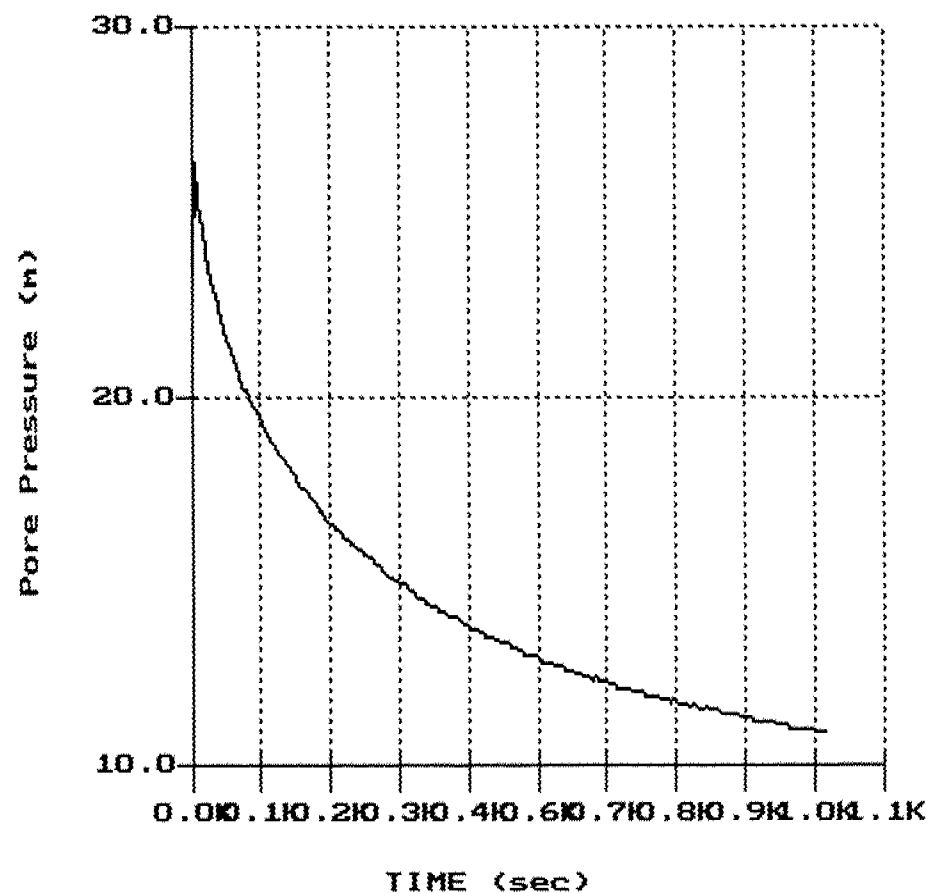
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Depth (m): 6.50

(ft): 21.33

Duration: 1005.0s

PORE PRESSURE DISSIPATION RECORD

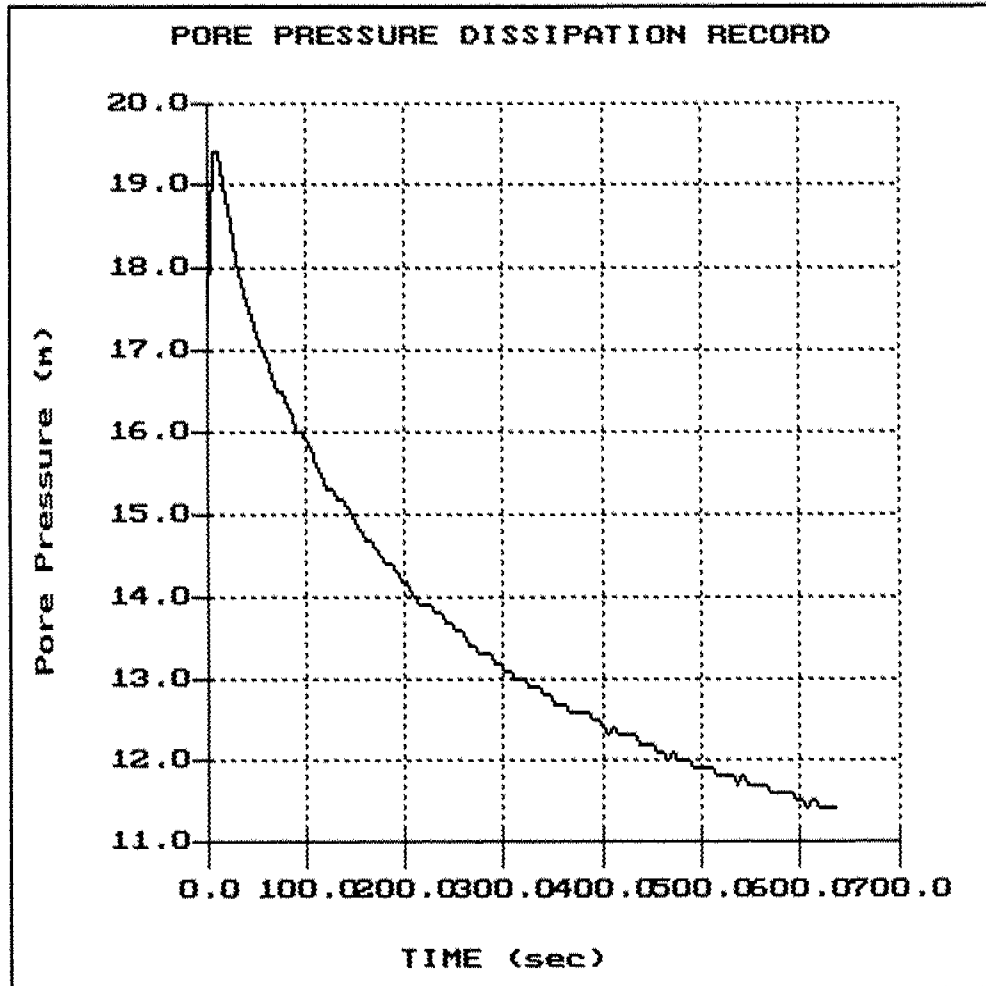


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 8.50  
(ft): 27.89  
Duration : 635.0s



Thurber Engineering

Hole: CPTUS2

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 11:29

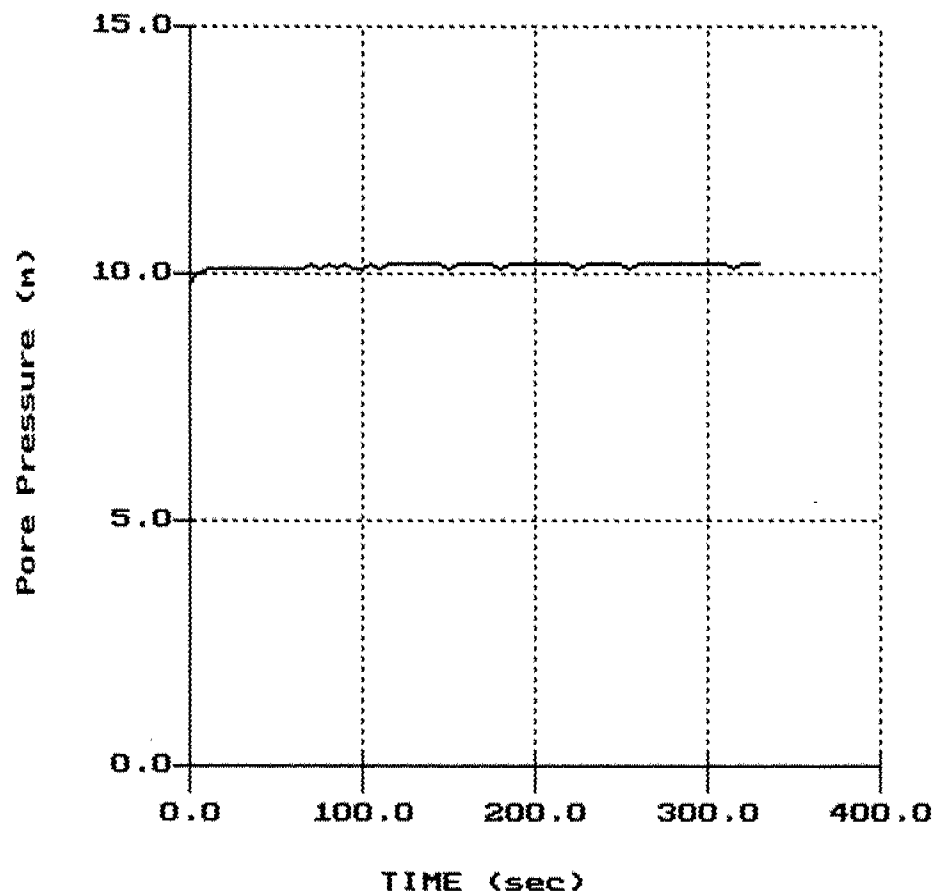
File: 141CPS2.PPD

Depth (m): 9.75

(ft): 31.99

Duration: 330.0s

PORE PRESSURE DISSIPATION RECORD



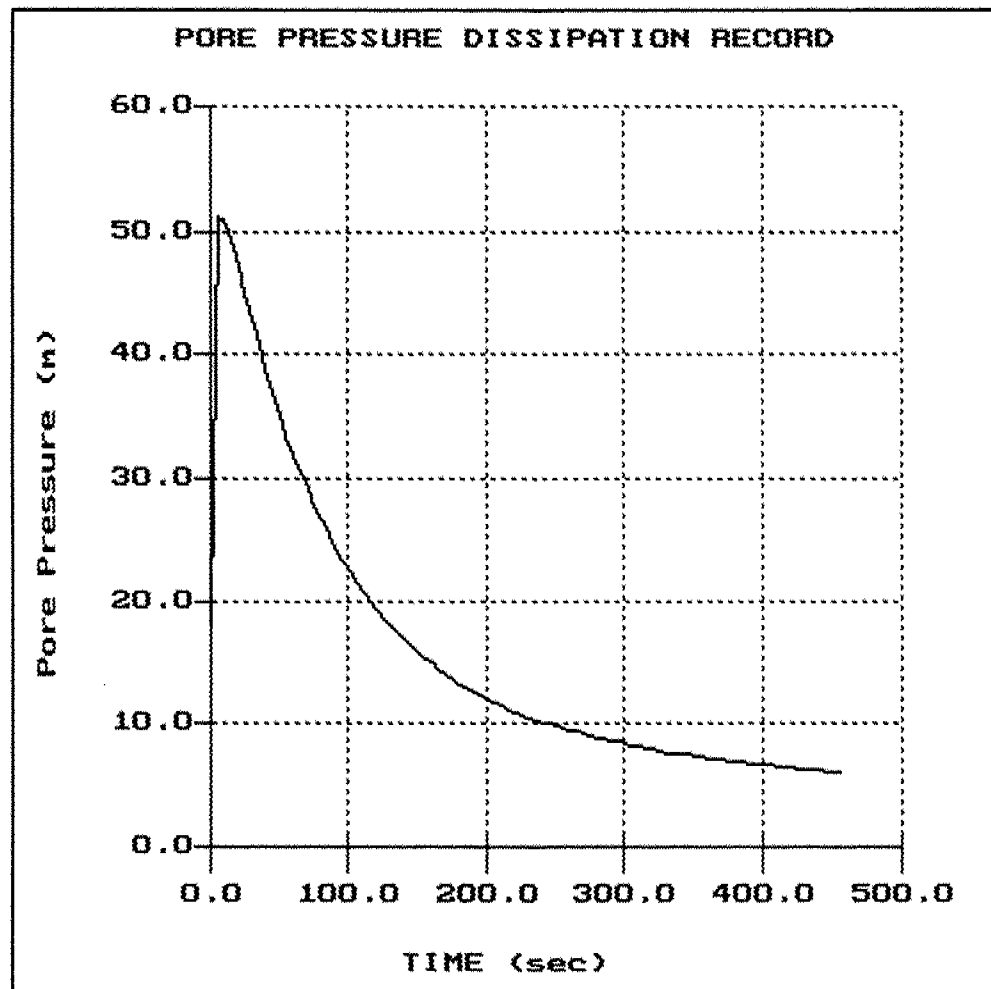


Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 3.50  
(ft): 11.48  
Duration : 455.0s



Thurber Engineering

Hole: CPTUS3

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 13:21

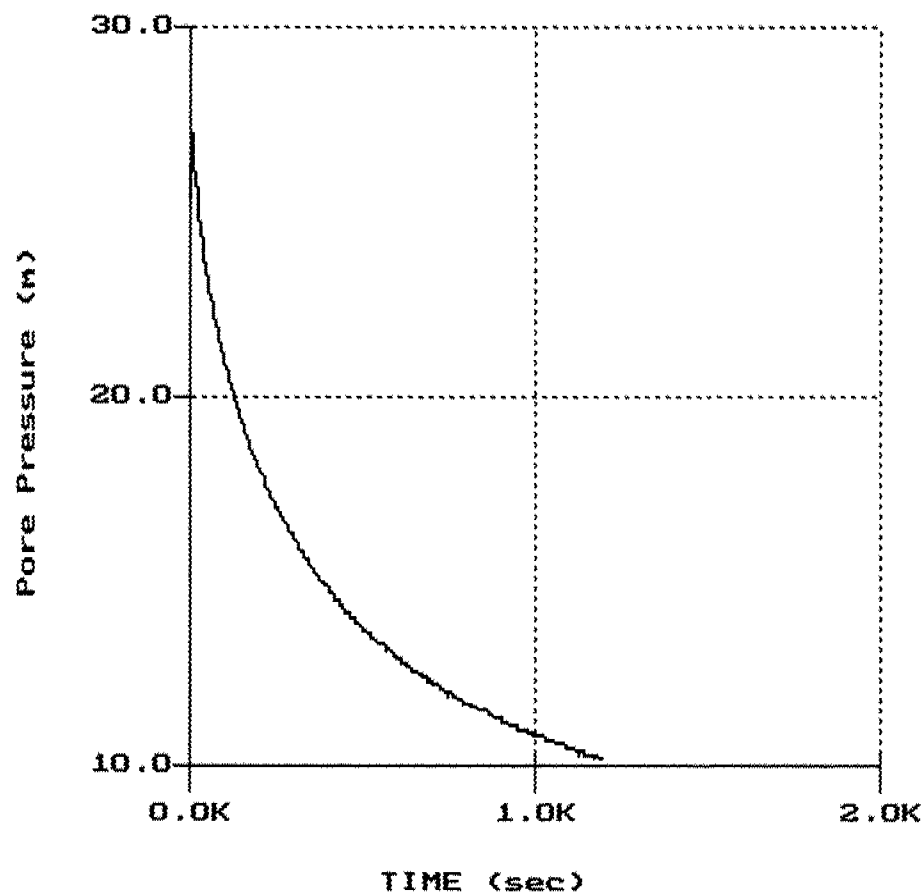
File: 141CPS3.PPD

Depth (m): 5.50

(ft): 18.04

Duration: 1195.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS3

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 13:21

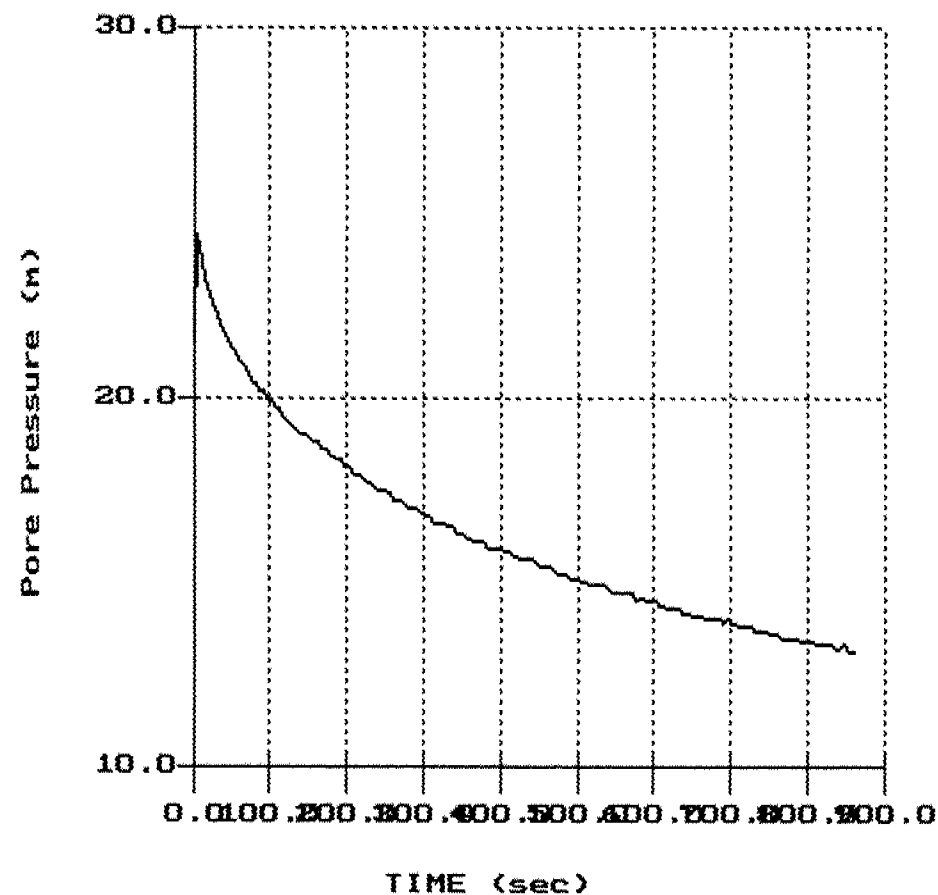
File: 141CPS3.PPD

Depth (m): 7.70

(ft): 25.26

Duration: 860.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS3

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 13:21

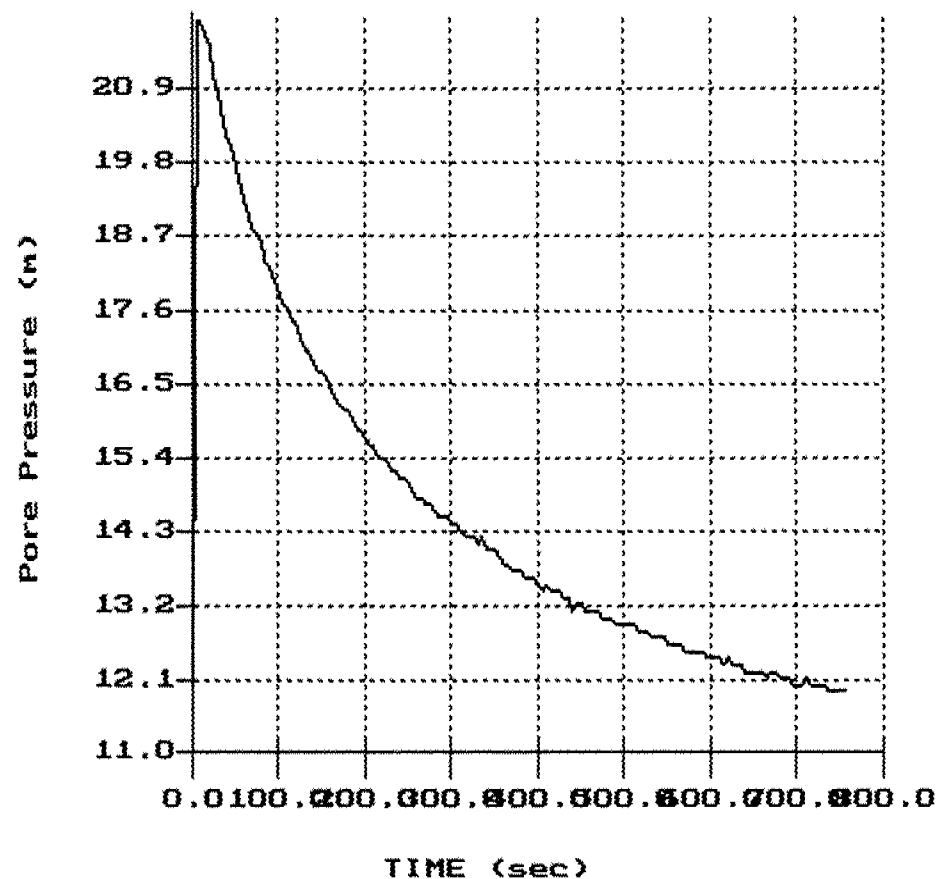
File: 141CPS3.PPD

Depth (m): 9.50

(ft): 31.17

Duration: 755.0s

PORE PRESSURE DISSIPATION RECORD

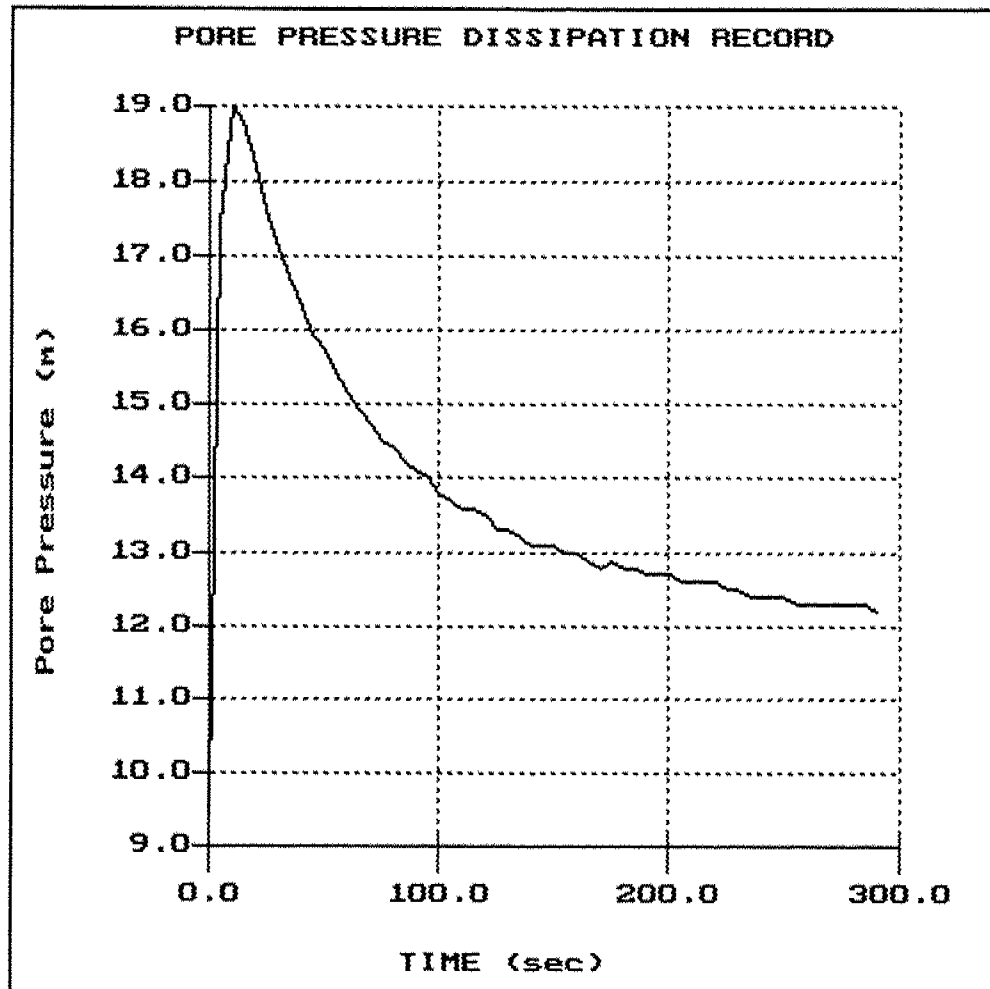


Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 11.50  
(ft): 37.73  
Duration: 290.0s



Thurber Engineering

Hole: CPTUS3

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 13:21

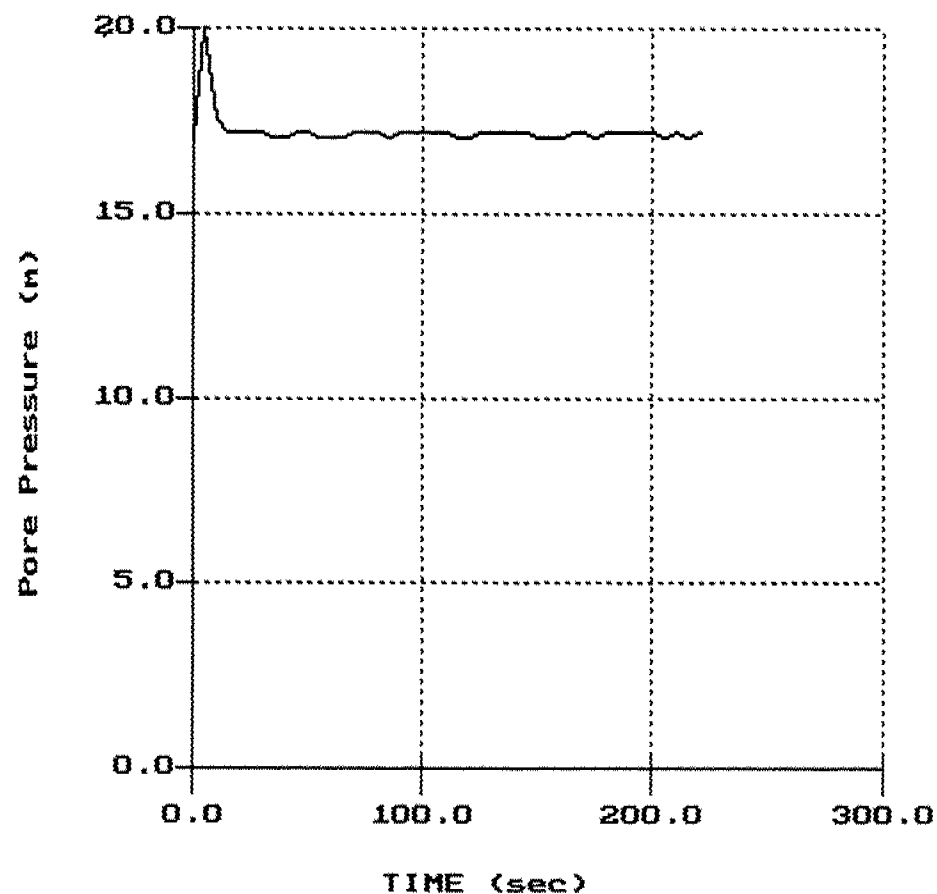
File: 141CPS3.PPD

Depth (m): 16.93

(ft): 55.54

Duration: 220.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

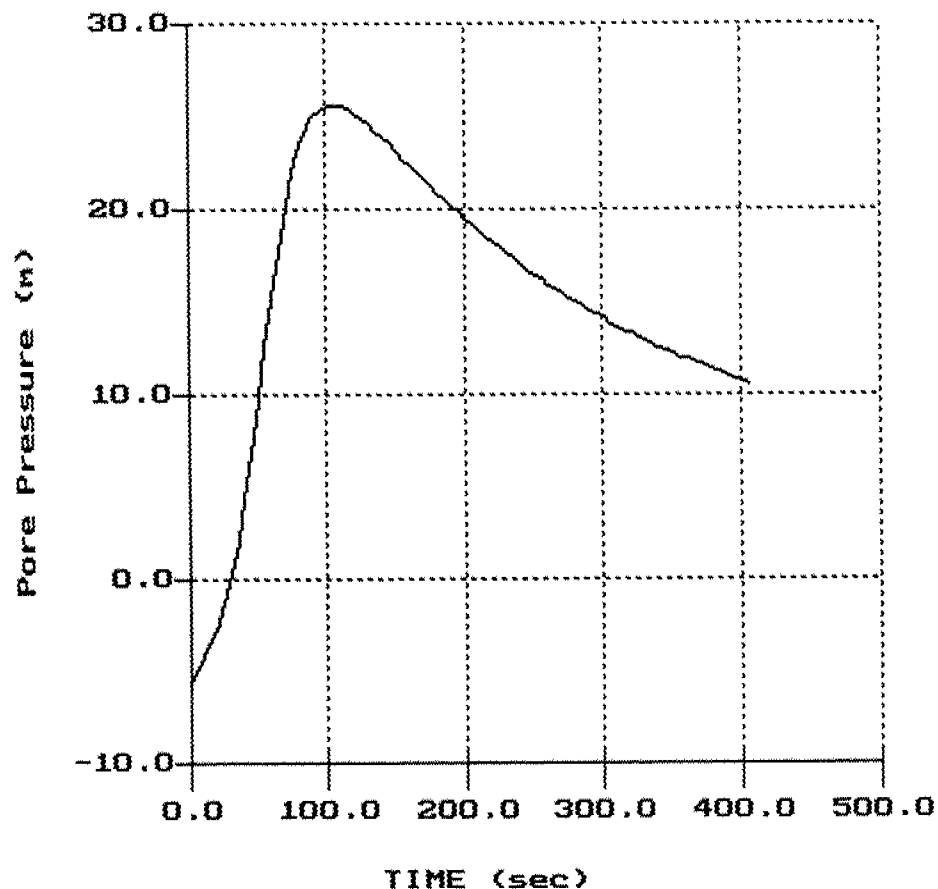
File: 141CPS4.PPD

Depth (m): 3.50

(ft): 11.48

Duration: 405.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

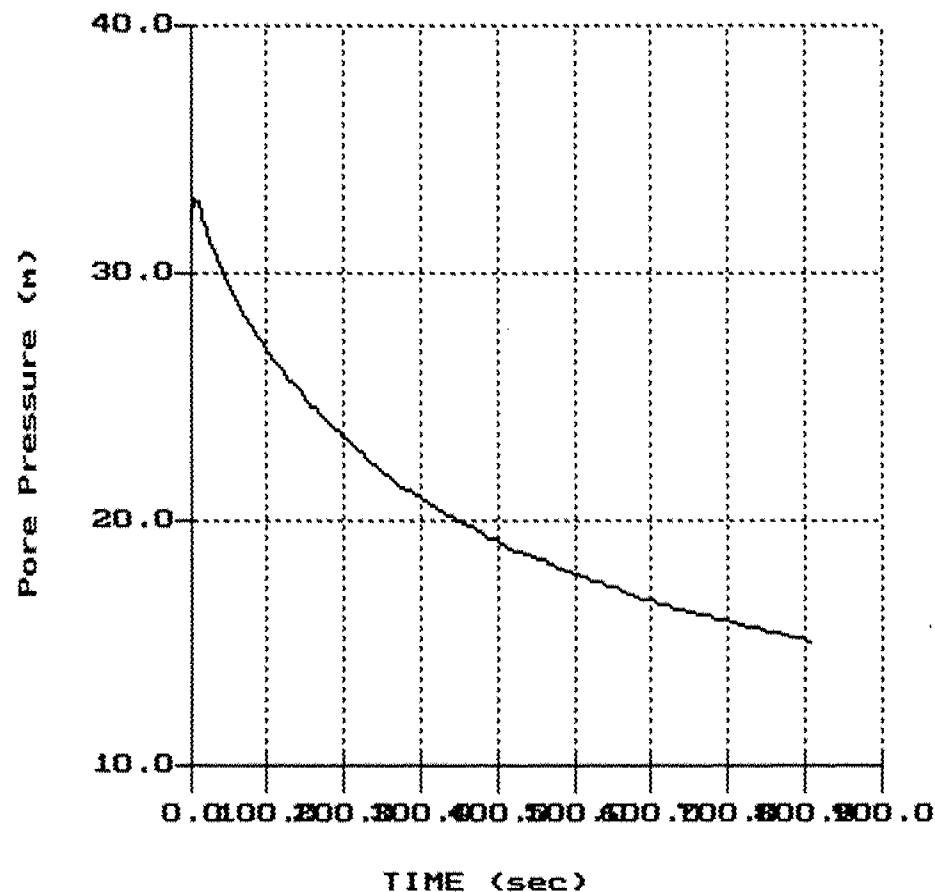
File: 141CPS4.PPD

Depth (m): 5.50

(ft): 18.04

Duration: 805.0s

PORE PRESSURE DISSIPATION RECORD





Thurber Engineering

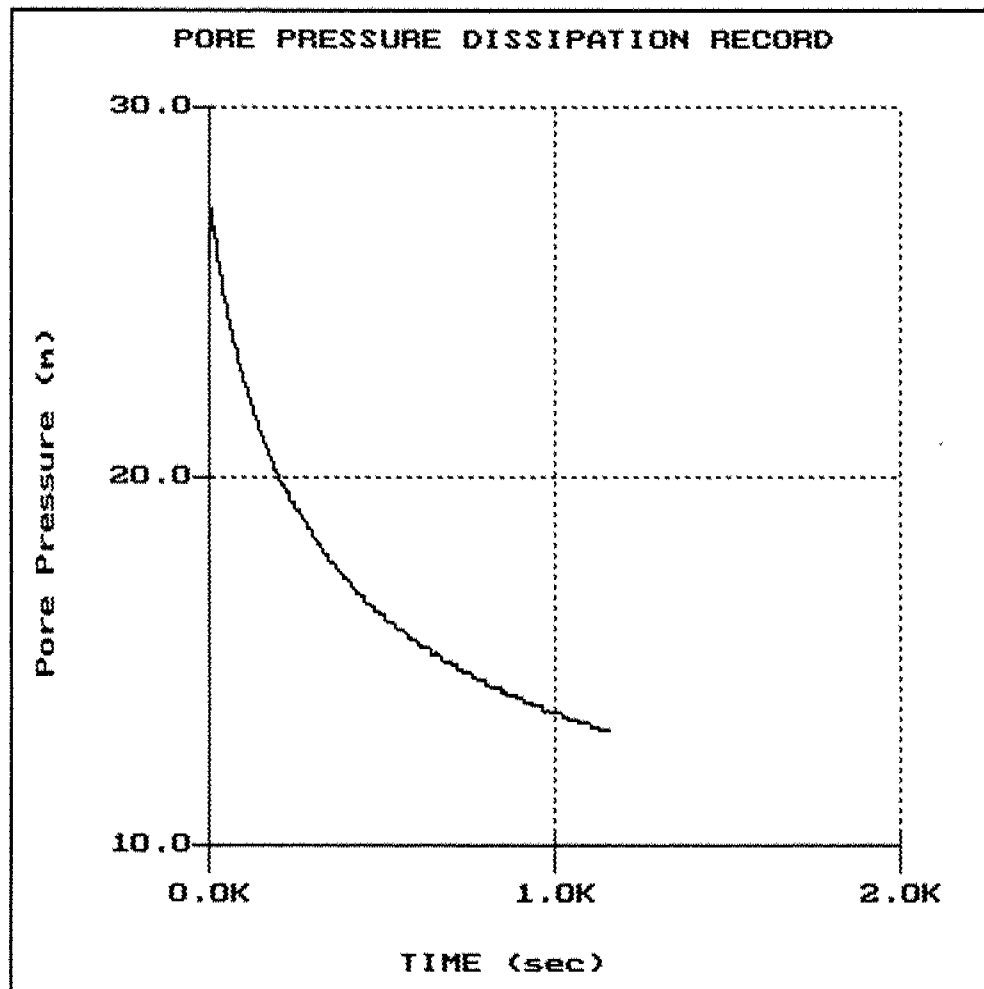
Hole: CPTUS4

Location: S. INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

File: 141CPS4.PPD  
Depth (m): 7.50  
(ft): 24.61  
Duration: 1160.0s



Thurber Engineering

Hole: CPTUS4

Location: S. INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

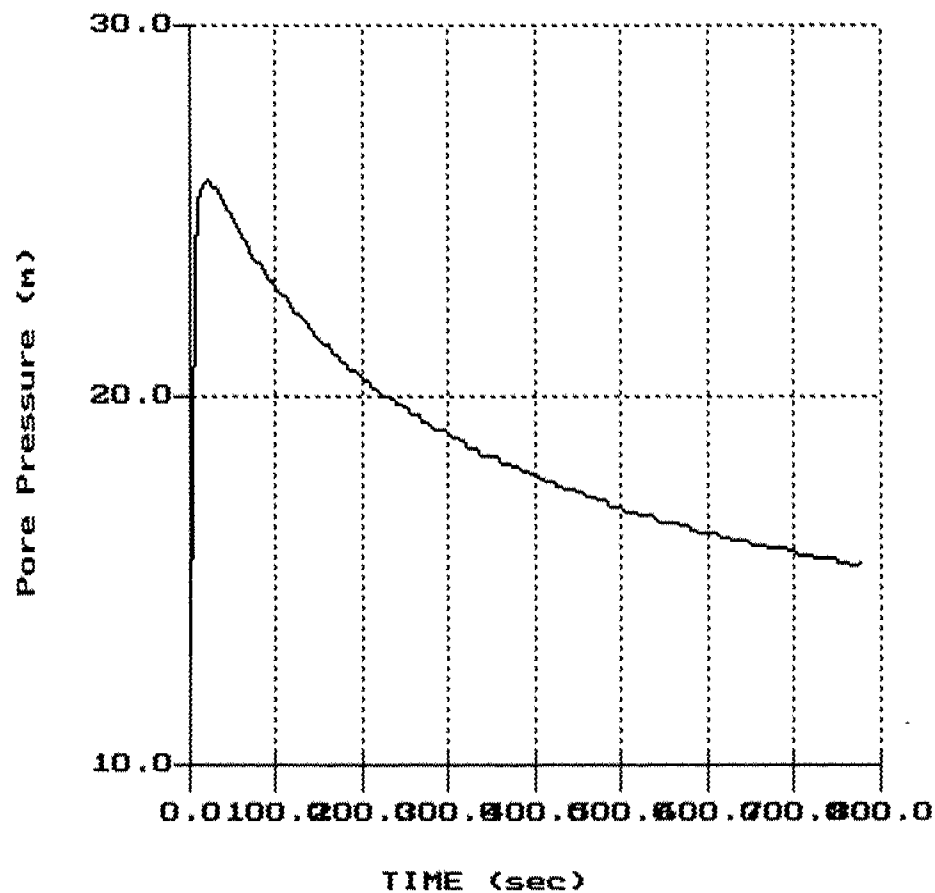
File: 141CPS4.PPD

Depth (m): 9.50

(ft): 31.17

Duration: 775.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

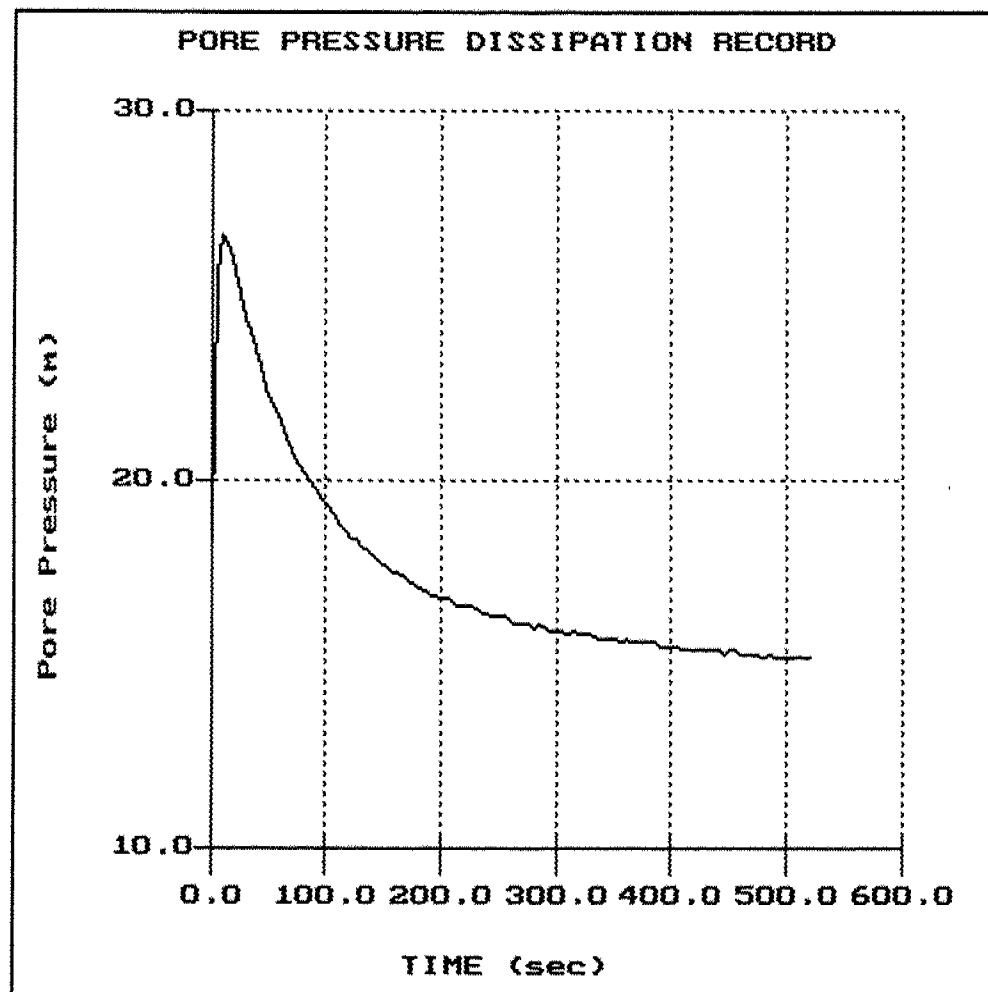
Date: 03:25:99 15:35

File: 141CPS4.PPD

Depth (m): 13.00

(ft): 42.65

Duration: 520.0s



Thurber Engineering

Hole: CPTUS5

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 17:56

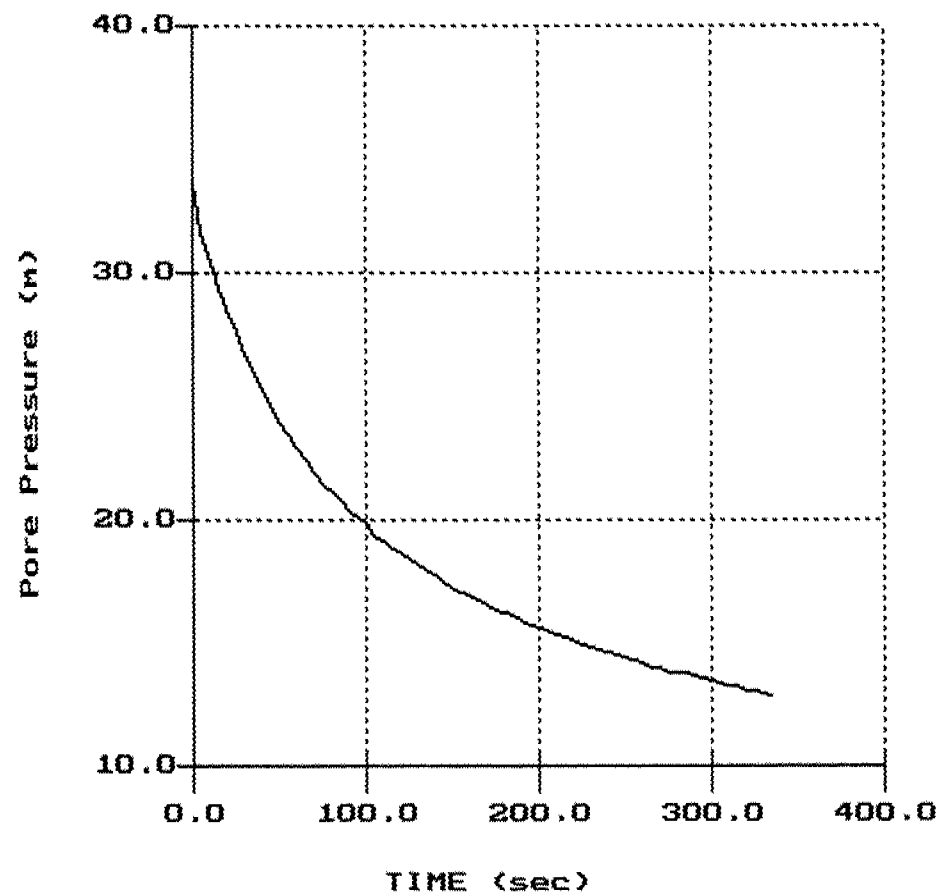
File: 141CPS5.PPD

Depth (m): 7.00

(ft): 22.97

Duration : 335.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS5

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 17:56

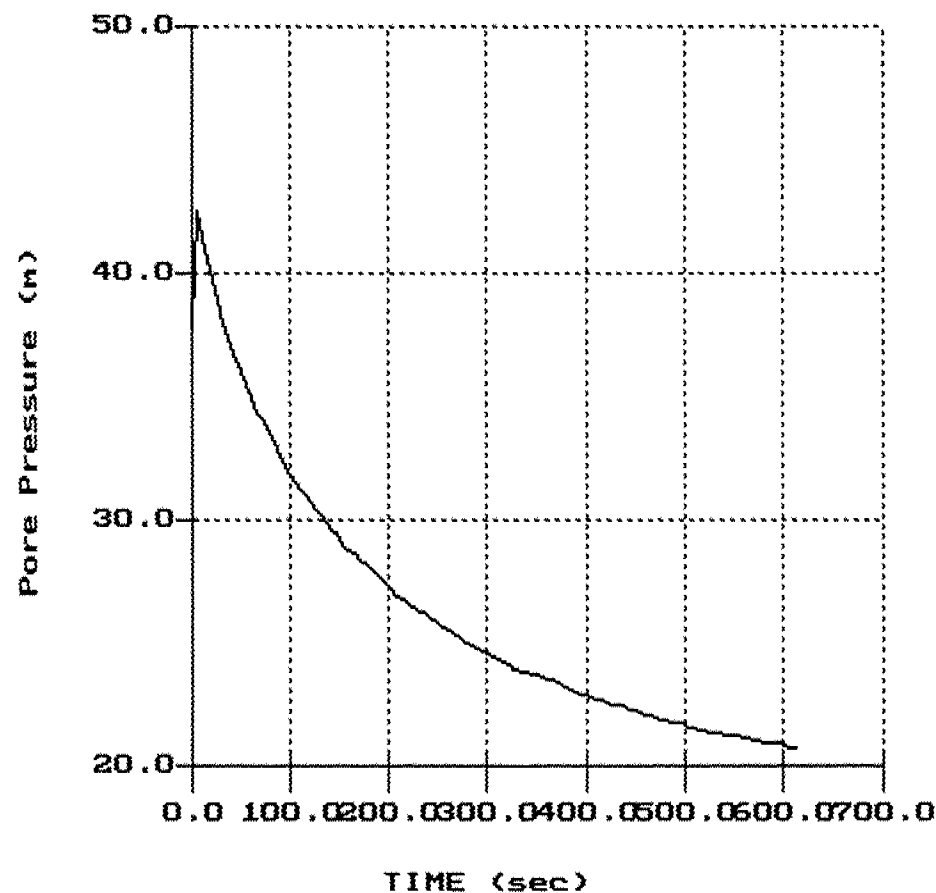
File: 141CPS5.PPD

Depth (m): 15.00

(ft): 49.21

Duration: 610.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS5

Location: S. INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 17:56

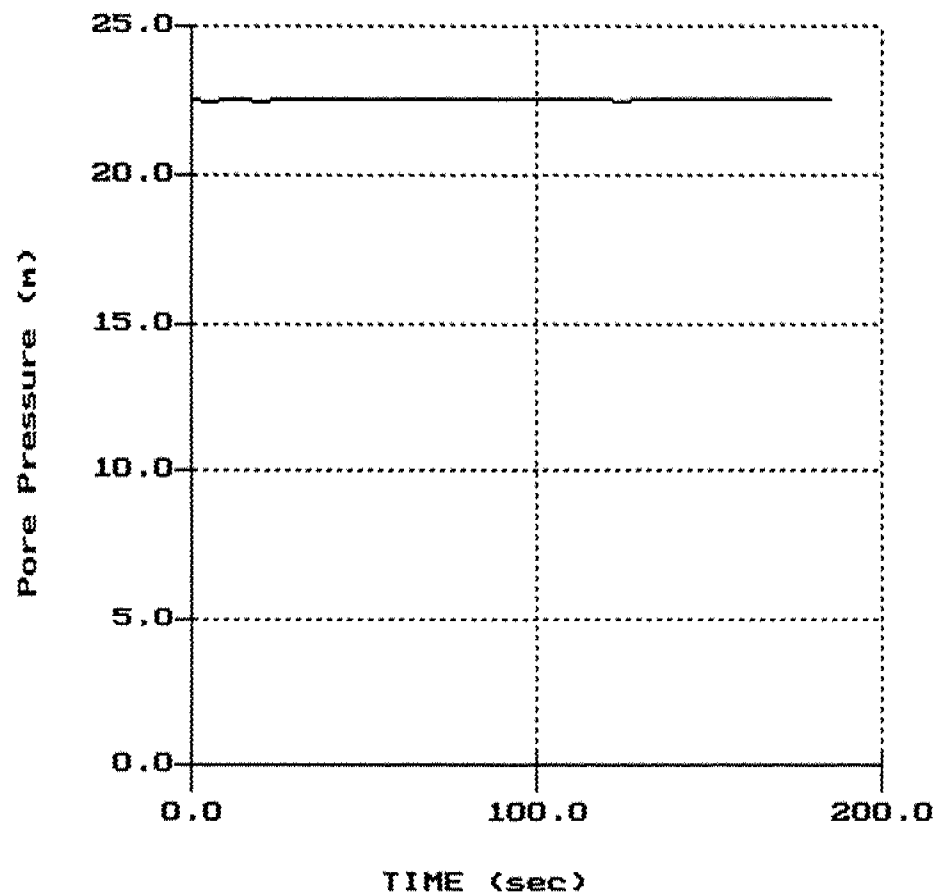
File: 141CPS5.PPD

Depth (m): 22.08

(ft): 72.44

Duration : 185.0s

PORE PRESSURE DISSIPATION RECORD





**APPENDIX D**

**NON STANDARD SPECIAL PROVISIONS**

**Granular Blanket**

**Wick Drains**



Special Provision

**1.0 SCOPE**

This non-standard special provision specifies the requirements for the surface preparation, supply, placement and compaction of the Granular Filter blanket in connection with the installation of the prefabricated vertical drains.

**2.0 MATERIALS**

The Granular Filter Blanket shall be Granular 'A' material and shall satisfy the physical and gradation requirements as specified in OPSS 1010.

**3.0 CONSTRUCTION**

3.1 The Granular 'A' blanket shall be placed and compacted to the limits and, grades shown on the plans or as directed by the Contract Administrator.

3.2 The Granular 'A' blanket shall be placed subsequent to the required subexcavation.

3.3 The Granular 'A' blanket shall be end-dumped in areas of land reclamation.

3.4 The Granular 'A' blanket shall be placed and compacted in lift thicknesses not exceeding 250 mm except in land reclamation areas.

3.5 The Granular 'A' blanket shall be compacted to 90%  $\pm$  2% of its standard proctor density.

**4.0 PAYMENT**

**4.1 Measurement of Payment**

Measurement of payment shall be by the tonne. The method of determining

the mass of materials for payment shall conform to OPSS 102.

#### 4.2 Basis of Payment

Granular 'A' Blanket - Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment and material required to do the, work.

**Special Provision****1.0 GENERAL****1.1 Scope**

This non-standard special provision specifies the requirements for the supply and installation of wick drains in accordance with the details shown on the plans and with the requirements of these specifications.

**1.2 Qualifications**

This work shall be undertaken by a recognized specialist subcontractor with at least 5 years of proven satisfactory experience in work of this type and magnitude.

**2.0 SITE CONDITIONS**

The Contractor shall refer to the Foundation Investigation Report in the Contract Documents for a description of subsurface conditions at this site. The Record of Borehole sheets are not represented as a complete description of the subsurface conditions, but only present what was found in borings at the indicated locations on the date boreholes were drilled. The subsurface conditions may be variable between the borehole locations. The Contractor should verify existing surface conditions.

**3.0 MATERIALS****3.1** The prefabricated drain shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile material. The core configuration should be 'Studded' or 'Groved' ('Filament' or 'Cuspated' are not acceptable).

The Contractor shall submit samples of the prefabricated drain for evaluation and approval to the Contract Administrator at least one month

prior to commencement of work under this item.

Fabricated wick drain material shall meet the minimum Specifications included in the table attached at the end of this text.

- 3.3 The Contractor shall submit a 1 m sample of the vertical drain material to the Contract Administrator prior to usage and shall allow two weeks for the Contract Administrator to evaluate the material. The sample shall be stamped or labelled by the manufacturer as being representative of the drain material having the specified trade name. Documentation indicating the source of the drain shall be provided. Approval of the sample by the Contract Administrator shall be required prior to site delivery of the vertical drain material.
- 3.4 Manufacturer certification shall be provided for all drain material delivered to the project.
- 3.5 All drains supplied shall be free of defects, rips, holes or flaws. During shipment the drain shall be protected from damage. During on-site storage the storage area shall be such that the drain is protected from sunlight, dirt, dust, mud, debris and any other detrimental substances.

#### **4.0 EQUIPMENT**

- 4.1 Vertical drains shall be installed with equipment which will minimise disturbance to the granular 'A' blanket or the native subsoil during the installation operation. Static or vibratory methods are considered acceptable. Falling weight impact hammers will not be allowed.
- 4.2 The Contractor is advised that the site is considered as an environmentally sensitive area and therefore the control of any water effluent needs to be carefully planned and organized. Jetting techniques, therefore, shall be subjected to the approval of the Contract Administrator.
- 4.3 The Contractor shall be permitted to use augering equipment to predrill or to loosen the native soils and the granular 'A' blanket if required to facilitate the installation of the wick drains.
- 4.4 Each prefabricated wick drain shall be installed using a mandrel or sleeve

which shall be advanced through the underlying soil and the granular blanket. The mandrel shall protect the prefabricated drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation on the drain. The mandrel shall be provided with an "anchor" rod or plate at the bottom to prevent the soil from entering the bottom of the mandrel during installation of the drain and to anchor the bottom of the drain at the required depth at the time of mandrel removal. The projected cross-sectional area of the mandrel and anchor combination shall not exceed 7700 mm<sup>2</sup>.

## **5.0 INSTALLATION**

### **5.1 Installation Method Proposal Submission**

At least three weeks prior to the installation of the drainage strips, the Contractor shall submit to the Contract Administrator, for review and approval, details of the sequence and method of installation. The submittals shall satisfy the specifications and at a minimum contain the following specific information:

- Size, type, weight, maximum pushing force, and configuration of the installation rig.
- Dimensions and length of mandrel.
- Details of drain anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for overcoming obstructions.
- Proposed methods for splicing drains.

Approval by the Engineer will not relieve the Contractor of his responsibilities to install vertical drain strips in accordance with the plans and specifications.

### **5.2 Construction Sequence**

Vertical drains shall be installed subsequent to the construction of the

granular 'A' blanket and prior to installation of monitoring instruments and placement of the embankment material.

### 5.3 Trial Drains

Prior to the installation of prefabricated drains within the areas designated on the plans, the Contractor shall demonstrate that the proposed materials, equipment and installation method produces a satisfactory drain installation in accordance with these specifications. The Contractor will be required to install a total of ten trial drains at locations within the work area as designated by the Contractor Administrator.

Should the ten trial drains be installed to the satisfaction of the Contract Administrator, the trial drains can be incorporated as part of the permanent installation. The Contractor will be compensated for each trial drain if the installation satisfies the requirements of this specification, at the same unit price as the production drains. The Contractor shall not be compensated for unsatisfactory trial drains.

Approval by the Contract Administrator of the method and equipment used to install the trial drains shall not constitute, necessarily, acceptance of the method for the remainder of the project. If, at any time, the Contractor Administrator installation considers that the method of installation does not produce a drain which satisfies the project requirements, the Contractor shall alter his method and/or equipment as necessary to comply with these specifications.

### 5.4 Layout

Prefabricated drains shall be located and staked out by the Contractor. The location of the drains shall not vary by more than 150 mm from the locations indicated on the drawings.

### 5.5 Plumbness

Drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The equipment shall be carefully checked for plumbness, and the Contractor shall provide the Contract Administrator with a suitable means of verifying the plumbness of the mandrel and of determining the

depth of the drain at any time.

5.6 Splices

Splices or connections in the vertical drain material shall be done in a professional manner so as to ensure continuity and to avoid any reduction of the flow characteristics of the wick material. Splices shall be a minimum of 150 mm in length.

5.7 Cut-off

The prefabricated drain shall be cut at the surface such that at least a 150 mm length protrudes above the top of the granular blanket at each drain location.

5.8 Obstructions

Where obstructions are encountered below the working surface which cannot be penetrated by the drain installation equipment, the Contractor shall complete the drain from the elevation of the obstruction to the working surface and notify the Contract Administrator. At the direction of the Contract Administrator, the Contractor shall attempt to install a new drain within a 500 mm radius of the obstructed drain. A maximum of two attempts shall be made as directed by the Contract Administrator. The Contractor will be compensated for each obstructed drain unless the drain is improperly completed, in which case no compensation will be allowed.

5.9 Preaugering

It may be necessary to preauger the some of the native soils and the granular 'A' blanket to facilitate the installation of the prefabricated wick drain. Preaugering shall not extend more than 1 metre into the clayey silt and silty clay deposit at the site. Any additional cost for preaugering, shall be incorporated into the unit price.

5.10 Rejected Drains

Prefabricated drains that are installed beyond the plan location by more than 150 mm, or that are damaged or are not installed in accordance with the

specifications described above shall be rejected. Rejected drains may be removed at the Contractor's own expense and time. The Contractor shall not be compensated for the materials and work associated with rejected drains.

Replacement drains shall be installed within a 50 cm radius from the location of the rejected drain as directed by the Contract Administrator.

#### 5.11 Geotechnical Instrumentation

Installation of the drains should be coordinated with the placement of geotechnical instrumentation as shown on the drawings. Special care should be taken to install drains in such a manner so as not to disturb instrumentation already in place. The replacement of instrumentation damaged as a result of the Contractor's activities will be the responsibility of the Contractor.

### 6.0 **PAYMENT**

#### 6.1 Measurement of Payment

Measurement of the item "WICK DRAINS" is by Plan Quantity, as may be revised by Adjusted Plan Quantity shall be by the linear metre for all accepted drains installed including the protruding portion. Properly completed obstructed wick drains and properly installed replacement wick drains and trial drains will be measured for payment.

#### 6.2 Basis for Payment

Item - Wick Drains

Payment at the contract unit price per linear metre for the above item shall be full compensation for all labour, materials and equipment to complete the work in accordance with the Plans and Specifications.

No payment shall be made for unacceptable drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.



PRODUCT SPECIFICATIONS			
	TEST METHOD	UNITS	VALUE
PHYSICAL PROPERTIES			
Drain Body Material		Studded or Groved	Polypropylene
Filter Material		Non-Woven	Polypropylene
Weight	ASTM-D-1777	g/m	75
Width		mm	not less than 100
Thickness	ASTM-D-5199	mm	not less than 3
Mass of Filter	ASTM-D-1777	g/m <sup>2</sup>	154
MECHANICAL PROPERTIES			
Drain composite Tensile Strength	ASTM D-4595	kN	0.375 @ 10%
Filter Puncture Strength	ASTM-D-751-68	kN	0.335
Filter Grab Strength	ASTM-D-1682	kN	0.800
Filter Trapezoidal Tear	ASTM-D-1117	kN	0.220
Filter Burst Strength	ASTM-D-751-68	kPa	2000
Discharge Capacity @ 70 kPa	ASTM-D4716	m <sup>3</sup> /s	100x10 <sup>-6</sup>
FOS	CAN/CGSB-148.1 No. 10.2	μm	15 to 100
Minimum elongation at break (%)	CAN/CGSB-148.1 No. 7.3	%	15
Water Permeability	ASTM D-4491	m/s	5.0E-06

## **MEMORANDUM**

TO: Robert Kivi, P.Eng., MMM

DATE: June 2, 1999

FROM: Paulo Branco, P.Eng., Thurber

FILE: 19-1104-4

---

### **TROUT CREEK BYPASS - KING'S HIGHWAY 11 SOUTH INTERCHANGE WICK DRAIN DESIGN AND MONITORING PROGRAM**

This memorandum summarizes the changes included in our Final Report dated June 2, 1999, for the above noted project, following discussions with Mr. Tony Sangiuliano, P.Eng. of MTO - Pavements and Foundations Section. Mr. Sangiuliano's review comments on our Draft Report dated April 22, 1999, were included in a memorandum to the MTO - Northern Region, dated May 5, 1999.

#### **1: Introduction**

Reference to the Terms of Reference has been included in the report

#### **8 Engineering Analysis**

##### **8.1 General**

##### *Areas and Geometry:*

- Figure A1 has been modified to clearly include the stations referred to in the text.

##### *Soil Properties:*

- Reference to Trow's oedometer test results has been included in the text (Page 10). The text also explain that, in view of the CPTU and Trow's tests, and the sensitivity of our analysis to the Pc values, a parametric analysis was carried out assuming two sets of Pc values: Most Likely and Reduced (50% of M.L.; not necessarily reflecting normally consolidated conditions)

## 8.2 Stability Analysis

### *Geometry*

- Figures A7 to A12 present typical embankment cross-sections. MMM has prepared embankment cross-sections, which will be included in the contract documents. The text has been modified to explain why the upper portion of the embankments will be temporarily slightly steeper.

### *Surcharge*

- The height of surcharge varies up to 1.5 m depending on the magnitude and rate of settlements due to primary consolidation.

### *Results*

- Requirements for EPP dissipation during construction stages have been included in Table B31
- The reason for carrying out an analysis of an embankment with a berm width of 8m has been included in the end of Page 12.
- EPP versus time for most likely values of  $P_c$  have also been included in Appendix A (Figures A13B, A15B to A18B)

## 8.3 Settlement Analysis

### 8.3.2 One-Dimensional Consolidation - No Wick Drains

- Reference to wick drains requirements for different construction schedules have been included in the text

### 8.3.3 Settlements due to Primary Consolidation - With Wick Drains

- EPP dissipation and EPP values have been included in the text (Page 20)

### 8.3.4 Settlements due to Secondary Consolidation

- No action from Thurber required

## **9 Embankment Design Recommendations**

### **9.1 Embankment Geometry and Construction Schedule**

- Illustrations of the general layout of the wick drains for different construction schedules have been prepared by MMM.
- The reason for selecting an 8 m wide berm has been explained at the end of Page 12

### **9.2 Site Preparation**

- NSSP for the sand blanket has been included in Appendix D. As discussed, there should be no need for dewatering at this site as far as the wick drain installation is concerned.

### **9.3 Wick Drain Specification**

- NSSP for the wick drain has been included in Appendix D.

### **9.4 Monitoring Program**

- A layout of instruments and specifications will included in the detailed design of the monitoring program. As discussed with Mr. Sangiuliano, preparation of monitoring drawings and specifications was beyond the scope of this work.
- Settlement pins are valuable if anchored below the surcharge. They provide information about the settlement of the embankment top, which, when analysed in conjunction with the settlement rod data, indicate the embankment compressibility.
- Prediction of lateral displacements at depth have been included in Section 8.4

### **9.5 Trial Embankment**

No action from Thurber required.

## **MEMORANDUM**

**TO:** Robert Kivi, P.Eng., MMM

**DATE:** September 16, 1999

**FROM:** Paulo Branco, P.Eng., Thurber

**FILE:** 19-1104-4

---

### **TROUT CREEK BYPASS - KING'S HIGHWAY 11 NORTH INTERCHANGE WICK DRAIN DESIGN AND MONITORING PROGRAM**

This memorandum summarizes the changes included in our Final Report for the above noted project, dated September 17, 1999, and a response to a review of our report carried out by Mr. Sangiuliano, P.Eng. Mr. Sangiuliano's review comments on our Draft Report dated June 1, 1999, were included in a memorandum to the MTO - Northern Region, dated June 7, 1999.

#### **7. Subsurface Conditions**

Page 6 - The comparison of the results from oedometer tests and the piezocone are not directly comparable. The comparison of the results requires the use of empirical conversion factors which we thought would better be left out of this factual portion of the report.

Page 6 - The use of the term "Clayey Silt " was included in the report as a result of the analysis of the piezocone data. Some of the test results indicate that the silt content is actually high in the lower portion of the Silty Clay. In any event, for the sake of consistency with Trow's report we have included the term Silty Clay where it read Clayey Silt.

Page 6 - Undrained shear strength results are provided automatically by the piezocone when it detects the presence of clayey material. For the sake of consistency with our description of that soil layer we have removed the Cu values from the text. Pore pressure dissipation tests were carried out in the Lower Silt in order to provide us with Ch values for the consolidation analysis. The Lower Silt impedes vertical drainage of water from the Silty Clay and it should be included in the consolidation analysis. Therefore Ch values in the Lower Silt layer are required.

## **8. Engineering Analysis**

### **8.1 General**

The base drawing used to prepare Figure A1 is already very crowded and difficult to read. Therefore we decided to show the limits of the "study areas" by highlighting the Stations at the boundaries between regions.

The ramp designations have been corrected.

### **8.2 Stability Analysis**

Reference to Figures A3 to A7 was made in the last column of Table B3. Reference to these figures has been included in the report text as well.

Reference to pore pressure dissipation plots and reference to the use of excess pore pressure in the analysis have been included in Section 8.3.

Pore pressure dissipation plots for the cases with wick drains have been included in Appendix A.

### **8.3 Settlement Analysis**

8.3.2 Modifications have been made to the text to explain the meaning of "minimum time"

8.3.3 The text has been modified to clarify the selection of wick drain spacing

8.3.4 No action required

## **9 Embankment Design Recommendations**

9.2 and 9.3 These section have been modified accordingly

9.4.1 Thurber has submitted a proposal for preparation of specifications for the supply and installation of instruments

9.5 No action required

GEOCRETS No. 31E-140DIST. 54 REGION                     W.P. No. 774-93-00(D)CONT. No.                     W. O. No.                     STR. SITE No. 44-372HWY. No. 11LOCATION Trout Cr. South  
Interchange HendersonNo of PAGES -                     

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     REMARKS:



GEOCRES #31E-180

**Foundation Investigation and Design Report  
Bridge Structure, Approaches and Embankment Fills  
South Interchange (Boundary Road) - Site 44-372  
Trout Creek By-Pass, King's Highway 11  
District 54, Sudbury, Ontario  
GWP No. 774-93-00**

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## **Preface**

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. This project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a by-pass of the existing Highway 11 to the west of the Town of Trout Creek.

This highway section is located in the Townships of Laurier and South Himsworth, within the geographic District of Parry Sound, as shown on the Key Plan, Figure A1 in Appendix A. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek Northbound Lanes, Site 44-371.
- New structure, Trout Creek Southbound Lanes, Site 44-371.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

The following report deals with the new bridge structure at the proposed Trout Creek South Interchange (Boundary Road), Site 44-372, as well as the embankments and approach fills. Separate reports will be submitted for the additional components.

Part 1 of this report, Foundation Investigation, describes the geotechnical investigation methodology and the results derived, as pertaining to the design parameters required for the bridge foundations and related earthworks.

Part 2 of this report, Engineering Discussion and Recommendations, addresses the geotechnical engineering design considerations pertaining to the bridge foundations and the approaches and embankment fills.

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## **Part 1 Foundation Investigation**

### **1.1 Introduction**

This report presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the proposed bridge structure, approaches and embankment fills at the South Interchange to the Town of Trout Creek (the proposed King's Highway 11 Trout Creek By-Pass and Boundary Road) at Site 44-372.

It is Trow's understanding that a two span structure will be constructed to carry Boundary Road (presently McFadden Line) traffic over the realigned four lane Highway 11, with the central pier located in the median of the proposed King's Highway 11. An approximate 4 m grade increase of the new four lanes is proposed at the bridge location, requiring up to approximately 12 m grade raises for the realigned section of Boundary Road at the bridge abutments, in accordance with the grading plan proposed to meet the design objectives.

### **1.2 Site Description and Geological Setting**

The site is located in the Townships of South Himsforth and Laurier, in the vicinity of the intersection of McFadden Line and Highway 11, about 2 km south of the Town of Trout Creek, as shown on Figures A1 and A2, in Appendix A.

The terrain at the site is generally flat and poorly drained (swampy), as evidenced by surficial ponding water. The relief generally varies within only a few metres.

There are mature trees, with heavy underbrush, across the site. The easement for TransCanada PipeLines runs in a north-south direction, located approximately 400 m west of the proposed bridge location.

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P. 3160 (Quaternary geology, South River area), the site is located in what is known as the Central Gneiss Belt, i.e. mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden soils have been mapped as comprising organic deposits (peat) over much of the site of the South Interchange with underlying glacio-lacustrine deposits. These deposits consist of laminated, rhythmically bedded (also referred to as varved) to massive silts and clays. The western portion of the site, in the vicinity of the proposed N-EW and EW-S ramps, is mapped as a bedrock drift complex with relatively thin, primarily cohesionless soil cover (till).

## 1.3 Investigative Procedures

### 1.3.1 General

Part 1 of this report describes the investigative procedures adopted for the geotechnical assessment of the south interchange (Boundary Road) at Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by *in situ* and laboratory testing and the procedures employed during the investigation are described below.

### 1.3.2 Field Investigation

The initial field work for the investigation related to the proposed bridge structure and highway embankments was carried out between May 28 and August 13, 1998. The locations of boreholes, cones and probes are shown on Figures A2a, A2b, A3 and A4, in Appendix A. These locations, as well as the surface elevations, were established by a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

Investigations in connection with the bridge foundations consisted of three boreholes (BH-1FF, 2FF, 3FF), three dynamic cone penetration tests (C-1FF, 2FF, 3FF) and three additional auger probes (AP-12FF, 13FF, 14FF). The dynamic cones and boreholes were advanced to refusal at depths ranging from 14.6 m to 22.1 m.

Investigation in connection with the embankments included 21 fully sampled boreholes (BH-1FP to BH-11FP, and BH-15FP to BH-24FP) and 5 dynamic cones (C-1FP to C-5FP). Following a September, 1998 progress meeting with the MTO and with their approval, additional boreholes were drilled and sampled to more fully outline the aerial and vertical extents of the soils in areas where the lower grade raises are proposed. These include the areas along the proposed Highway 11 south of the bridge structure, the south portion of the S-EW Ramp, and the north-northwest end of Boundary Road. Between September 17, 1998 and September 23, 1998, eight additional holes were

drilled (BH-25FP to BH-32FP) and on November 26, 1998, BH-33FP was completed. Thus, 30 boreholes were drilled and sampled in connection with the embankments.

The boreholes, cones and probes were advanced through the overburden soils using a Bombardier mounted CME-55 drill and a Dietric 50 drill, equipped with solid and hollow stem augers, and supplied by a soils drilling contractor, Master Soil Investigations Limited. Soil samples were obtained by using a 51 mm OD split-spoon sampler in conjunction with standard penetration tests at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness or consistency of the overburden soils. Sampling and testing procedures were in general accordance with ASTM D1586.

Selected, undisturbed, 50 mm diameter, "Shelby" tube samples (50.88 mm outside diameter) were also obtained in cohesive deposits. Field vane testing was also completed in the boreholes and the auger probes throughout the cohesive soils to measure the *in situ* undrained shear strength of the cohesive soils. The field vane used had dimensions of 152 mm long by 70 mm diameter, not including the pointed 45° point. Torque measurement was by using two calibrated scales on a calibrated lever arm threaded to the drill rods. The testing was in general accordance with ASTM D2573.

All of the recovered soil samples were taken to Trow's Sudbury laboratories for additional examination, identification and laboratory testing.

At the three borehole locations, at each of the three bridge foundation elements, conventional rock coring techniques were used to advance the boreholes approximately 3 m into the underlying bedrock. A BQ size core barrel and casing was used and core samples of the bedrock were retrieved for rock quality determination and classification.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix B.

### 1.3.3 Laboratory

The laboratory testing program for selected soil samples consisted of the following:

- Natural moisture content
- Grain size distribution

- Laboratory shear tests
- Uniaxial compression tests
- Atterberg limits
- 1-d consolidation tests

The laboratory test results are summarized on the attached borehole logs in Appendix B and are presented in Appendix C, also.

## 1.4 Subsurface Conditions

The borehole locations are shown on the site plans, Figures A2a, A2b, A3 and A4, in Appendix A. Included in Appendix B are the borehole, probe and dynamic cone penetration logs. Soil sections, longitudinal, as well as at each of the three foundation elements, are plotted on Figures A3 and A4. Stratigraphic sections along Highway 11, Boundary Road and the various ramps are presented as Figures A5 to A9, inclusive. In general, the following different soil layers were encountered, with increasing depth:

- organics
- silt to sandy silt
- silty clay
- silt
- sand/sand and gravel
- bedrock

A summary of the above soil strata encountered in the boreholes, and inferred from the probes and dynamic cone penetration tests, is presented below.

### 1.4.1 Organics

The majority of the site is overlain by a surficial layer of black to dark brown organics on the flat, poorly drained terrain. Based on the soil exploration data, it appears that the organics consist of very soft, fibrous peat and ranges in thickness to about 1.7 m.

Peat was not encountered in Boreholes BH-18FP to 21FP, inclusive. These holes are located in the area mapped as bedrock drift complex and a thin (up to about 600 mm) layer of sandy topsoil was encountered on the surface.



#### 1.4.2 Silt to Sandy Silt

A thin deposit of silt to sandy silt was encountered in all boreholes, except BH-18FP, 19FP and 20FP, immediately beneath the peat. These three holes encountered sand or sand and gravel, as described below. The silt contains some root fibres and is grey and wet, and locally contained very thin clay laminations. The standard penetration resistance "N" values ranged from 3 to 30 blows/300 mm, indicating a very loose to compact condition. The thickness ranged from about 1.0 m to 4.5 m, and the moisture content from about 15% to 25%.

#### 1.4.3 Silty Clay

Beneath the upper silt, a stratum of silty clay was encountered as the principal soil in all boreholes except BH-18FP, 19FP, 20FP and 21FP, at the western end of the site, where sand and gravel was encountered.

The silty clay persists to depths of up to about 18 m, with a maximum thickness of about 14 m. Generally, the silty clay is thinly laminated with silt and clayey silt (varved). The individual layers, or laminations, varied in thickness from a few millimetres to a few centimetres, but in general were less than about one centimetre. The proportions of clay to silt and clayey silt varied also, but in general the clay portion dominated.

*In situ* field vanes, laboratory unconfined and laboratory shear vane testing indicate that the silty clay has a relatively stiff crust with undrained shear strengths exceeding 100 kPa. The silty clay consistency, however, reduces with depth to soft to firm, with undrained shear strengths of 20 kPa to 30 kPa, at depths of about 5 m to 6 m, and gains strength thereafter to a maximum value of about 40 kPa at a depth of about 15 m. Sensitivity, the measure of peak shear strength to remoulded shear strength, ranged from 2 to 8, with an average of about 4, indicating the silty clay is moderately sensitive. The undrained shear strength profile which includes shear strength data from all boreholes is shown on Figure A10.

It is evident from the data and interpretation presented on Figure A10, that the silty clay is heavily to moderately overconsolidated in the upper 4 m to 5 m, becoming lightly overconsolidated with increasing depth. Preconsolidation pressures have been estimated to range as high as about 400 kPa

near the top of the silty clay. Overconsolidation ratios have been estimated to range from over 30 to less than 2.

The natural moisture content of the silty clay varies from about 30% to almost 60% (depending on the silt content). Atterberg limit determinations provided the following approximate ranges: Plastic Limit, 15 to 24; Liquid Limit, 25 to 60; Plasticity Index, 7 to 25. These data indicate that, in general, the clay can be described as a medium plasticity silty clay, CI (in accordance with the MTO Soil Classification System). The data are shown on the borehole logs, on Figure A10, and in Appendix C.

Four conventional one-dimensional consolidation tests were performed on samples of the silty clay extruded from thin walled "Shelby" tubes, obtained from four boreholes. In addition, horizontal specimens were subsampled from two of the "Shelby" tubes and similarly tested, in order to measure the horizontal coefficient of consolidation. The results are presented graphically on strain vs. pressure and coefficient of consolidation vs. pressure graphs on Figures C8 to C11, inclusive, in Appendix C. The data are also summarized below in Table 1-1.

<b>Table 1-1. Measured and Calculated Consolidation Test Parameters on Silty Clay</b>				
<b>Parameter</b>	<b>Borehole and Sample Depth</b>			
	<b>BH-7FP 6.3m</b>	<b>BH-8FP 5.0m</b>	<b>BH-26FP 9.4m</b>	<b>BH-30FP 7.9m</b>
Initial Void Ratio, $e_0$	0.99	1.31	1.07	1.31
Compression ratio, $C_c' (= C_c/(1+e_0))$	0.08	0.20	0.07	0.21
Recompression ratio, $C_r' (= C_r/(1+e_0))$	-	0.015	0.002	0.035
Coefficient of consolidation (recompression), $C_{vr}$	11	35	22-47	14-17
Coefficient of consolidation (virgin), $C_v$	12-15	7-14	12-15	2-6
Horizontal coefficient of consolidation, $C_h$	-	-	35-45	8-18
$C_h/C_v$	-	-	2.3 - 3.6	1.4 - 8.6
Coefficient of secondary compression, $C_{\alpha\epsilon}^*$	0.002-0.003	0.005-0.006	0.002-0.003	0.003-0.008
Notes: Coefficients of consolidation in units of $m^2/year$				
* $C_{\alpha\epsilon} = \Delta H/H_0$ (= secondary compression ratio, in some literature)				

#### 1.4.4 Silt

A second zone of essentially non-plastic silt was generally encountered beneath the silty clay, where the silty clay is present. Locally, very thin silty clay and/or sandy silt layers were encountered. The silt varies in thickness from approximately 1.5 m to 5.5 m thick. The standard penetration resistance "N" values ranged from about 2 to 14 blows/300 mm, indicating a very loose to compact condition. Moisture contents are generally in the range of 20% to 30%.

#### 1.4.5 Sand/Sand and Gravel

A basal deposit of sand and/or sand with gravel was encountered as the principal soil in BH-18FP, 19FP, 20FP and 21FP, to depths of auger refusal ranging from about 2.0 to 6.7 m. These holes are located on the western side of the project site. The basal sand and gravel was also encountered directly above the bedrock in the three cored holes at the bridge site (BH-1FF, 2FF, 3FF) and beneath the lower silt in the remaining boreholes, where the silt was fully penetrated.

The proven thickness of this stratum ranges from about 2 m to 9 m, where encountered. Standard penetration resistance "N" values ranged from 2 to over 50 blows/300 mm, indicating a very loose to very dense condition. The higher N values are likely due to a larger proportion of gravel and, perhaps, cobbles. Moisture contents range from about 8% to 20%.

#### 1.4.6 Bedrock

The presence of bedrock was established by retrieving "BQ" size cores in the sampled boreholes (BH-1FF, 2FF and 3FF), i.e. at one borehole beneath each of the three foundation elements. Based on the borehole, probe and dynamic cone penetration tests, the bedrock was established at the following depths:

- East Abutment (BH-3FF and C-3FF)  
18.5 m (~El. 294.6 m)
- Centre Pier (BH-2FF and C-2FF)  
19 m (~El. 294.4 m)
- West Abutment (BH-1FF and C-1FF)  
15 m (~El. 298.3 m)

Detailed descriptions of the rock are presented in Table 1-1 in Appendix B, following the logs. Generally, the bedrock can be described as a pinkish, light grey, biotite-hornblende gneiss. The rock is strong and unweathered for the most part.

Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values ranged from 69% to 96%. The bedrock quality, based on the RQDs, is described as fair to excellent.

## 1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The measured groundwater levels are shown on the borehole logs and the stratigraphic sections. In general, the groundwater table at the time of the field work was established close to the ground surface (within the upper metre). In several areas, however, ponding water, up to 400 mm deep, was evident above the ground surface in random, local depressions over the poorly drained, flat terrain.

## **Part 2     Engineering Discussion and Recommendations**

### **2.1     Introduction**

The following subsections address geotechnical design considerations pertaining to the proposed two-span bridge for the Boundary Road, Trout Creek By-Pass (King's Highway 11) interchange, as well as the approaches and embankment fills.

A two-span bridge is proposed to carry Boundary Road traffic over the four lanes of the new By-Pass. Each span will be about 43 m in length. The central pier will be located in the By-Pass median, with the abutments located on the west and east sides of the north and south bound lanes of Highway 11.

Fills of up to about 12 m height above existing grade will be required to achieve the design objectives for the realigned Highway 11, Boundary Road (new), and the various ramps. Over 1,600 lineal metres of Highway 11 and Boundary Road construction will require fill, while over 2,000 lineal metres of the various ramps will require fill construction.

It is understood that the project is scheduled for completion within a two year time frame. Accordingly, some of the discussions and design recommendations presented herein are based on this time frame.

### **2.2     Foundations**

In view of the presence of substantial thicknesses of weak and compressible clay at the locations of the three proposed foundation elements, it is not considered feasible to support the proposed bridge foundations on spread footings. Accordingly, it is recommended that the structure be supported on end-bearing steel H-piles driven to refusal on the underlying bedrock. Bedrock was encountered at depths of approximately 15 m (west abutment), 19 m (central pier) and 18.5 m (east abutment).

Current design practice requires that consideration be given to downdrag loads that may be generated as a result of soil consolidation due to fills, groundwater table fluctuations and the soil stresses induced by pile installation. We consider that, even after primary consolidation of the clayey soils due to the fill placement is complete, the potential for downdrag loads due to events such as significant groundwater lowering and the long term process of secondary compression exists.

Secondary compression of the clay foundation soils is discussed further in a subsequent section of this report. Accordingly, we have reduced the pile capacities given in the following subsection, where applicable.

## 2.2.1 Pile Capacity and Length

Piles driven to bedrock can be designed based on the following ultimate limit states (ULS) design values, and should not exceed the factored axial resistance values, as shown in Table 2-1, below.

<b>Table 2-1. Design Pile Capacities (kN)</b>									
	<b>HP 310x79</b>			<b>HP 310x110</b>			<b>HP 310x132</b>		
Factored Structural Capacity	2325			3285			3890		
Factored Axial Resistance (MTO*)	1430			2000			2300 (estimate)		
Pile Location ---->	W	P	E	W	P	E	W	P	E
Factored downdrag load	1450	350	1095	1490	355	1120	1505	360	1135
Factored Axial Capacity at ULS (OHBDC)	875	1975	1230	1795	2930	2165	2385	3530	2755
<b>Factored Axial Capacity at ULS (Design)**</b>	<b>875</b>	<b>1430</b>	<b>1230</b>	<b>1795</b>	<b>2000</b>	<b>2000</b>	<b>2300</b>	<b>2300</b>	<b>2300</b>
Notes: MTO* = Structural Office Policy Memo 98-01, April 15, 1998 W = west abutment, P = pier, E = east abutment ** Factored axial capacity at ULS (Design) is the lesser of, a) factored structural capacity minus factored downdrag load, or b) factored axial resistance. SLS capacity not applicable to piles driven to bedrock.									

The axial capacity at SLS is not applicable to steel piles driven to bedrock because very high loads, in excess of the ULS capacity, are required to produce unacceptable deformations. The pile structural capacity will govern.

The capacities given are axial capacities, for both vertical and inclined piles. No reduction is required for inclined piles. Notwithstanding the above, the horizontal and vertical loads acting on all piles must be resolved axially, such that the vector sum of these loads does not exceed the ULS capacity provided above.

For design purposes, the modulus of horizontal subgrade reaction for steel H-piles can be taken as 8,000 kN/m<sup>3</sup> for the cohesive soils (clays) and 40,000 kN/m<sup>3</sup> for the cohesionless soils.

Based on the attached borehole logs in Appendix B, the following Table 2-2 shows a summary of the approximate bedrock elevation at the test locations at which piles would be expected to be founded. Figures A3 and A4, in Appendix A, show interpreted soil and rock subsurface profiles at the two abutments and pier.

Table 2-2. Estimated Pile Tip Refusal Depths and Elevations			
Location	Boreholes & Probe Holes	Approximate Existing Overburden Thickness (m)	Approximate Bedrock Elevation (m)
West Abutment	Borehole 1FF Cone C-1FF	15.0	298.3
Centre Pier	Borehole 2FF Cone C-2FF	19.0	294.4
East Abutment	Borehole 3FF Cone C-3FF	18.5	294.6

It should be noted that the elevations given in Table 2-2 are based on the findings in the boreholes and dynamic cone holes drilled near the abutments and pier locations. Interpolation between boreholes and probe holes is approximate; accordingly, actual founding elevations will depend on the conditions encountered at the time of construction. Although not experienced in the borings advanced at this site, the bedrock elevation in northern Ontario can be variable and may change significantly over a short distance.

Pile caps should be provided with a minimum of 2.0 m of earth cover for frost protection.

### 2.2.2 Pile Installation

As discussed in following subsections of this report, substantial settlements of the approach fills will occur as will some associated lateral strains. Accordingly, piles should not be installed until after the majority of the fill settlement has occurred, based on monitoring during construction. This is particularly important for inclined piles, that would be subjected to bending stresses.

All piles should be driven to bedrock. Since the boreholes indicate that the bedrock elevations are relatively uniform, the potential for irregular steeply sloping bedrock at the foundation locations is

considered to be low to moderate. The bedrock surface in this part of Northern Ontario, however, is known to be variable. As such, some minor problems may arise during pile seating. At some locations, the piles may have a tendency to skip over the bedrock surface resulting in alignment problems and deeper penetration. In the event that this problem occurs, somewhat longer piles may be required and, in some cases, piles may have to be added or replaced.

To minimize seating difficulties, rock injector points should be used to facilitate proper seating. All piles must be fitted with reinforcing plates welded to the flanges as per OPSD 3301 to minimize pile damage. It is recommended that, during pile driving and upon initial contact with the bedrock, the pile driving energy should be reduced and subsequently increased incrementally until the piles have been sufficiently seated.

## 2.3 Backfill

Backfill for abutments or retaining walls should consist of free draining granular materials such as Granular A, Granular B, or rock fill. Computation of earth pressures shall be in accordance with Section 6.7.4 of the Ontario Highway Bridge Design Code. Unfactored properties for backfill materials are provided in the following Table 2-3.

<b>Table 2-3. Fill Types and Unfactored Geotechnical Properties</b>					
<b>Material</b>	<b>Friction Angle, <math>\phi'</math></b>	<b><math>\gamma</math> (kN/m<sup>3</sup>)</b>	<b><math>K_A</math></b>	<b><math>K_p</math></b>	<b><math>K_0</math></b>
Granular A	35 degrees	22.0	0.27	3.7	0.43
Granular B	30 degrees	21.0	0.33	3.0	0.50
Rock Fill	42 degrees	20.0	0.20	5.0	0.33
Note: Values given for $K_A$ and $K_p$ are for horizontal backfill, and will vary for other configurations. $K_A$ is the earth pressure coefficient corresponding to the active state. $K_p$ is the earth pressure coefficient corresponding to the passive state. $K_0$ is the earth pressure coefficient at rest.					

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation, in general accordance with that indicated in Figure C6-7.1 of the OHBDC. Therefore, unless the structural element can tolerate these deflections, the at rest earth



pressure should be used in design. Alternatively, partially mobilized active and passive earth pressure coefficients may be used, in accordance with the deflections given in the figure.

The effects of compaction surcharge should be taken into account in the calculation of active and at rest earth pressures. In accordance with Section 6-7.4.3 of the OHBDC, the lateral pressure due to compaction should be taken as at least 16 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the depth where the active (or at rest) pressure is equal to 16 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to walls to prevent overstressing.

If rock fill is used as backfill behind abutments, the particle size should be limited to no greater than 300 mm and the backfill must be placed carefully in a manner that does not cause damage to the abutments or other structural components of the bridge.

Weep holes should be provided in the abutments and a filter wrapped, 150 mm diameter perforated PVC drainage pipe should be installed behind the abutments, at or slightly above the base.

## 2.4 Excavations

Minimal excavations for the pile caps will be required, since the grades will be raised. The existing organic zone (~600 mm to 1500 mm thick) will have to be removed from the entire construction area. In accordance with the Occupational Health and Safety Regulations for Construction Projects, excavation procedures for Type 3 soils will be adequate, provided the groundwater in the overburden soil is removed. If appropriate dewatering is not done, the soil would have to be classified as a Type 4 soil and any excavation greater than 1.2 m should then be sloped to 3 horizontal to 1 vertical, starting from the base of the excavation or appropriate shoring provided.

Dewatering of the excavations, to remove surface and groundwater infiltration, can likely be accomplished by pumping from sumps located within the excavations. The collected water should be discharged to suitable locations with appropriate sediment control measures.

## 2.5 Bridge Approach Fills and Embankments

The construction of the south interchange, including the bridge, will require embankment fills of up to about 12 m height, over areas with varying thicknesses of soft to firm, compressible clay soils. This creates two principal design and construction considerations: embankment stability and consolidation settlement. These two issues are discussed in the following; however, it is noted that the implications of the two issues are interrelated.

In all of the following discussions, it is assumed that all organic material is removed beneath the embankments and they are constructed on the native mineral soils, and fill heights should be measured from the top of the native mineral soil.

### 2.5.1 Embankment Stability

Highway embankments can be constructed with rock or earth fill. However, it is understood that in this area they are typically constructed using rockfill as the principal component. A typical MTO section will consist of a minimum (steepest) slope of 1.25H to 1V to a maximum height of 6 m. For embankment sections greater than 6 m height, a 2 m wide horizontal bench is required before the next 6 m, 1.25H to 1V lift is constructed. This geometry as well as a 16 m crest width has been assumed for the analyses.

Slope stability analyses have been performed using SLOPE/W (ver. 3.x), based on Bishop's Method using both total stress and effective stress parameters. The undrained shear strength profile shown on Figure A10 was used to provide the shear strength parameters for the clay soils. Table 2-4 lists the parameters used. Effective stress parameters were established from multistage consolidated undrained triaxial strength tests performed on representative samples from the project<sup>[1]</sup> as well as from various geotechnical literature and our experience.

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<sup>[1]</sup>Sample from Trout Creek Bridge Site, see Figure C12.

**Table 2-4. Layers and Geotechnical Parameters for Slope Stability Analyses**

Material (thickness - m)	$\gamma_{\text{total}}$ (kN/m <sup>3</sup> )	$c_u$ (kPa)*	$\phi'$	$c'$ (kPa)
Rockfill	20.0	0	42°	0
Silty Clay 1 (2 m)	20.5	120 - 50	28°	8
Silty Clay 2 (1 m)	18.3	50 - 30	27°	7
Silty Clay 3 (1 m)	18.0	30 - 25	26°	5
Silty Clay 4 (2 m)	17.3	25	26°	4
Silty Clay 5 (2 m)	17.8	25 - 27.5	26°	4
Silty Clay 6 (2 m)	17.8	27.5 - 32.5	26°	4
Silty Clay 7 (2 m)	18.0	32.5 - 37.5	26°	4
Lower Silt (2 m)	19.5	0	31°	0
Sand and Gravel	21.5	0	35°	0
Notes: * See Figure A10 for the undrained shear strength profile Embankment crest width 16 m, side slopes = 1.25H:1V				

Many of the SLOPE/W graphical printouts, for the various analyses performed and discussed below, are included in Appendix D. Note that for the total stress analyses,  $C_u$  is shown as  $C_v$  on the printouts.

### 2.5.1.1 Total Stress Analyses

The results of the slope stability analyses, in terms of total stresses using undrained shear strengths for the clay, as would apply to rapid construction (short term stability), are shown graphically in the top panel of Figure A11 (Figure A11-A), and in Table 2-5, below. Interpolation of the curves is possible. All embankments up to about 7.5 m height can be constructed based on this analysis, with a resulting factor of safety against foundation failure greater than the recommended value of 1.3. Depending on the clay thickness underlying the embankments, however, some of the higher embankments can not be built rapidly, based on this analysis.

In general, the factor of safety decreases not only with increased embankment height, but with increased clay thickness as well. These require special consideration for design and construction,

as discussed in the following subsections. The embankments with height/clay thickness combinations resulting in factors of safety greater than 1.3 should be safe, based on the total stress analyses conducted.

<b>Table 2-5. Factors of Safety for Total Stress (Short Term) Stability Analyses</b>					
<b>Embankment Height</b>	<b>Silty Clay Thickness</b>				
	<b>4 m</b>	<b>5 m</b>	<b>6 m</b>	<b>8 m</b>	<b>&gt;10 m</b>
6 m	2.15	1.89	1.74	1.64	1.59
8 m	1.80	1.56	1.41	1.31	1.24
10 m	1.54	1.31	1.19	1.09	1.02
12 m	1.40	1.15	1.03	< 1	< 1
Notes: Embankment crest width 16 m, side slopes = 1.25H:1V, with mid height bench above 6 m Shaded data indicates factor of safety < 1.3					

### 2.5.1.2 Total Stress Analyses with Stabilizing Berms

We have considered the use of stabilizing berms to allow the safe, rapid construction of the embankments, while maintaining a calculated factor of safety 1.3 against foundation failure. Typical berm heights would be in the order of one-third to one-half the embankment height. The various calculated configurations are shown in Table 2-6, below, and graphically on Figure A11-B, in Appendix A.

While the use of properly designed berms would allow for rapid construction while maintaining adequate factors of safety against foundation failure, the settlement issues, discussed in Section 2.5.2, below, would persist.

Table 2-6. Required Berm Configurations for Short Term FS = 1.3			
Embankment Height	Clay Thickness	Berm Height	Berm Length
8 m	8 m	2.5 m	1.0 m
	10 m	2.5 m	4.5 m
	12 m	2.5 m	5.5 m
10 m	6 m	3.5 m	5.0 m
	8 m	3.5 m	9.5 m
	10 m	3.5 m	14.0 m
	12 m	3.5 m	17.0 m
12 m	5 m	4.0 m	5.0
	6 m	4.0 m	8.5
	8 m	4.0 m	15.0
	10 m	5.0 m	19.5
	12 m	6.0 m	23.0
Notes: Embankment crest width 16 m, side slopes = 1.25H:1V			

### 2.5.1.3 Effective Stress Analyses

The results of our effective stress stability analyses are presented in Table 2-7, below and are shown graphically on Figure A12-A. The analyses are based on the assumption that the embankments will be constructed to full height over a period of 3 months (steady ramp rate), thereby allowing for some dissipation of excess porewater pressures that will develop in the clay. The pore pressure parameter,  $A$ , that measures the pore pressure response to increases in total stress was assumed to be equal to 0.7, based on the results of our triaxial tests and geotechnical literature. Based on this analysis, and considering only vertical consolidation drainage (no sand drains or wicks), as governed by the  $C_v$  values discussed in Section 2.5.2, the figure shows that steady slow (3 month loading) should result in higher factors of safety at the end of construction. Most embankments higher than about 8 m will require special consideration, as discussed in the following.

A longer, steady ramping of the embankment loads, say 6 months, would increase all factors of safety significantly.

**Table 2-7. Factors of Safety for Effective Stress Stability Analyses at End of Construction (3 months)**

Embankment Height	Clay Thickness			
	6 m	8 m	10 m	12 m
6 m	1.43	1.40	1.39	1.38
8 m	1.35	1.28	1.27	1.26
10 m	1.28	1.18	1.16	1.14
12 m	1.21	1.10	1.07	1.0

Notes: Embankment crest width 16 m, side slopes = 1.25H:1V, with mid height bench above 6 m  
Shaded data indicates factor of safety < 1.3

#### 2.5.1.4 Effective Stress Analyses using Wick Drains

Table 2-8, below, and Figure A12-B (in Appendix A) shows the factors of safety, again based on effective stresses, with a 3 month construction period and the use of vertical sand or wick drains. The calculations are based on drain spacings of 3 m, 4 m, and 5 m, installed in a triangular pattern, as discussed in Section 2.5.2. The use of such vertical drainage will allow the construction of all of the proposed embankments while maintaining an adequate factor of safety against foundation failure.

**Table 2-8. Factors of Safety for Effective Stress Stability Analyses at End of Construction Using Wick Drains (3 months)**

Embankment Height	Wick Drain Spacing		
	3 m	4 m	5 m
8 m	1.64	1.53	1.43
10 m	1.51	1.41	1.31
12 m	1.44	1.35	1.24

Notes: Embankment crest width 16 m, side slopes = 1.25H:1V, with mid height bench above 6 m  
Shaded data indicates factor of safety < 1.3

## 2.5.2 Consolidation Settlement of Embankments

### 2.5.2.1 Magnitudes of Consolidation Settlement

Consolidation calculations have been performed using the effective stress profiles shown on Figure A10 and an average compression ratio ( $C_c' = C_c / [1 + e_0]$ ) equal to 0.18. This average value was established from the consolidation test data as well as from geotechnical literature. A recompression index ( $C_r' = C_r / [1 + e_0]$ ) equal to 0.015 was used. The stress increases in the foundation soils due to the embankment loadings have been calculated based on the Boussinesq elastic solutions. Recompression and virgin consolidation has been calculated based on the assumed existing overburden pressure and preconsolidation stress profile shown on Figure A10.

The results of the calculations for embankment centerline settlement using rockfill to construct the embankments are provided in Table 2-9, below and are shown graphically on Figure A13.

<b>Table 2-9. Estimated Embankment Centerline Consolidation Settlement (mm)</b>						
<b>Embankment Height</b>	<b>Clay Thickness</b>					
	<b>2 m</b>	<b>4 m</b>	<b>6 m</b>	<b>8 m</b>	<b>10 m</b>	<b>12 m</b>
2 m	15	25	30	40	45	50
4 m	20	55	115	170	210	240
6 m	25	105	205	295	370	430
8 m	35	155	285	405	505	590
10 m	55	200	360	505	630	735
12 m	70	240	420	585	730	860
Notes: Embankment crest width 16 m, average side slopes = 1.5H:1V Values rounded to nearest 5 mm						

As an example, the western approach for the proposed bridge requires a grade raise of about 12 m and the clay thickness at this location is about 8 m. Accordingly, about 585 mm of consolidation settlement of the clay (and overlying soil and fill) can be expected.

Figures A14, A15 and A16 show the calculated settlements (for embankment heights ranging from 2 m up to 12 m) that may be expected under the various portions of the embankments, measured out from the centerline to the toe. It is apparent that in addition to total consolidation settlements, differential settlement between the embankment centerline and crest will occur, and the design should take these into account by specifying overbuilding of the embankments.

All of these charts will allow superposition of overlapping embankments and the total consolidation settlement can be taken as the sum of the individual cases.

If consideration is to be given to the use of light weight fill, for preliminary design purposes, the total consolidation settlements can be reduced **approximately** by proportion of rockfill replaced by lightweight polystyrene (eg. 30% replacement of fill height with polystyrene will result in about 70% of the indicated settlement).

#### 2.5.2.2 Time Rate of Consolidation Settlement

The time rate of consolidation settlement has been calculated for the various cases of embankment height and clay thickness for vertical drainage only, and for sand (or wick) drains spaced in a triangular pattern at distances of 3 m, 4 m and 5 m. It is also assumed for the purposes of calculation, all embankments are raised steadily over a 3 month construction period. A coefficient of consolidation,  $C_v$ , of 10 m<sup>2</sup>/year has been used in the analyses, based on the results of the consolidation tests and the geotechnical literature. For radial (horizontal) drainage, a conservative ratio of horizontal to vertical coefficient of consolidation of 3 has been assumed, based on the consolidation test data and the geotechnical literature. It is noted that the thinly laminated nature of the predominantly clay foundation soils make consideration of the use of vertical drains attractive.

Figure A17 shows the fraction of excess porewater pressure remaining (ie. the fraction of settlement remaining) for the various cases considered for vertical and for radial drainage as a function of time following start of construction. These curves are based on a three month, steady loading construction period and can be applied to the settlement magnitudes given in the previous figures. It can be seen that the use of vertical drains greatly accelerates the rate of settlement, compared to drainage without vertical drains.

Figures A18 to A23, inclusive, show the calculated magnitudes of embankment centerline consolidation settlement remaining for the various heights of rockfill embankments.



### **2.5.3 Wick Drain Design and Construction Considerations**

Detailed vertical drain design is beyond the scope of this phase of the project. The charts and tables provided herein and discussed above (embankment stability, settlement magnitude, time rate of settlement) will allow the detailed design of vertical drain installation patterns, depending on project scheduling constraints and tolerable post construction settlements. Relative to time rate, three vertical drain spacings have been presented in addition to time rates for no drains. It is expected that larger spacings (and perhaps no drains) can be used in some of the non-critical areas, such as near to the toes of the embankments, as well as where total settlements can confidently be completed in a relatively short period of time. We expect that by optimizing the drain installation pattern once the final embankment configuration for the project is established, along with scheduling constraints, a significant savings in the drain installation costs will result, compared to specifying a single spacing for the entire project.

It is expected that if vertical drainage is to be implemented on this project, drainage wicks will be selected over sand drains, primarily due to cost. It is noted that either should perform similarly, provided that in the case of drainage wicks (or prefabricated vertical drains), their discharge capacity is not impaired by kinking that will reduce their efficiency. Vertical strains of up to about 8% have been calculated due to consolidation settlement. Systems such as those with a filter fabric covered ribbed core construction should be used, since these appear to better maintain their hydraulic properties than the corrugated or grooved types, for example, when kinking or folding occurs, or due to the high lateral pressures at depth within the consolidating soil.

Additionally, these drains should fully penetrate the clay and underlying silt, and be terminated a minimum of 1 m into the underlying sand, to ensure adequate drainage.

### **2.5.4 Secondary Compression of Clays**

Calculations have been performed to estimate the magnitudes of secondary compression of the foundation clays, following the completion of primary consolidation. For purposes of analysis and discussion, the primary consolidation is assumed to be essentially complete within 1.5 years from the start of construction of the embankments. For this assumption to be valid, vertical sand drains or drainage wicks will be required for much of the project. The spacings required to achieve this can be determined from the previously described charts and figures, using the appropriate embankment height and clay thickness.

The stress increases in the clay foundation soils due to embankment loading will, in most cases, exceed the preconsolidation pressures when the embankment height exceeds about 2 m. The graphs in Figure A24 show the calculated embankment centerline settlement due to secondary compression. Table 2-10, below, summarizes the calculated secondary compression at 15 years. The calculations are based on use of a coefficient of secondary compression,  $C_{\alpha\epsilon}$ , of 0.004, based on the results of the consolidation tests and the geotechnical literature.

Table 2-10. Calculated Secondary Compression at 15 Years						
Embankment Height	Clay Thickness					
	2 m	4 m	6 m	8 m	10 m	12 m
2 m	< 5 mm	< 5 mm	< 5 mm	10 mm	10 mm	10 mm
3 m	< 5 mm	< 5 mm	10 mm	20 mm	30 mm	35 mm
4 m	< 5 mm	10 mm	15 mm	25 mm	30 mm	40 mm
6 m	< 5 mm	10mm	15 mm	25 mm	30 mm	40 mm
8 m	< 5 mm	10mm	15 mm	25 mm	30 mm	40 mm
10 m	< 5 mm	10 mm	15 mm	25 mm	30 mm	40 mm
12 m	< 5 mm	10 mm	15 mm	25 mm	30 mm	40 mm
Notes: Values are rounded to nearest 5 mm. Refer to graphs, Figure A24.						

While the magnitudes are essentially independent of the stress levels (as long as the preconsolidation pressure is exceeded), the graphs have been produced using the effective stress profiles shown in Figure A10, which takes into account the previously calculated loading and clay thickness cases where the preconsolidation pressure is exceeded.

As an example, at the western abutment where the fill height is about 12 m and the clay thickness is about 8 m, the lower panel of Figure A24 shows that the secondary clay compression after 5, 10 and 20 years may be about 15 mm, 20 mm and 30 mm, respectively.

It is noted that while the magnitude of the secondary compression can be controlled by limiting final stresses to less than the preconsolidation pressures, its rate cannot be accelerated.

### 2.5.5 Rockfill and Rockfill Settlement

Rockfill used in the embankments and approaches should consist of hard, durable, angular quarried rock. Rockfill should be tested for acid drainage potential and checked against the appropriate regulatory requirements for acceptability.

For the bridge abutments that are to be supported by driven steel H-piles, as discussed in a previous section, these will have to be installed after all the embankment fill has been placed. The driving of steel piles through rockfill will be difficult, if not impossible, unless care is taken to ensure that the rockfill meets a tight size range, generally between 50 mm and 150 mm. Larger rockfill sizes may require predrilling for pile installation. Consideration should be given to a 75 mm maximum size. For the majority of the embankments and approach fills, however, larger rockfill can be used.

The use of large rockfill, loosely placed or end dumped and compacted by conventional construction traffic only may result in long term settlements of up to about 2% of the fill height. Accordingly, a 10 m high rockfill may settle up to 200 mm following completion of construction. This is primarily due to the rockfill "adjusting" under highway service conditions.

In order to minimize the long term settlements associated with the rockfill itself, consideration can be given to specifying the use of a finer graded rockfill, with a maximum size of 400 mm. This finer graded rockfill should be placed in lifts limited to about 800 mm and compacted with heavy vibratory rollers. While the production of the finer graded rockfill and its placement, as described above, carries with it a cost premium, the long term performance of the finished highway pavement will be improved.

### 2.5.6 Surcharging of Embankment Fill

In most cases where the embankment fill height will exceed about 2 m, the final stresses in the silty clay foundation soils will exceed the preconsolidation pressure. This will result in a new "normally consolidated" condition. Accordingly, additional loadings will result in potentially large settlements, as shown on Figure A13 and in Table 2-9. It is therefore recommended that surcharging be implemented on these embankments. This should consist of a minimum 1 m additional fill (20 kPa), to be removed on completion of the required consolidation settlement, prior to final grading.

## 2.6 Culverts

While we have not specifically been requested to address culverts, it is expected that these will be required as part of the site drainage plan. The number of culverts and their locations are not presently known. Because of the settlement issues discussed previously, any centerline culverts installed prior to the embankment construction will settle with the embankment. Differential settlements between the embankment centerline and the toe may be as high as several hundred millimetres, as shown on the figures discussed previously. This must be considered in the design and several options are presented for your consideration.

Preferably, culverts should be located in areas where smaller settlements are expected, such as under the lower height embankments and thinner clay areas.

If culverts must be located in areas of greater potential settlement, they can be designed with a reverse camber to accommodate some of the differential settlement. In this case, they should be oversized and standing water at the inlets and/or outlets should be tolerable, since it will be impossible to predict (ensure) a positive final grade along the length of the culvert.

Alternatively, culverts can be supported on piled foundations. It is expected, however, that this technique will result in differential settlements between the pile supported culvert (essentially zero settlement) and the highway on either side, resulting in a pronounced "bump".

Finally, culverts in higher settlement areas may be installed following completion of the majority of the associated embankment settlement. In some cases, this may require deep excavations into the embankment fills.

## 2.7 Instrumentation and Construction Monitoring

Construction of embankments, based on effective stress analyses and design, are recommended to be monitored during construction. The effective stress analyses on which the design recommendations summarized herein are based, rely on excess pore water pressure dissipation (and resulting settlement). This should be monitored during construction using a properly designed and effective system of instrumentation, consisting primarily of piezometers installed in the clay, as well as settlement points. Lateral slope movements should also be monitored both during and following construction of the embankments.

Monitoring and continual interpretation of the data is essential in order to control the rate of excess porewater pressure generation and dissipation by controlling the rate of embankment fill placement. Excess porewater pressures must be kept below calculated threshold values that may indicate impending failure, that may require a slowing or stoppage of construction until pore pressures further dissipate sufficiently to maintain stability and allow construction to resume. The monitoring may, on the other hand, indicate that construction can proceed faster than originally planned, resulting in potential cost savings.

Notwithstanding the above, if stabilizing berms are designed for use to allow rapid construction of portions of the embankments, a monitoring program is still recommended. The use of berms is based on total stress analyses and design and does not require the construction monitoring of excess porewater pressures. However, some porewater pressure monitoring as well as settlement monitoring is recommended to allow for modifications to the final grading design, if necessary. This is primarily related to the amount of overbuilding of the final grades, in anticipation of the calculated settlements.

Detailed design of a construction monitoring program is beyond the scope of this phase of the project, but can be provided when the final design is nearing completion.

## 2.8 Closing Comments

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the use of Marshall Macklin Monaghan and its design team for the design of the bridge foundations, approach fills and embankments at the South Interchange of the Highway 11 Trout Creek By-Pass Project. We request that we be retained to review the design and our recommendations as the design proceeds, to ensure that the final design is in general agreement with our recommendations and that our recommendations have been interpreted as intended.

A subsurface investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional field work and analyses.

Contractors bidding on or undertaking the works should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as the their own interpretations of the

factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions at the site of the proposed Boundary Road and King's Highway 11 (Trout Creek By-Pass South Interchange). The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

This report has been prepared by Mr. D.N. Georgiou, P.Eng. and was reviewed by Messrs. S.E. Gonsalves, P.Eng., and E. Gonneau, P.Eng. The field investigation was performed by Messrs. I. Dumpis, C.E.T., R. Moore, C.E.T., and S. McAuliffe, and was supervised by Mr. E.A. Gonneau, P.Eng.

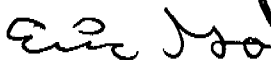
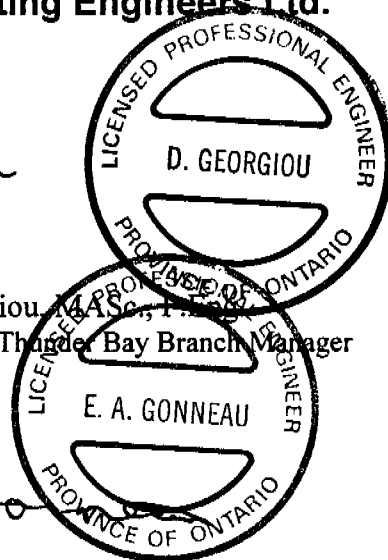
We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact us.

All the foregoing and attachments respectfully submitted,


**Trow Consulting Engineers Ltd.**



Demetri N. Georgiou, M.A.Sc., P.Eng.  
Principal Engineer/Thunder Bay Branch Manager



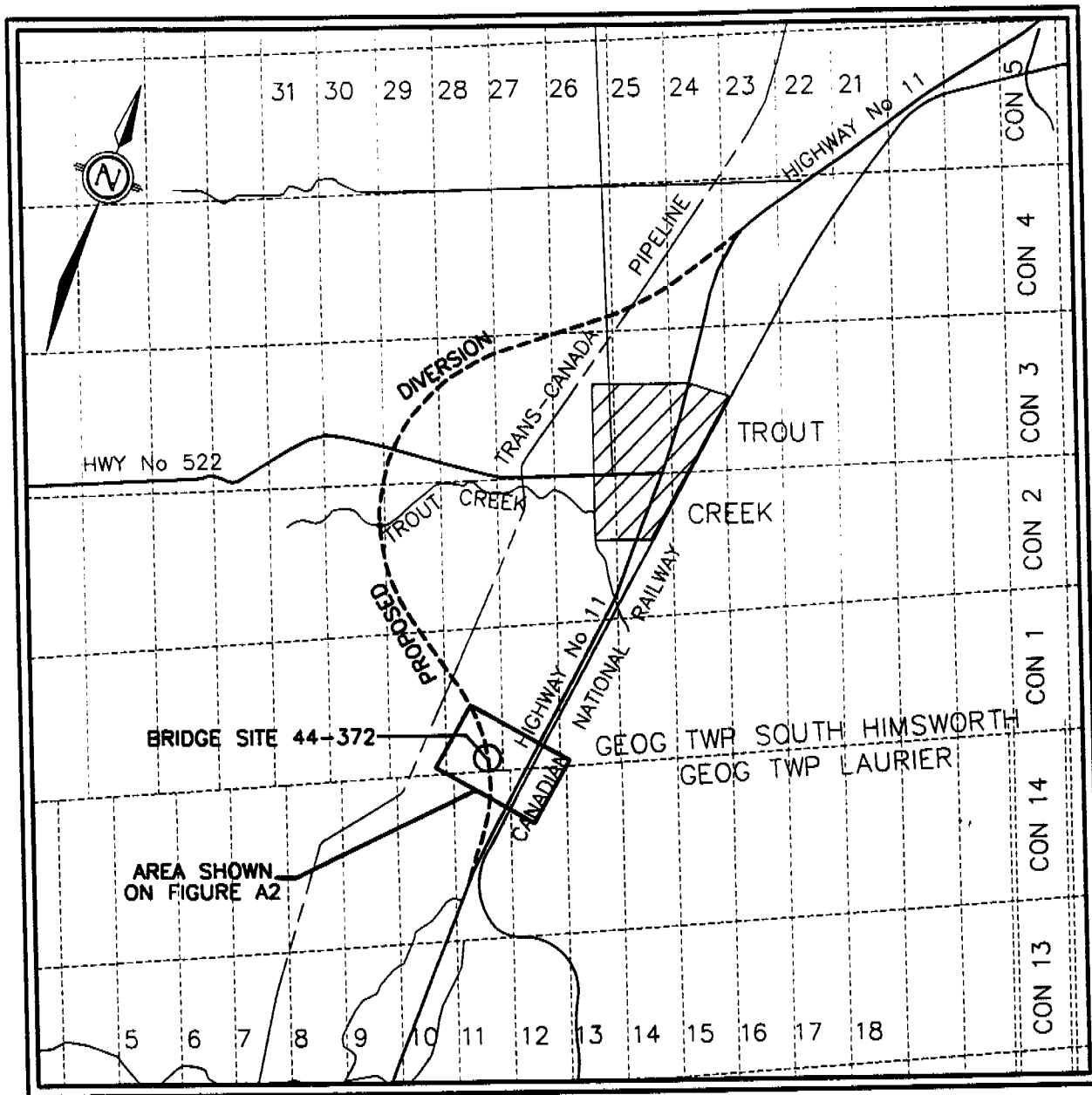
Eric A. Gonneau, P.Eng.  
Project Manager



S.E. Gonsalves, M.Eng., P.Eng.  
Principal Engineer/Vice President  
Designated MTO Representative



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Thunder Bay, Ontario

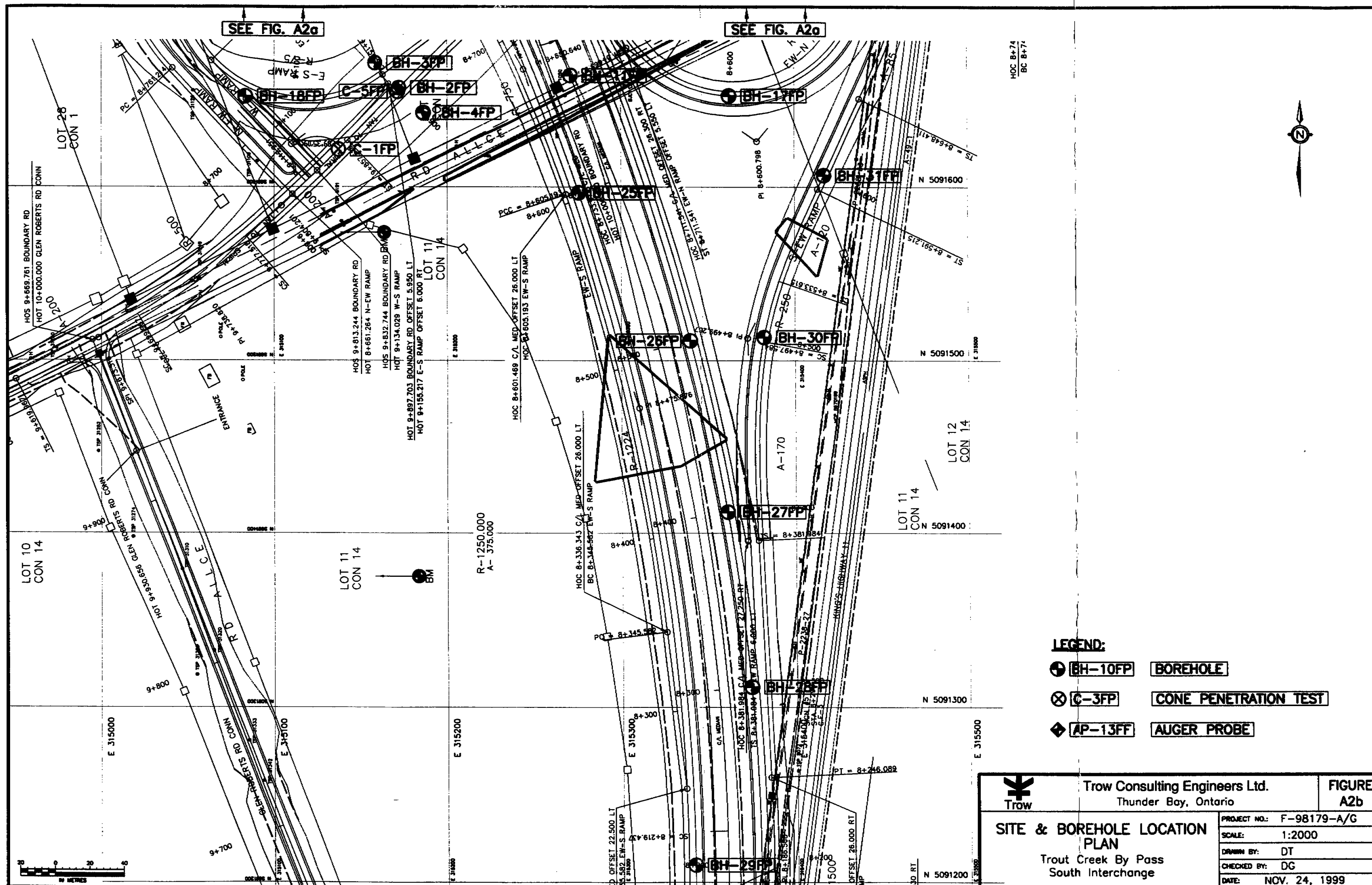
FIGURE  
A1

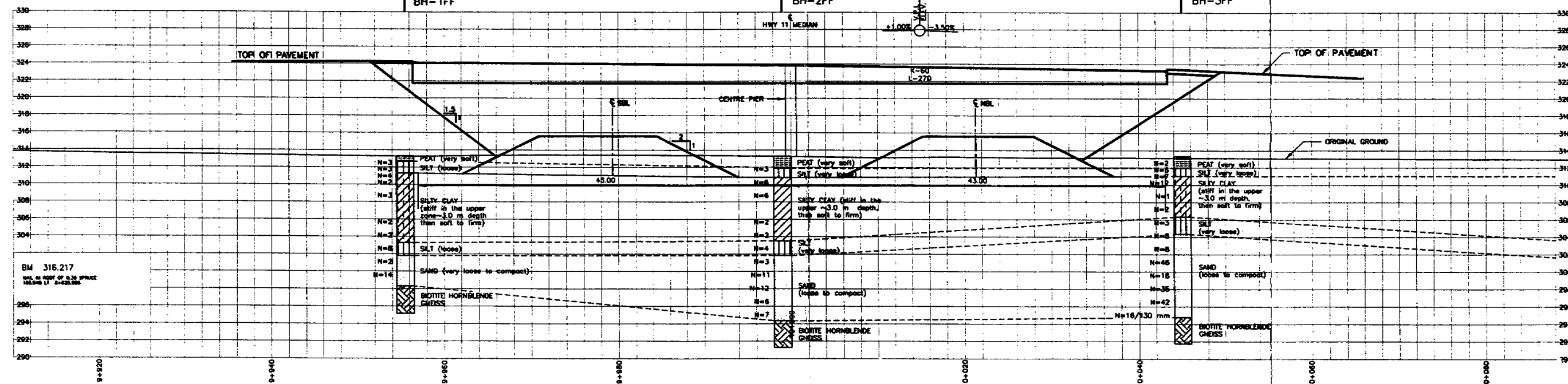
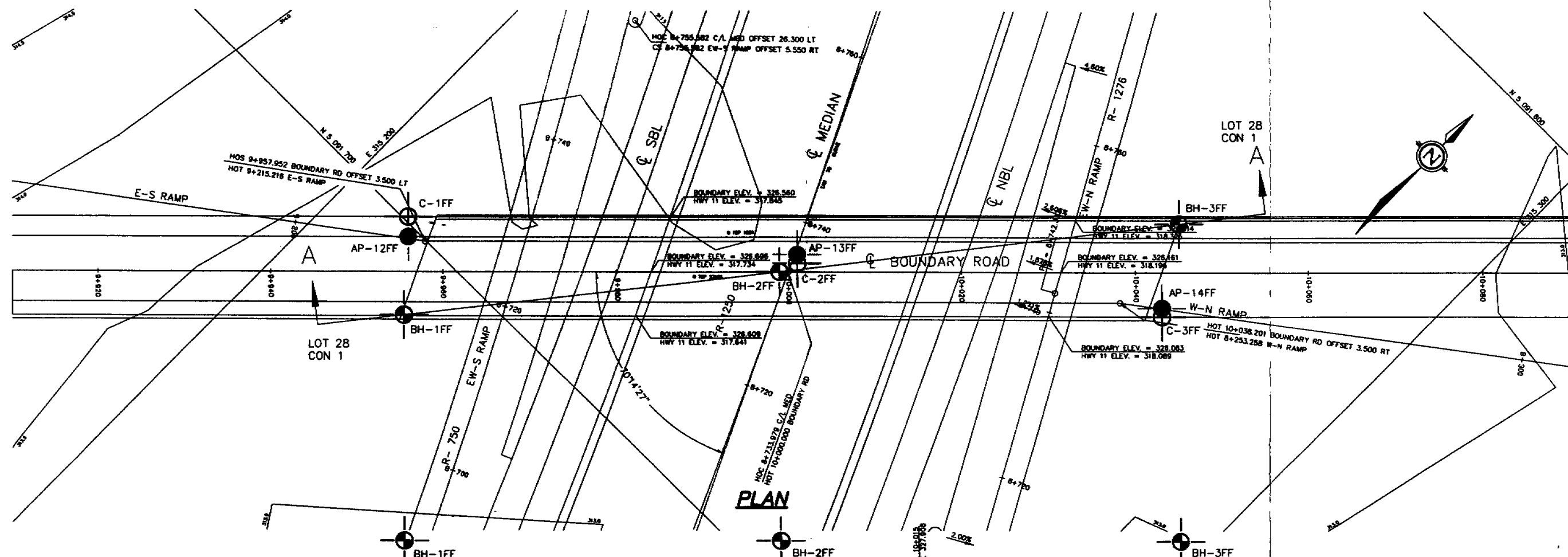
KEY PLAN  
Trout Creek By Pass  
South Interchange

PROJECT NO.: F-98179-A/G  
SCALE: AS SHOWN  
DRAWN BY: DT  
CHECKED BY: DG  
DATE: NOV. 24, 1999









SECTION A-A  
PROFILE OF BOUNDARY RD

**NOTE:**

The stratigraphic boundaries and soil types have been established at Test Hole locations. Between Test Holes they are assumed and may be subject to error.

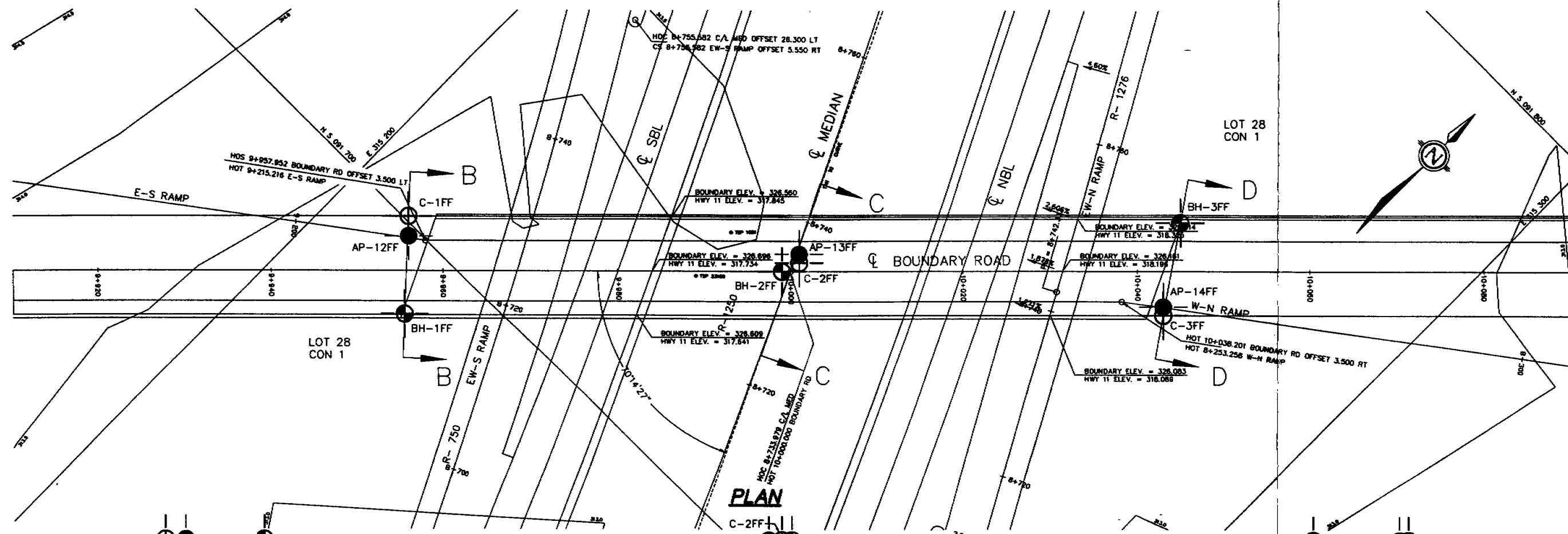


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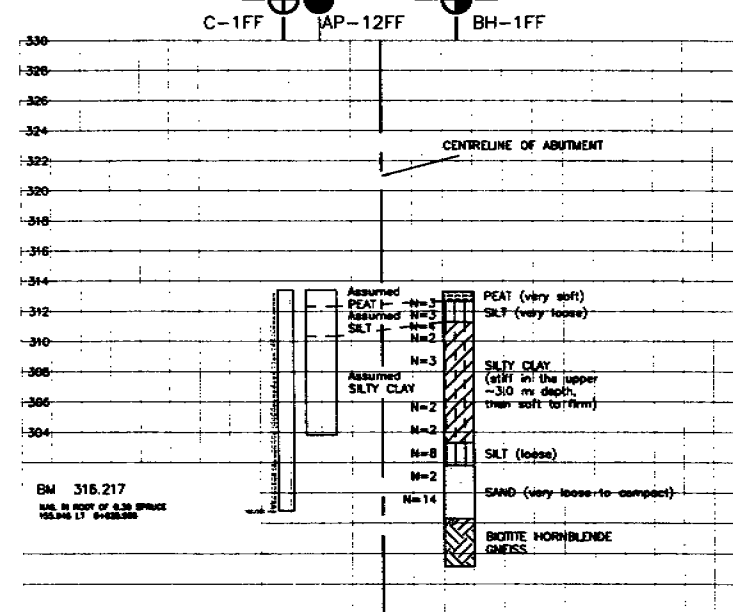
FIGURE  
A3

PLAN & LONGITUDINAL SECTION  
AT PROPOSED BRIDGE  
Trout Creek By Pass  
South Interchange

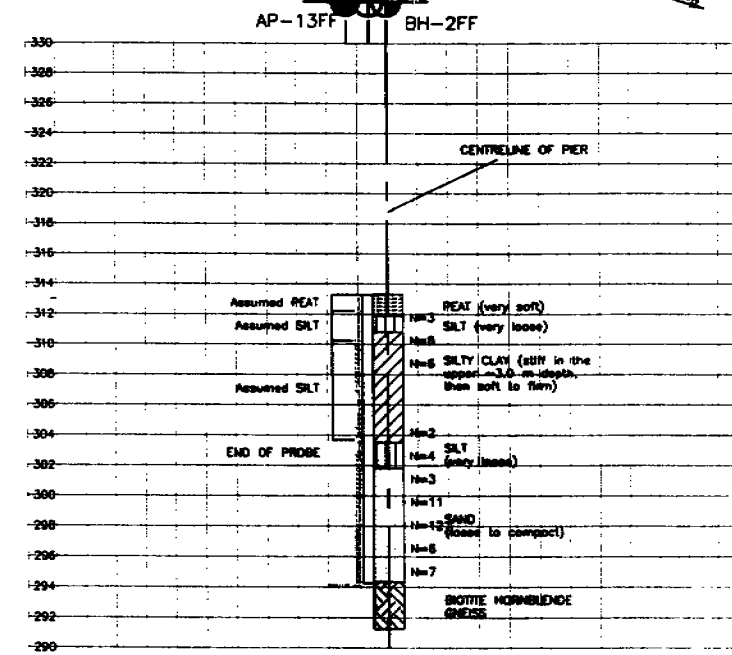
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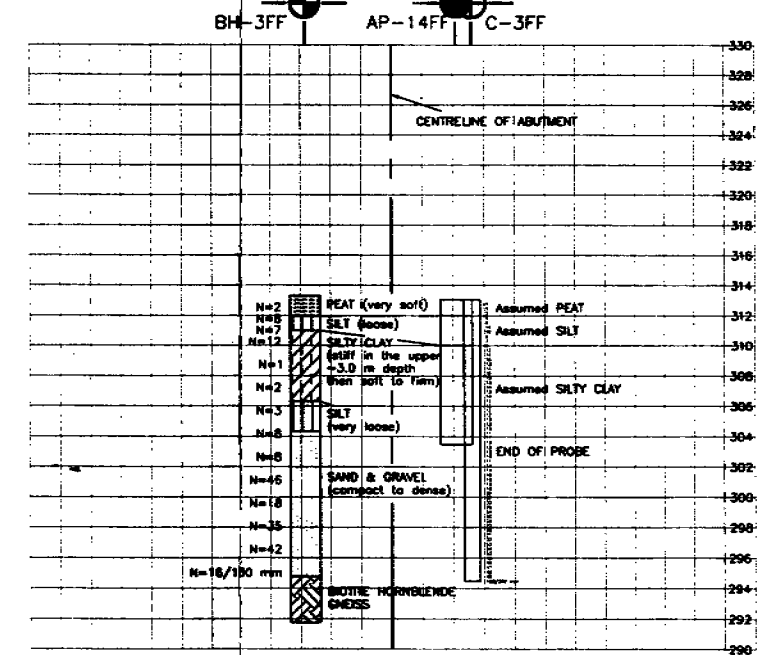
**PLAN**



**SECTION B-B  
PROFILE OF BOUNDARY RD**




**SECTION C-C  
PROFILE OF BOUNDARY RD**

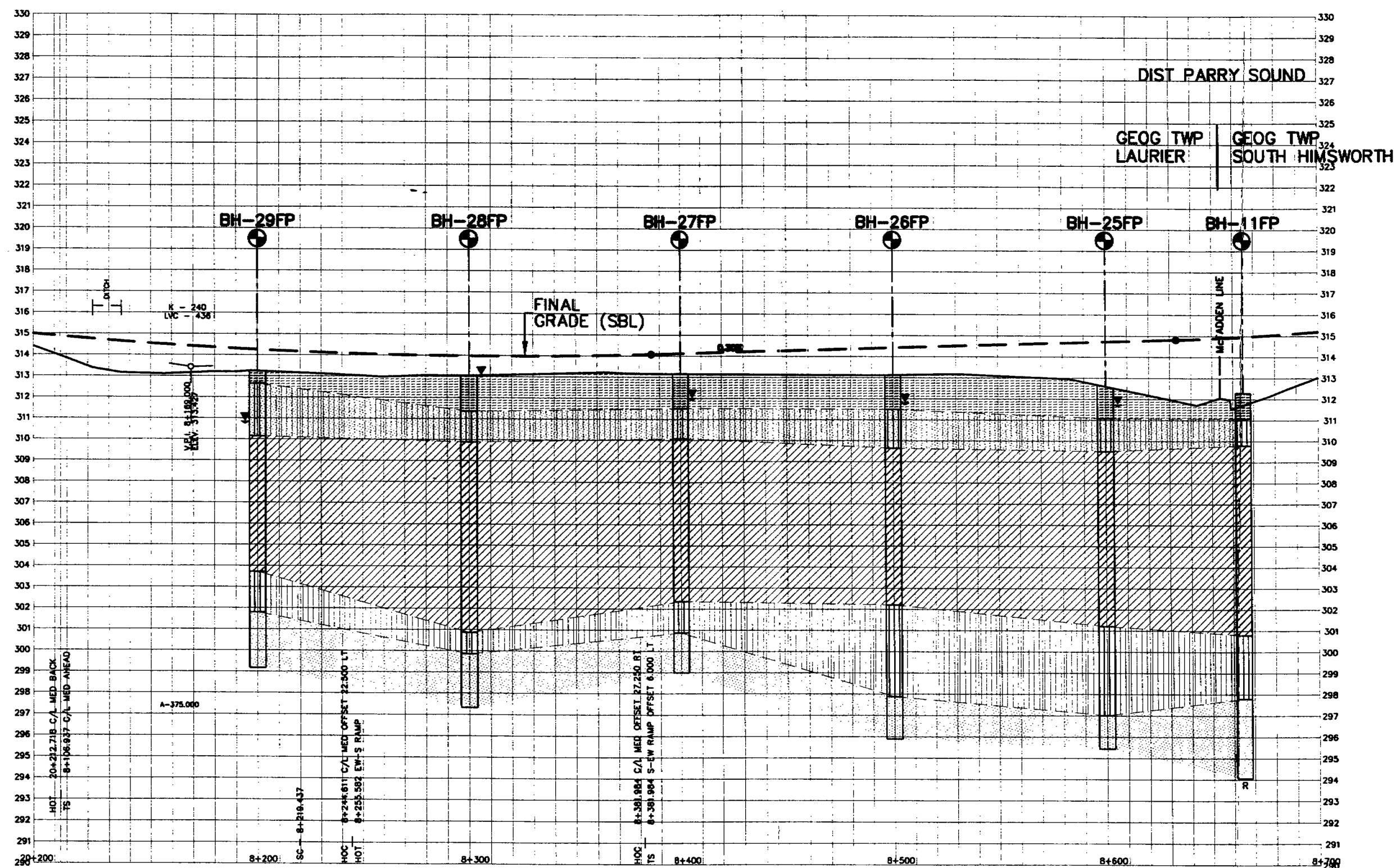


**SECTION C-C / PROFILE OF BOUNDARY RD**



**NOTE:**  
The stratigraphic boundaries and soil types have been established at Test Hole locations. Between Test Holes they are assumed and may be subject to error.

 Trow	Trow Consulting Engineers Ltd. Thunder Bay, Ontario	FIGURE A4
PLAN & CROSS SECTIONS AT PROPOSED BRIDGE FOUNDATION ELEMENTS Trout Creek By Pass South Interchange		PROJECT NO.: F-98179-A/G SCALE: 1:500 DRAWN BY: DT CHECKED BY: DG DATE: NOV. 24, 1999



**LEGEND:**

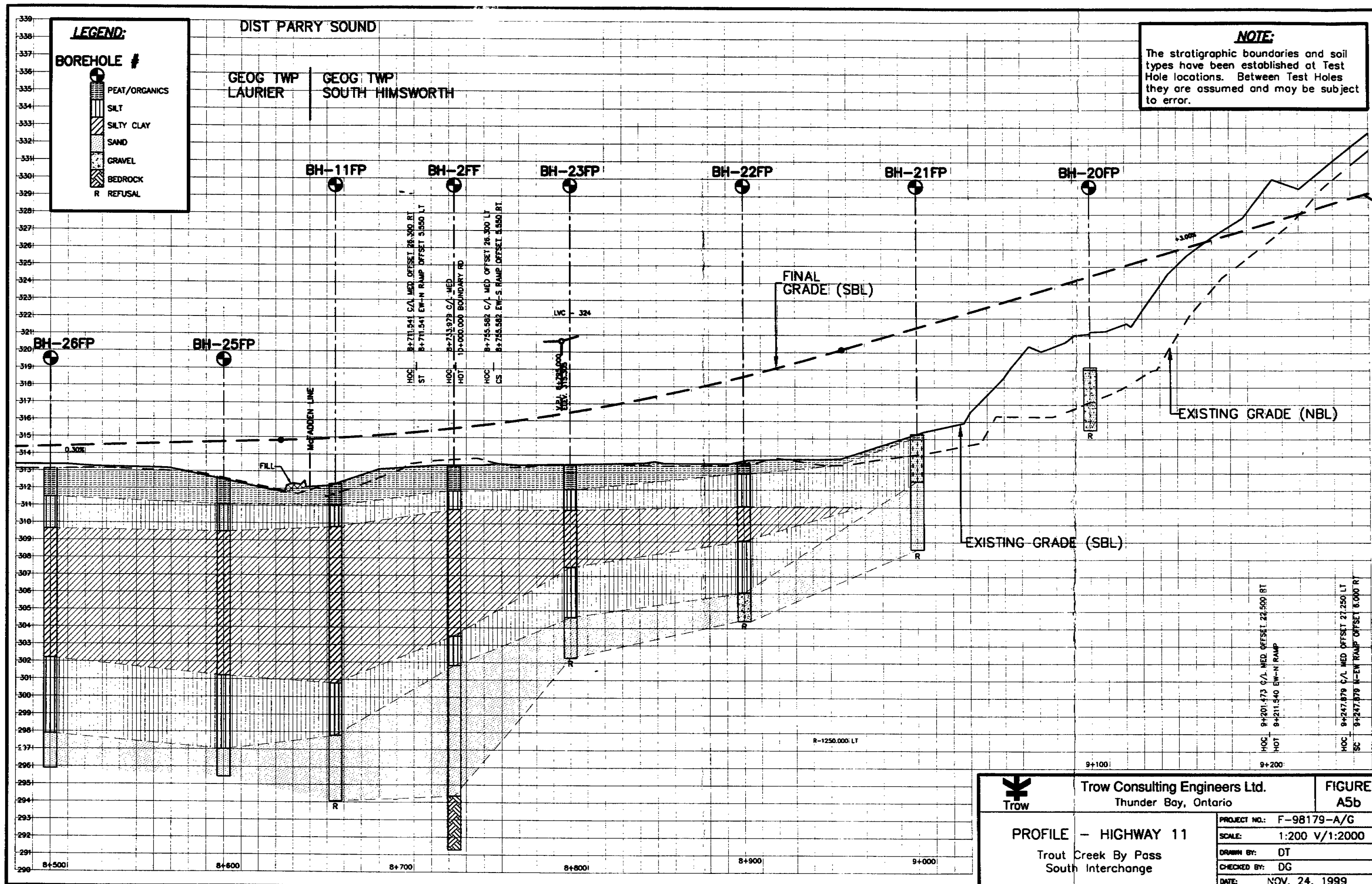
**BOREHOLE #**

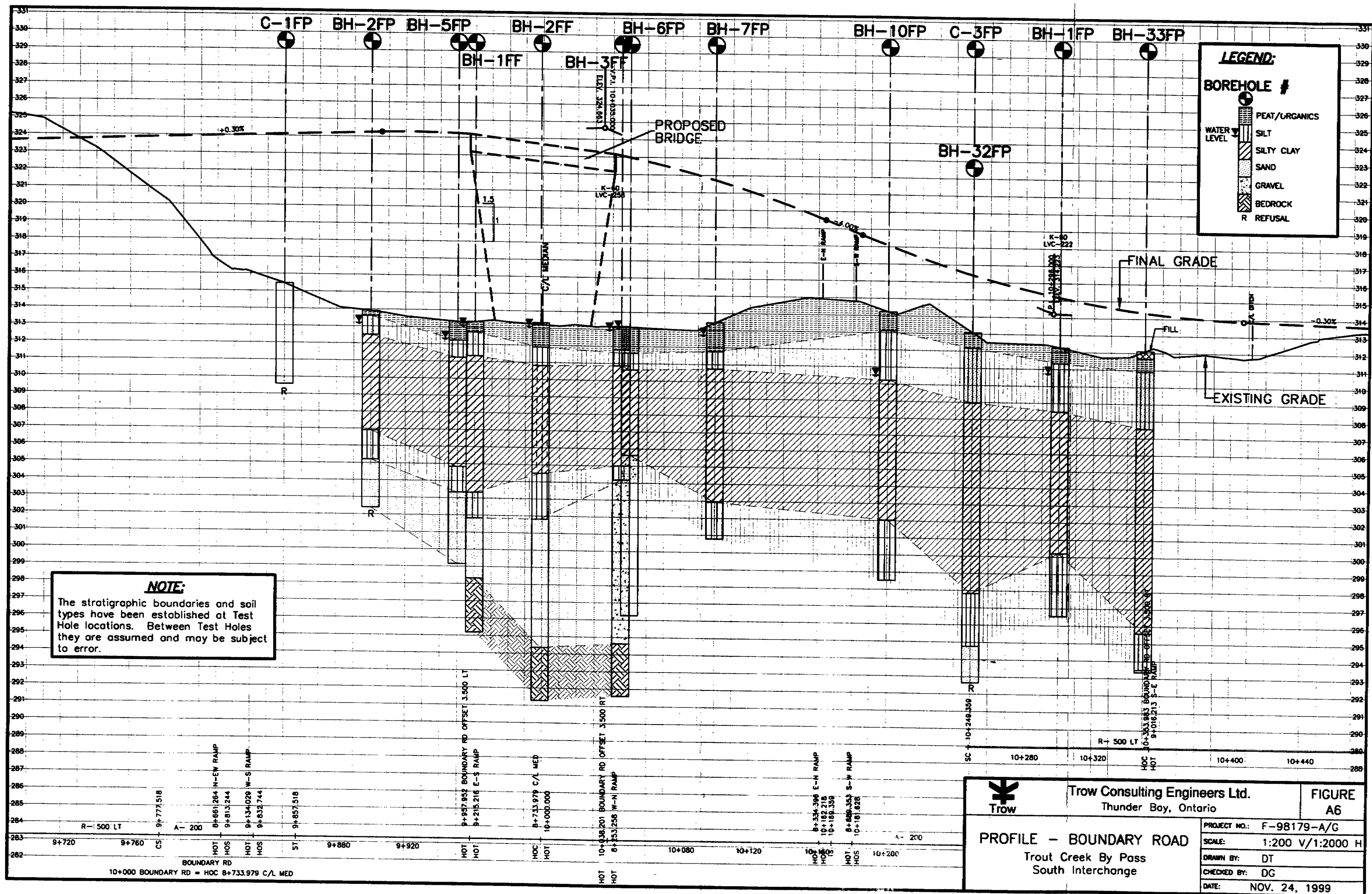
- PEAT/ORGANICS
- SILT
- SILTY CLAY
- SAND
- GRAVEL
- BEDROCK
- R REFUSAL

**NOTE:**  
The stratigraphic boundaries and soil types have been established at Test Hole locations. Between Test Holes they are assumed and may be subject to error.

 <b>Trow</b>	<b>Trow Consulting Engineers Ltd.</b> Thunder Bay, Ontario		<b>FIGURE</b> <b>A5a</b>
	<b>PROFILE - HIGHWAY 11</b> Trout Creek By Pass South Interchange		
PROJECT NO.: F-98179-A/G		SCALE: 1:200 V/1:2000 H	
DRAWN BY: DT		CHECKED BY: DG	
DATE: NOV. 24, 1999			







**LEGEND:**

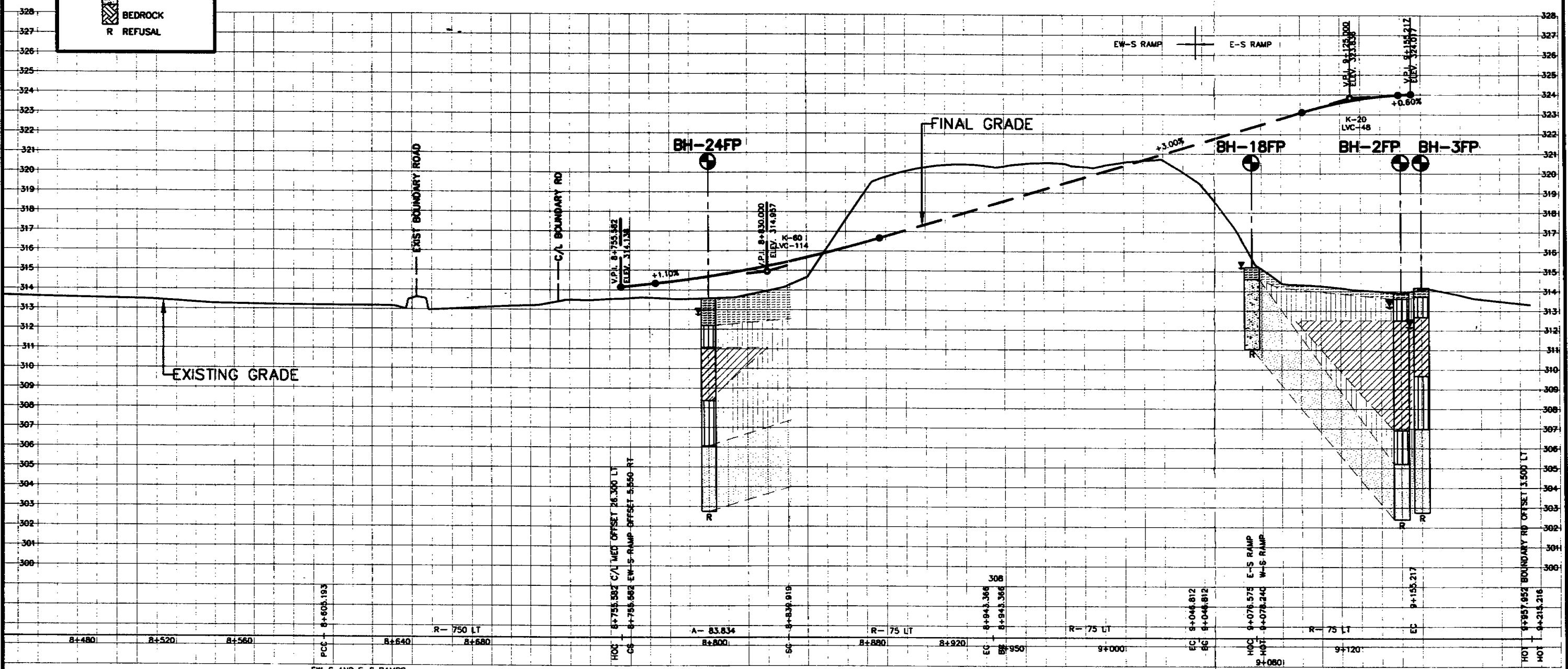
**BOREHOLE #**

PEAT/ORGANICS  
SILT  
SILTY CLAY  
SAND  
GRAVEL  
BEDROCK  
R REFUSAL

**NOTE:**  
The stratigraphic boundaries and soil types have been established at Test Hole locations. Between Test Holes they are assumed and may be subject to error.

EW-S

+ E-S



EW-S AND E-S RAMPS  
8+255.582 = HOC 8+246.611 C/L MED OFFSET 22.500 LT

 <b>Trow</b> Trow Consulting Engineers Ltd. Thunder Bay, Ontario	<b>FIGURE A7</b>	
	PROJECT NO.: F-98179-A/G	
	SCALE: 1:200 V/1:2000 H	
	DRAWN BY: DT	
	CHECKED BY: DG	
DATE: NOV. 24, 1999		

**PROFILE**  
EW-S to E-S RAMP  
Trout Creek By Pass  
South Interchange

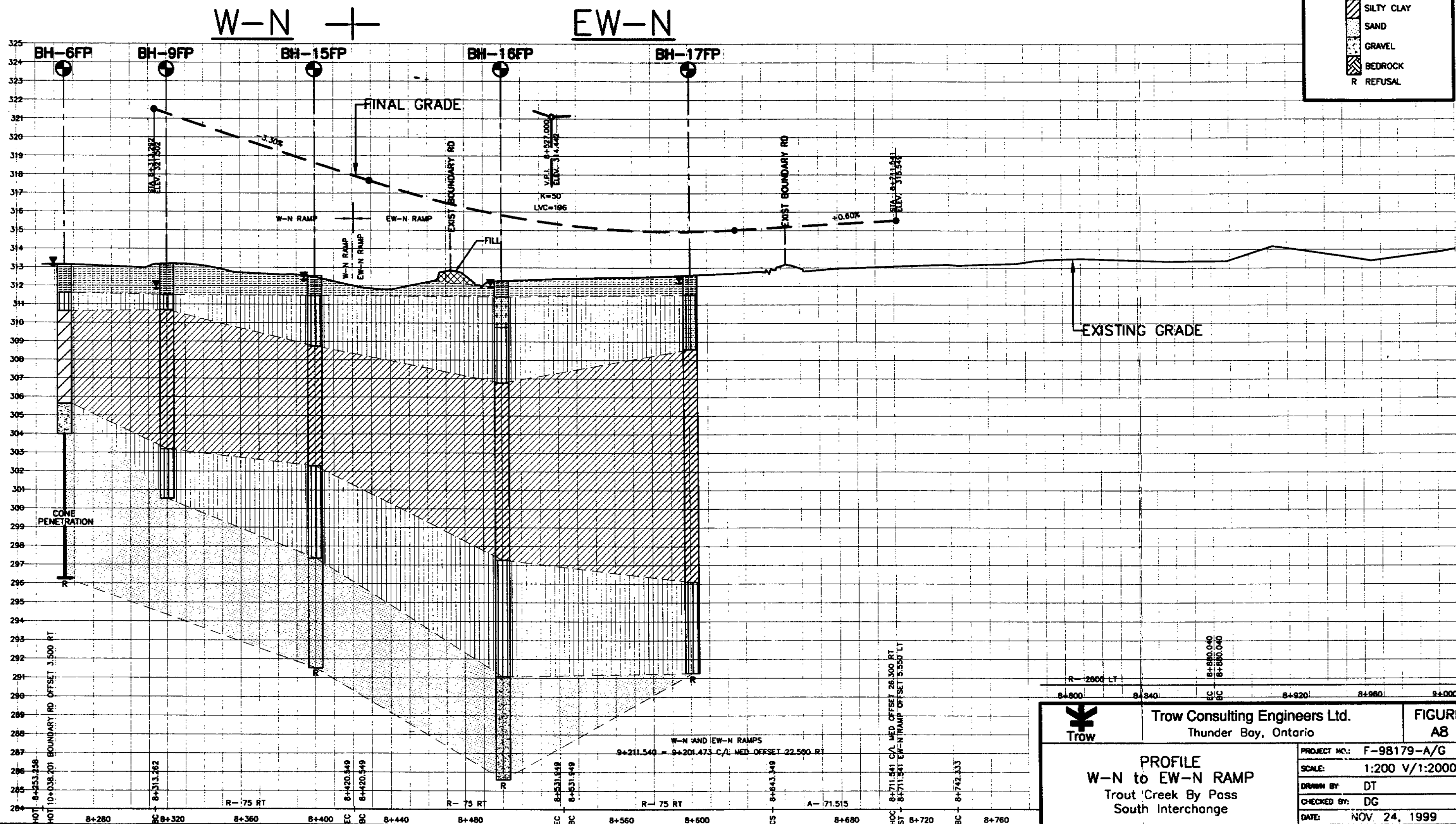
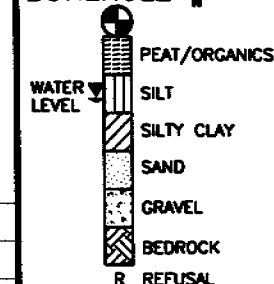


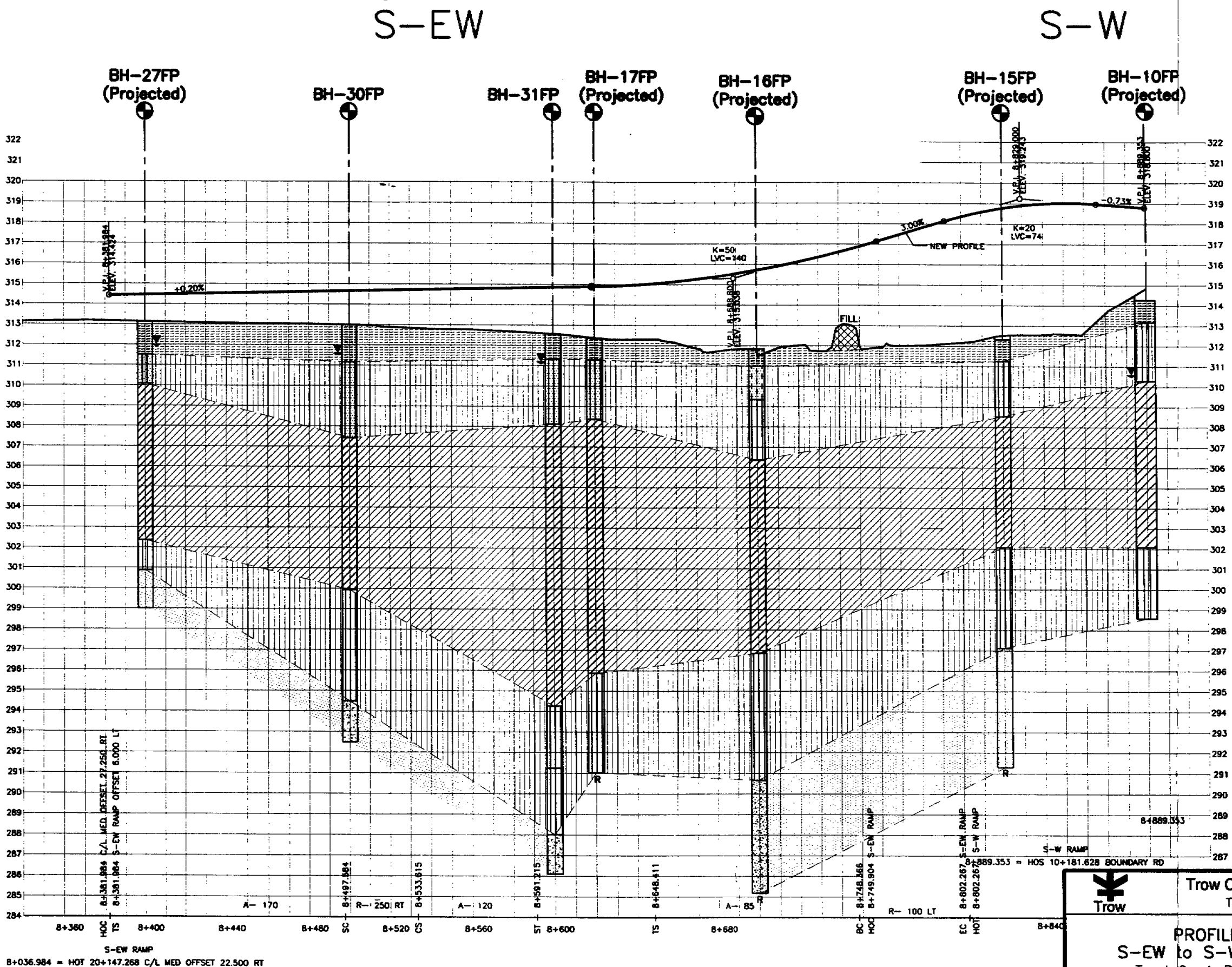
**NOTE:**

The stratigraphic boundaries and soil types have been established at Test Hole locations. Between Test Holes they are assumed and may be subject to error.

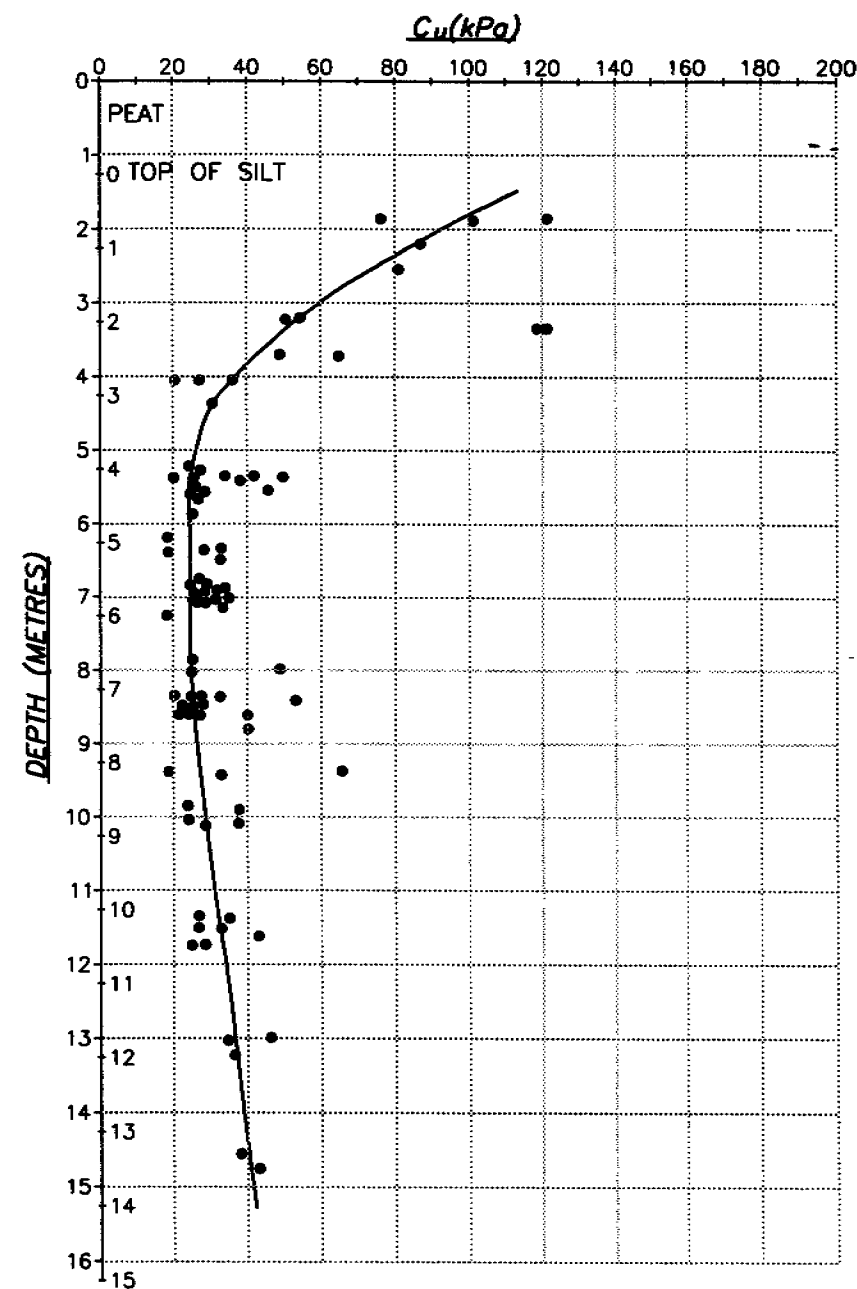
**LEGEND:**

**BOREHOLE #**

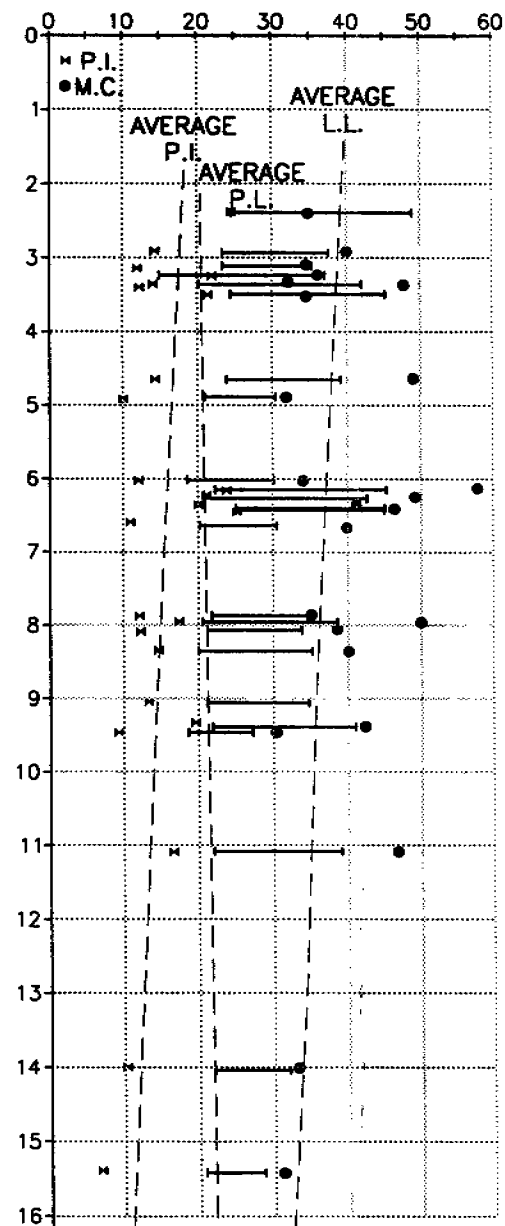




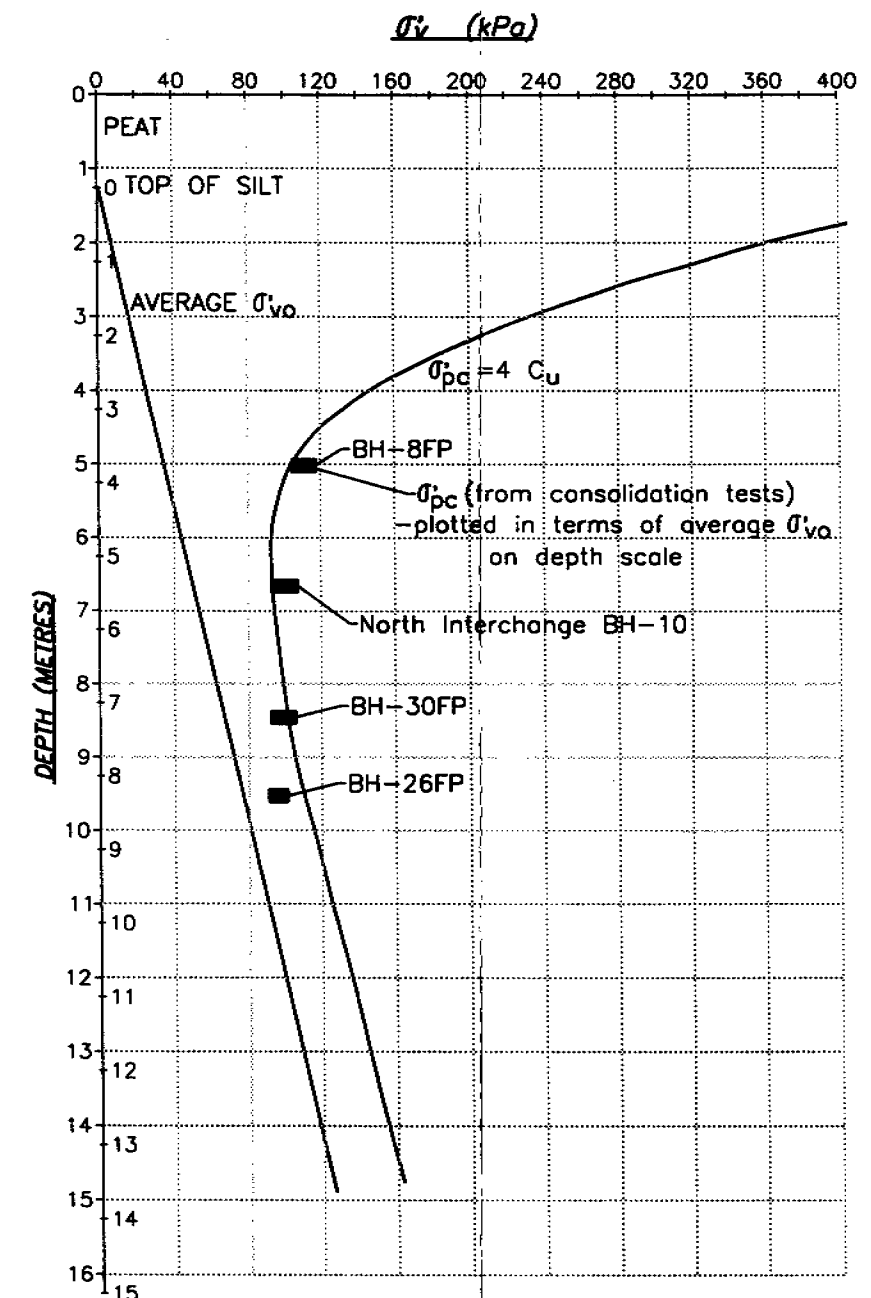
<b>Trow Consulting Engineers Ltd.</b> Thunder Bay, Ontario		<b>FIGURE</b> <b>A9</b>
PROJECT NO.: F-98179-A/G		
SCALE: 1:200 V/1:2000 H		
DRAWN BY: DT		
CHECKED BY: DG		
DATE: NOV. 24, 1999		




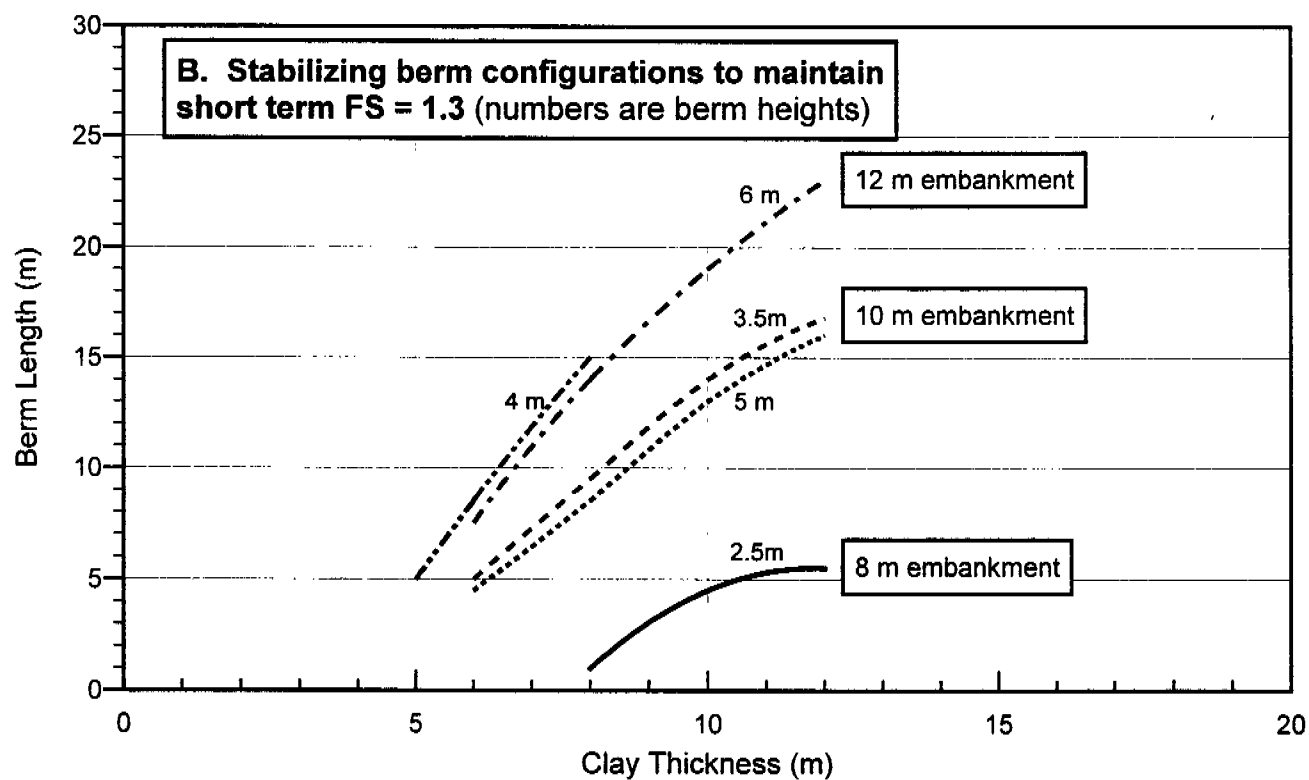
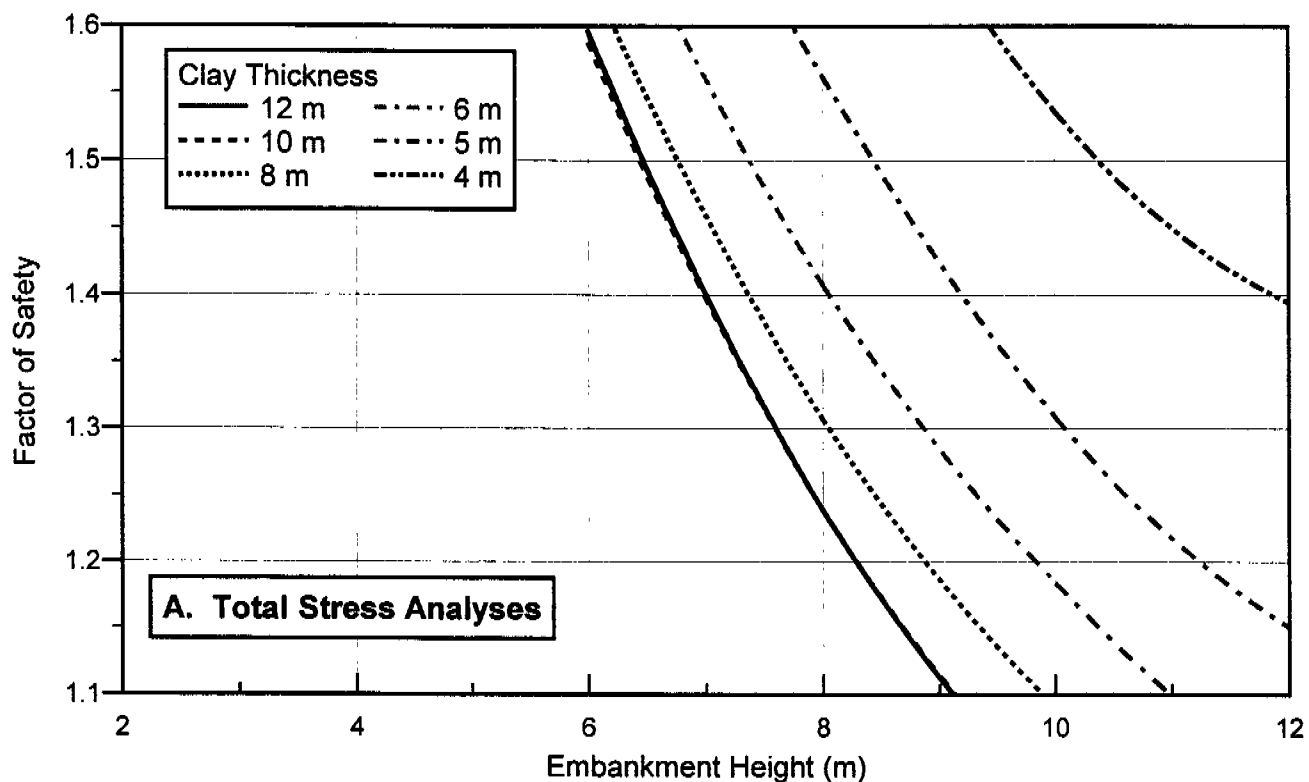
### MOISTURE CONTENT & ATTERBERG LIMITS



Only moisture contents associated with Atterberg Limits are shown.



 <b>Trow Consulting Engineers Ltd.</b> Thunder Bay, Ontario	<b>FIGURE A10</b>	
	PROJECT NO.: F-98179-A/G	
	SCALE: NOT TO SCALE	
	DRAWN BY: DT	
	CHECKED BY: DG	
UNDRAINED SHEAR STRENGTH, ATTERBERG LIMITS & EFFECTIVE STRESS PROFILES Trout Creek By Pass South Interchange		DATE: NOV. 24, 1999



Trow Consulting Engineers Ltd.  
Thunder Bay, Ontario

### Embankment Stability Analyses Total Stresses

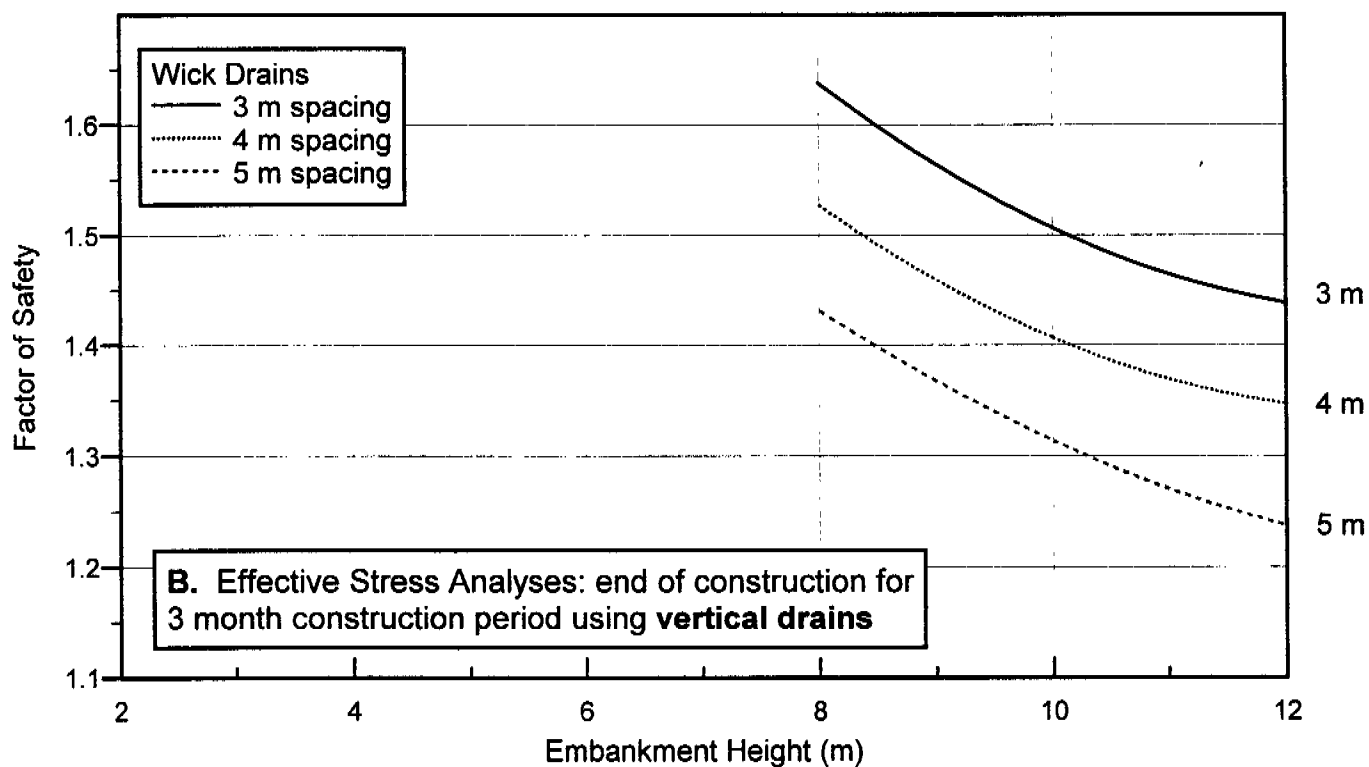
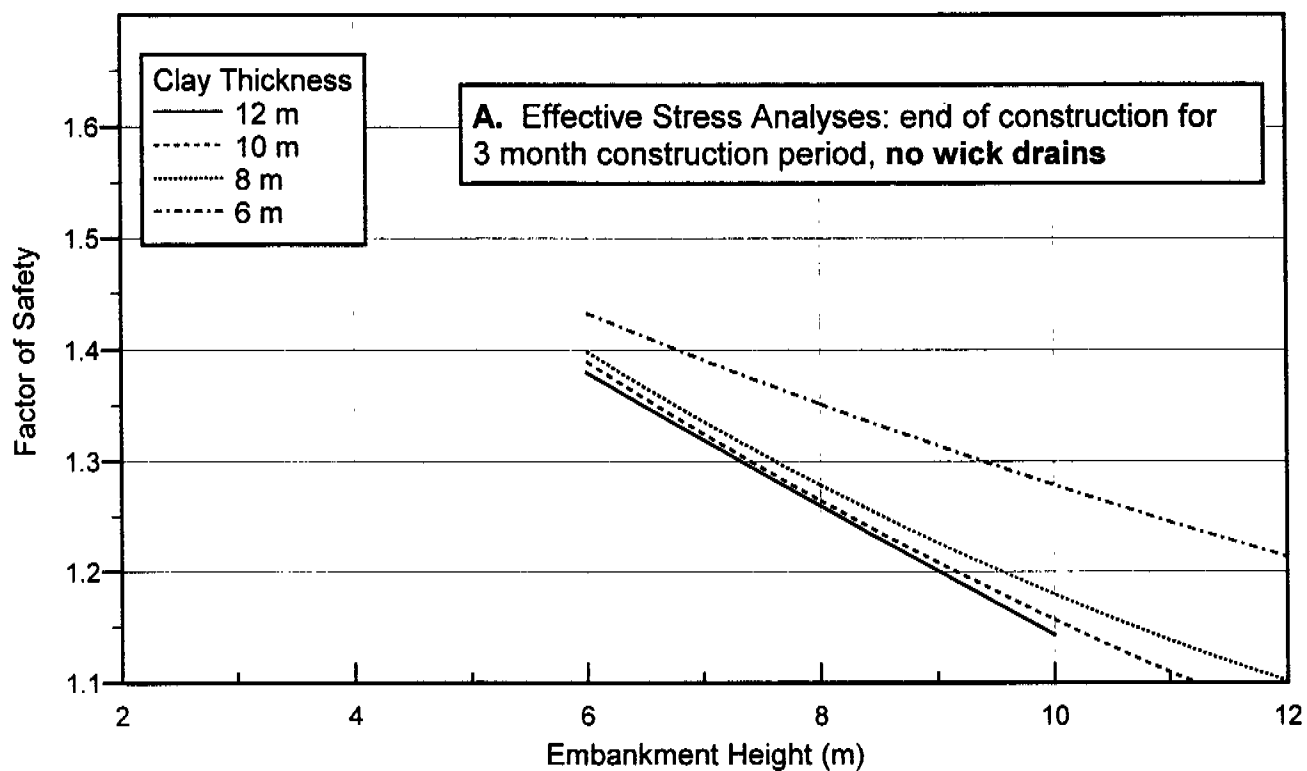
F98179-A/G

Mar 30/99

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Trout Creek By Pass - South Interchange

Figure A11



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**Embankment Stability Analyses  
Effective Stresses**

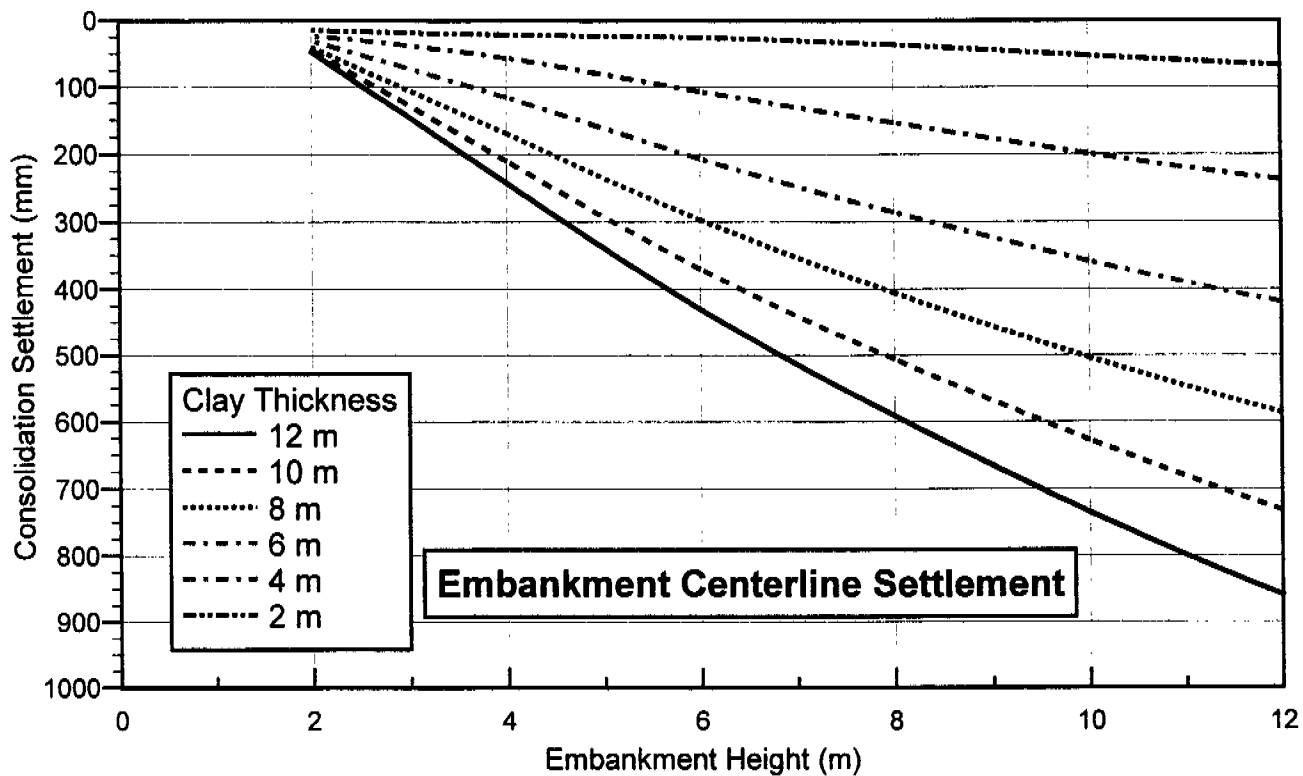
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**Trout Creek By Pass - South Interchange**

Figure A12



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### Estimated Embankment Consolidation Settlement - Centerline

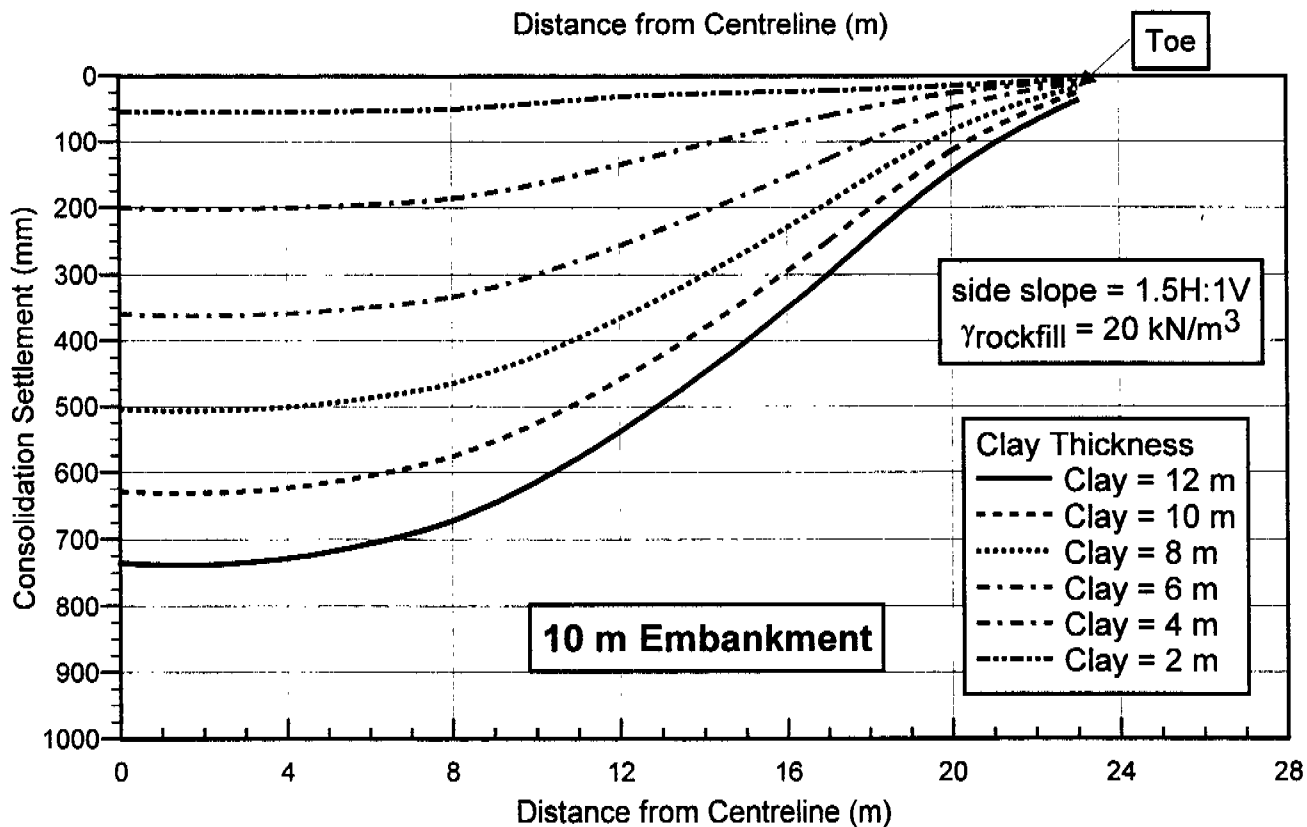
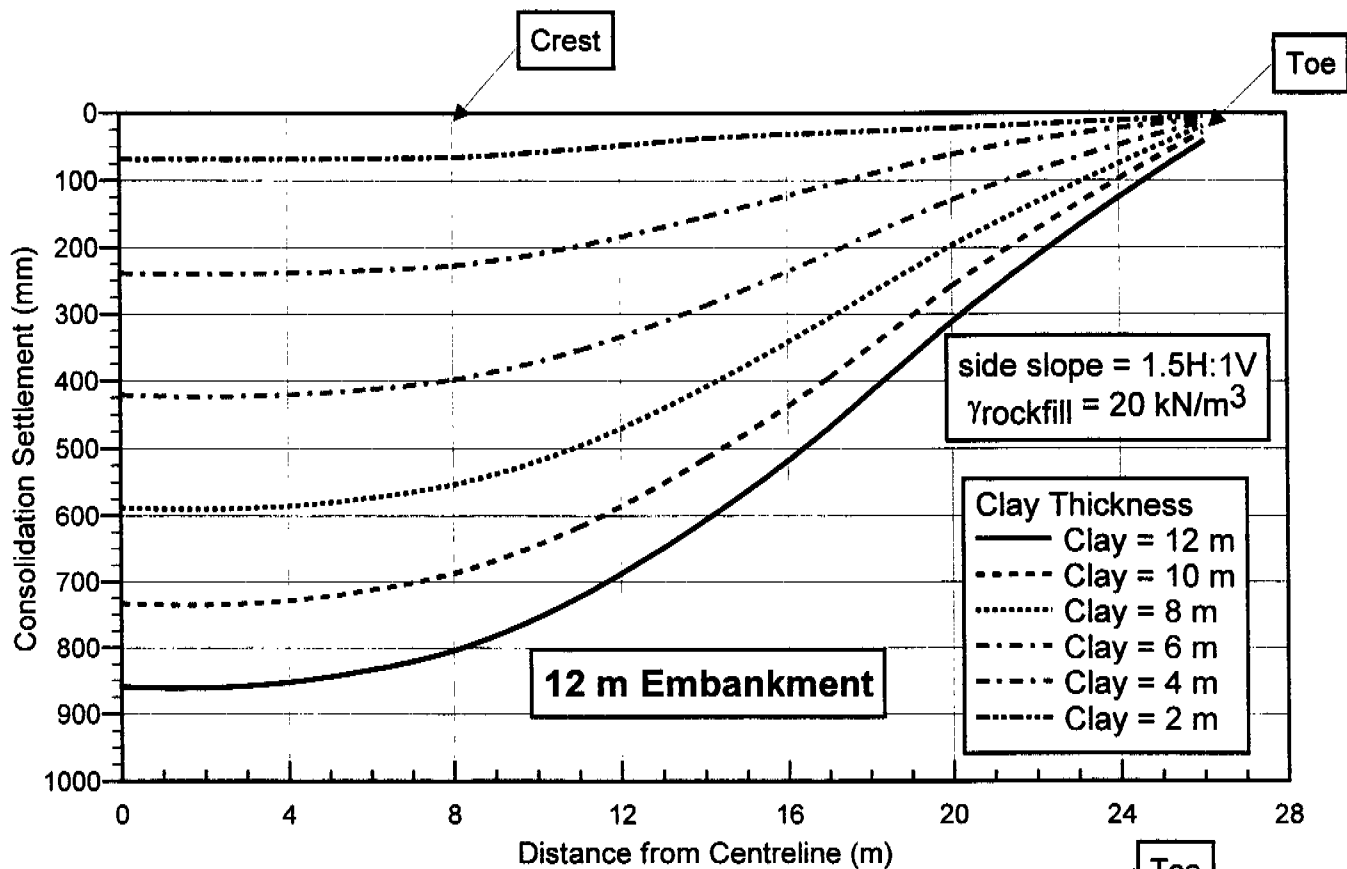
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Trout Creek By Pass - South Interchange

Figure A13



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**Estimated Embankment Consolidation  
 Settlement Profile: 12 m and 10 m Height**

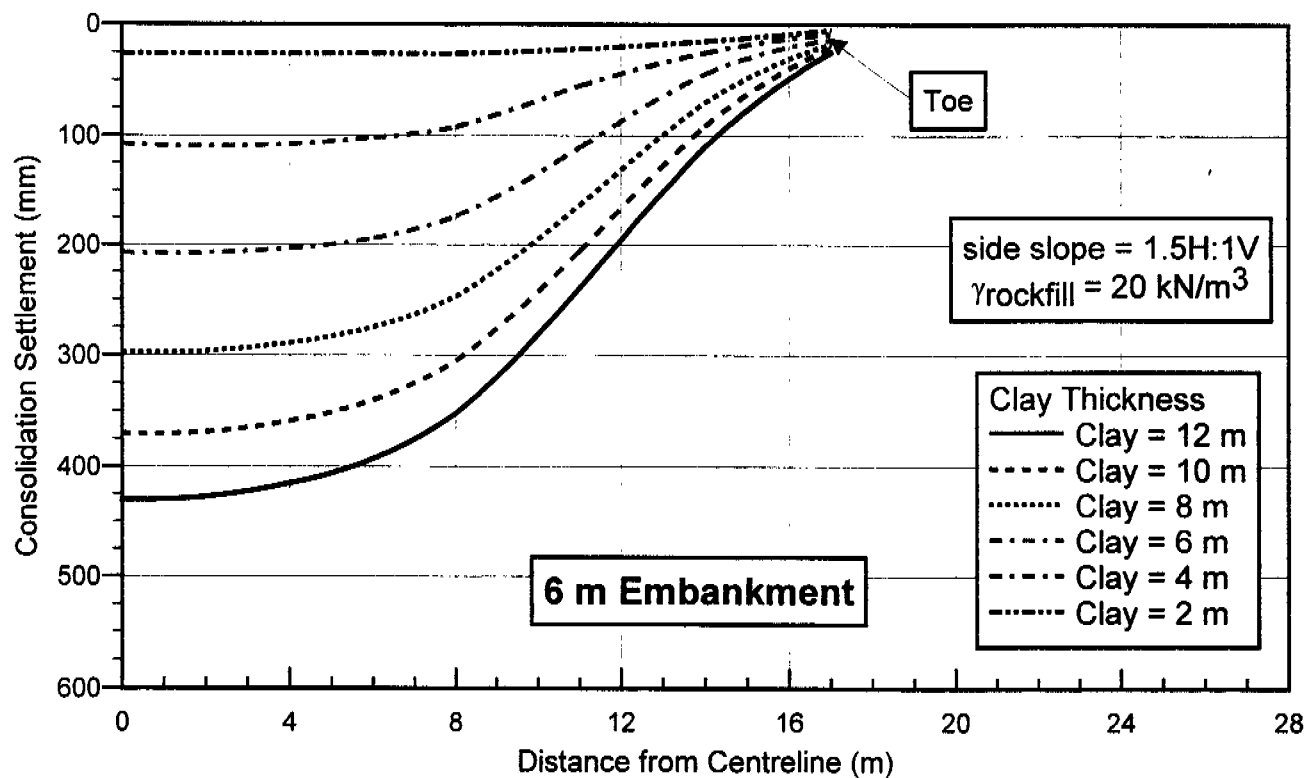
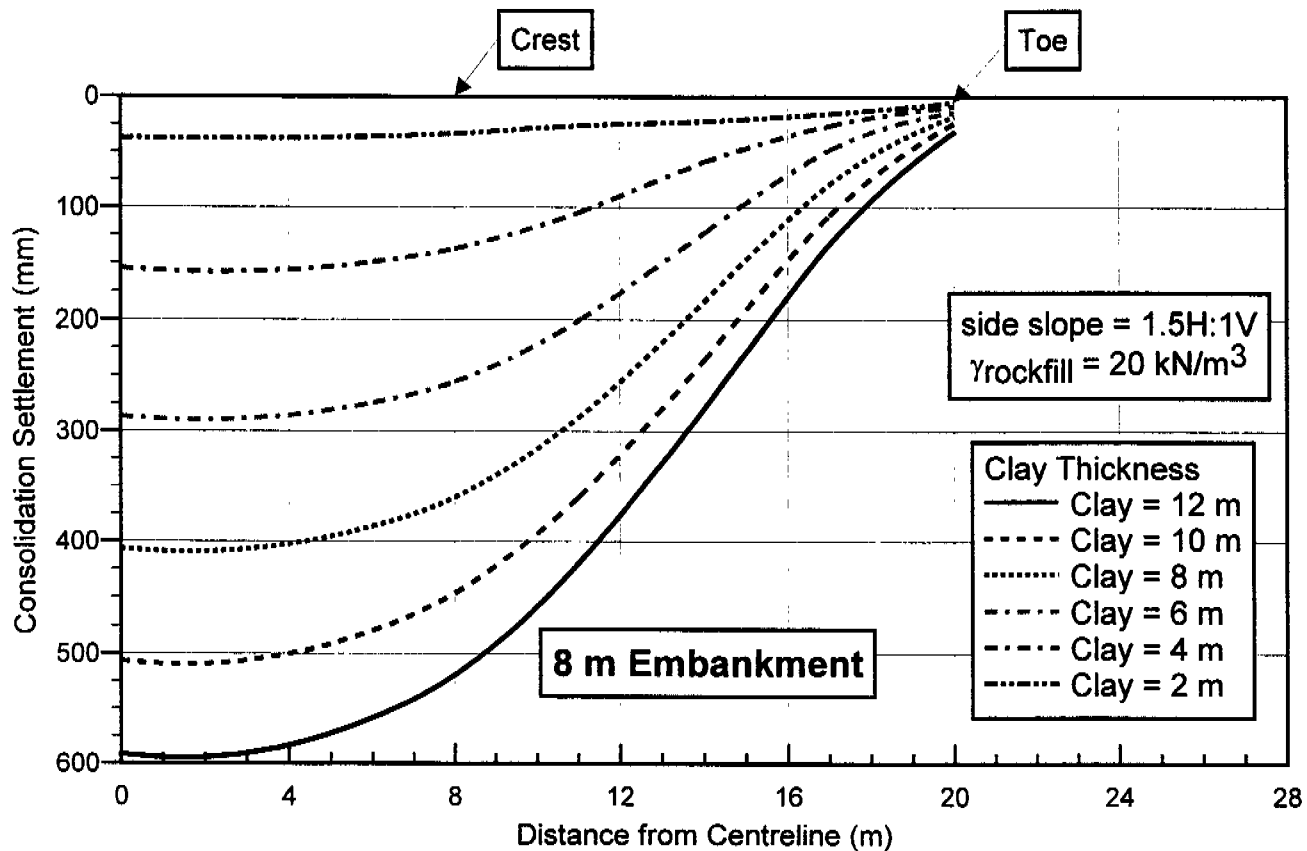
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**Trout Creek By Pass - South Interchange**

Figure A14



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**Estimated Embankment Consolidation  
 Settlement Profile: 8 m and 6 m Height**

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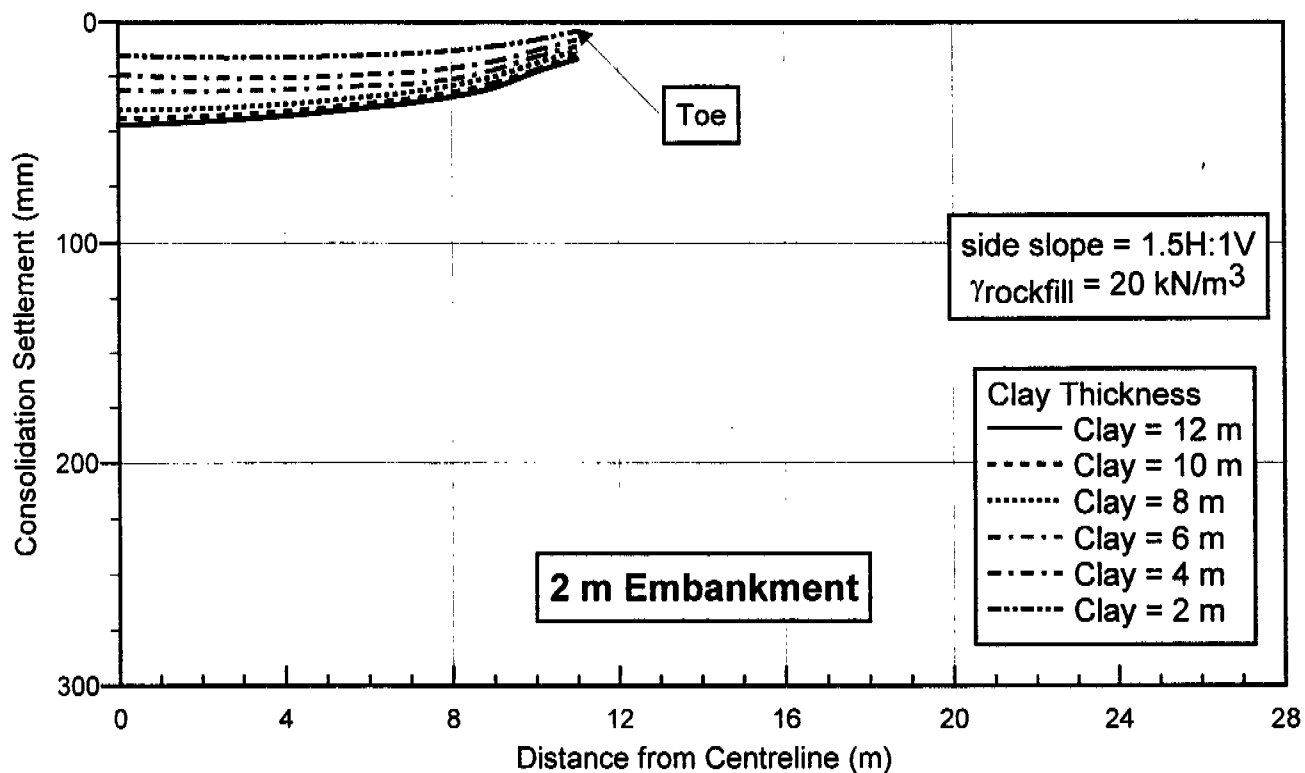
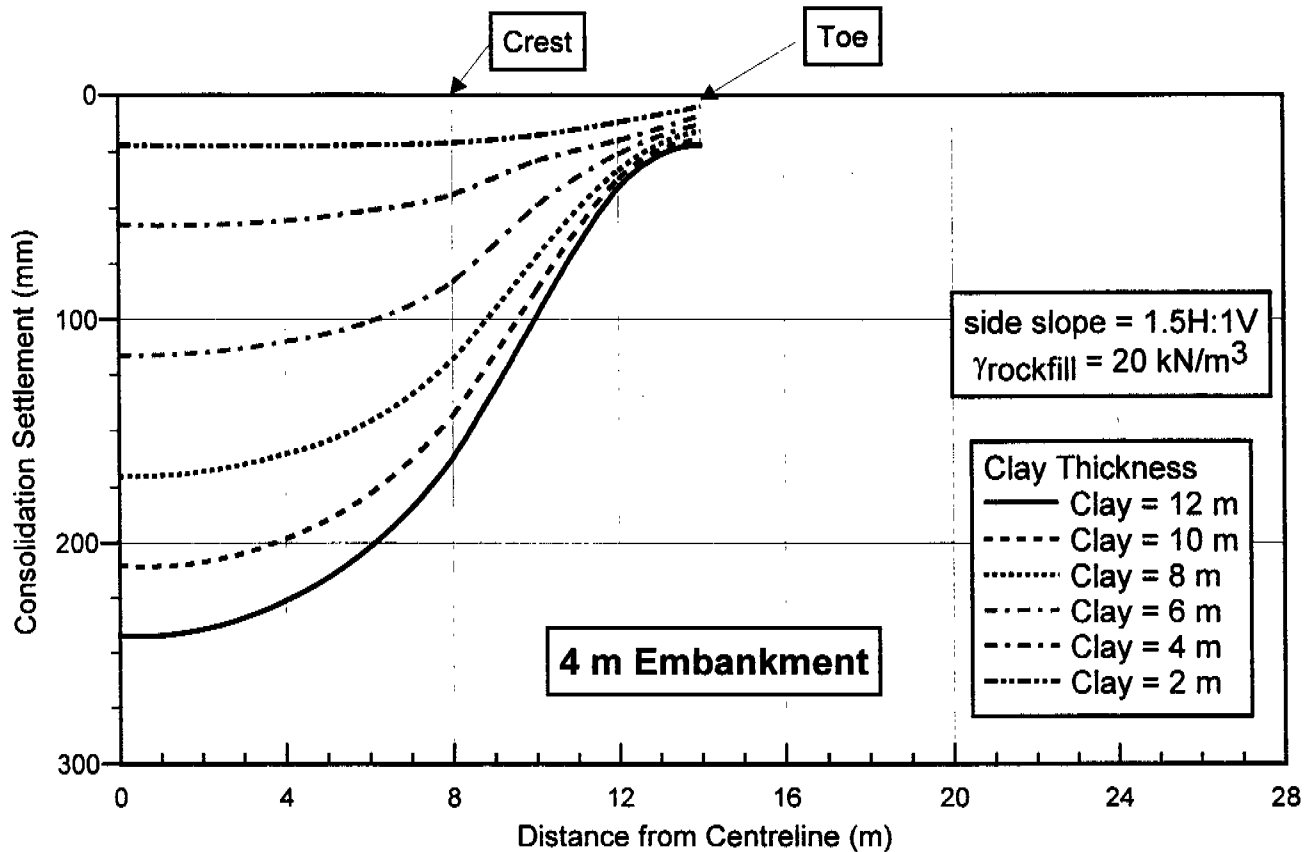
**Trout Creek By Pass - South Interchange**

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Figure A15





Trow Consulting Engineers Ltd.  
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**Estimated Embankment Consolidation  
 Settlement Profile: 4 m and 2 m Height**

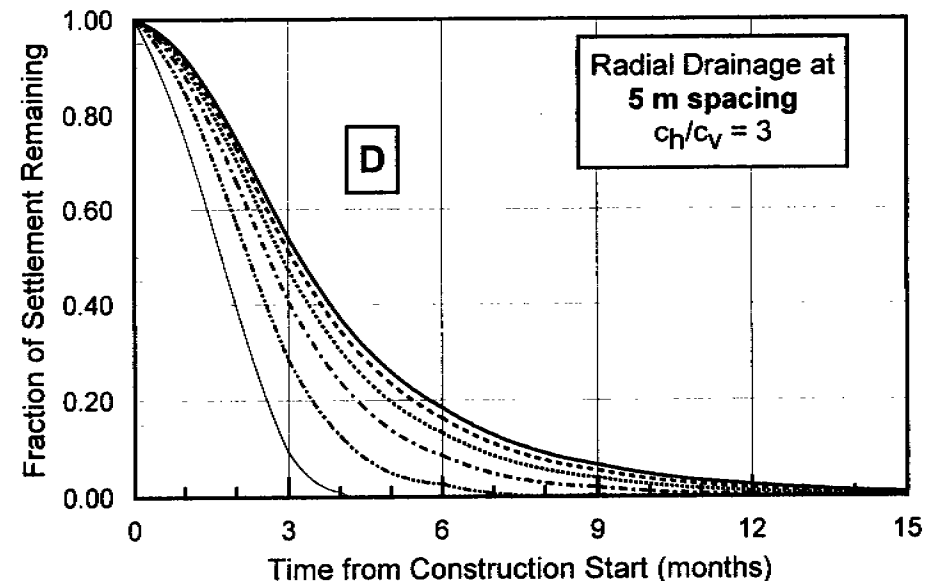
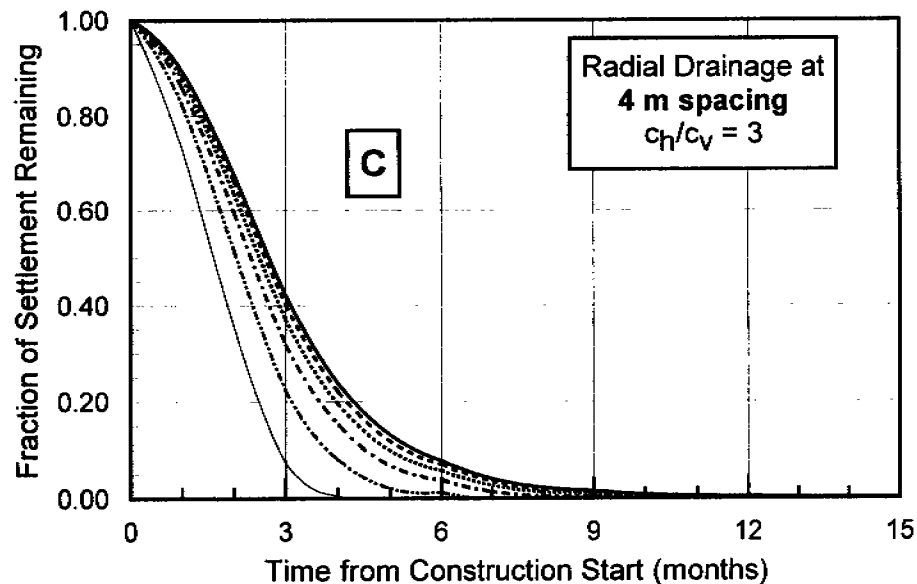
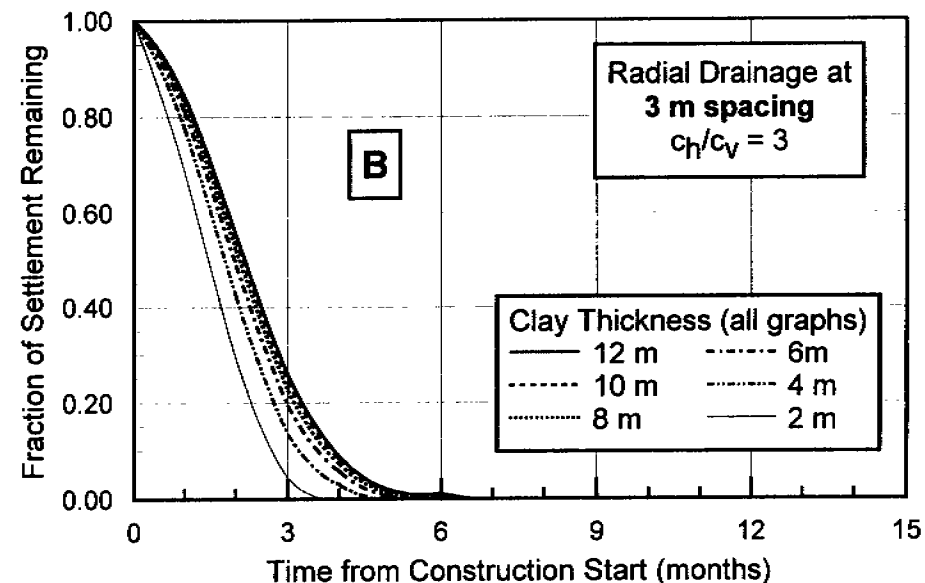
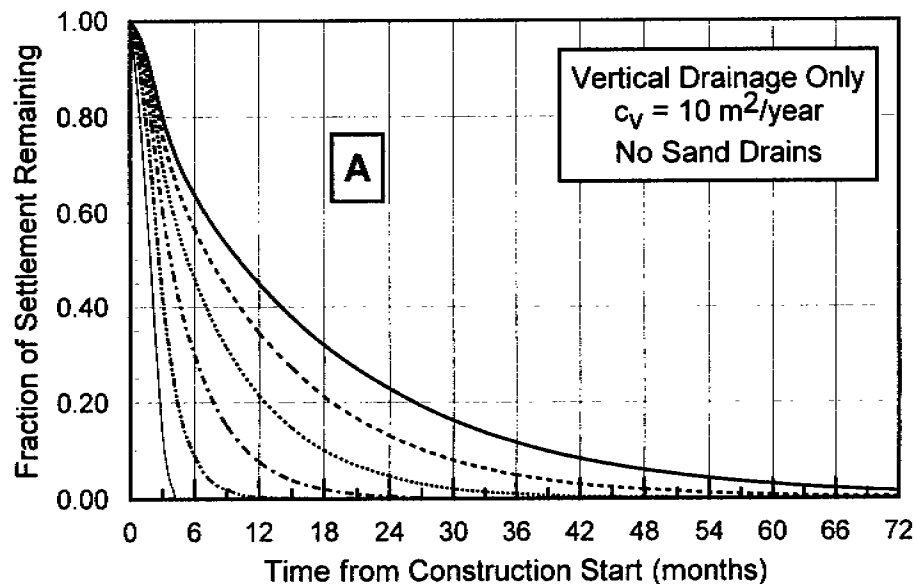
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**Trout Creek By Pass - South Interchange**

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Figure A16



Charts based on 3 month (steady loading) construction period



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Estimated Rate of Consolidation Settlement  
 Various Clay Thickness and Drainage Provisions

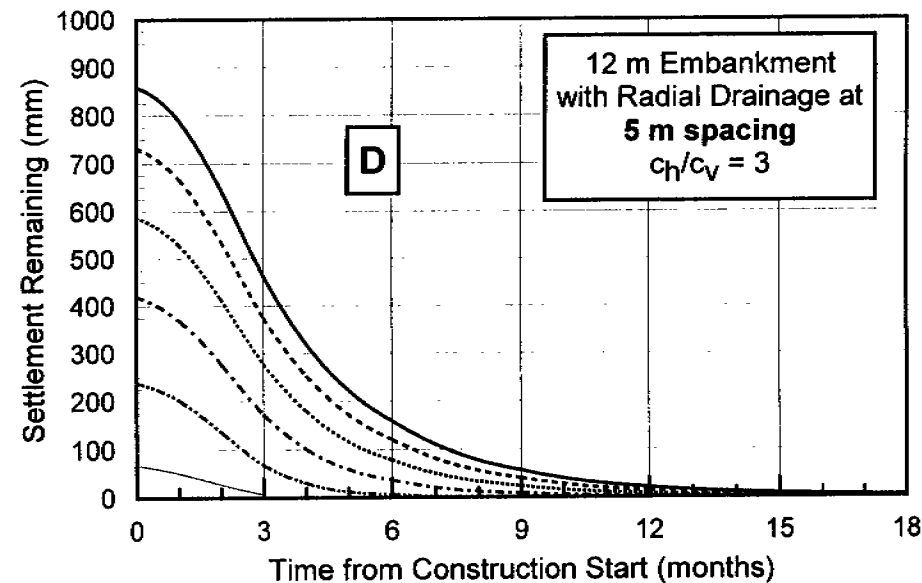
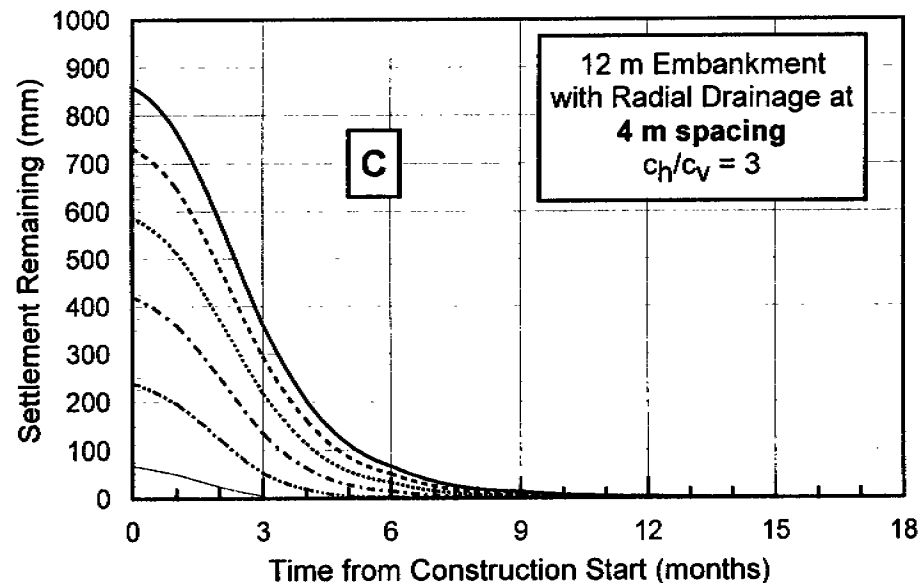
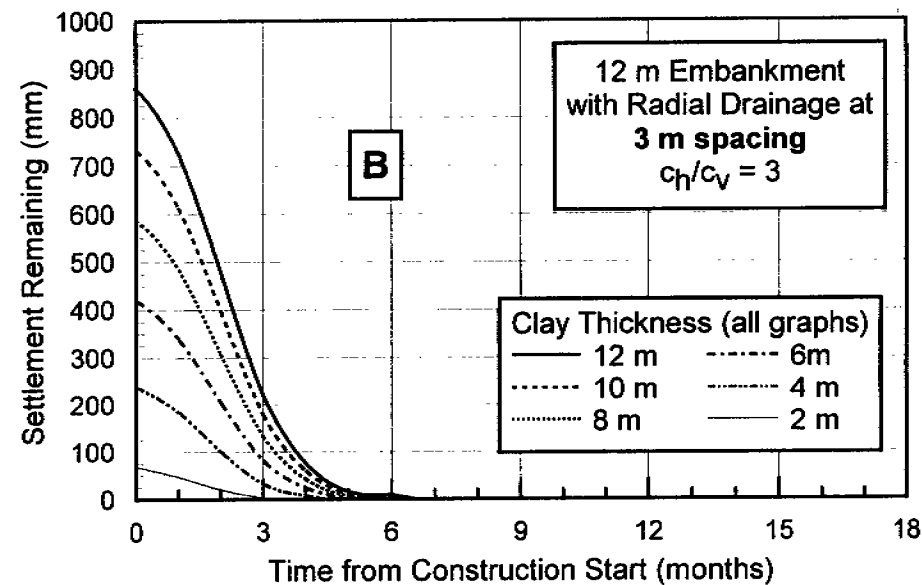
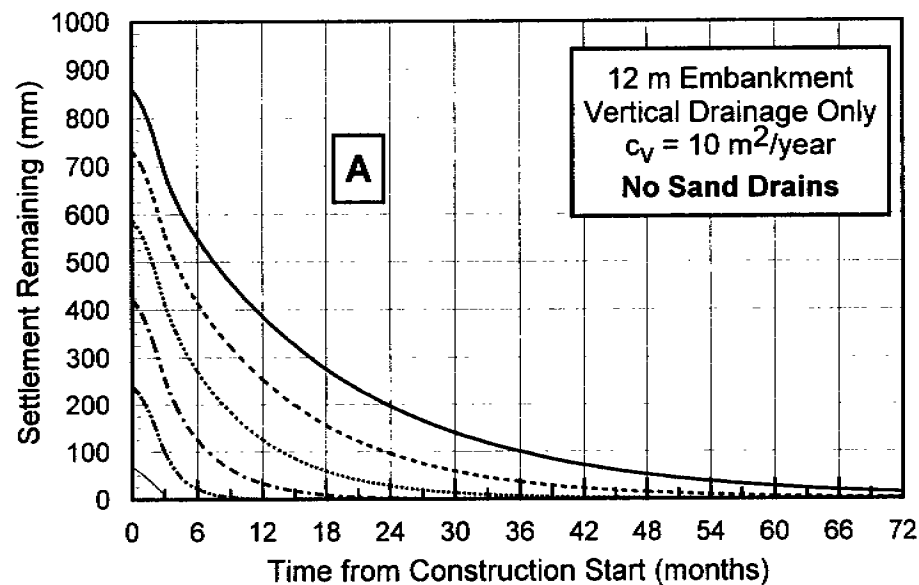
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Trout Creek By Pass - South Interchange

Figure A17



Charts based on 3 month (steady loading) construction period



Trow Consulting Engineers Ltd.  
Thunder Bay, Ontario

### Estimated Rate of Centerline Consolidation Settlement 12 m High Embankment

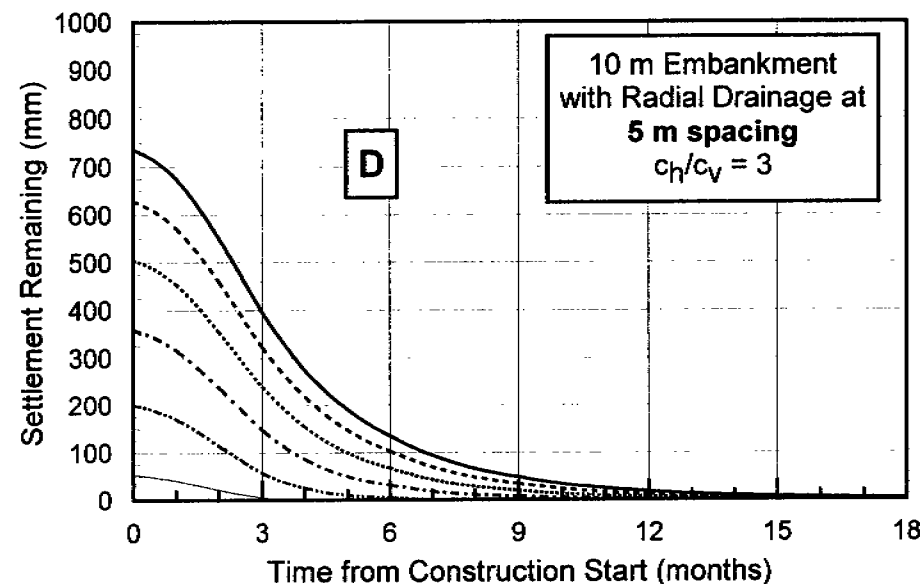
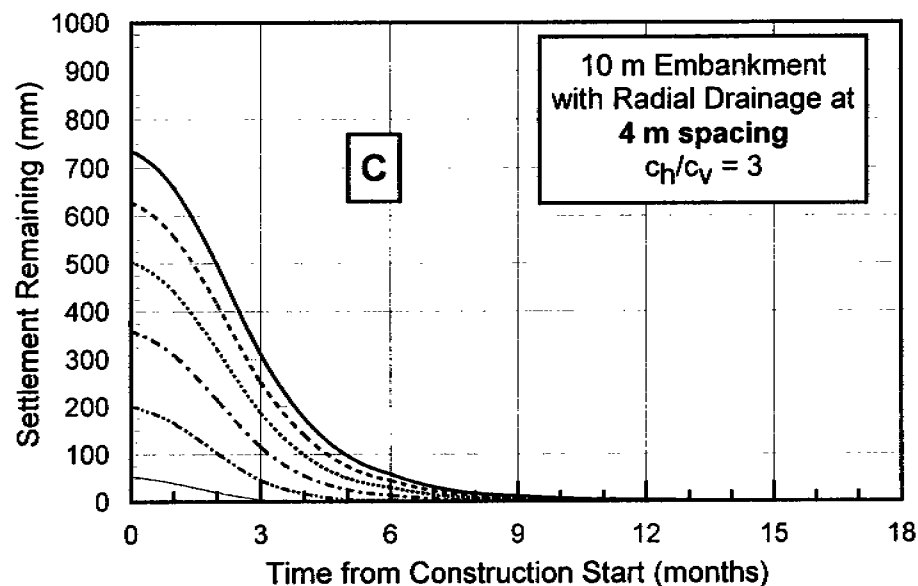
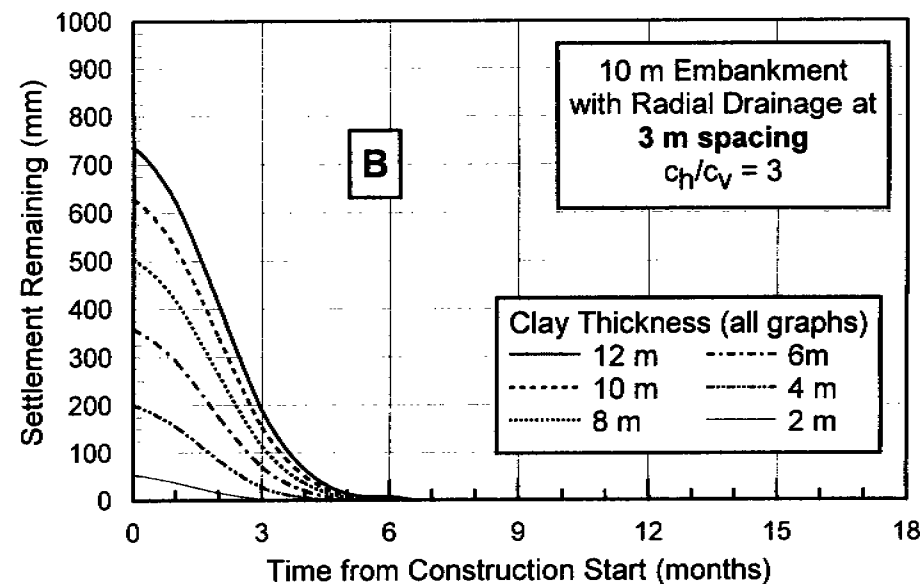
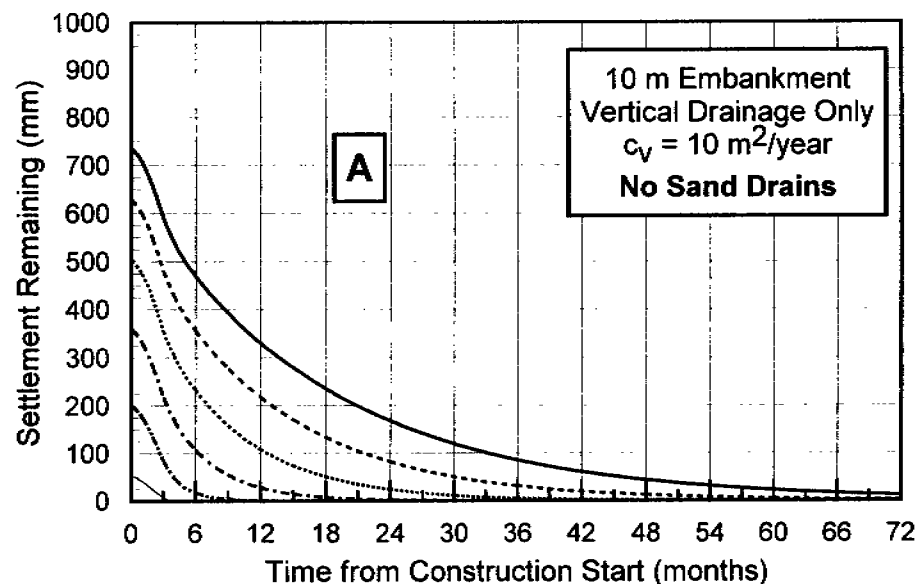
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Trout Creek By Pass - South Interchange

F98179-A/G

Dec 3/98

Figure A18



Charts based on 3 month (steady loading) construction period



Trow Consulting Engineers Ltd.  
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Estimated Rate of Centerline Consolidation Settlement  
10 m High Embankment

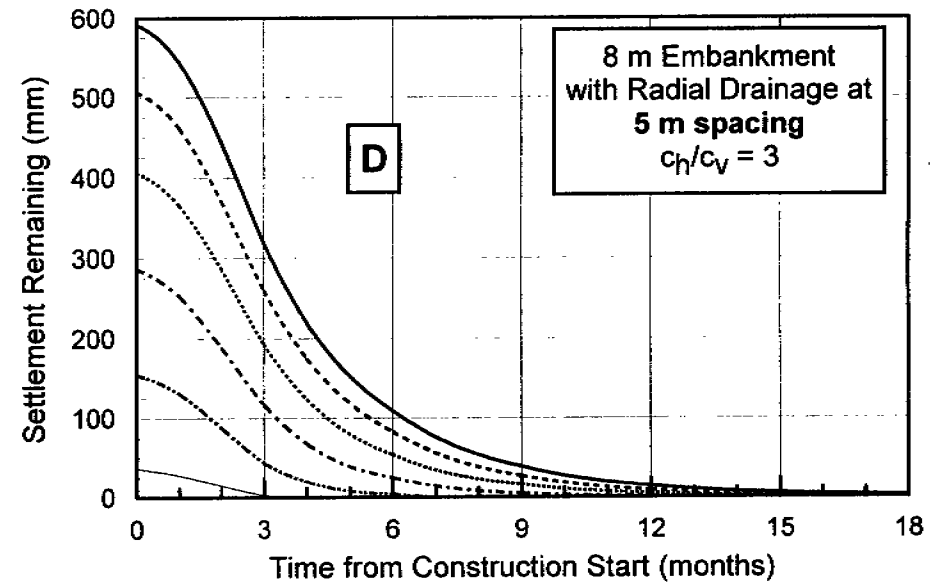
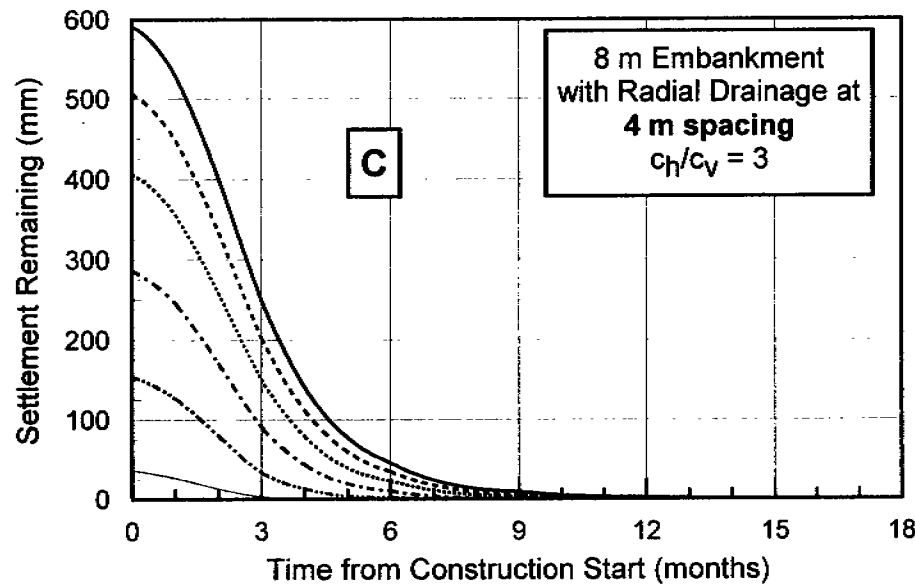
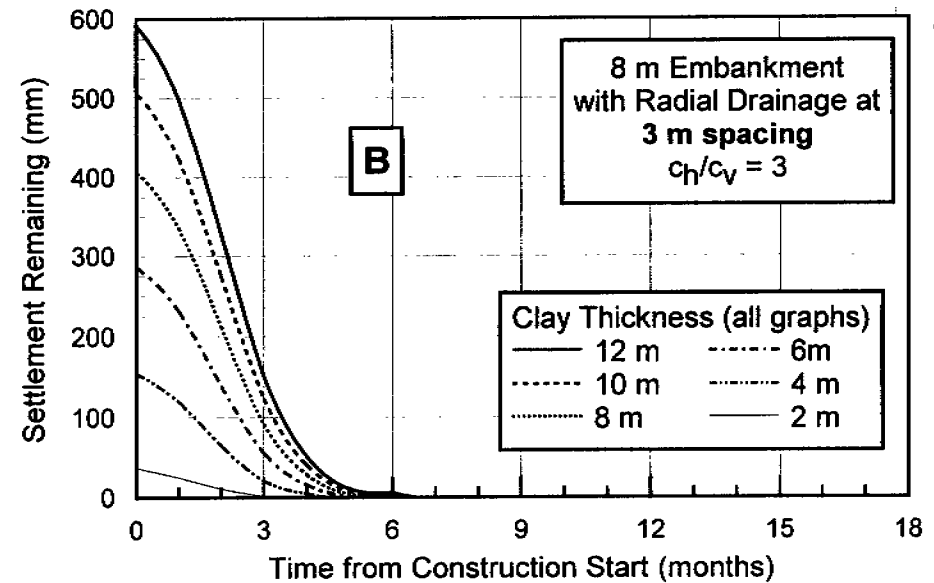
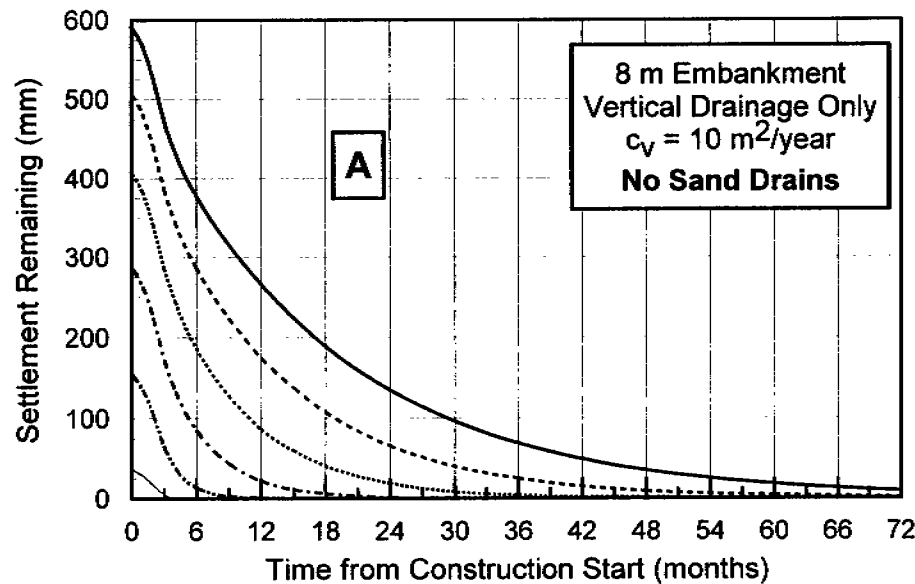
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Trout Creek By Pass - South Interchange

Figure A19



Charts based on 3 month (steady loading) construction period



Trow Consulting Engineers Ltd.  
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Estimated Rate of Centerline Consolidation Settlement  
8 m High Embankment

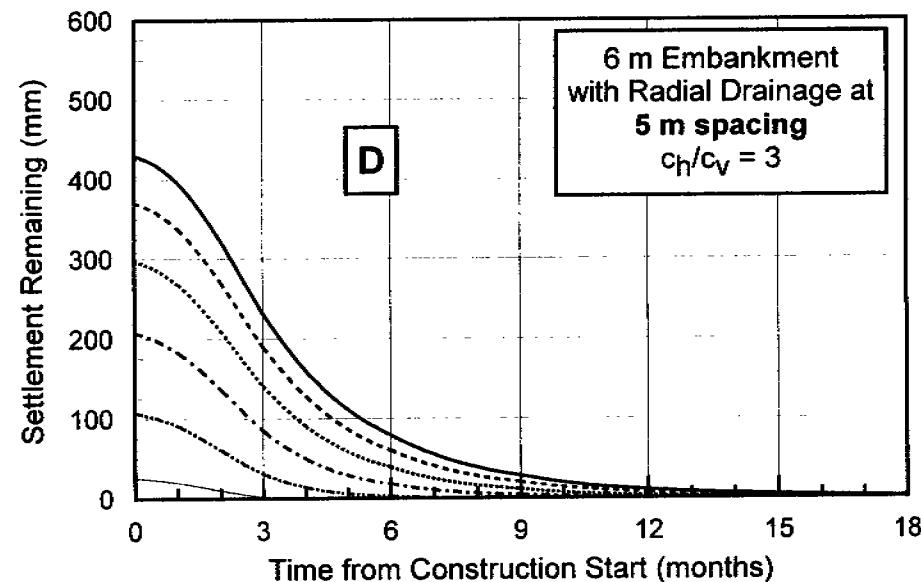
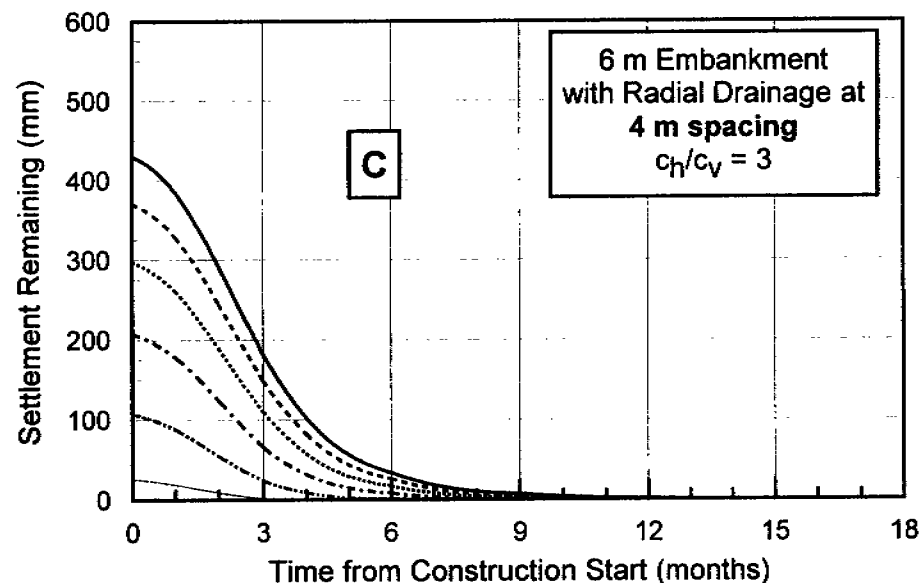
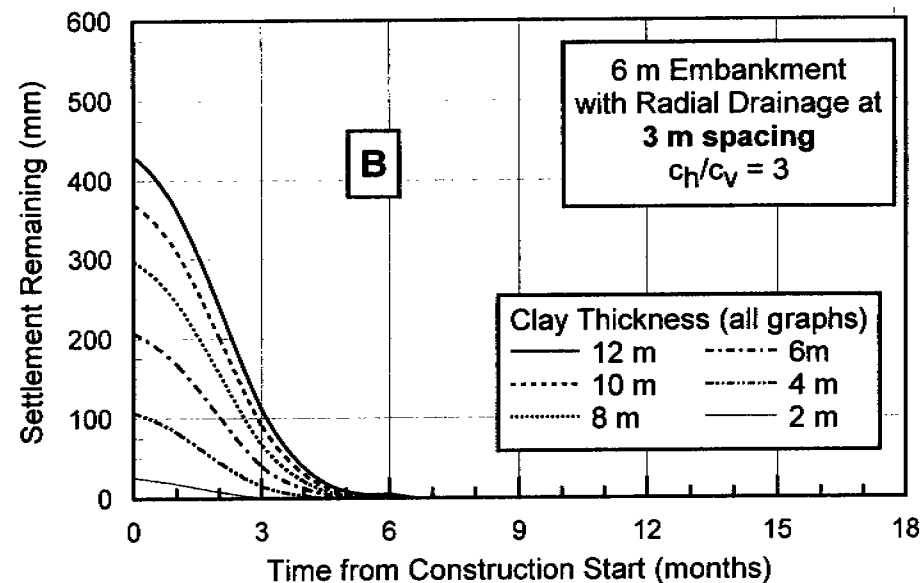
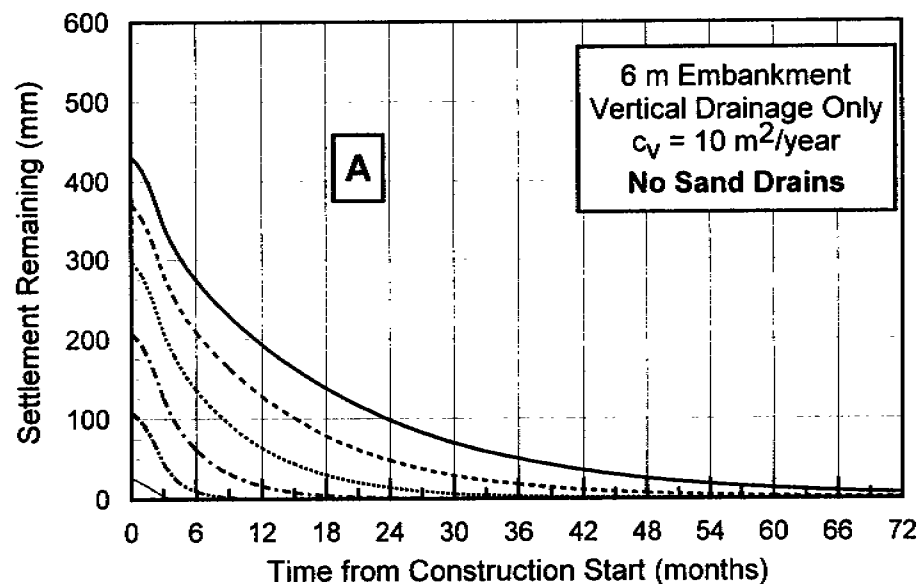
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Trout Creek By Pass - South Interchange

Figure A20



Charts based on 3 month (steady loading) construction period



Trow Consulting Engineers Ltd.  
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### Estimated Rate of Centerline Consolidation Settlement 6 m High Embankment

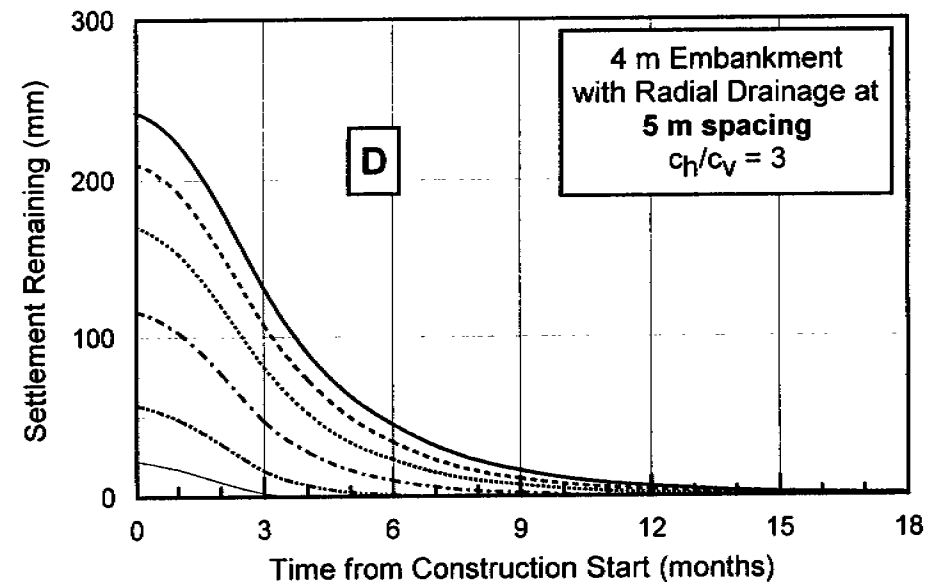
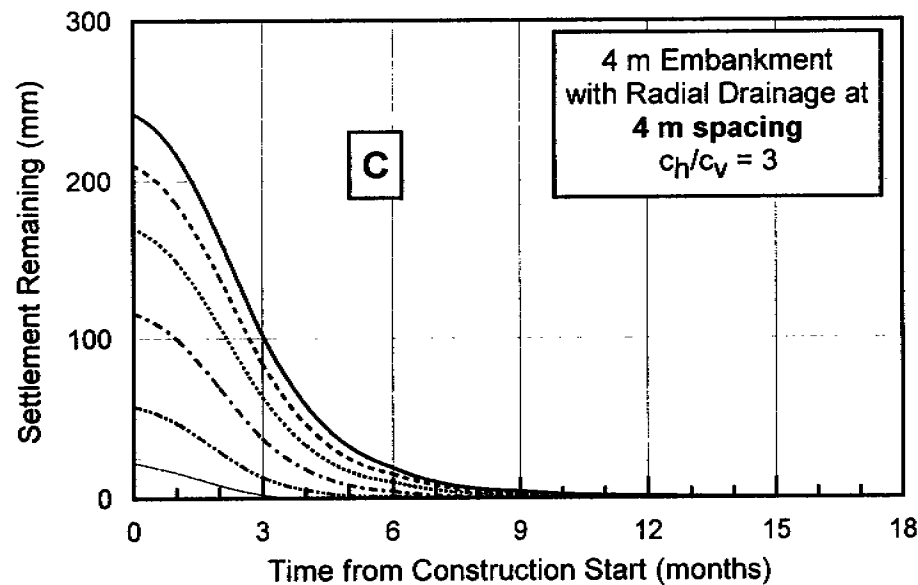
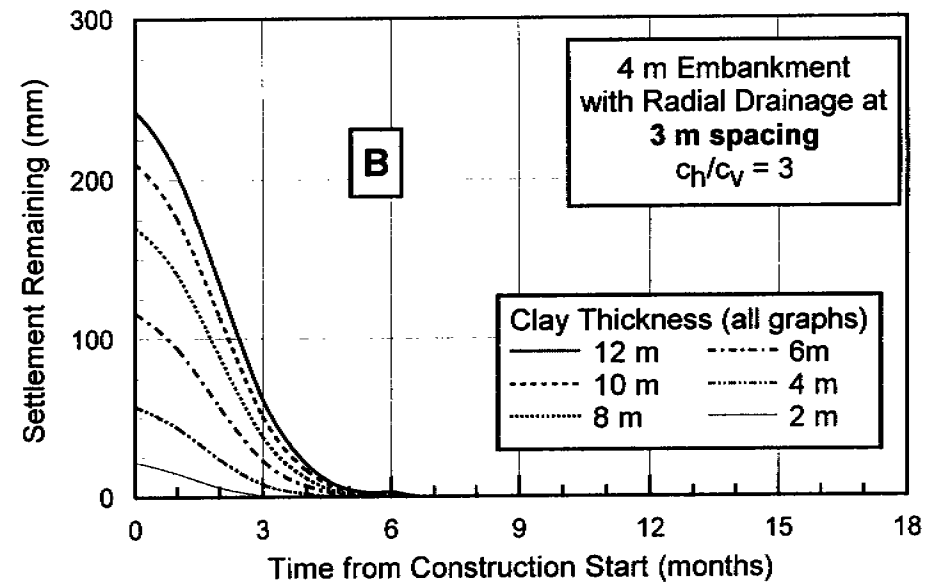
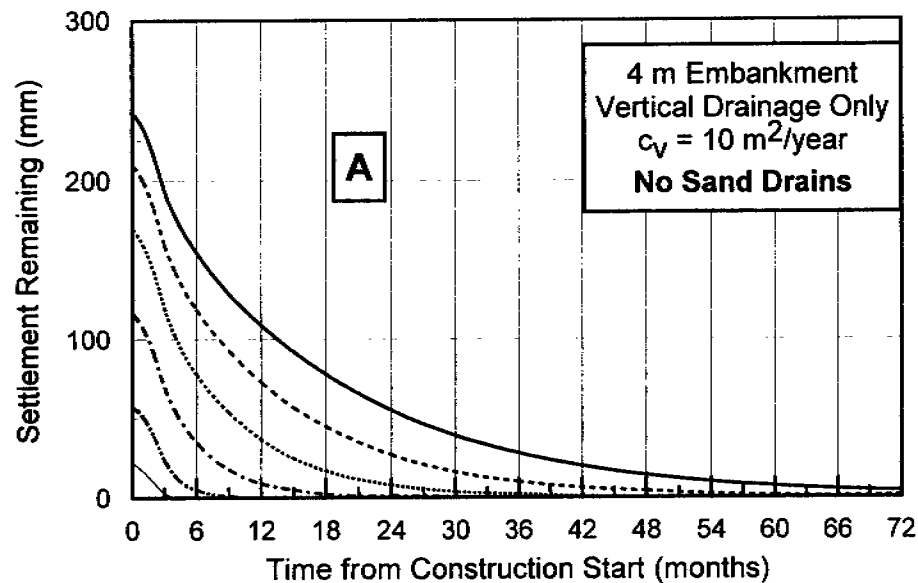
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Trout Creek By Pass - South Interchange

Figure A21



Charts based on 3 month (steady loading) construction period



Trow Consulting Engineers Ltd.  
Thunder Bay, Ontario

Estimated Rate of Centerline Consolidation Settlement  
4 m High Embankment

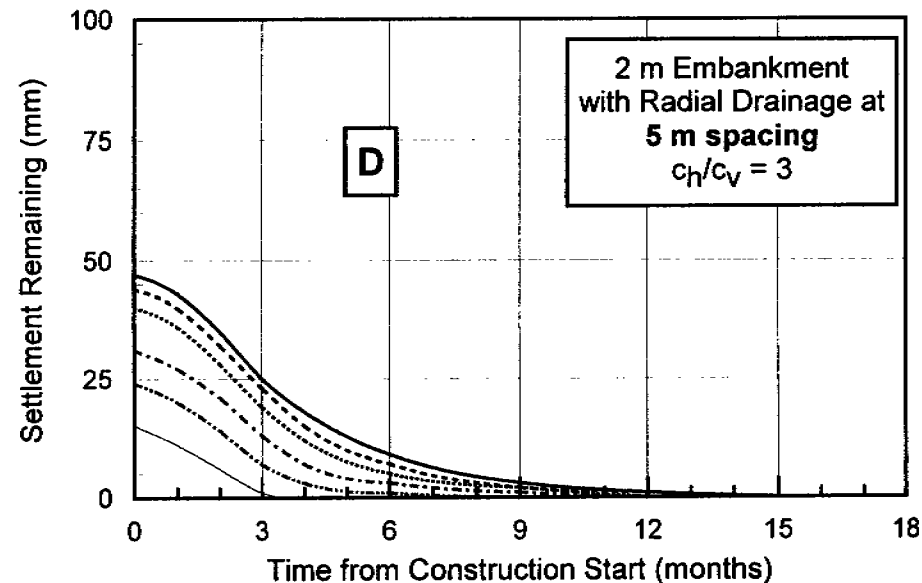
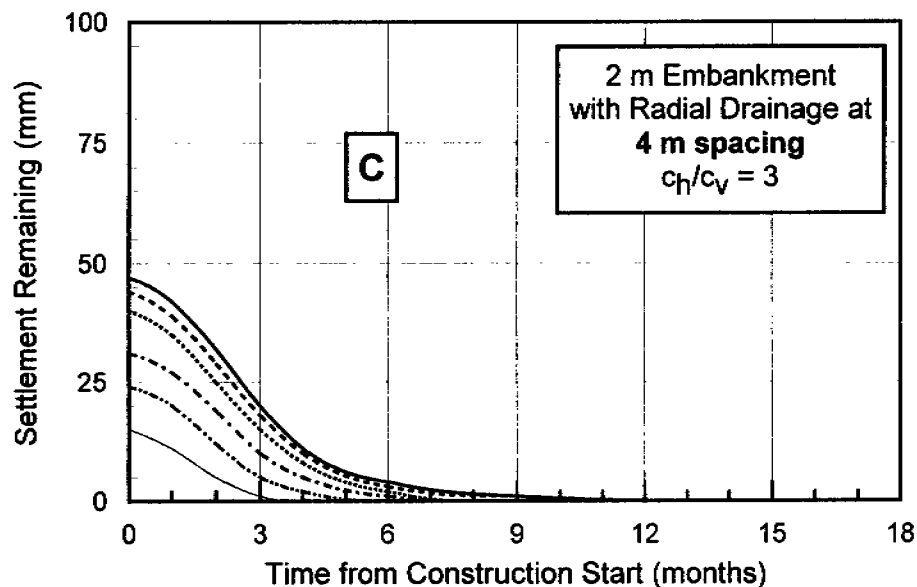
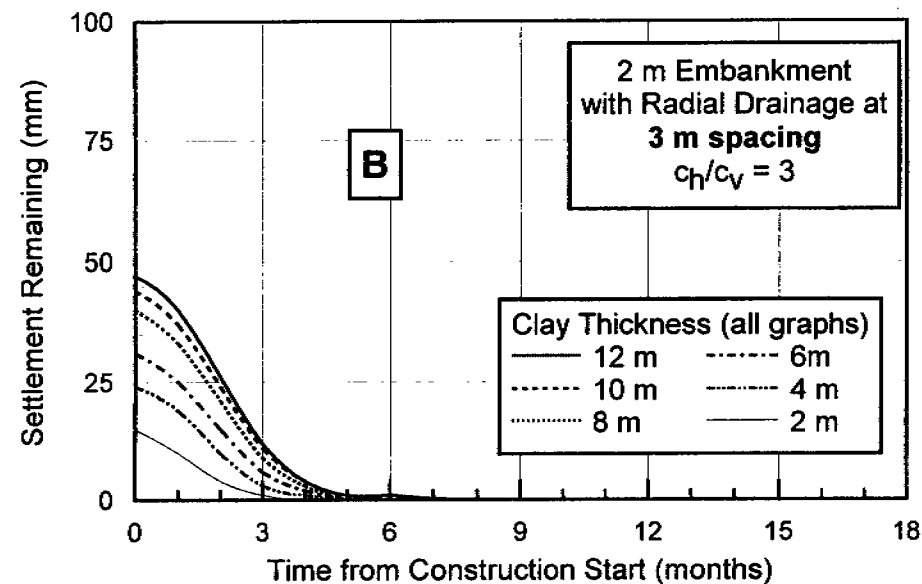
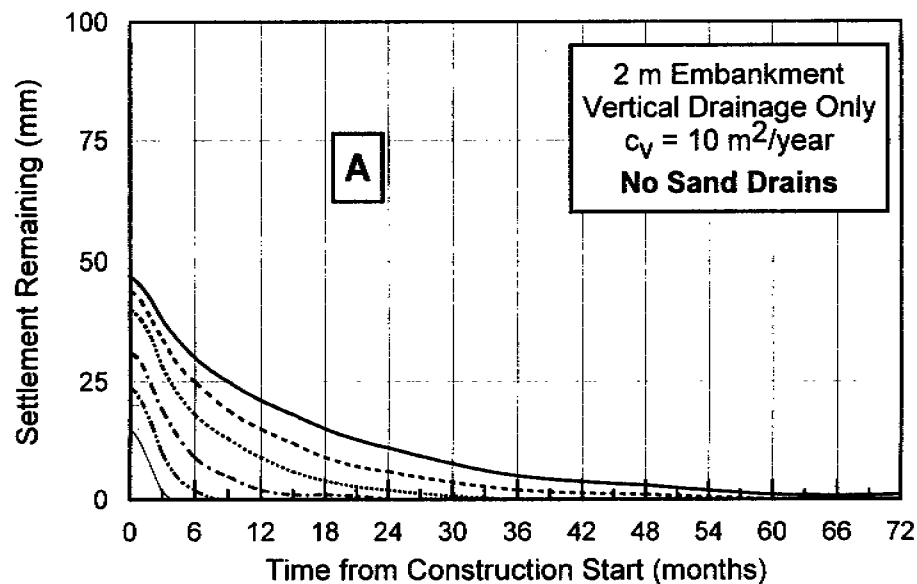
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Trout Creek By Pass - South Interchange

F98179-A/G

Dec 3/98

Figure A22



Charts based on 3 month (steady loading) construction period



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Thunder Bay, Ontario

### Estimated Rate of Centerline Consolidation Settlement 2 m High Embankment

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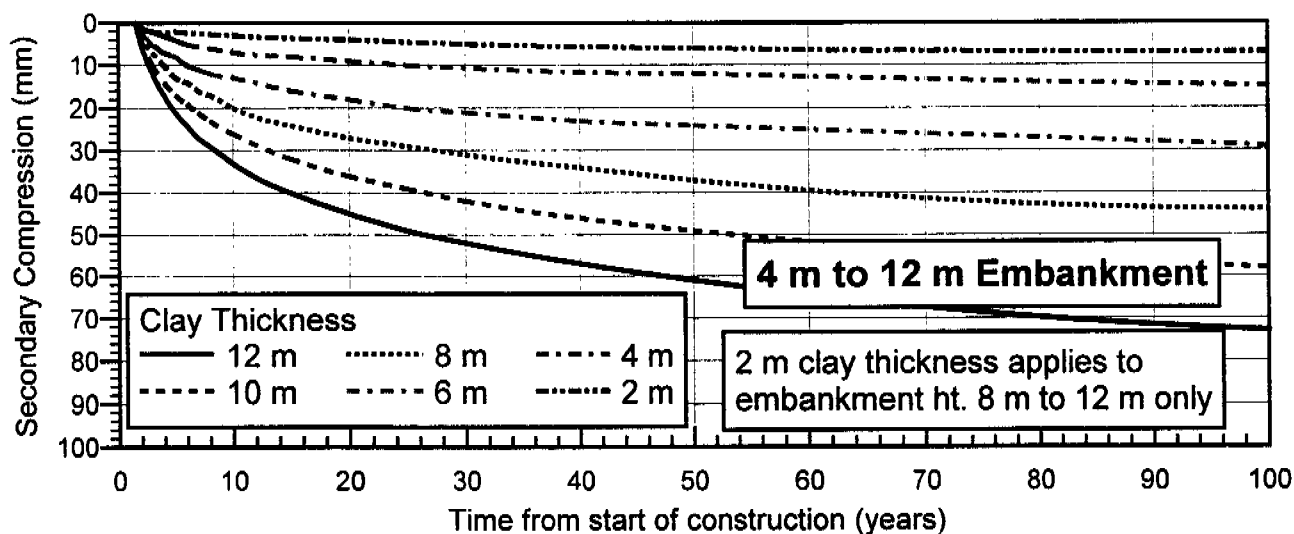
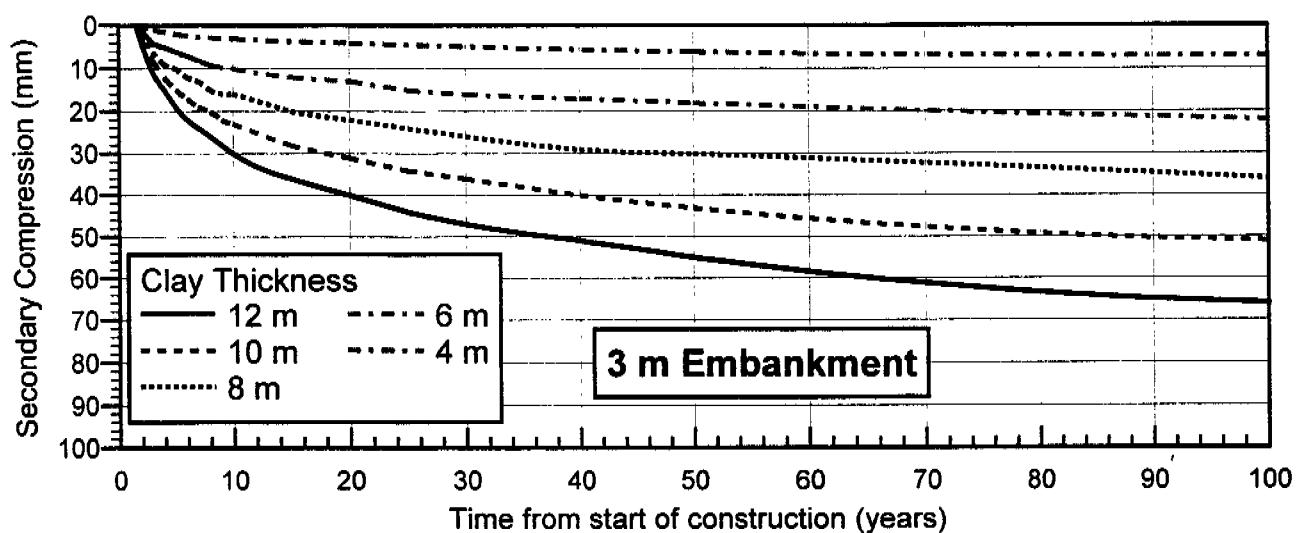
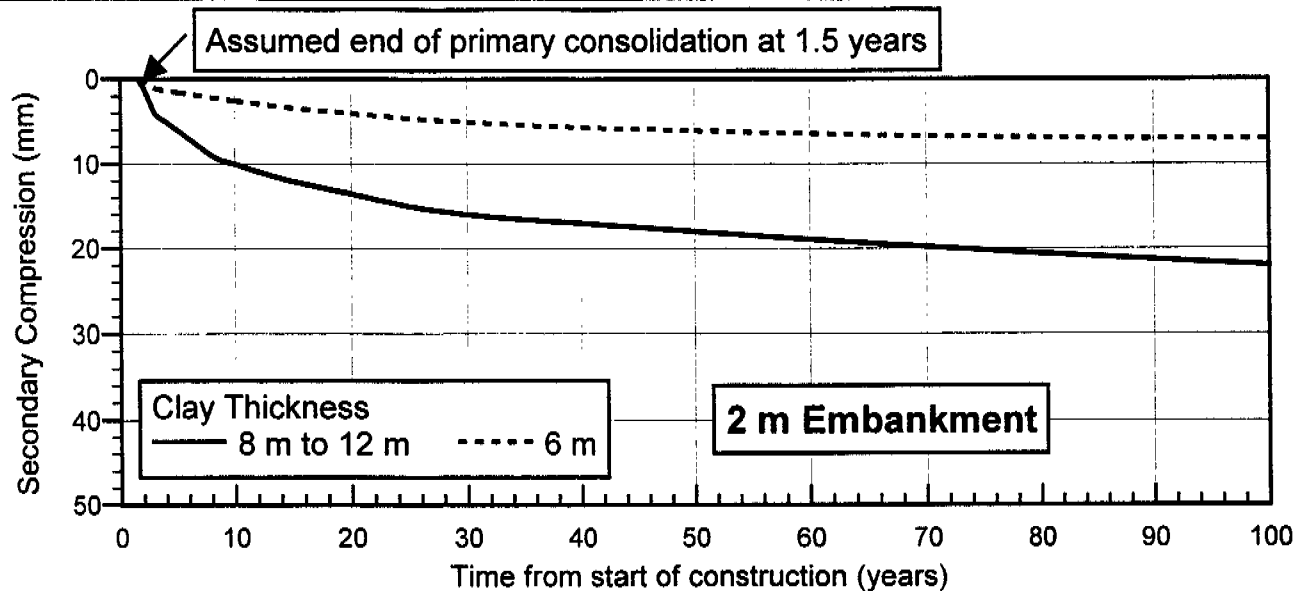
Trout Creek By Pass - South Interchange

F98179-A/G

Dec 3/98

Figure A23





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Thunder Bay, Ontario

Marshall Macklin Monaghan

### Estimated Embankment Settlement Due to Secondary Compression of Clay

Trout Creek By Pass - South Interchange

F98179-A/G

Oct 21/98

Figure A24

B

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# RECORD OF BOREHOLE BH-1FF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 692.1 N, 315 215.4 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow Stem Augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE May 29, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80		wp   — w —   wl					
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR		WATER CONTENT (%)					
							20 40 60 80		10 20 30 40						
313.33	GROUND SURFACE														
0.00	PEAT, black, wet. (very soft)														
312.71															
0.62	SILT, grey, some small root fibers, wet. (very loose)		1	SS	3								1% 21% 78%		
312.00															
1.33	SILTY CLAY, grey, wet, thinly laminated with SILT. (stiff to very stiff)		2	SS	3			X					0% 2% 98%		
			3	SS	4										
			4	SS	2										
			5	SS	3										
			6	TW											
			7	SS	2										
			8	SS	2										
303.33															
10.00	SILT, grey, wet, with thin clay seams, wet. (loose)		9	SS	8								0% 0% 100%		
301.83															
11.50	SAND & SILTY SAND, brown, wet, grading to SAND with GRAVEL. (very loose to compact)		10	SS	2								0% 72% 28%		
			11	SS	14										
298.33															
15.00	BIOTITE HORNBLENDE GNEISS, excellent rock quality, unweathered.		12	BQ									Rec. 100% RQD 93%		
			13	BQ									Rec. 100% RQD 96%		
295.19															
18.14	END OF BOREHOLE														
	Notes: 1) This borehole forms part of the South Interchange Foundation Investigation. 2) Borehole located at Station 9+955, offset 5 m right of centreline as referenced to Boundary Road. 3) Water level was at 0.2 m & hole was open to 0.5 m depth on completion.														



# RECORD OF BOREHOLE BH-2FF 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 726.3 N, 315 242.7 E	ORIGINATED BY I.D.
DIST 54 HWY 11	BOREHOLE TYPE Hollow Stem Augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE June 1, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80		wp  -----  w  -----  wl				WATER CONTENT (%) 10 20 30 40
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL    FIELD VANE LAB SHEAR						
313.32	GROUND SURFACE													
0.00	PEAT, black, wet. (very soft)						313							
311.89							312							
1.43	SILT, grey, some small root fibers, wet. (very loose)		1	SS	3		311							
310.82							310							
2.50	SILTY CLAY, grey, wet, thinly laminated with SILT or CLAYEY SILT. (stiff to soft)		2	SS	6		309							
			3	SS	6		308							
			4	TW			307							
			5	SS	2		306							
			6	SS	2		305							
303.52			7	SS	4		304							
9.80	SILT, with thin clay seams, grey, wet. (very loose)						303							
301.82							302							
11.50	SAND, brown, wet, grading to SAND with GRAVEL. (loose to compact)		8	SS	3		301							
			9	SS	11		300							
			10	SS	12		299							
			11	SS	6		298							
	Occasional cobble sizes at base.		12	SS	7		297							
294.38							296							
18.96	BIOTITE HORNBLENDE GNEISS, fair to good rock quality, slightly weathered.		13	BQ			295							
			14	BQ			294							
291.28							293							
22.04	END OF BOREHOLE						292							
<div>Notes: 1) This borehole forms part of the South Interchange Foundation Investigation. 2) Borehole located at Station "9+999, on centreline as referenced to Boundary Road. 3) Water level was at 0.2 m &amp; hole was open to 0.7 m depth on completion.</div>														



# RECORD OF BOREHOLE BH-3FF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 762.6 N, 315 271.4 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE June 2, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40					
313.17 0.00	GROUND SURFACE												
	PEAT, black, wet. (very soft)		1	SS	2							540	
311.80 1.37	SILT, trace of sand, grey, some small root fibers, wet. (loose)		2	SS	8								0% 22% 78%
310.87 2.30	SILTY CLAY, grey, wet, thinly laminated with SILT. (stiff to firm)		3	SS	7								CL
			4	SS	12							51	
			5	SS	1								
			6	SS	2							52	
			7	SS	3								0% 10% 90%
306.02 8.15	SILT, with thin clay seams, grey, wet. (very loose)		8	SS	8								
304.17 9.00	SAND & GRAVEL, some cobble sizes, brown, wet. (compact to dense)		9	SS	8								32% 60% 8%
			10	SS	46								
			11	SS	18								
			12	SS	35								
			13	SS	42								21% 59% 20%
294.63 18.54	BIOTITE HORNBLende GNEISS, good rock quality, unweathered.		14	SS	16								Rec. 100% RQD 89%
			15	BQ									
			16	BQ									Rec. 100% RQD 88%
281.59 21.58	END OF BOREHOLE												
Notes: 1) This borehole forms part of the South Interchange Foundation Investigation. 2) Borehole located at Station "10+045, offset "6 m left of centreline as referenced to Boundary Road. 3) Water level was at "0.2 m & hole was open to "0.9 m depth on completion.													



# RECORD OF BOREHOLE AP-12FF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 698.9 N, 315 209.3 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 9, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT				UNIT WEIGHT  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20   40   60   80				wp   ——— w   ——— wl					
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL   X   FIELD VANE LAB SHEAR 20   40   60   80				WATER CONTENT (%) 10   20   30   40					
313.41 0.00	GROUND SURFACE														GR   SA   (SI & CL)		
312.34 1.07	Probable PEAT																
	Probable SILT																
310.34 3.07																	
	Probable SILTY CLAY			VS													
				VS													
				VS													
303.81 9.60	END OF AUGER PROBE																
<p>Notes:</p> <p>1) This auger probe forms part of the South Interchange Foundation Investigation.</p> <p>2) Auger probe located at Station +9+956, offset -4 m left of centreline as referenced to Boundary Road.</p>																	



# RECORD OF BOREHOLE AP-13FF 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 729.1 N, 315 242.7 E	ORIGINATED BY I.D.
DIST 54 HWY 11	BOREHOLE TYPE Standard augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE July 10, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80	20 40 60 80	wp	w			wl	
313.29 0.00	GROUND SURFACE														
312.22 1.07	Probable PEAT														
	Probable SILT														
310.24 3.05	Probable SILTY CLAY with SILT														
			VS												
			VS												
303.69 9.60	END OF AUGER PROBE														
Notes: 1) This auger probe forms part of the South Interchange Foundation Investigation. 2) Auger probe located at Station +10+001, offset 2 m left of centreline as referenced to Boundary Road.															



# RECORD OF BOREHOLE AP-14FF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 754.4 N, 315 276.8 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 10, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER	TYPE		20	40	60	80					
313.07 0.00	GROUND SURFACE													
312.00 1.07	Probable PEAT													
310.02 3.05	Probable SILT													
	Probable SILTY CLAY with SILT			VS										
				VS										
				VS										
303.47 9.60	END OF AUGER PROBE			VS										
Notes: 1) This auger probe forms part of the South Interchange Foundation Investigation. 2) Auger probe located at Station 10+042, offset ~4 m right of centreline as referenced to Boundary Road.														





1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 700,5 N, 315 200,8 E

ORIGINATED BY I.D.

DIST 54 HWY 11

**BOREHOLE TYPE** Standard augers / Dynamic cone

COMPILED BY M.D.

**DATUM** Geodetic

DATE May 28, 1998

CHECKED BY D.G.

[illegible]

1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 728.4 N, 315 243.4 E

ORIGINATED BY I.D.

DIST 54 HWY 11

**BOREHOLE TYPE** Standard augers / Dynamic cone

COMPILED BY M.D.

DATUM Geodetic

DATE June 1, 1998

CHECKED BY D.G.

[illegible]

# RECORD OF BOREHOLE C-3FF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 753.7 N, 315 271.4 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / Dynamic cone

COMPILED BY M.D.

DATUM Geodetic

DATE June 2, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				CONE PENETRATION TEST			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	20	40						
313.07	GROUND SURFACE					313													
0.00	Dynamic cone penetration test only.																		
						312													
						311													
						310													
						309													
						308													
						307													
						306													
						305													
						304													
						303													
						302													
						301													
						300													
						299													
						298													
						297													
						296													
						295													
294.48 18.59	END OF CONE TEST BOUNCING REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER																		
	Notes: 1) This cone test forms part of the South Interchange Foundation Investigation. 2) Cone test located at Station 10+041.6, offset 5.0 m right of centreline as referenced to Boundary Road.																		



1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 795.3 N, 315 316.5 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic Cone / CME-55

COMPILED BY M.D.

**DATUM** Geodetic

DATE June 5, 1998

**CHECKED BY** D.G.

[illegible]

# RECORD OF BOREHOLE BH-1FP 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 943.9 N, 315 450.0 E	ORIGINATED BY I.D.
DIST 54 HWY 11	BOREHOLE TYPE Hollow Stem Augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE June 4, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION														
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80			wp	wl												
							SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)																	
					UNCONFINED QUICK TRIAXIAL		FIELD VANE LAB SHEAR																			
					20		40		60		80		10		20		30		40		GR		SA		(SI & CL)	
312.25	GROUND SURFACE																									
0.00	PEAT, brown, wet.																									
311.33																										
0.92	SILT, grey, moist to wet, local thin clay laminations. (compact)		1	SS	13																			0%	5%	95%
308.50			2	SS	17																					
3.75	SILTY CLAY, grey, wet, thinly laminated with SILT. (soft to firm)		3	SS	2																					
			4	SS	2																					
			5	SS	1																					
			6	SS	1																					
300.21																										
12.04	SILT, grey, wet, local SILTY CLAY or SANDY SILT layers. (loose to compact)		7	SS	6																					
			8	SS	9																					
296.55			9	SS	11																					
15.70	END OF BOREHOLE																									
<p>Notes:</p> <p>1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation.</p> <p>2) Borehole located at station +10+300, on centreline as referenced to Boundary Road.</p> <p>3) Water level was at 1.5 m &amp; hole was open to 4.7 m depth on completion.</p> <p>4) Borehole extended to full depth on August 13, 1998.</p>																										



# RECORD OF BOREHOLE BH-2FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 656.6 N, 315 172.3 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE June 8, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER TYPE			20 40 60 80	20 40 60 80	20 40 60 80	20 40 60 80	wp — w — wl	WATER CONTENT (%)		
313.91	GROUND SURFACE												
313.91	ORGANICS/PEAT												
0.30	SILT, grey, wet. (loose)												
312.51	SILTY CLAY, grey, wet, locally laminated. (stiff to firm)		1 SS 6										
1.40			2 SS 4										
			3 SS 4										
			4 SS 6										
306.91	SILT, grey, wet, trace of clay. (loose to compact)		5 SS 9										0% 10% 90%
7.00			6 SS 10										
306.21	SAND, brown, wet. (compact) Grading to SAND with GRAVEL. (compact to dense)		7 SS 13										
8.70			8 SS 10										
302.40	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER												3% 72% 25%
11.51	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station +9 + 900, on centreline as referenced to Boundary Road. 3) Water level was at ~0.7 m & hole was open to ~4.8 m depth on completion.												



# RECORD OF BOREHOLE BH-3FP 1 OF 1

METRIC

W.P. 774-93-00  
 DIST 54 HWY 11  
 DATUM Geodetic

LOCATION 5 091 670.8 N, 315 158.3 E  
 BOREHOLE TYPE Hollow Stem Augers / CME-55  
 DATE June 9, 1998

ORIGINATED BY I.D.  
 COMPILED BY M.D.  
 CHECKED BY D.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80						
								SHEAR STRENGTH: Cu, KPa						
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR					
							20 40 60 80		wp — w — wl			WATER CONTENT (%) 10 20 30 40		
314.18	GROUND SURFACE													
313.92	ORGANICS/PEAT													
0.46	SILT, grey, moist, trace of CLAY. (compact)													
312.68														
1.50	SILTY CLAY, grey, wet, thinly laminated with SILT. (stiff to firm)		1	SS	9				120					
			2	TW									18.30	
309.68														
4.50	SILT, grey, wet, local thin CLAY or fine SAND layers. (loose)		3	SS	6									
			4	SS	6									0% 27% 73%
306.98														
7.20	SAND, brown, wet grading to SILTY SAND with GRAVEL. (compact to dense)		5	SS	11									
			6	SS	13									
			7	SS	31									34% 50% 16%
302.75														
11.43	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER													
	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station +9+900, offset 20 m left of centreline as referenced to Boundary Road. 3) Water level was at 2.0 m & hole was open to 6.0 m depth on completion.													



# RECORD OF BOREHOLE BH-4FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 642.4 N, 315 186.4 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE June 9, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER TYPE			20 40 60 80	20 40 60 80	wp	wl		
313.62	GROUND SURFACE										
0.00	ORGANICS/PEAT										
312.85											
0.77	SILT, gray, wet.										
312.12	(compact)										
1.50	SILTY CLAY, gray, wet, thinly laminated with SILT. (stiff to soft)		1 SS 8								
			2 SS 3								
			3 TW								
			4 SS 2								
306.62											
7.00	SILT, gray, wet, trace of clay. (loose)		5 SS 7								
			6 SS 2								
304.82											
8.80	SAND, gray, wet, grading to SAND with GRAVEL. (very loose to compact)		7 SS 5								
301.28											
12.34	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER										
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station ~9+900, offset ~20 m right of centreline as referenced to Boundary Road. 3) Water level was at ~0.5 m & hole was open to ~5.6 m depth on completion.											





# RECORD OF BOREHOLE BH-5FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 691.8 N, 315 207.9 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow Stem Augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 8, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20    40    60    80				wp ——— w ——— wl				
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
							UNCONFINED QUICK TRIAXIAL      FIELD VANE      LAB SHEAR									
							20    40    60    80				10    20    30    40					
313.33	GROUND SURFACE															
0.00	PEAT, black to brown, wet. (soft)															
312.23																
1.10	SILT, grey, wet, thin CLAY laminations. (loose)		1	SS	5											
311.23																
2.10	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)		2	SS	2											
			3	SS	1											
			4	SS	0											
			5	SS	5											
304.83																
8.60	SILT, grey, wet, trace of CLAY. (loose)		6	SS	4											
303.33																
10.00	SAND, brown, wet, grading to SAND with GRAVEL. (loose to compact)		7	SS	9											
			8	SS	10											
			9	SS	13											
289.16																
14.17	END OF BOREHOLE															
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station 9+950, on centreline as referenced to Boundary Road. 3) Water level was at 1.0 m & hole was open to 4.7 m depth on completion.																



# RECORD OF BOREHOLE BH-6FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 762.2 N, 315 278.9 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow Stems / Cone / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 4, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20 40 60 80	20 40 60 80			
313.13 0.00	GROUND SURFACE					313					
	ORGANICS/PEAT, black, wet, woody. (very soft)										
311.61 1.52	SILT to SANDY SILT, grey, wet. (compact)		1	SS	18						
310.63 2.50	SILTY CLAY, grey, wet, laminated with SILT. (stiff to soft)		2	SS	8						
			3	SS	2						
			4	TW							
305.63 7.50	SAND and SAND with GRAVEL, brown, wet. (compact)		5	SS	12						
303.99 9.14	END OF BOREHOLE HOLLOW STEM AUGERS PLUGGED										
	(See Note 3)										
296.27 16.86	END OF CONE TEST AT "16.9 m DEPTH BOUNCING REFUSAL ON PROBABLE BOULDER OR POSSIBLE BEDROCK										
	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station 10+050, on centreline as referenced to Boundary Road. 3) Dynamic cone penetration test driven 1.2 m east of BH-6FP.										



# RECORD OF BOREHOLE BH-7FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 797.4 N, 315 314.4 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow Stem Augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 5, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER TYPE BLOWS/0.3m			20 40 60 80	20 40 60 80	wp	wl		
313.44	GROUND SURFACE										
0.00	ORGANICS/PEAT, brown, wet, woody. (very soft)										
311.78			1 SS 15		313						
1.68	SILT to SANDY SILT, grey, wet. (compact)				312					276.2	
310.74			2 SS 12		311						
2.70	SILTY CLAY, grey, wet, laminated with SILT. (stiff to soft)				310		120				
			3 SS 2		309						
			4 TW		308						
			5 SS 1		307						
			6 SS 2		306						
302.94			7 SS 6		305		S-8				
10.50	SILT, grey, wet, local SILTY CLAY or SANDY SILT layers. (loose)				304						
			8 SS 7		303						
300.79					302						
12.65	END OF BOREHOLE				301						
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station 10+100, on centreline as referenced to Boundary Road. 3) Water level was at 0.7 m & hole was open to 5.7 m depth on completion.											



## 1 OF 1

METRIC

LOCATION 5 091 811.6 N. 315 300 3 E

ORIGINATED BY I.D.

BOREHOLE TYPE Hollow Stem Augers / CME-55

COMPILED BY M.D.

DATE June 8, 1998

**CHECKED BY** D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80		wp  -----  w  -----  wl			
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL      FIELD VANE LAB SHEAR		WATER CONTENT (%) 10 20 30 40			
313.65	GROUND SURFACE												
0.00	ORGANICS/PEAT, brown, wet, woody. (very soft)												
312.13													
1.52	SILT to SANDY SILT, grey, wet. (compact)		1	SS	10								
311.15													
2.60	SILTY CLAY, grey, wet, laminated with SILT. (stiff to soft)		2	SS	9								
			3	TW									
			4	SS	3								
			5	SS	4								
			6	SS	5								
303.65													
10.00	SILT, grey, wet, local SILTY CLAY or SANDY SILT layers. (loose)		7	SS	6								
			8	SS	5								
301.00													
12.65	END OF BOREHOLE												
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station ~10+100, offset ~25 m left of centreline as referenced to Boundary Road. 3) Water level was at ~0.8 m & hole was open to ~5.5 m depth on completion.													

# RECORD OF BOREHOLE BH-9FP 1 OF 1

METRIC

W.P. 774-93-00  
 DIST 54 HWY 11  
 DATUM Geodetic

LOCATION 5 091 783.2 N, 315 328.5 E  
 BOREHOLE TYPE Hollow Stem Augers / CME-55  
 DATE June 8, 1998

ORIGINATED BY I.D.  
 COMPILED BY M.D.  
 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	wp	w		wl	GR	SA	(SI & CL)
312.92	GROUND SURFACE																	
0.00	ORGANICS/PEAT, brown, wet, woody. (very soft)																	
311.24			1	SS	11													
1.68	SILT to SANDY SILT, grey, wet. (compact)																	
310.42			2	TW														
2.50	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)																	
			3	SS	1													
			4	SS	3													
			5	SS	2													
			6	SS	4													
302.92			7	SS	9													
10.00	SILT, grey, wet, local SILTY CLAY or SANDY SILT layers. (loose)																	
			8	SS	8													
300.27	END OF BOREHOLE																	
12.65	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station +10 + 100, offset ~25 m right of centreline as referenced to Boundary Road. 3) Water level was at ~1.3 m & hole was open to ~4.9 m depth on completion.																	



# RECORD OF BOREHOLE BH-11FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 663.7 N, 315 270.8 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 9, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80				wp   — w —   wl				
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
								UNCONFINED QUICK TRIAXIAL      FIELD VANE LAB SHEAR				10 20 30 40				
313.16	GROUND SURFACE															
0.00	PEAT, brown, wet. (very soft)															
311.94																
1.22	SILT, grey, wet. (loose)		1	SS	6											
310.66																
2.50	SILTY CLAY, grey, wet, locally thinly laminated with SILT. (stiff to soft)		2	SS	7											
			3	TW												
			4	SS	2											
			5	SS	1											
			6	TW												
			7	SS	3											
301.66																
11.50	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose to compact)		8	SS	6											
			9	SS	11											
298.66																
14.50	SAND, brown, wet, grading to SAND with GRAVEL. (loose to dense)		10	SS	7											
			11	SS	43											
294.93																
18.23	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at station "8+665, on centreline as referenced to the Highway 11 Median. 3) Water level was at ~0.5 m & hole was open to ~11.1 m depth on completion.																



# RECORD OF BOREHOLE BH-15FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 795.8 N, 315 404.9 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 13, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp	w	wl		
312.55 0.00	GROUND SURFACE														
311.48 1.07	PEAT, brown, wet. (very soft)														
309.75 3.80	SILT to SANDY SILT, grey, wet. (compact to dense)		1	SS	11										
			2	SS	36										
	SILTY CLAY, grey, wet, locally thinly laminated with SILT. (firm to soft)		3	SS	2										
			4	TW											
			5	SS	2										
			6	TW											
302.30 10.25	SILT, grey, wet, locally thin SILTY CLAY or SANDY SILT layers. (loose to compact)		7	SS	6										
			8	SS	9										
			9	SS	10										
297.35 15.20	SAND, grey, wet, grading to SAND with GRAVEL. (compact to very dense)		10	SS	9										
			11	SS	25										
			12	SS	156										
291.52 21.03	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+400.0, offset ~4.0 m left of centreline as referenced to the EW-N Ramp. 3) Water level was at ~0.2 m & hole was open to ~7.0 m depth on completion.															



# RECORD OF BOREHOLE BH-16FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 706.5 N, 315 438.0 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 13, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
312.27	GROUND SURFACE					312									
0.00	PEAT, brown, wet. (very soft)														
311.42															
0.85	SILTY SAND, grey, wet. (compact)		1	SS	10										
309.77						311									
2.50	SILT to SANDY SILT, grey, wet. (compact to loose)		2	SS	31										
306.77						310									
5.50	SILTY CLAY, grey, wet, thinly laminated with SILT. (soft to firm)		3	SS	7										
			4	SS	2										
			5	TW											
			6	SS	2										
			7	SS	2										
			8	SS	3										
			9	SS	6										
297.27						309									
15.00	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose to compact)		10	SS	9										
			11	SS	14										
						308									
						307									
						306									
						305									
						304									
						303									
						302									
						301									
						300									
						299									
						298									
						297									
						296									
						295									
						294									
						293									
						292									
291.07						291									
21.20	SAND to SAND WITH GRAVEL, grey, wet. (compact to dense)		12	SS	29										
						290									
						289									
						288									
						287									
						286									
285.60															
26.67	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station														





8+500.0, on centreline as  
referenced to the EW-N Ramp.  
3) Water level was at ~0.3 m &  
hole was open to ~20.9 m depth  
on completion.

# RECORD OF BOREHOLE BH-17FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 652.2 N, 315 362.8 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE July 14, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
312.58 0.00	GROUND SURFACE														
311.51 1.07	PEAT, brown, wet. (very soft)														
308.58 4.00	SANDY SILT, grey, wet. (compact)		1	SS	10										
			2	SS	17										
			3	SS	2										
	SILTY CLAY, grey, wet, locally thinly laminated with SILT. (soft to firm)		4	SS	2										
			5	SS	2										
			6	SS	2										
			7	SS	3										
			8	SS	4										
			9	SS	6										
			10	SS	6										
296.08 16.50	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (compact)														
291.24 21.34	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation investigation. 2) Borehole located at Station 8+600.0, on centreline as referenced to the EW-N Ramp. 3) Water level was at ~0.4 m & hole was open to ~11.8 m depth on completion.															



# RECORD OF BOREHOLE BH-18FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 651.9 N, 315 083.6 E

ORIGINATED BY R.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 15, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp	w	wl			
316.28	GROUND SURFACE															
0.00	TOPSOIL															
315.68	SAND WITH GRAVEL, brown, wet. (compact to dense)		1	SS	13											
0.60			2	SS	38											
312.09	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
4.17	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 9+075.0, on centreline as referenced to the W-S Ramp. 3) Water level was at surface & hole was open to 3.0 m depth on completion.															



# RECORD OF BOREHOLE BH-19FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 723.4 N, 315 023.1 E ORIGINATED BY R.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE July 15, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			CONE PENETRATION TEST								
							20	40	60	80					
							SHEAR STRENGTH: Cu, KPa								
							UNCONFINED QUICK TRIAXIAL	X	FIELD VANE LAB SHEAR						
							20	40	60	80					
							WATER CONTENT (%)								
							10	20	30	40					
321.83	GROUND SURFACE														
321.83	TOPSOIL														
0.30	SAND WITH GRAVEL, brown, wet.														
	(compact)														
319.85			1	SS	25										
1.98	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+990.0, offset ~20.0 m right of centreline as referenced to the EW-S Ramp. 3) Water level was at ~0.9 m & hole was open to ~1.8 m depth on completion.														



# RECORD OF BOREHOLE BH-20FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 092 031.6 N, 315 042.8 E ORIGINATED BY R.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE July 15, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m					wp   — w —   wl					
												WATER CONTENT (%)					
							SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR										
319.18	GROUND SURFACE						20	40	60	80							
318.83	TOPSOIL																
0.15	SAND WITH GRAVEL, brown, damp. (dense to very dense)																
			1	SS	56												
			2	SS	50												
315.52	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																
3.66	Notes: 1) This borehole forms part of the South Interchange Approach Foundation Investigation. 2) Borehole located at Station 9+100.0, on centreline of Highway 11 Median. 3) Borehole was dry & open to 3.0 m depth on completion.																



# RECORD OF BOREHOLE BH-21FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 954.4 N, 315 106.3 E ORIGINATED BY R.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE July 15, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION		
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER			TYPE	BLOWS/30.3m	20	40	60	80	wp	w			wl	10
314.88	GROUND SURFACE																
314.08	TOPSOIL																
0.30	SILTY SAND, brown, damp. (compact)		1	SS	15												
311.93	SAND to SAND WITH GRAVEL, damp to wet. (compact to dense)		2	SS	31												
2.75			3	SS	16												
			4	SS	50												
307.97	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																
6.71	Notes: 1) This borehole forms part of the South Interchange Approach Foundation Investigation. 2) Borehole located at Station 9+000.0, on centreline of Highway 11 Median. 3) Water level was at ~0.9 m & hole was open to ~5.8 m depth on completion.																



# RECORD OF BOREHOLE BH-22FP 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 872.4 N, 315 163.5 E	ORIGINATED BY R.M.
DIST 54 HWY 11	BOREHOLE TYPE Hollow stem augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE July 15, 1998	CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m					
313.55	GROUND SURFACE											
0.00	ORGANICS/PEAT											
312.95												
0.60	SILT, grey, moist, trace of CLAY. (loose)		1	SS	9							
311.05												
2.50	SILTY CLAY, stratified, grey, moist. (soft)		2	SS	4							
308.05												
4.50	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose)		3	SS	7							
306.05												
7.50	SAND WITH GRAVEL, grey, wet. (very dense)		4	SS	2							
304.41												
9.14	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER											
	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+900.0, on centreline of Median as referenced to Boundary Road. 3) Water level was at ~1.2 m & hole was open to ~6.1 m depth on completion.											



# RECORD OF BOREHOLE BH-23FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 786.1 N, 315 213.9 E

ORIGINATED BY R.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 16, 1998

CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
313.41	GROUND SURFACE														
0.00	PEAT, black, wet. (very soft)														
312.01															
1.40	SILT, grey, moist, with SILTY CLAY laminations. (compact)		1	SS	11										
310.91	SILTY CLAY, grey, wet, locally thinly laminated with SILT. (firm to soft)		2	SS	3										
2.50			3	SS	2										
307.51			4	SS	4										
5.90	SILT, grey, wet, local thin SILTY CLAY layers. (loose to very loose)		5	SS	2										
304.61			6	SS	3										
8.80	SAND, brown, wet, fine to medium grained. (loose)														
302.28															
11.13	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+800.0, on centreline of the Highway 11 Median. 3) Water level was at ~1.1 m & hole was open to ~9.1 m depth on completion.															





# RECORD OF BOREHOLE BH-24FP 1 OF 1

## METRIC

W.P. 774-93-00 LOCATION 5 091 768.6 N, 315 180.4 E ORIGINATED BY R.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE July 16, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp	w	wl					
313.57	GROUND SURFACE																	
0.00	PEAT, black, wet. (very soft)																	
312.20																		
1.37	SILT, grey, wet, with SILTY CLAY laminations. (loose)		1	SS	8													
311.07																		
2.50	SILTY CLAY, grey, wet, locally laminated with SILT. (firm)		2	SS	6													
308.37			3	SS	3													
5.20	SILT, grey, wet, local thin SILTY CLAY layers. (loose)																	
306.07			4	SS	9													
7.50	SAND to SAND WITH GRAVEL, grey, wet. (loose to compact)																	
306.07			5	SS	9													
7.50																		
302.75			6	SS	13													
10.82																		
302.75	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR PROBABLE BOULDER																	
10.82	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+800.0, on centreline of EW-S Ramp. 3) Water level was at ~0.8 m & hole was open to ~9.1 m depth on completion.																	



# RECORD OF BOREHOLE BH-25FP 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 596.7 N, 315 275.6 E	ORIGINATED BY S.M.
DIST 54 HWY 11	BOREHOLE TYPE Hollow stem augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE August 17, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLLOT	NUMBER	TYPE			20	40					
313.15	GROUND SURFACE												
0.00	PEAT, black, wet. (very soft)												
312.39	SILT to SANDY SILT, grey, wet. (loose)		1	SS	6								
0.76													
310.10	SILTY CLAY, grey, wet, locally thinly laminated with SILT. (stiff to soft)		2	SS	6								
3.05			3	SS	1								
			4	TW									
			5	SS	1								
			6	SS	0								
			7	SS	4								
301.87	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose)		8	SS	6								
11.28			9	SS	4								
			10	SS	7								
297.76	SAND, brown, wet, grading to SAND with GRAVEL. (loose to compact)		11	SS	22								
15.39													
295.93	END OF BOREHOLE												
17.22	<b>Notes:</b> 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station +8+600, on centreline of southbound lane. 3) Water level was at -1.1 m & hole was open to -9.9 m depth on completion.												



# RECORD OF BOREHOLE BH-26FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 511.5 N, 315 339.9 E

ORIGINATED BY S.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE September 17, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER			TYPE	BLOWS/0.3m	20	40					
313.15	GROUND SURFACE													
0.00	PEAT, black, wet. (very soft)													
311.63	SILT to SANDY SILT, grey, wet, local fine SAND layers. (loose)		1	SS	4									
309.65	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)		2	SS	7									
308.65			3	SS	1									
307.65			4	SS	0									
306.65			5	SS	0									
305.65			6	TW										
304.65			7	SS	0									
303.65			8	SS	7									
302.65			9	SS	11									
302.25	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose to compact)		10	SS	22									
301.25			11	SS	27									
297.91	SAND, grey brown, wet, grading to SAND with GRAVEL. (compact)													
295.83	END OF BOREHOLE													

## Notes:

- 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation.
- 2) Borehole located at Station -8+500, on centreline of northbound lane.
- 3) Water level was at ~1.2 m & hole was open to ~7.2 m depth on completion.



# RECORD OF BOREHOLE BH-27FP 1 OF 1

## METRIC

W.P. 774-93-00 LOCATION 5 091 412.3 N, 315 361.0 E ORIGINATED BY S.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE September 18, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/10.3m	20					
313.24	GROUND SURFACE												
0.00	PEAT, black, wet. (very soft)												
311.56			1	SS	5								
1.68	SILT to SILTY SAND, grey, wet. (loose)												
310.19			2	SS	5								
3.05	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)												
			3	TW									
			4	SS	2								
			5	SS	0								
			6	TW									
302.57			7	SS	3								
10.67	SILT, grey, wet, local thin SILTY CLAY layers. (loose)												
300.92			8	SS	16								
12.32	SAND, brown, wet, grading to SAND with GRAVEL. (compact to dense)												
289.07			9	SS	35								
14.17	END OF BOREHOLE												
<b>Notes:</b> 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station "8+400, on centreline of northbound lane. 3) Water level was at ~1.2 m & hole was open to ~7.2 m depth on completion.													



# RECORD OF BOREHOLE BH-28FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 311.6 N, 315 374.0 E ORIGINATED BY S.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE September 18, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40					
313.09 0.00	GROUND SURFACE												
	PEAT, black, wet. (very soft)												
311.41 1.68	SILTY SAND to SILT, grey, wet. (loose)		1	SS	3								
310.04 3.05	SILTY CLAY, grey, wet, thinly laminated with SILT. (stiff to soft)		2	SS	11								
			3	SS	2								
			4	TW									
			5	SS	0								
			6	SS	4								
			7	SS	2								
300.90 12.19	SILT, grey, wet. (loose)		8	SS	5								
299.99 13.10	SAND, brown, wet, grading to SAND with GRAVEL, local cobbles. (dense)		9	SS	44								
297.39 15.70	END OF BOREHOLE		10	SS	49								
<p>Notes:</p> <p>1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation.</p> <p>2) Borehole located at Station +8+300, on centreline of northbound lane.</p> <p>3) Water level was at surface &amp; hole was open to 6.8 m depth on completion.</p>													



# RECORD OF BOREHOLE BH-29FP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 209.9 N, 315 341.5 E ORIGINATED BY S.M.  
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE September 21, 1998 CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION							
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80						wp — w — wl						
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR 20 40 60 80						WATER CONTENT (%) 10 20 30 40						
313.48	GROUND SURFACE																			
0.00	PEAT, black, wet. (very soft)																			
312.87	SANDY CLAY to SILTY CLAY, grey, moist, grey, moist to wet. (stiff)		1	SS	9															
310.43	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)		2	SS	4															
3.05			3	SS	3															
			4	TW																
			5	SS	3															
			6	SS	5															
304.03	SILT to SANDY SILT, grey brown, wet. (loose)		7	SS	5															
9.45																				
302.08	SAND to SAND with GRAVEL, brown, wet, local cobbles.		8	SS	20															
11.40																				
299.31	END OF BOREHOLE		9	SS	43															
14.17	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station ~8+200, on centreline of southbound lane. 3) Water level was at ~2.5 m & hole was open to ~7.8 m depth on completion.																			



# RECORD OF BOREHOLE BH-30FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION

ORIGINATED BY S.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE September 21, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER	TYPE		20	40	60	80					
313.00	GROUND SURFACE													
0.00	PEAT, black, wet. (very soft)													
311.32			1	SS	5									
1.68	SILTY SAND to SANDY SILT, grey, wet. (loose to compact)		2	SS	12									
			3	SS	26									
307.52			4	SS	0									
5.48	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)		5	TW										
			6	SS	0									
			7	SS	0									
			8	SS	0									
299.89			9	SS	5									
13.11	SILT, grey, wet, local thin CLAY or SILTY CLAY layers in upper zone, thin SANDY layers with depth. (loose to compact)		10	SS	7									
			11	SS	11									
294.45			12	SS	13									
18.55	SAND to SAND with GRAVEL, brown, wet, local cobbles. (compact to dense)		13	SS	54									
292.73														
20.27	END OF BOREHOLE													
<b>Notes:</b> 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station "8+500, on centreline of S-E/W ramp. 3) Water level was at ~1.4 m & hole was open to ~10.2 m depth on completion.														



# RECORD OF BOREHOLE BH-31FP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 606.8 N, 315 417.2 E

ORIGINATED BY S.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE September 22, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m	20	40	60	80	wp			w
312.57	GROUND SURFACE														
0.00	PEAT, black, wet. (very soft)														
311.35															
1.22	SILTY SAND to SANDY SILT, grey, wet. (loose to compact)		1	SS	7										
			2	SS	24										
308.30															
4.27	SILTY CLAY, grey, wet, thinly laminated with SILT. (stiff to soft)		3	SS	6										
			4	TW	0										
			5	SS	0										
			6	SS	0										
			7	TW											
			8	SS	1										
			9	SS	5										
			10	SS	2										
			11	SS	3										
294.32															
18.25	SILT, grey, wet, local thin CLAY or SILTY CLAY layers. (loose)		12	SS	7										
			13	SS	5										
291.27															
21.30	SILT to SILTY SAND, grey, wet. (loose to compact)		14	SS	9										
			15	SS	11										
287.92															
24.65	SAND to SAND with GRAVEL, brown, wet. (compact to dense)		16	SS	16										
286.20															
26.37	END OF BOREHOLE		17	SS	33										
Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station 8+600, on centreline of S-E/W ramp. 3) Water level was at ~1.4 m & hole was open to ~11.8 m depth															





on completion.

# RECORD OF BOREHOLE BH-32FP 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION 5 091 904.5 N, 315 419.4 E	ORIGINATED BY S.M.
DIST 54 HWY 11	BOREHOLE TYPE Hollow stem augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE September 23, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION  GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			CONE PENETRATION TEST						
								20	40					
313.07	GROUND SURFACE													
0.00	PEAT, black, wet. (very soft)													
312.16	SILT to SANDY SILT, grey, wet. (compact)		1	SS	12									
0.91			2	SS	24									
308.96	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)		3	SS	2									
4.11			4	TW										
			5	SS	0									
			6	SS	1									
			7	SS	0									
			8	TW										
			9	SS	3									
297.83	SILT, grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose)		10	SS	8									
15.24			11	SS	6									
294.78	SAND, brown to grey, wet, local thin SILTY CLAY or SANDY SILT layers. (loose to dense)		12	SS	1									
18.28			13	SS	39									
292.65	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER													
20.42	Notes: 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Borehole located at Station +10 + 250, on centreline of Boundary Road. 3) Water level was at ~1.4 m & hole was open to ~10.5 m depth on completion.													



# RECORD OF BOREHOLE BH-33FP 1 OF 1

## METRIC

W.P. 774-93-00	LOCATION	ORIGINATED BY S.M.
DIST 54 HWY 11	BOREHOLE TYPE Hollow stem augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE November 26, 1998	CHECKED BY D.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80				wp — w — wl				
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
0.00	GROUND SURFACE															
0.00	GRAVEL (FILL)															
0.45	PEAT, black, wet. (very soft)															
-1.20	SILT to SANDY SILT, grey, wet. (loose to compact)															
1.20			1	SS		27										
-4.57	SILTY CLAY, grey, wet, thinly laminated with SILT. (firm to soft)															
4.57			2	SS		2										
			3	TW												
			4	SS		3										
			5	TW												
-16.50	SILT, grey, wet. (loose)															
16.50																
-18.60	SAND (loose) .M-SAND		6	SS		4										
18.60	END OF BOREHOLE															
-18.75																
18.75																

Notes:

1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation.

2) Borehole located at Station -10+350, offset -26 m right of centreline of Boundary Road.

3) Water level was at -1.8 m & hole was open to -13.6 m depth on completion.

Notes:  
 1) This borehole forms part of the South Interchange (Boundary Road) Approach Foundation Investigation.  
 2) Borehole located at Station 10+350, offset 26 m right of centreline of Boundary Road.  
 3) Water level was at 1.8 m & hole was open to 13.6 m depth on completion.



# RECORD OF BOREHOLE C-1FP

1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 621.4 N, 315 136.8 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic Cone / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 5, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLAT	NUMBER			TYPE	BLOWS/0.3m	20 40 60 80	20 40 60 80	wp		
315.48	GROUND SURFACE											
0.00	Dynamic cone penetration test only.											
315												
314												
313												
312												
311												
310												
309.58	END OF CONE TEST BOUNCING REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER											
5.88	Notes: 1) This cone test forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Cone test located at station 9+850, on centreline as referenced to Boundary Road.											



# RECORD OF BOREHOLE C-2FP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 832.6 N, 315 349.9 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic Cone / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE June 5, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT			NATURAL MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER			TYPE	BLOWS/0.3m	CONE PENETRATION TEST				wp	w	wl	WATER CONTENT (%)		
						SHEAR STRENGTH: Cu, KPa											
						UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR											
						20 40 60 80				10 20 30 40							
314.90	GROUND SURFACE																
0.00	Dynamic cone penetration test only.																
305.78	END OF CONE TEST																
9.14	Notes: 1) This cone test forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Cone test located at station 10+150, on centreline as referenced to Boundary Road.																



# RECORD OF BOREHOLE C-3FP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 091 904.5 N, 315 419.4 E ORIGINATED BY I.D.  
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic Cone / CME-55 COMPILED BY M.D.  
 DATUM Geodetic DATE June 5, 1998 CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m					
313.07	GROUND SURFACE				313							
0.00	Dynamic cone penetration test only.											
					312							
					311							
					310							
					309							
					308							
					307							
					306							
305.45	END OF CONE TEST											
7.62	Notes: 1) This cone test forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Cone test located at station ~10+250, on centreline as referenced to Boundary Road.											



# RECORD OF BOREHOLE C-5FP

1 OF 1

METRIC

W.P. 774-93-00

LOCATION 5 091 654.5 N, 315 151.6 E

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic Cone / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 5, 1998

CHECKED BY D.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		CONE PENETRATION TEST		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m	UNCONFINED QUICK TRIAXIAL	Cu, KPa	FIELD VANE LAB SHEAR	wp	w	wl	10	20		
313.91	GROUND SURFACE																
0.00	Dynamic cone penetration test only.																
302.51																	
11.40	END OF CONE TEST BOUNCING REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER																
	Notes: 1) This cone test forms part of the South Interchange (Boundary Road) Approach Foundation Investigation. 2) Cone test located at station +9+898, offset ~1 m right of centreline as referenced to Boundary Road.																



**S07524G/F/G**

**TABLE 1-1**  
**ROCK CORE DESCRIPTION**

BH#	Core Recovery				Core Description	
	Rock Core No.	Depth (m)	% CR*	% RQD**	Depth (m)	Description
<b>SOUTH INTERCHANGE FOUNDATIONS</b>						
1FF	12	15.00 to 16.52	100	93	15.00 to 18.14	<b>Biotite Hornblende Gneiss (Garnetigerous)</b> , white to grey pink, medium to coarse grained, some sulphate inclusions unweathered, fractures widely spaced, dipping at 45° from vertical, planar, smooth
	13	16.52 to 18.14	100	96		
2FF	13	18.96 to 20.39	100	69	18.96 to 22.04	<b>Biotite Hornblende Gneiss</b> , white to pink, medium to coarse grained, slightly unweathered, strong fractures widely spaced, dipping at 45° to 90° from vertical, planar, smooth
	14	20.39 to 22.04	100	72		
3FF	15	18.53 to 20.06	100	89	18.53 to 21.58	<b>Biotite Hornblende Gneiss (Garnetigerous)</b> , white to pink, medium to coarse grained, unweathered, strong fractures widely spaced, dipping at 90° from vertical, planar, smooth
	16	20.56 to 21.58	100	88		

\*CR = Core Recovery  
\*\*RQD = Rock Quality Designation

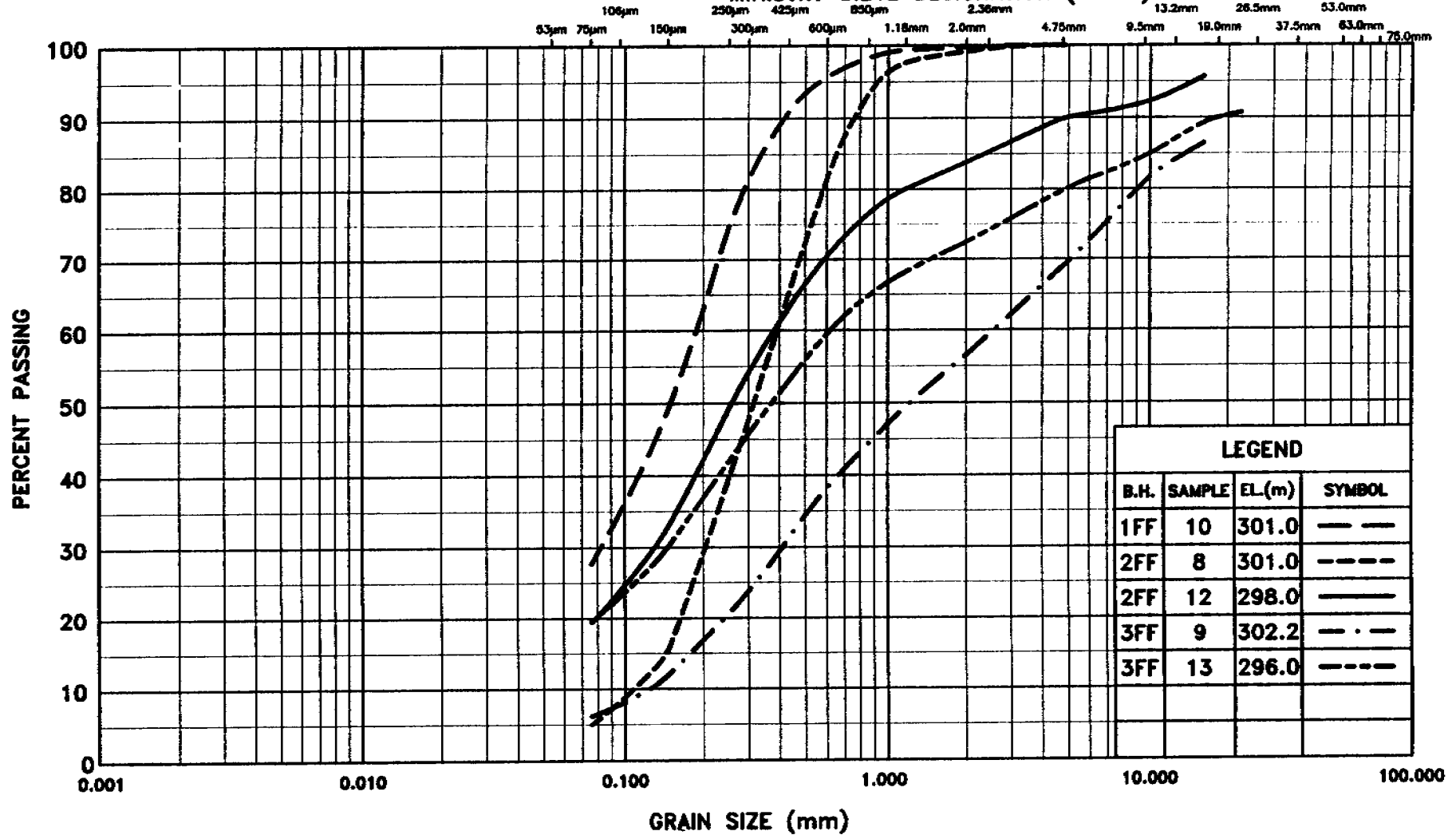


C

# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

## MINISTRY SIEVE DESIGNATION (Metric)



Ministry of  
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SAND / SAND & GRAVEL

FIGURE C1

W.P 774-93-00



S07524GFF / F98179-A/G

# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

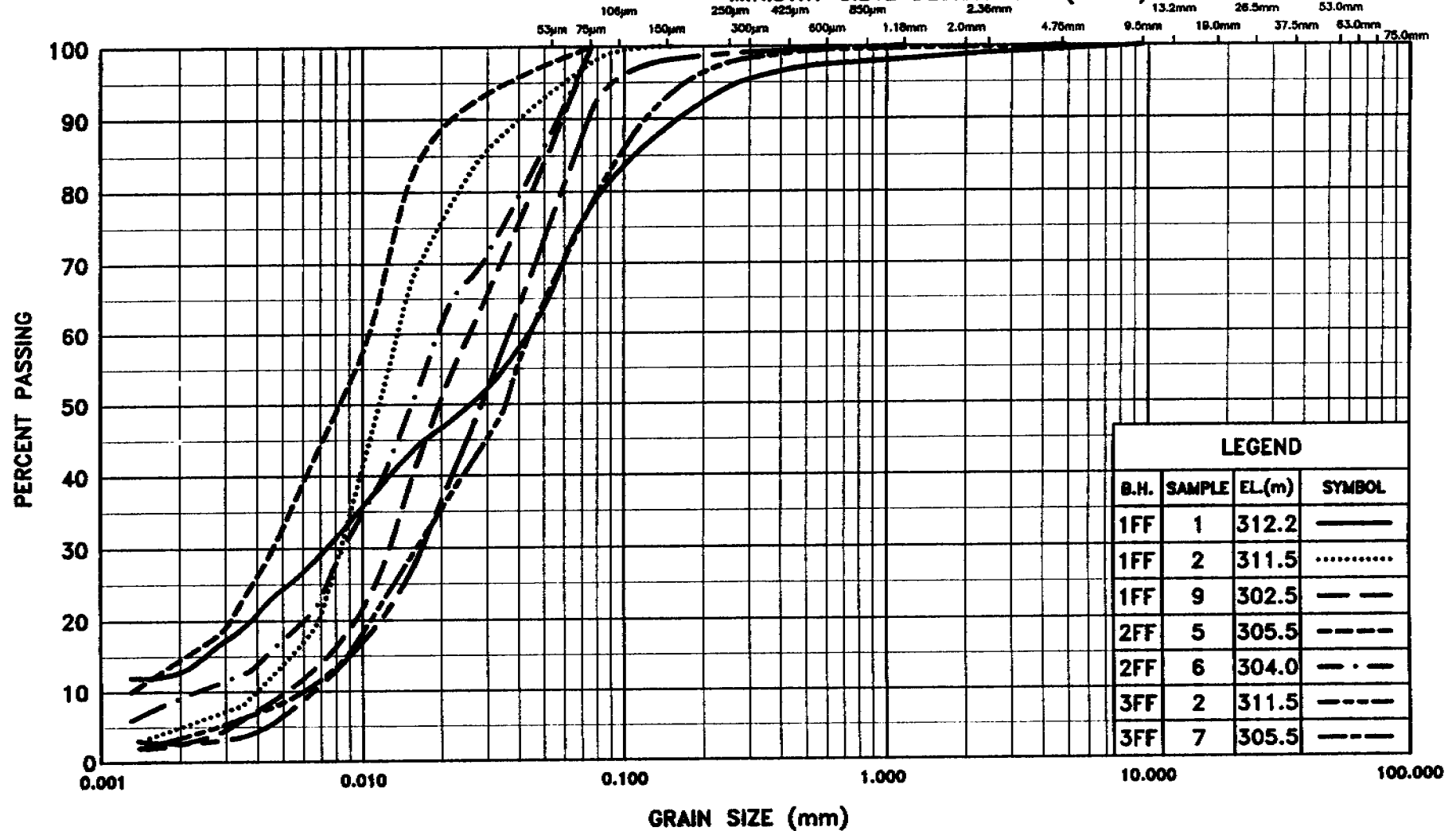
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of  
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SILT & CLAY

FIGURE C2

W.P 774-93-00



S07524GFF / F98179-A/G

# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

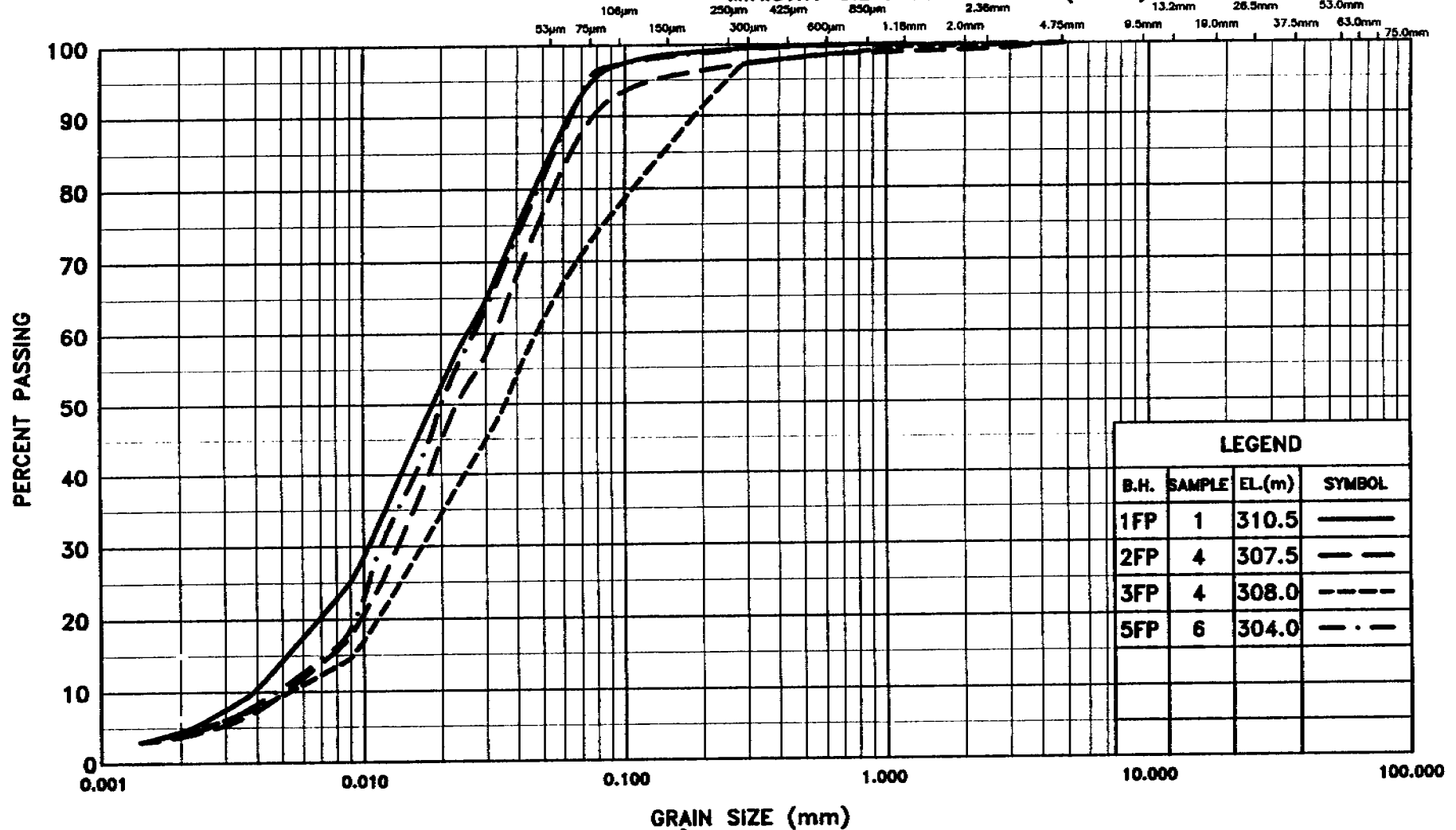
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of  
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

CLAY & SILT

FIGURE C3

W.P. 774-93-00

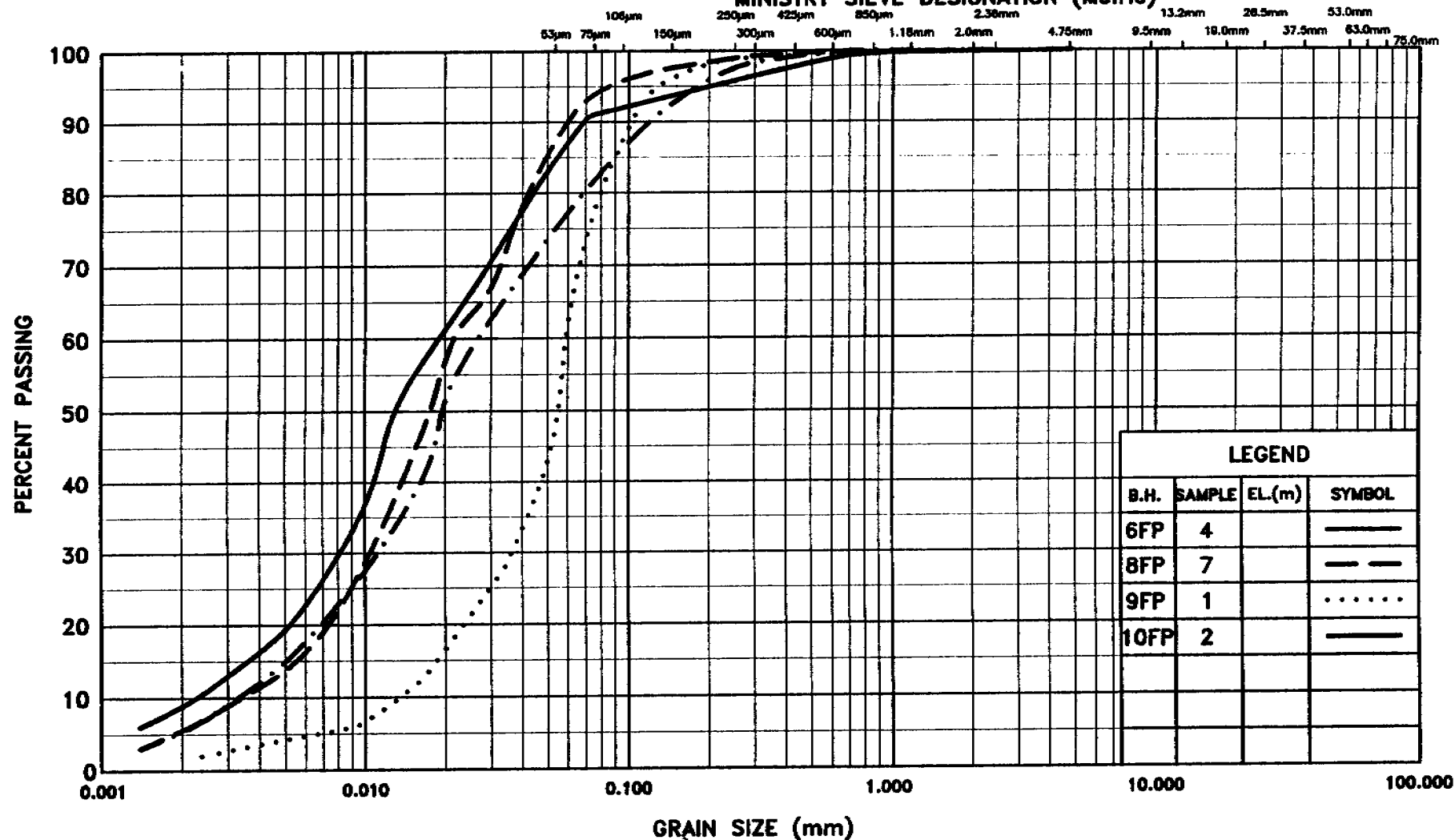


S07524GFP / F98179-A/G

# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

## MINISTRY SIEVE DESIGNATION (Metric)



Ministry of  
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

CLAY & SILT

FIGURE C4

W.P. 774-93-00

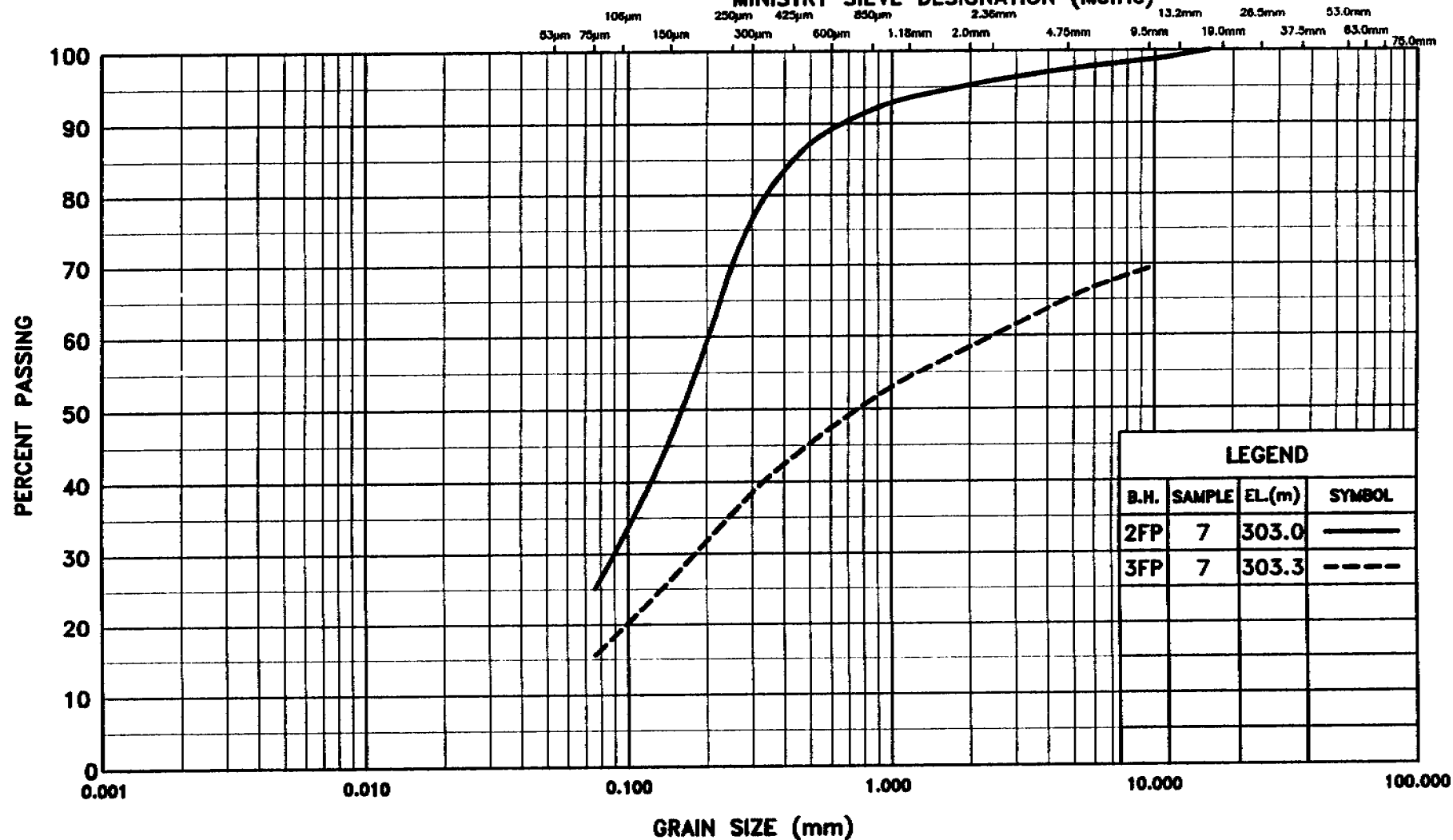


S07524GFP / F98179-A/G

# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

## MINISTRY SIEVE DESIGNATION (Metric)



Ministry of  
Transportation

METRIC

### GRAIN SIZE DISTRIBUTION

BH-2FP, SS-7  
BH-3FP, SS-7

SAND  
SAND

FIGURE C5

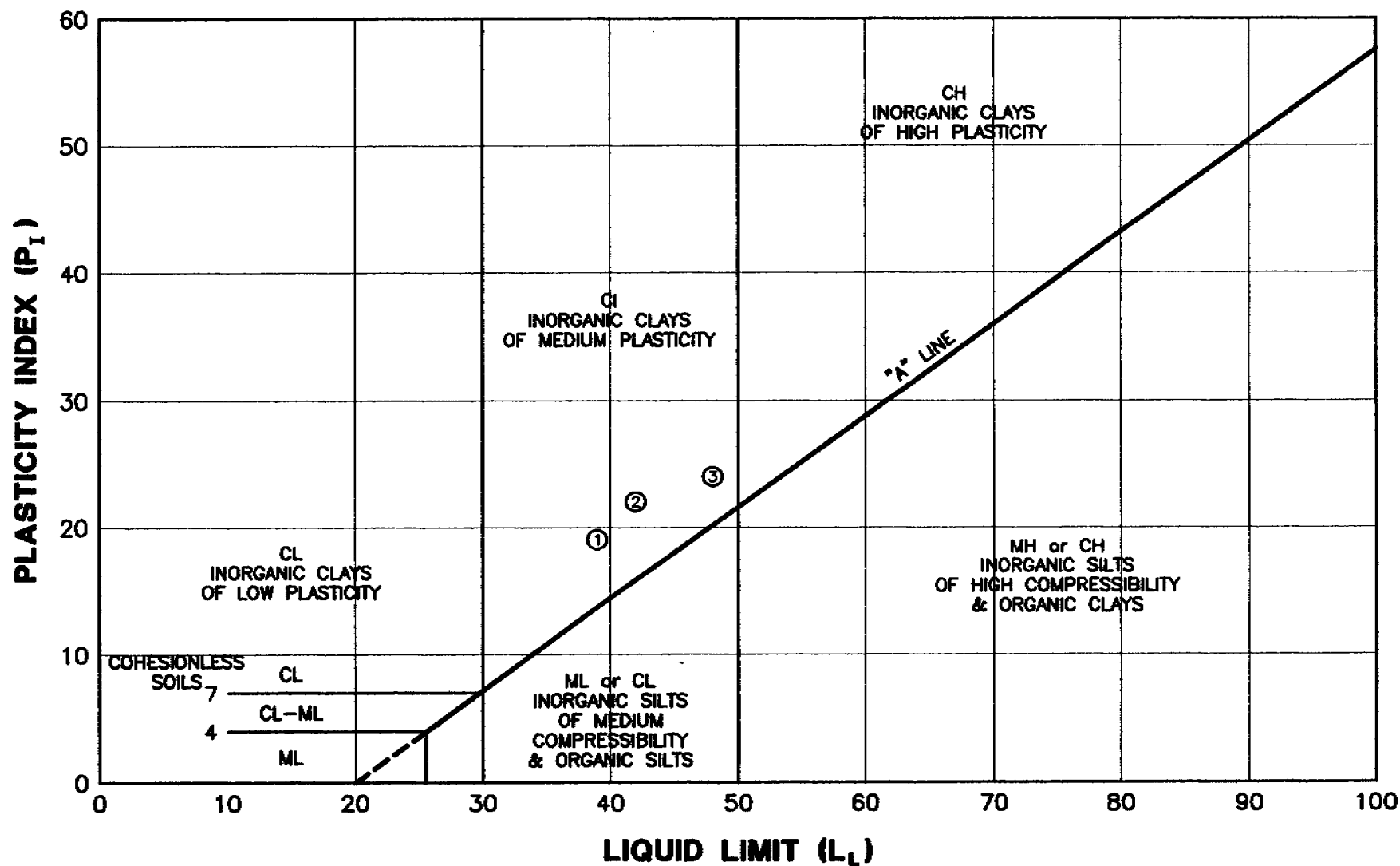
W.P. 774-93-00



S07524GFP / F98179-A/G

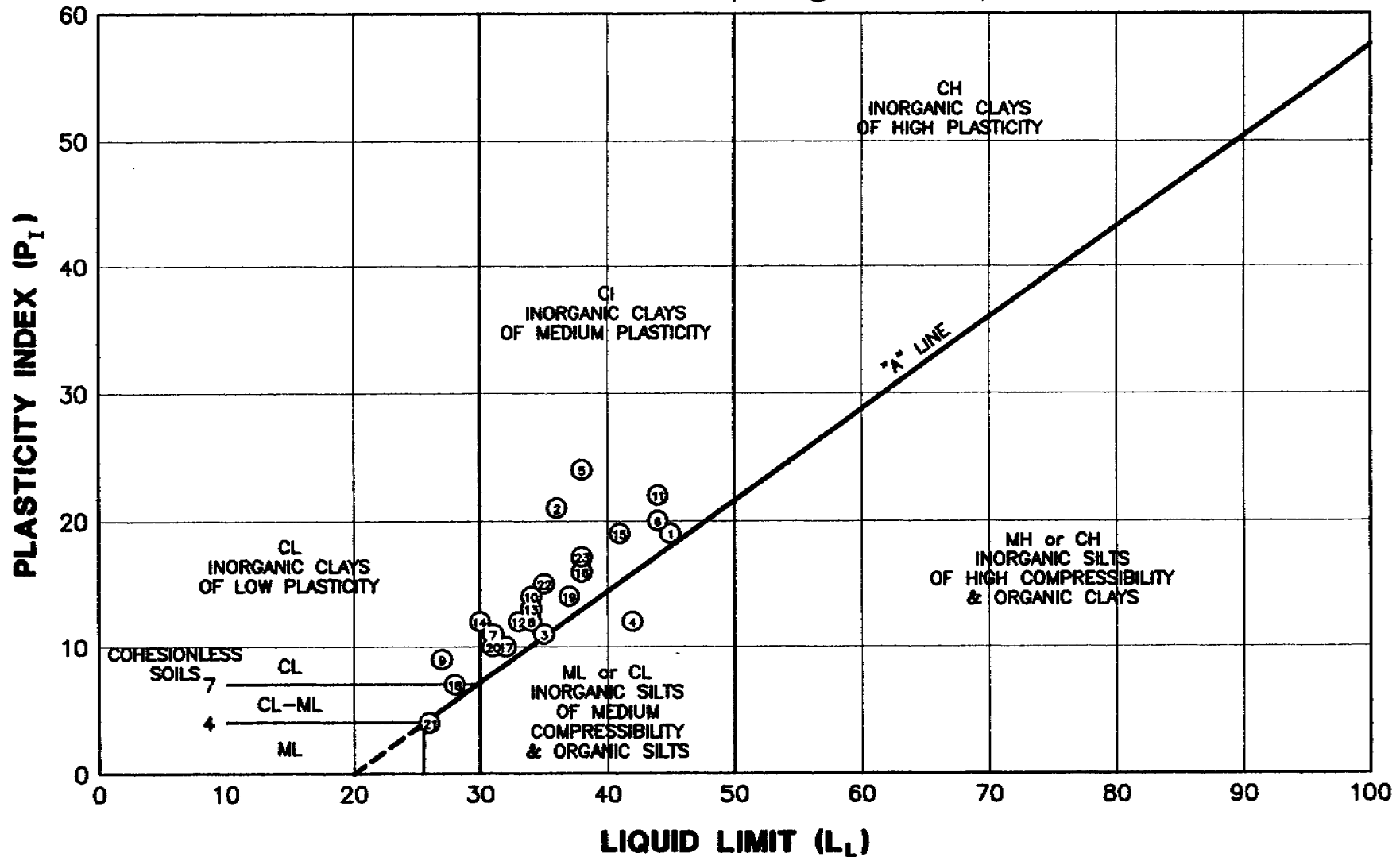
# **ATTERBERG LIMITS - PLASTICITY CHART**

SYMBOL	DESCRIPTION	SOIL TYPE	LL	PI
①	BH-1FF, TW-6	CI	39	19
②	BH-2FF, TW-4	CI	42	22
③	BH-3FF, SS-3	CI	48	24

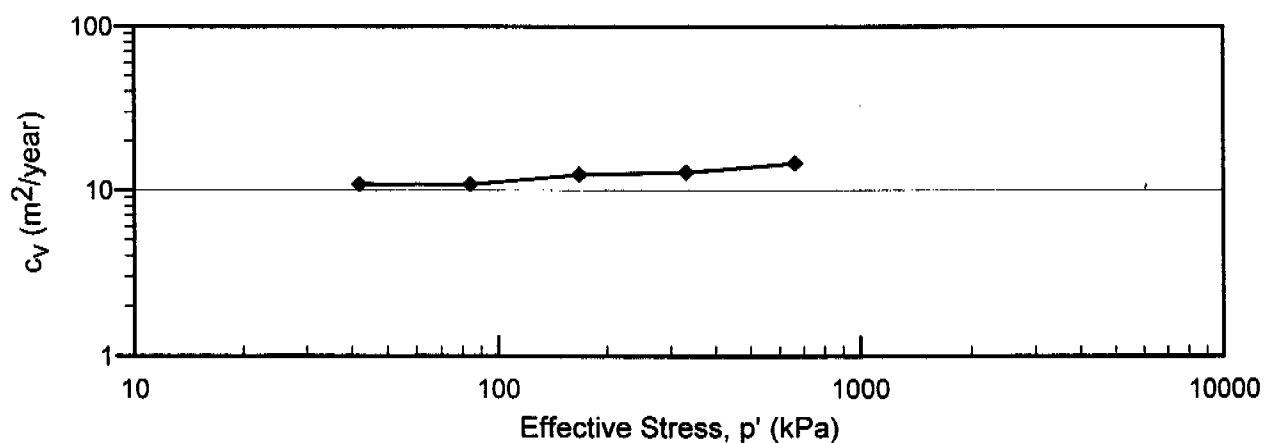
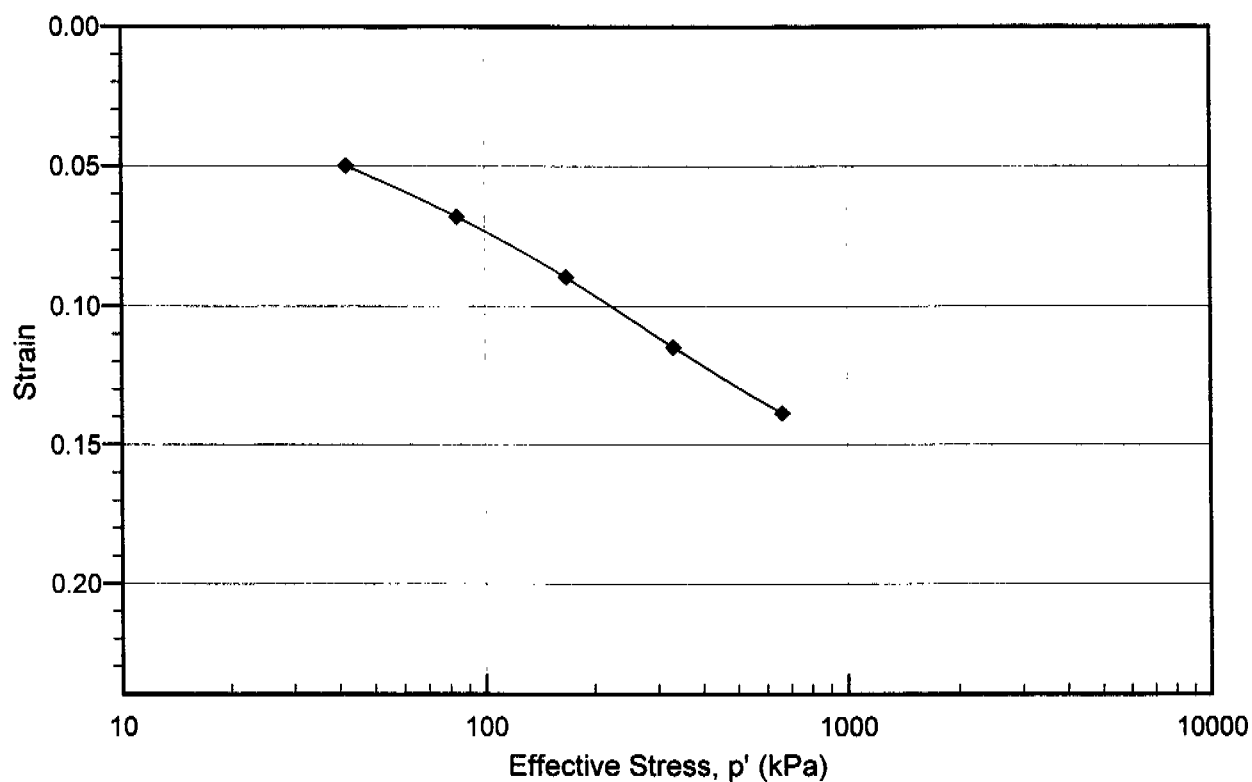


# **ATTERBERG LIMITS - PLASTICITY CHART**

SYMBOL	DESCRIPTION	SOIL TYPE	LL	PI	SYMBOL	DESCRIPTION	SOIL TYPE	LL	PI
1	BH-1FP, SS-4	CI	45	19	12	BH-11FP, SS-5	CI	33	12
2	BH-2FP, SS-2	CI	36	21	13	BH-11FP, TW-6	CI	34	13
3	BH-3FP, TW-2	CI-CL	35	11	14	BH-16FP, SS-4	CI	30	12
4	BH-4FP, SS-2	CL-ML	42	12	15	BH-16FP, SS-6	CI	41	19
5	BH-7FP, SS-3	CI	38	24	16	BH-16FP, SS-7	CI	38	18
6	BH-8FP, SS-2	CI	44	20	17	BH-16FP, SS-9	CI	32	10
7	BH-8FP, SS-4	CI	31	11	18	BH-16FP, SS-10	CL-ML	28	7
8	BH-8FP, SS-5	CI	34	12	19	BH-23FP, SS-2	CI	37	14
9	BH-8FP, SS-6	CL	27	9	20	BH-23SP, SS-3	CI	31	10
10	BH-11FP, SS-2	CI	34	14	21	BH-23FP, SS-4	CL-ML	26	4
11	BH-11FP, SS-4	CI	44	22	22	BH-26FP, TW-6	CI	35	15
					23	BH-30FP, TW-5	CI	38	17

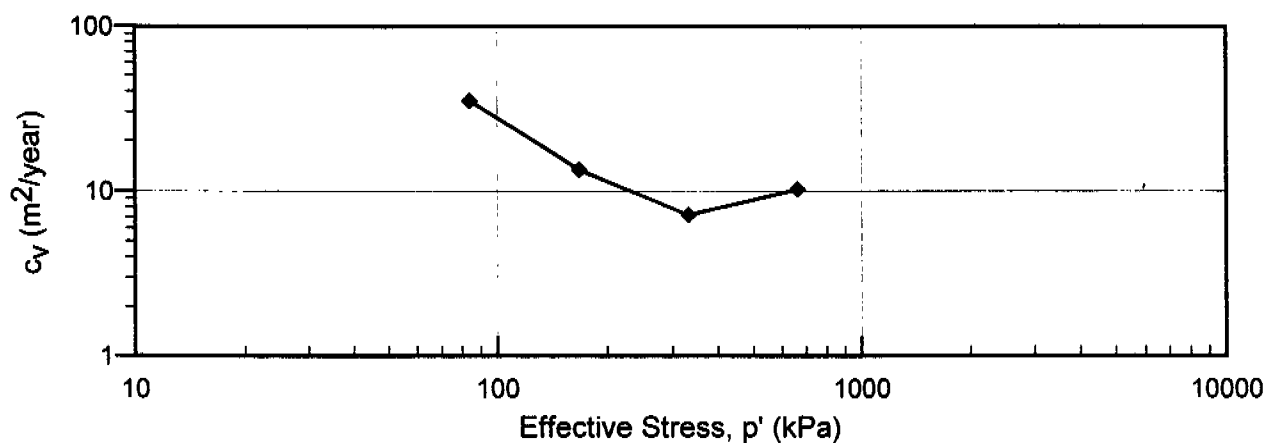
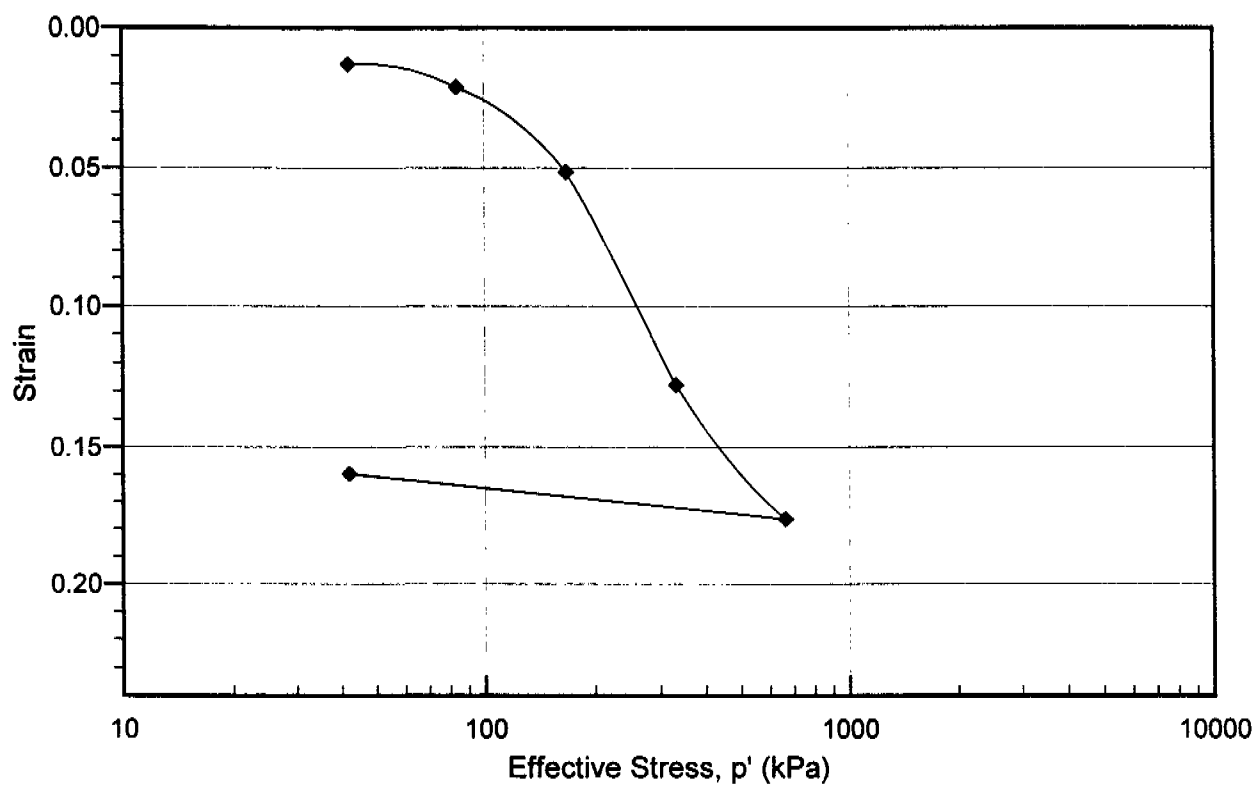






$$C_c/(1+e_0) = 0.08$$

$$\sigma'_{v0} = 45 \text{ kPa}$$

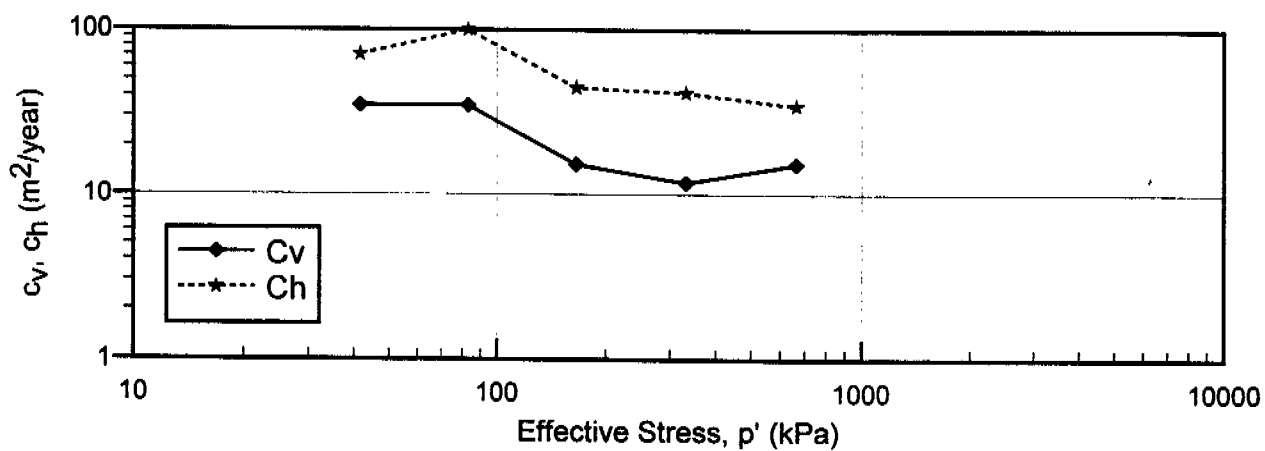
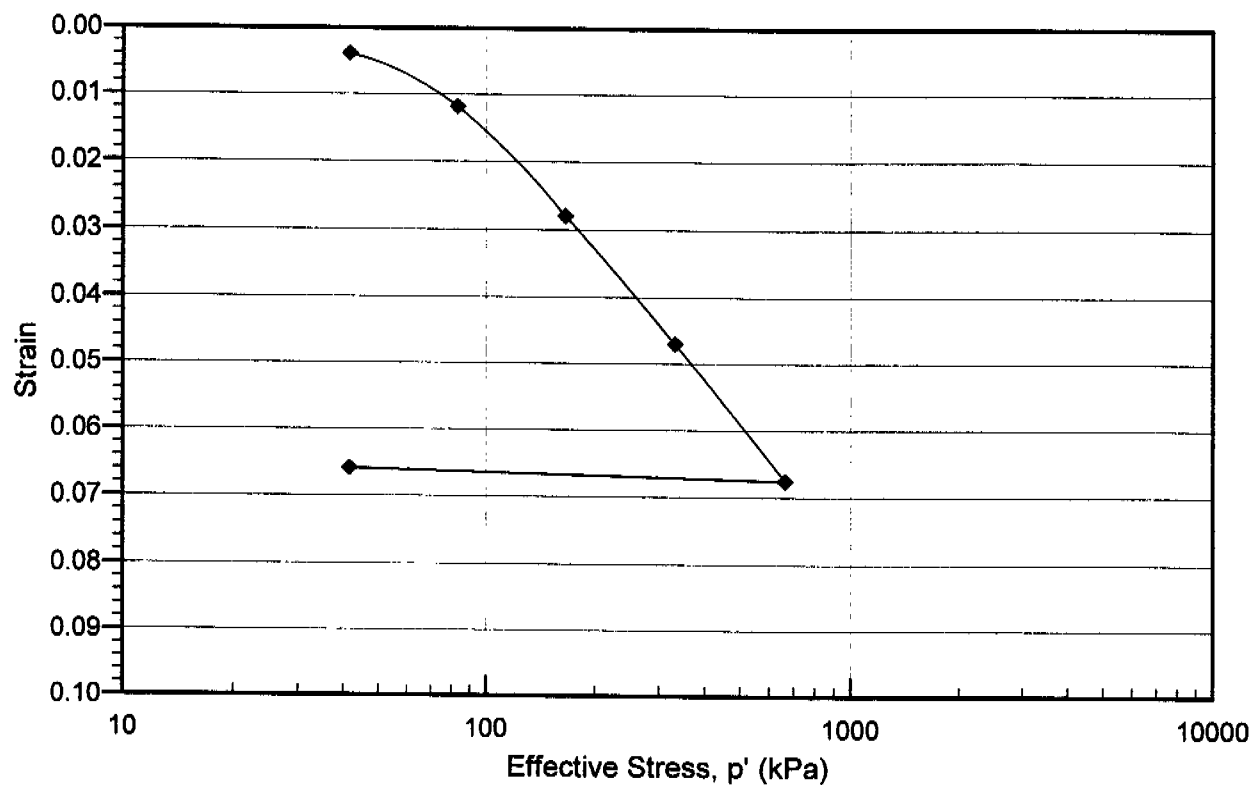


$$C_c/(1+e_0) = 0.20$$

$$C_r/(1+e_0) = 0.015$$

$$\sigma'_{v0} = 35 \text{ kPa}$$

$$\sigma'_{pc} = 110 \text{ kPa}$$

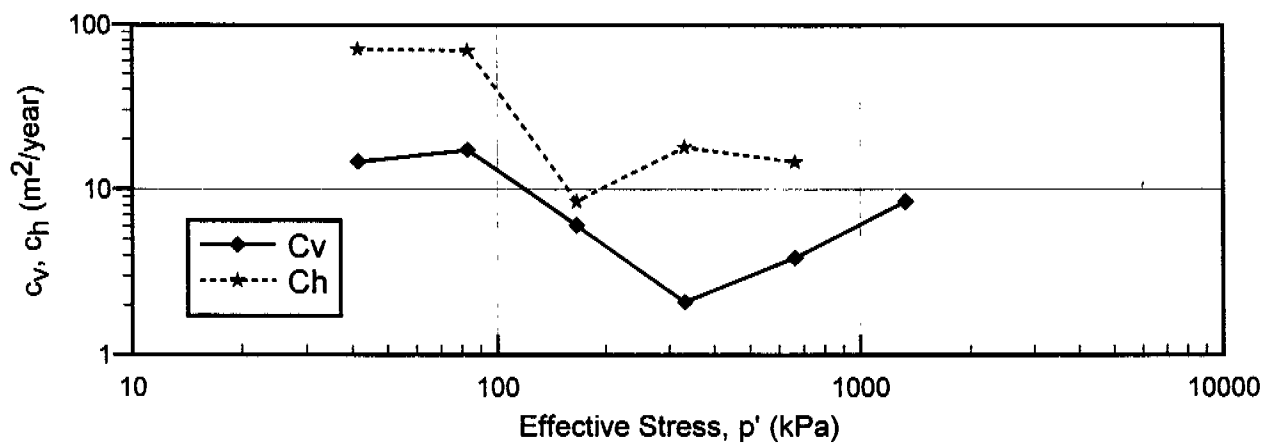
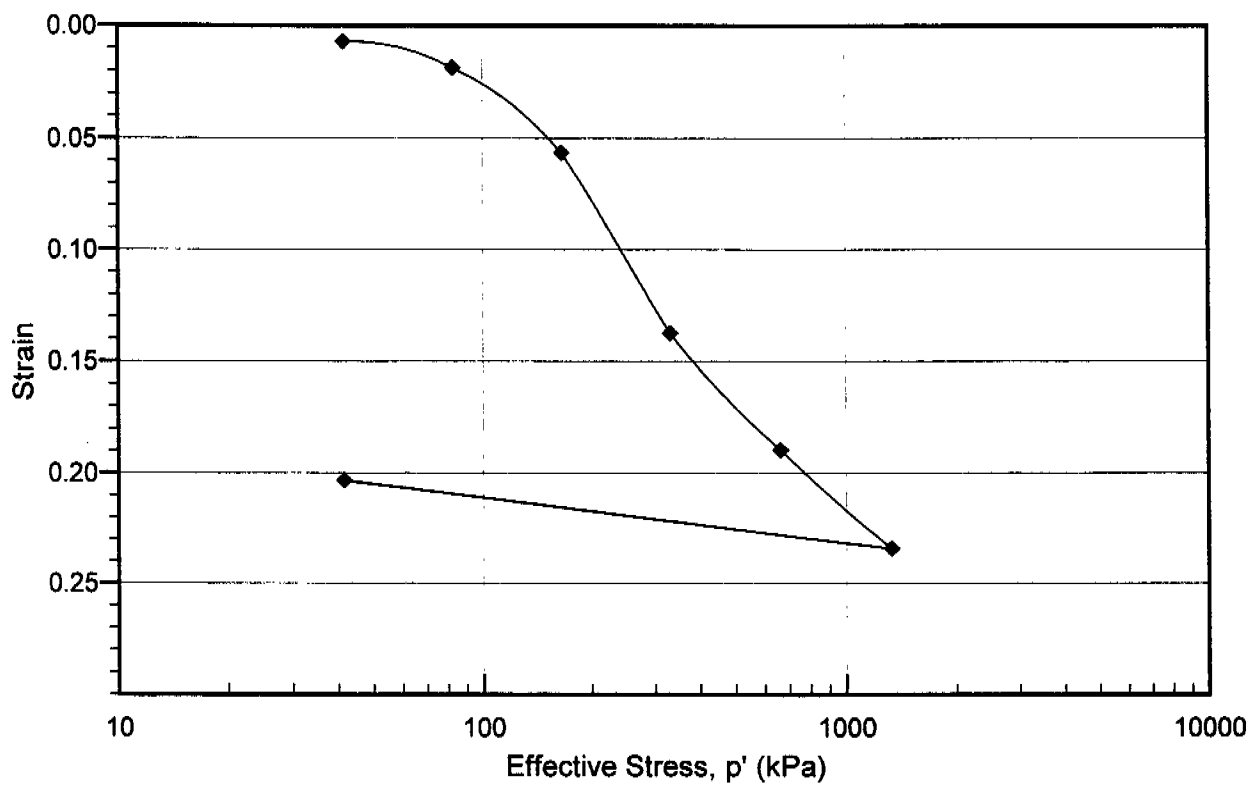


$$C_c/(1+e_0) = 0.07$$

$$C_r/(1+e_0) = 0.002$$

$$\sigma'_{vo} = 76 \text{ kPa}$$

$$\sigma'_{pc} = 90 \text{ kPa}$$

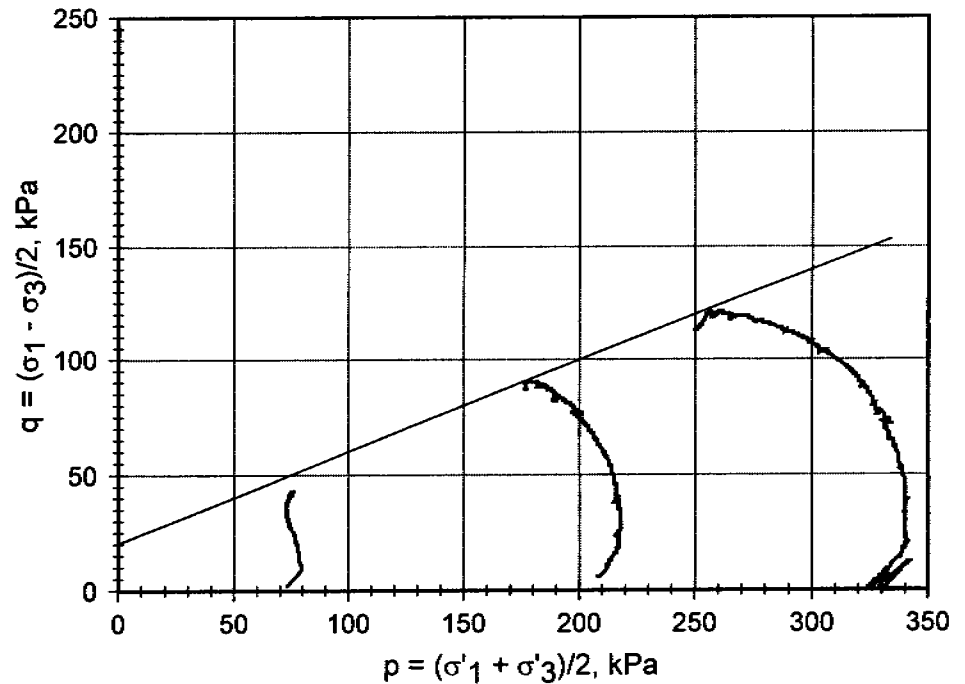
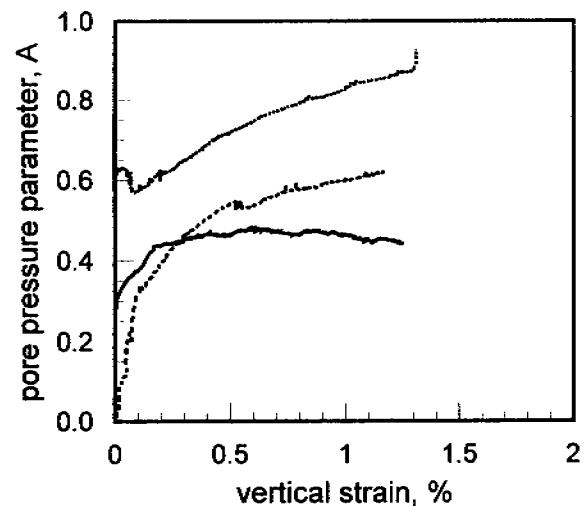
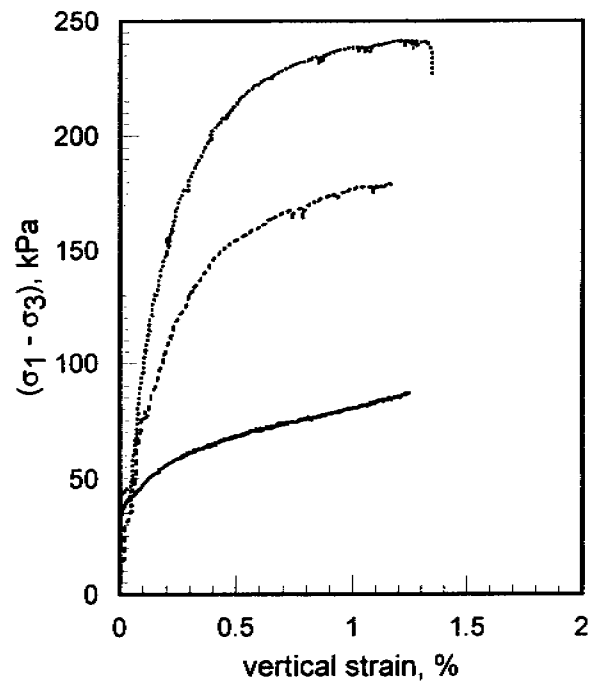


$$C_c/(1+e_0) = 0.21$$

$$C_r/(1+e_0) = 0.035$$

$$\sigma'_{v0} = 65 \text{ kPa}$$

$$\sigma'_{pc} = 90 - 100 \text{ kPa}$$



Trow Consulting Engineers Ltd.  
Thunder Bay, Ont.

### Triaxial Test Data 1

Client: Marshall Macklin Monaghan

Trout Creek Project - Trout Creek

F98179-A/G

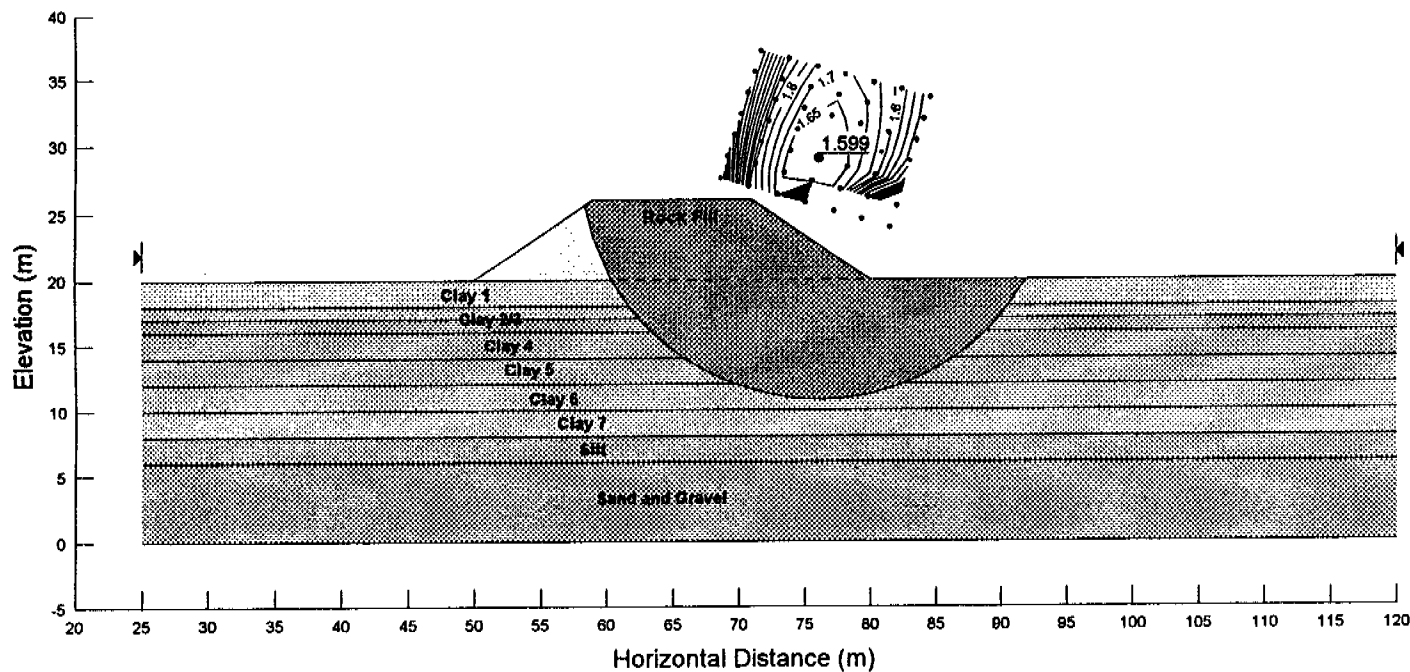
Aug. 24/98

Figure C12

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Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 6 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H06T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

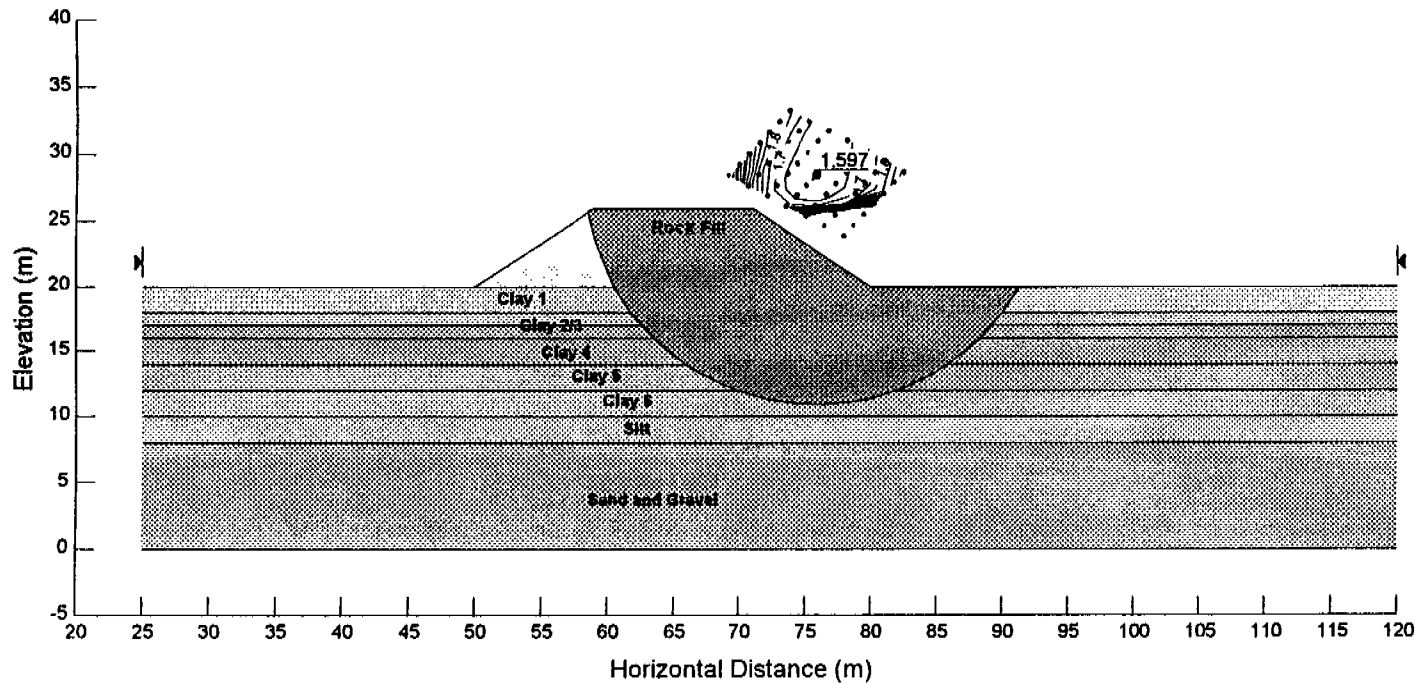
Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 6 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H06T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

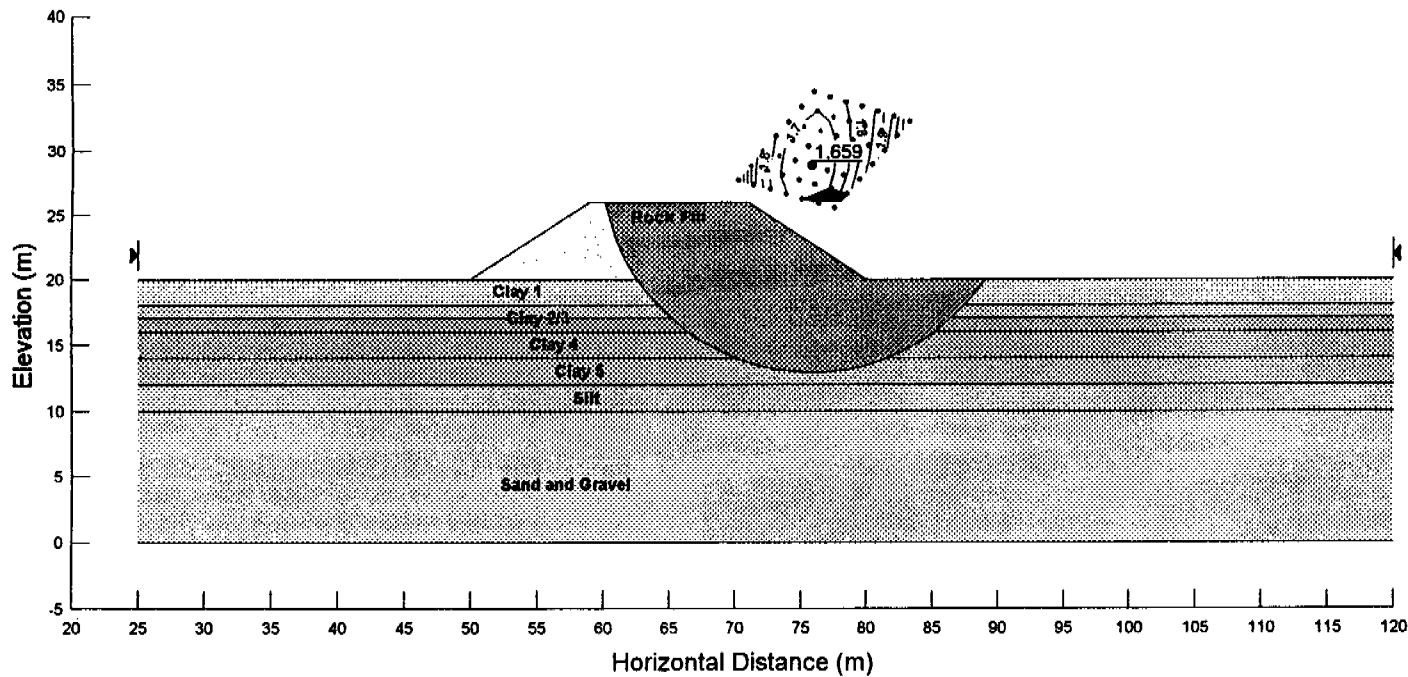
Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 6 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H06T08CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

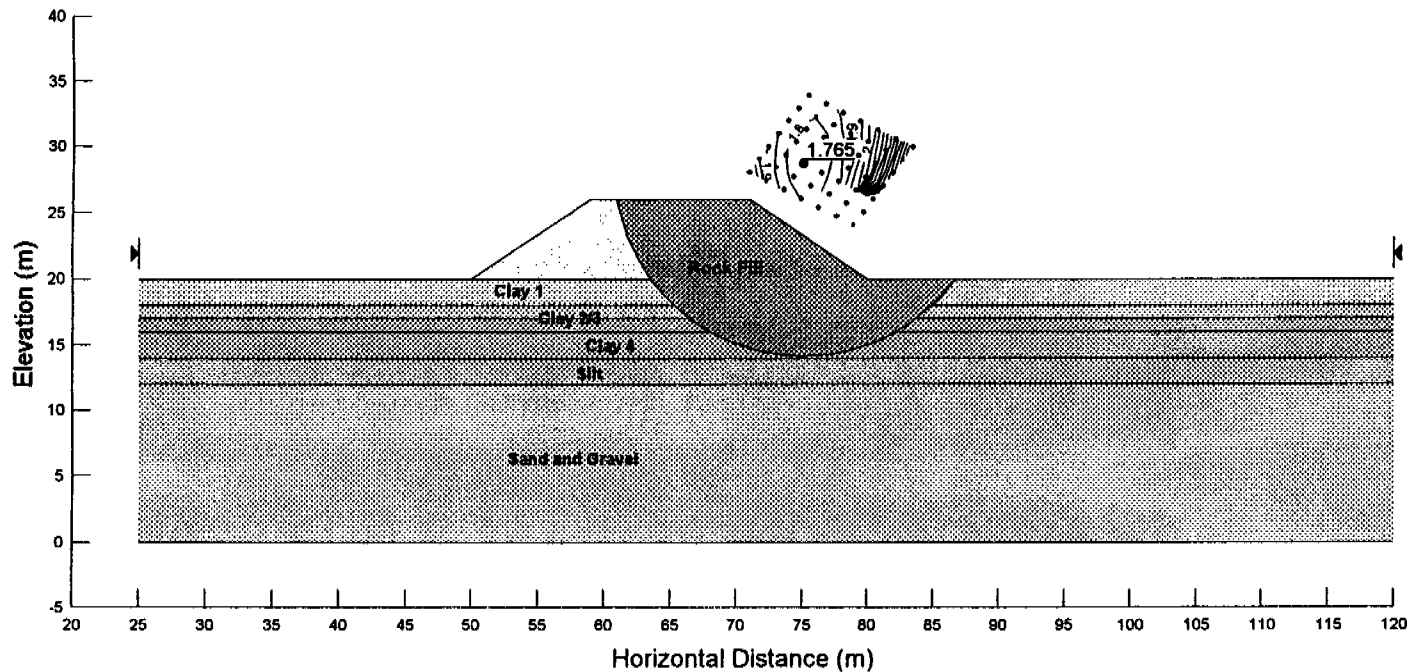
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 6 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H06T06CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

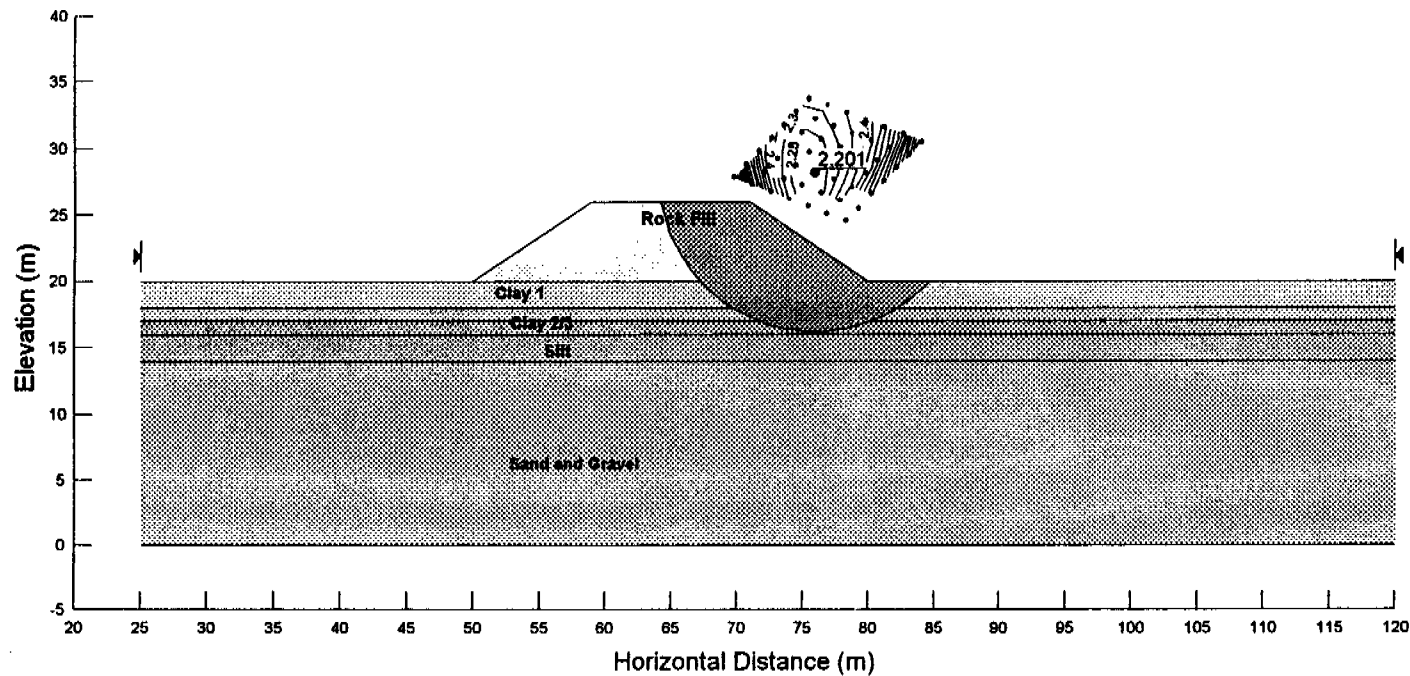
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 6 metre embankment height, 1.5:1 overall side slope  
 4 metre clay foundation  
 H06T04CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

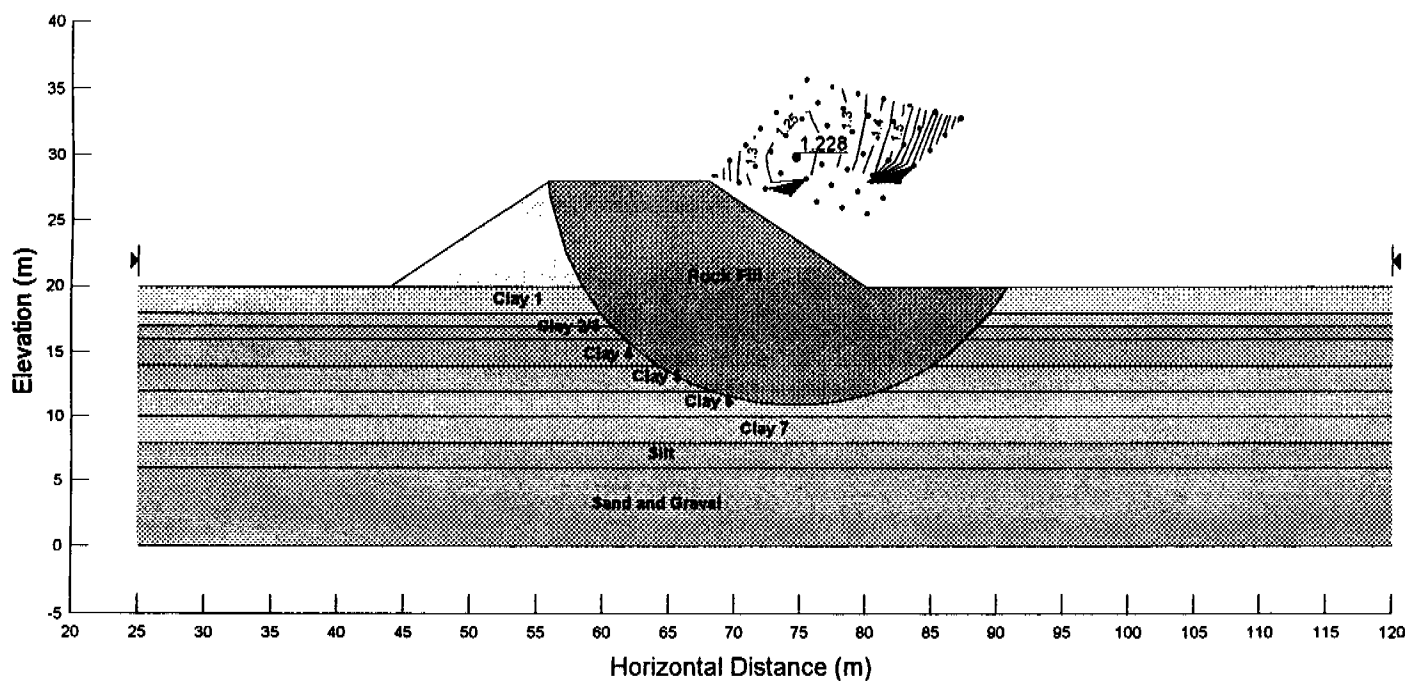
Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 6 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 7 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H08T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

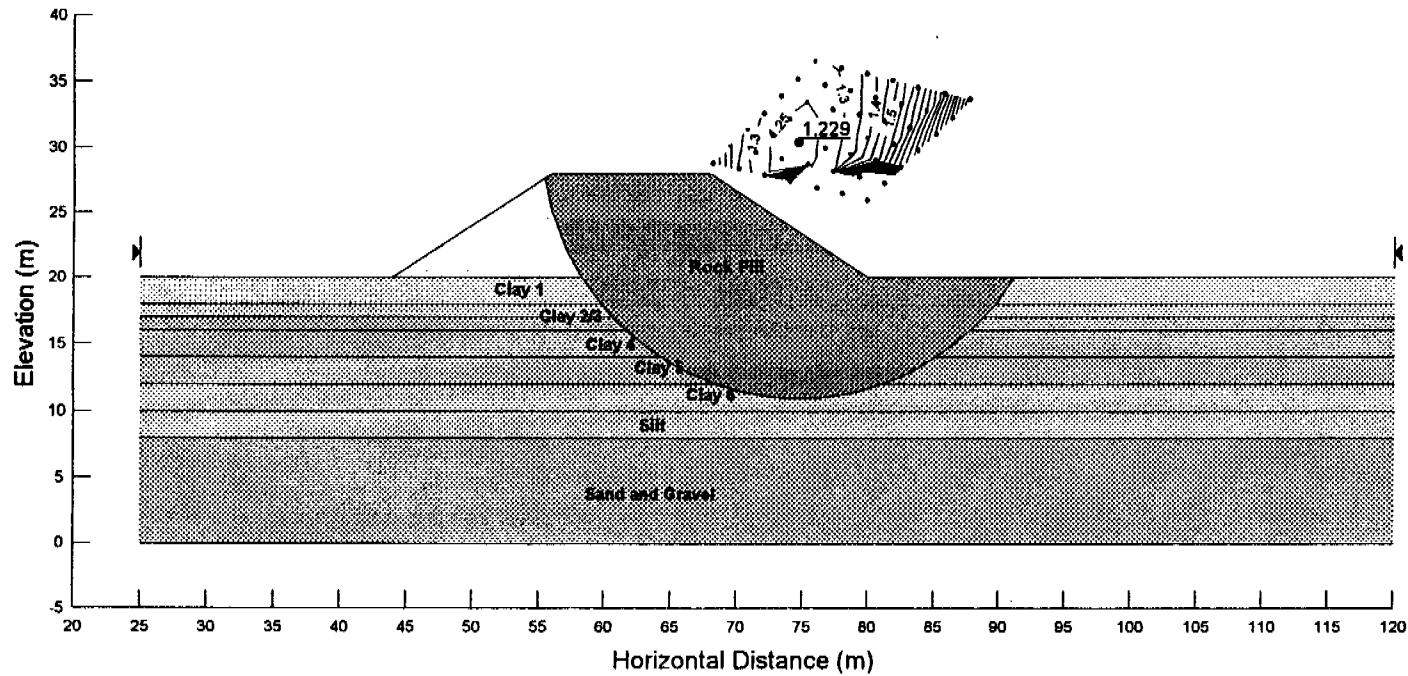
Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H8T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

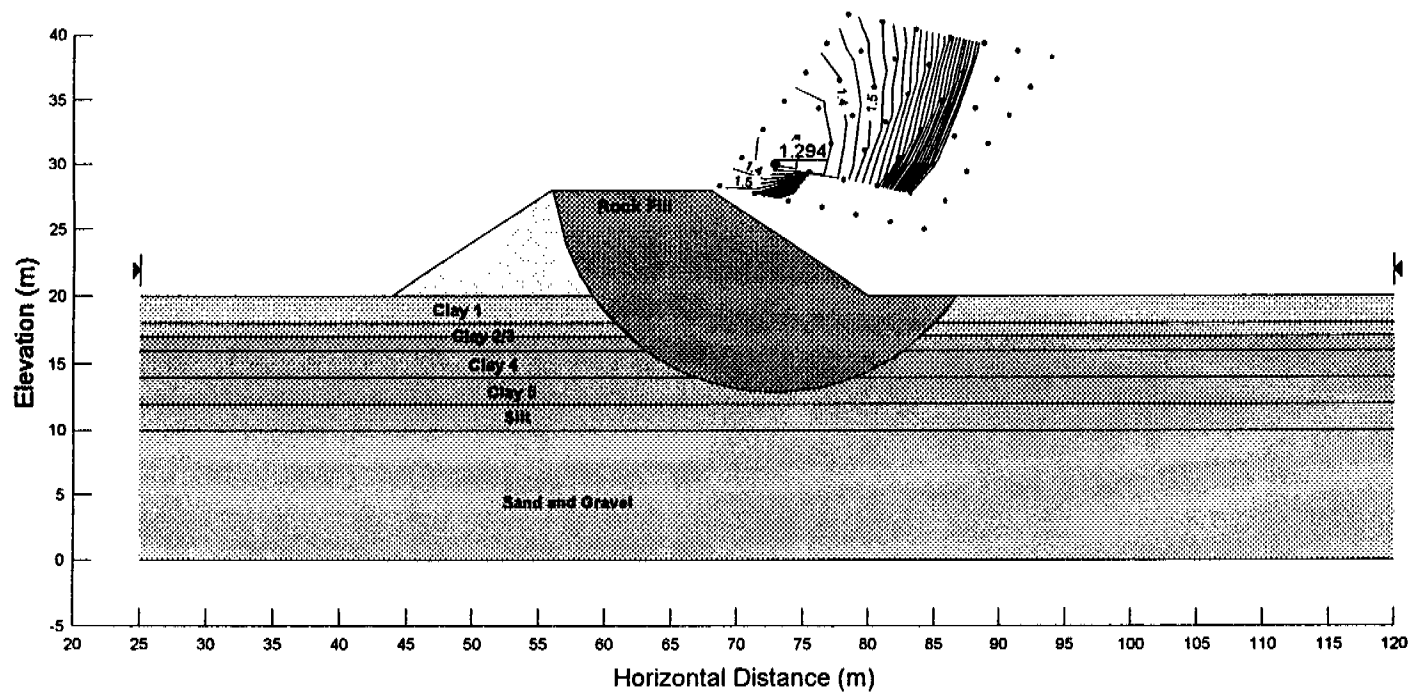
Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H08T08CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

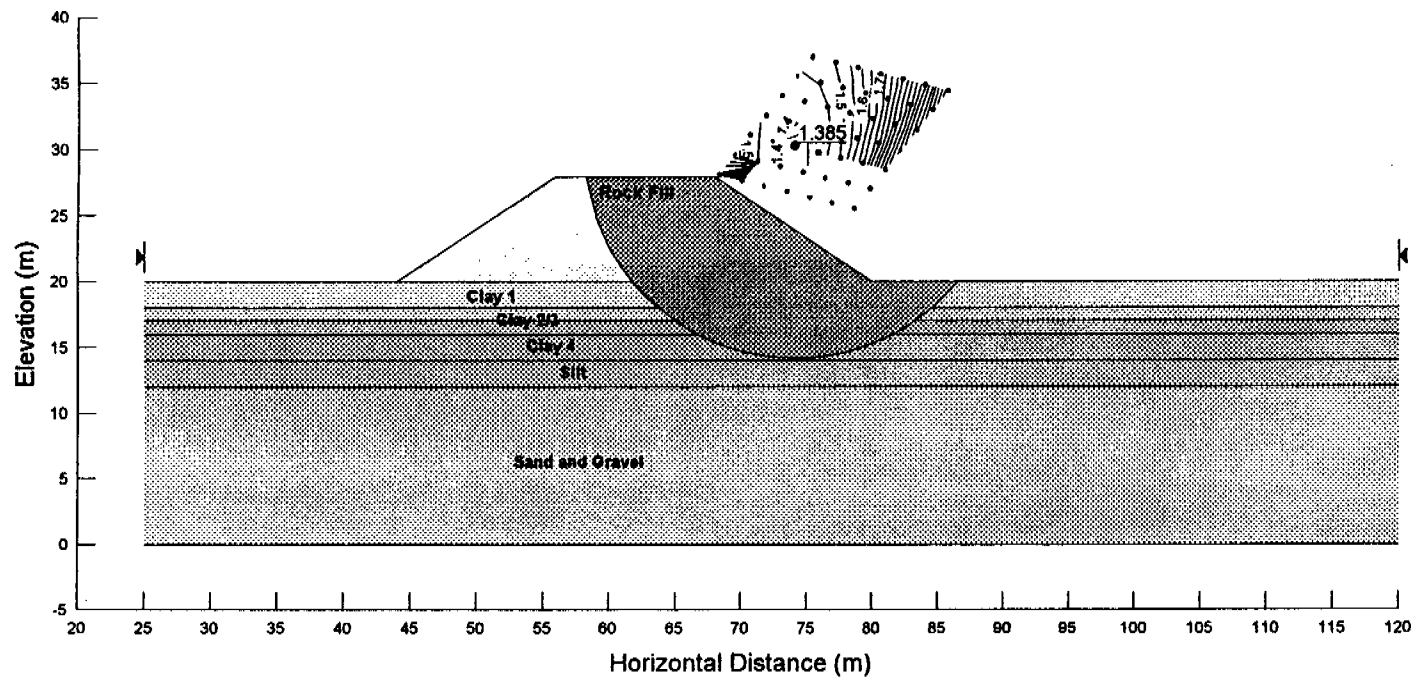
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H08T06CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 5 metre clay foundation  
 H08T05CU.SLP

Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

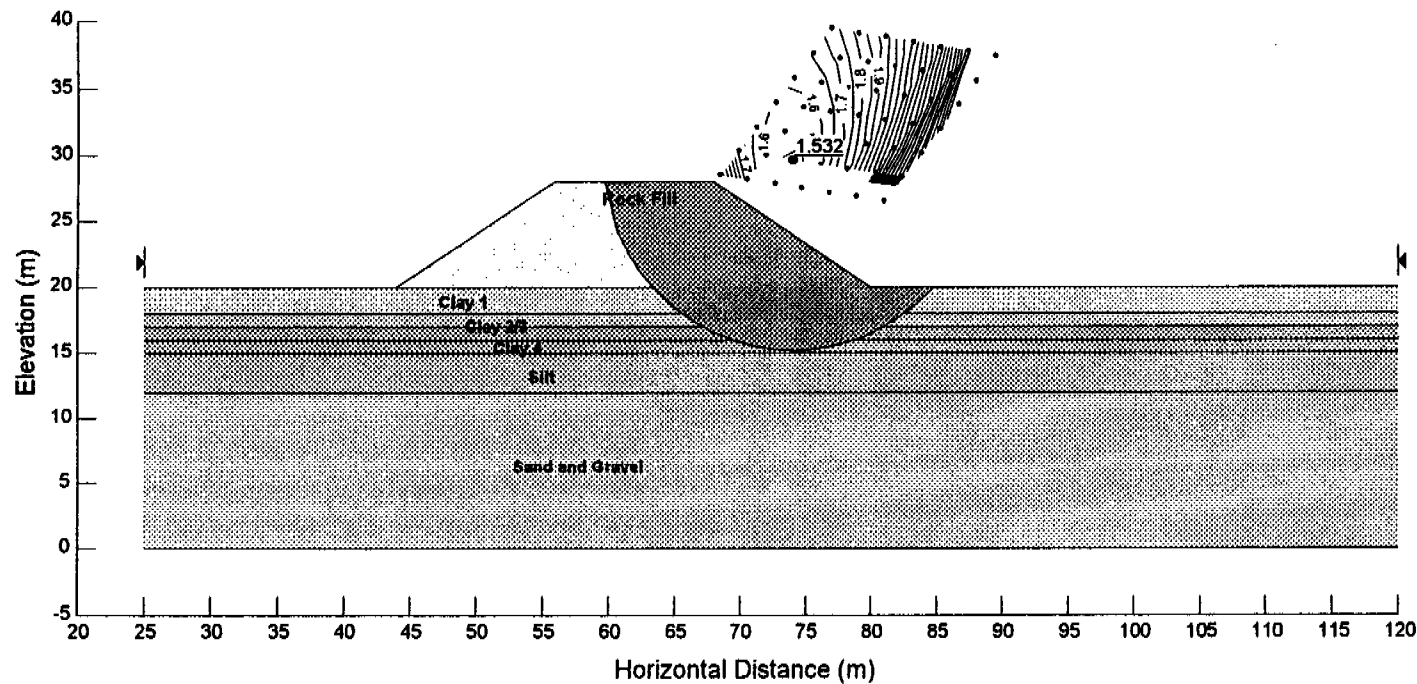
Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1





Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 4 metre clay foundation  
 H08T04CU.SLP

Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

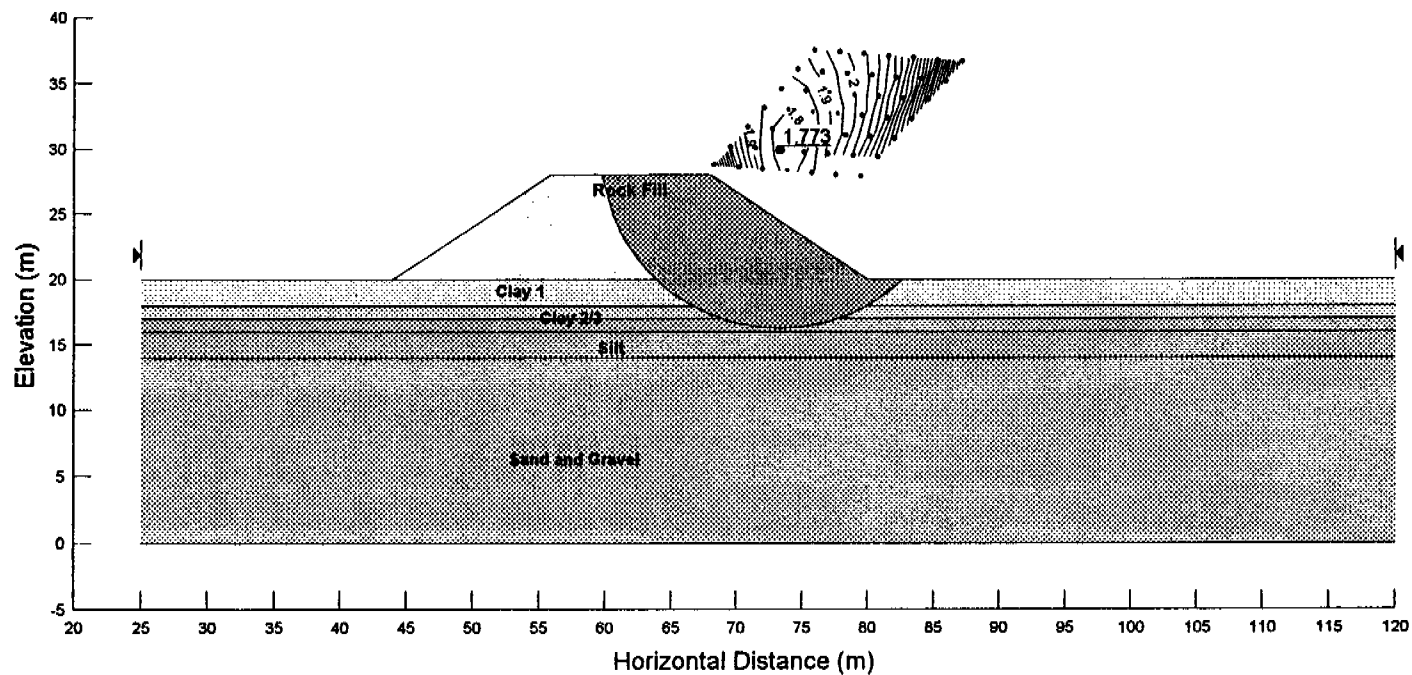
Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

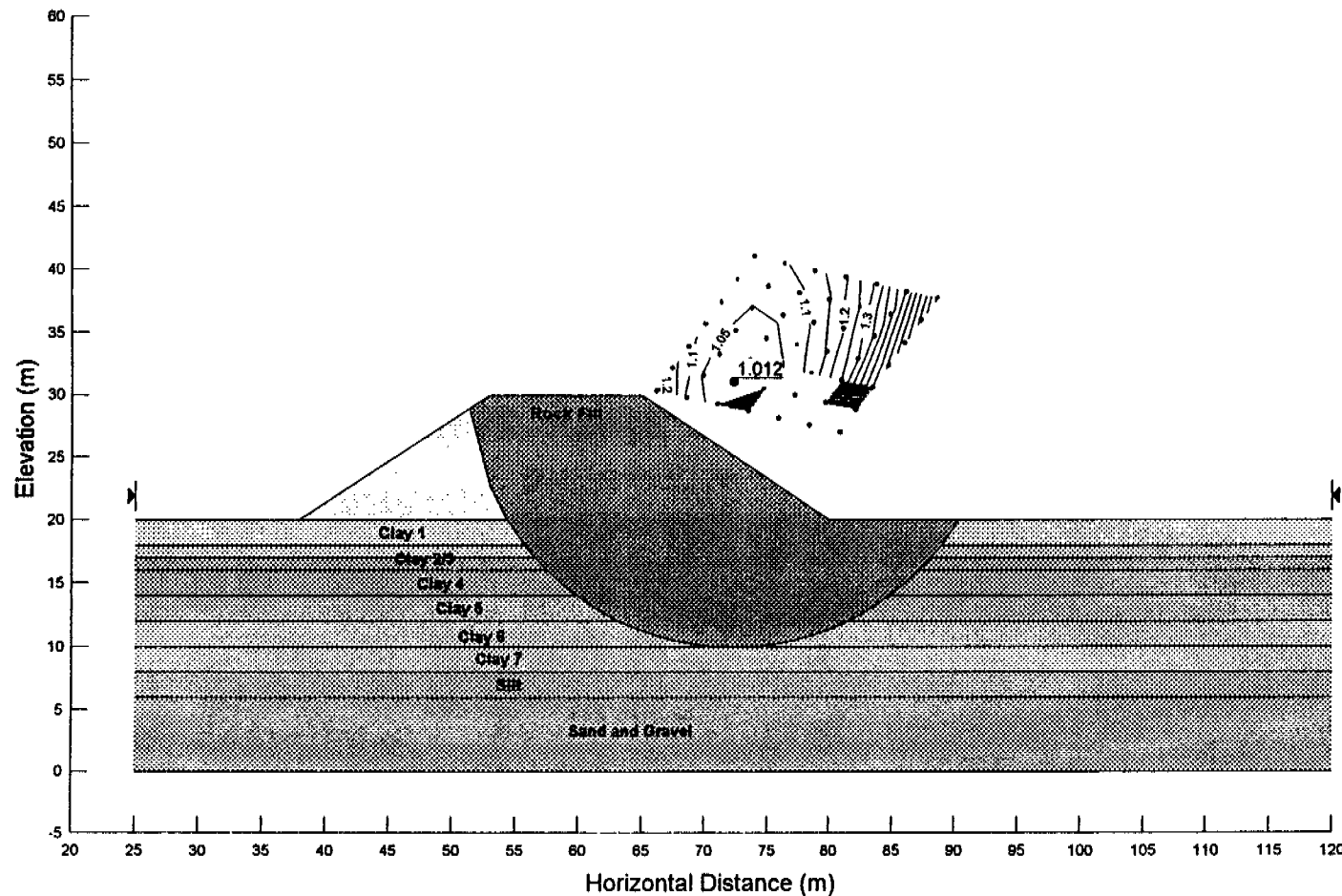
Soil 5 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 6 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 7 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H10T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

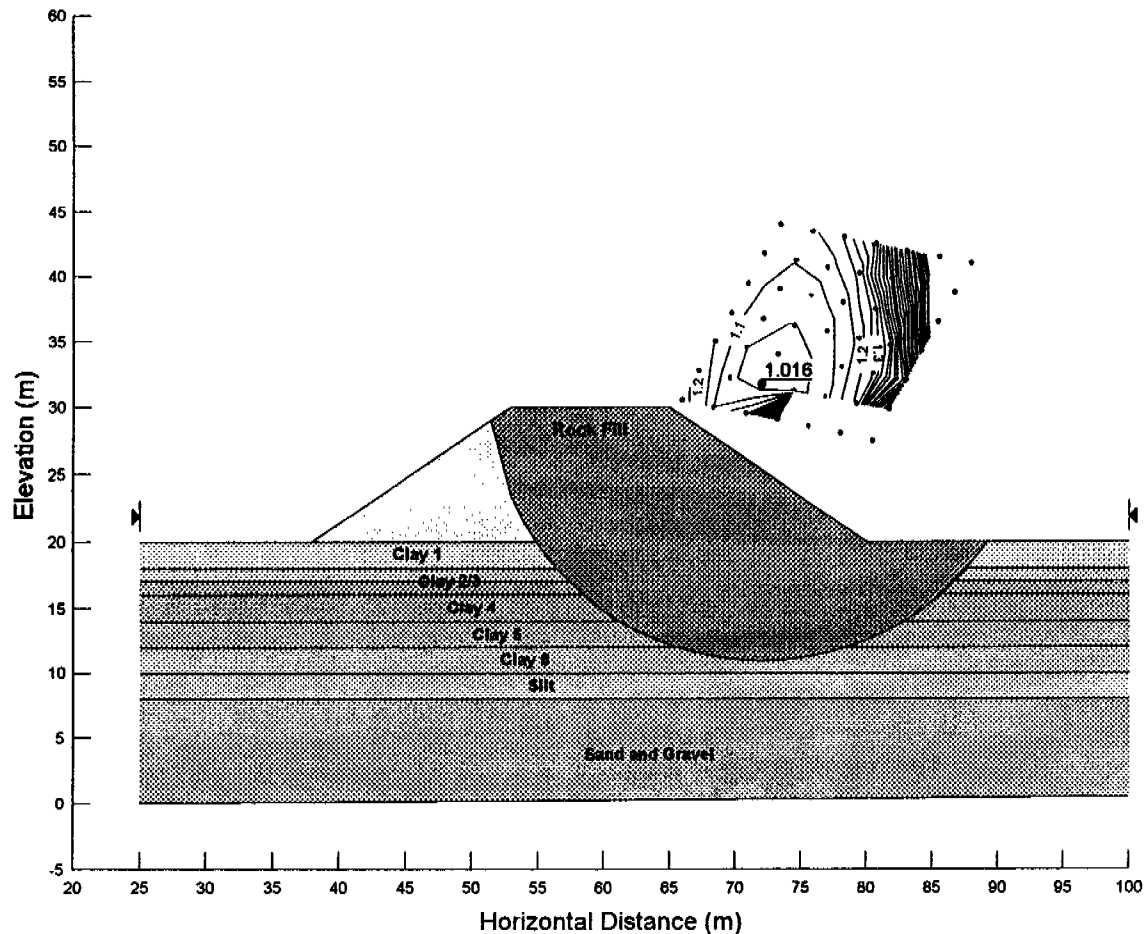
Soil 8 - Clay 7  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H10T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

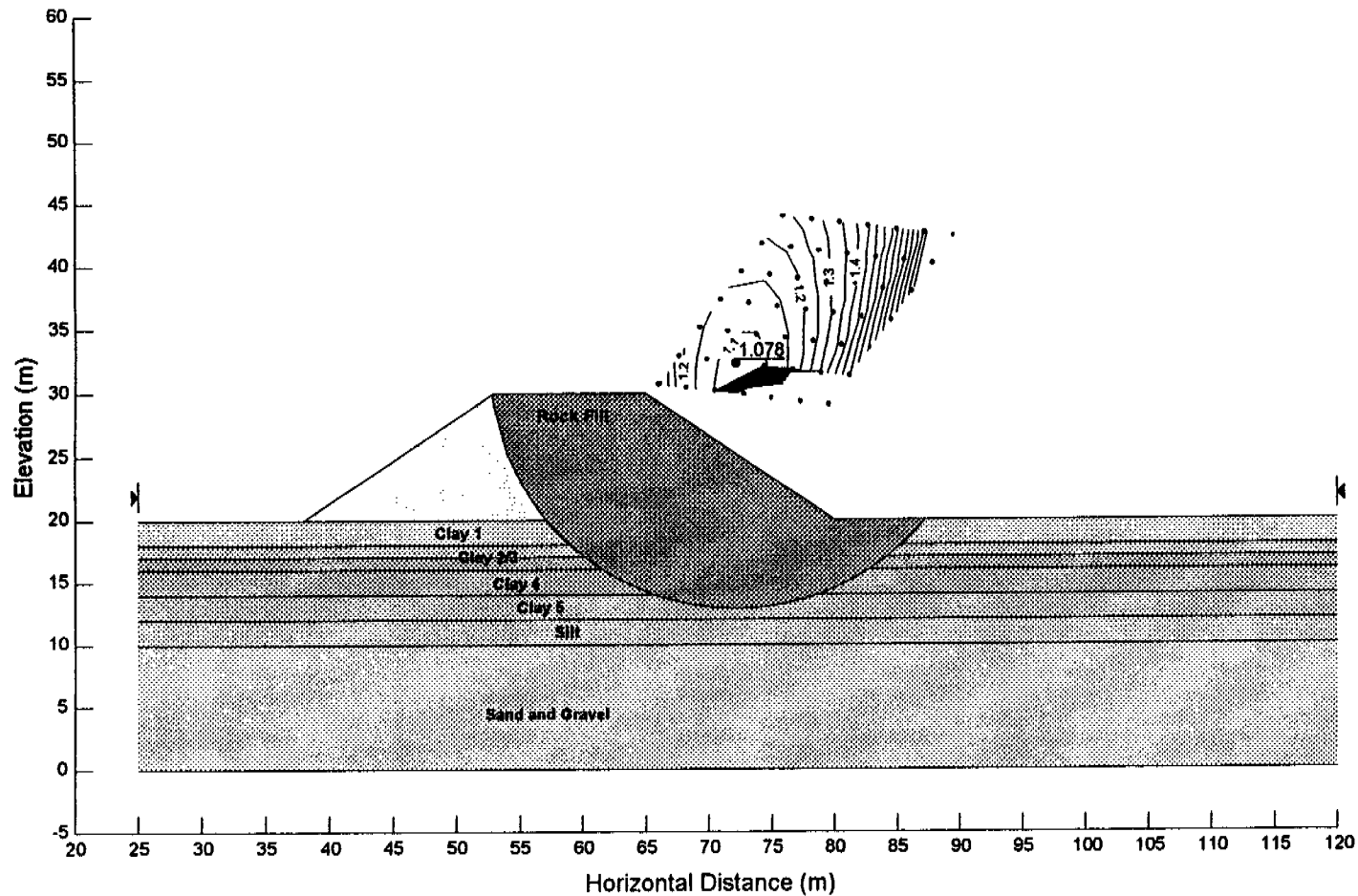
Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H10T08CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

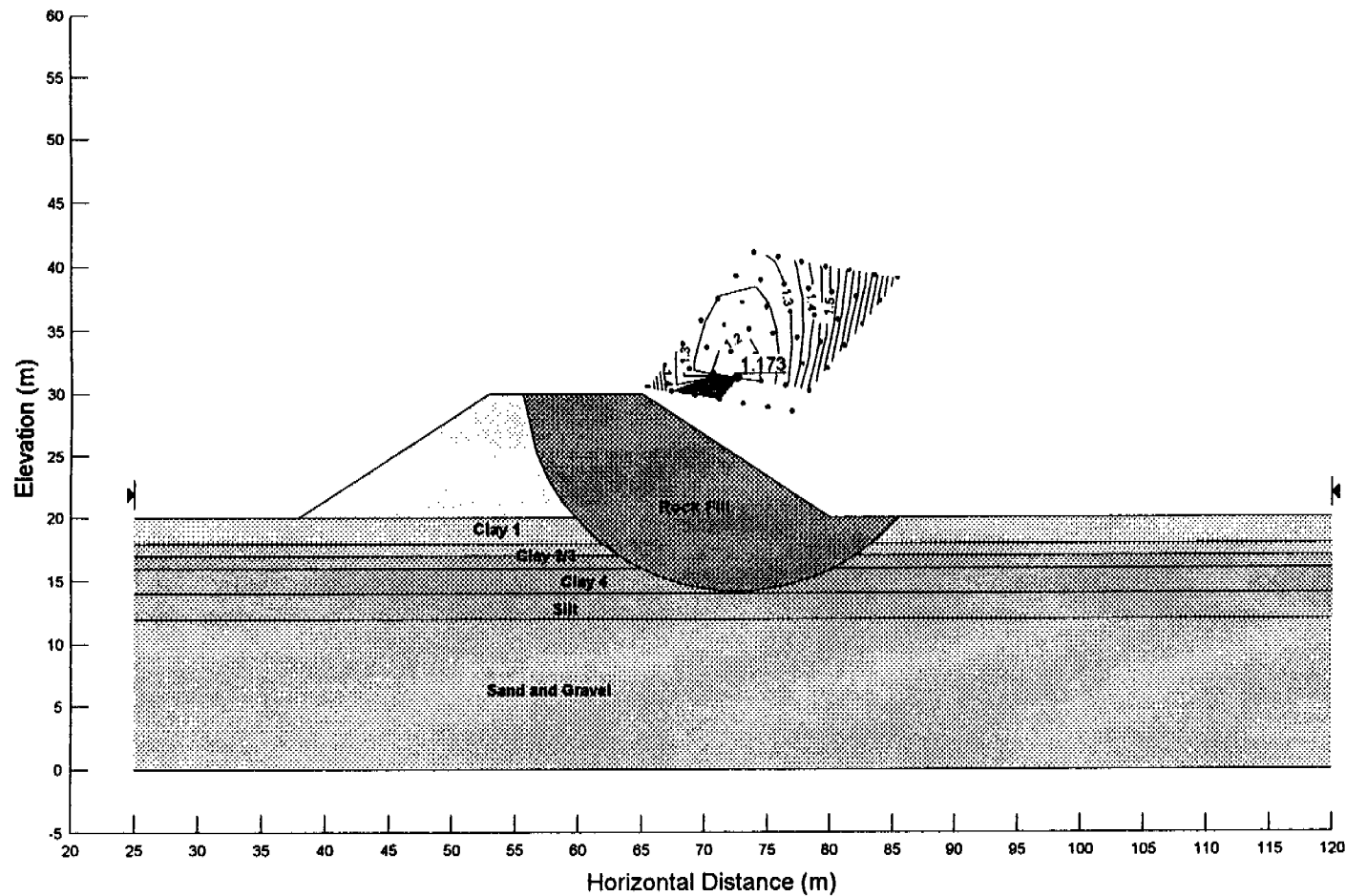
Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H10T06CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

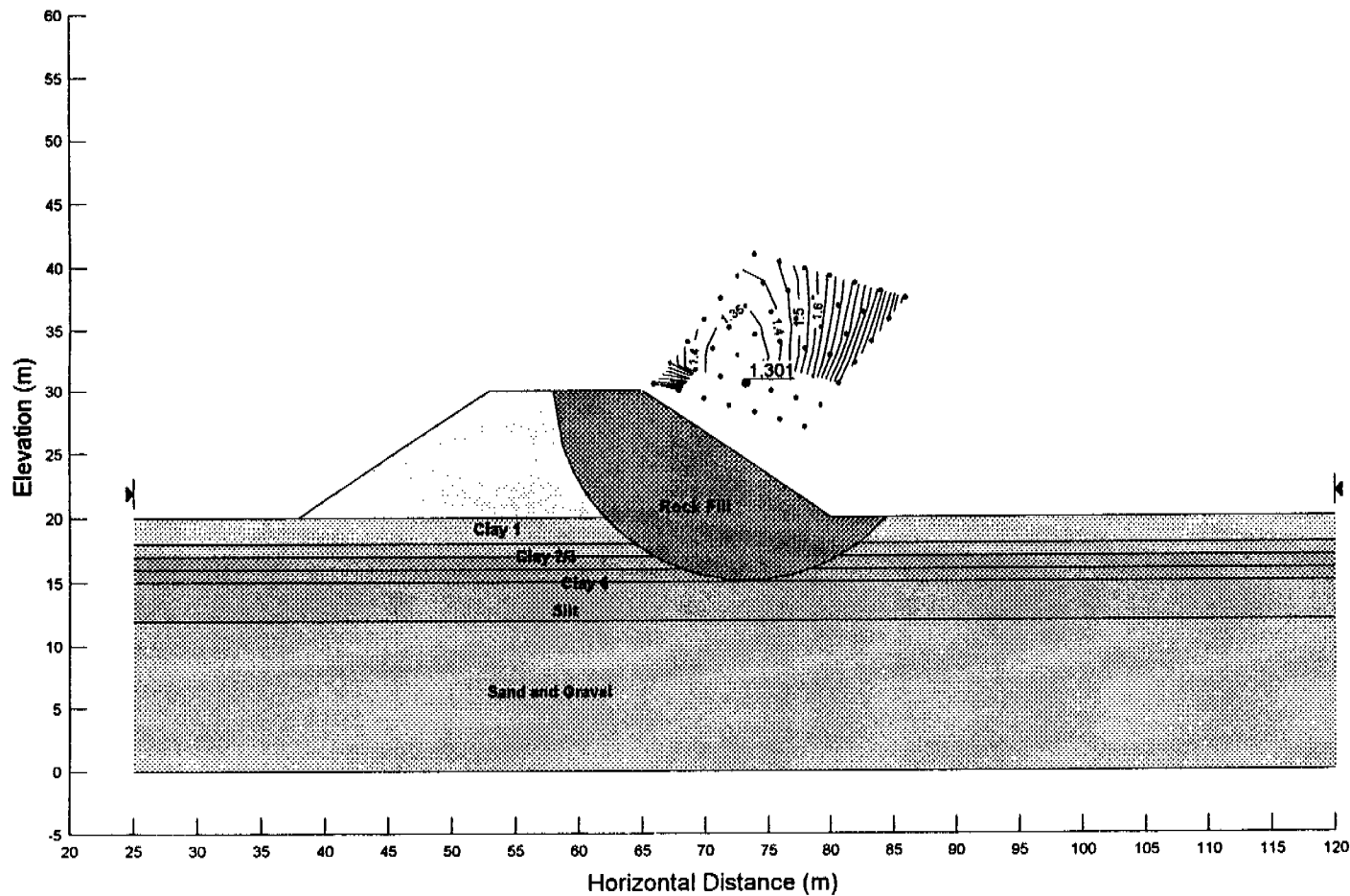
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 5 metre clay foundation  
 H10T05CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 4 metre clay foundation  
 H10T04CU.SLP

Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

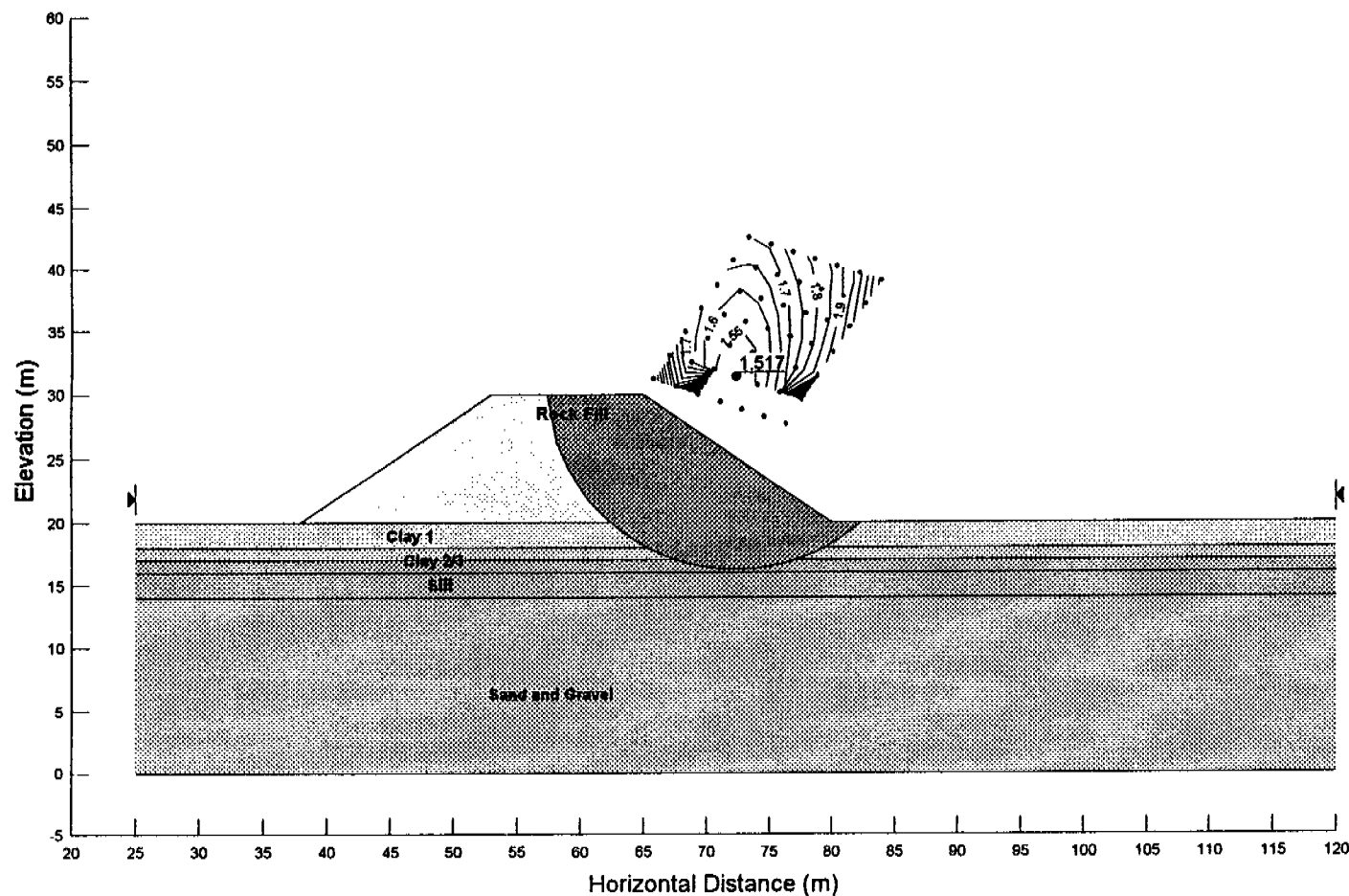
Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

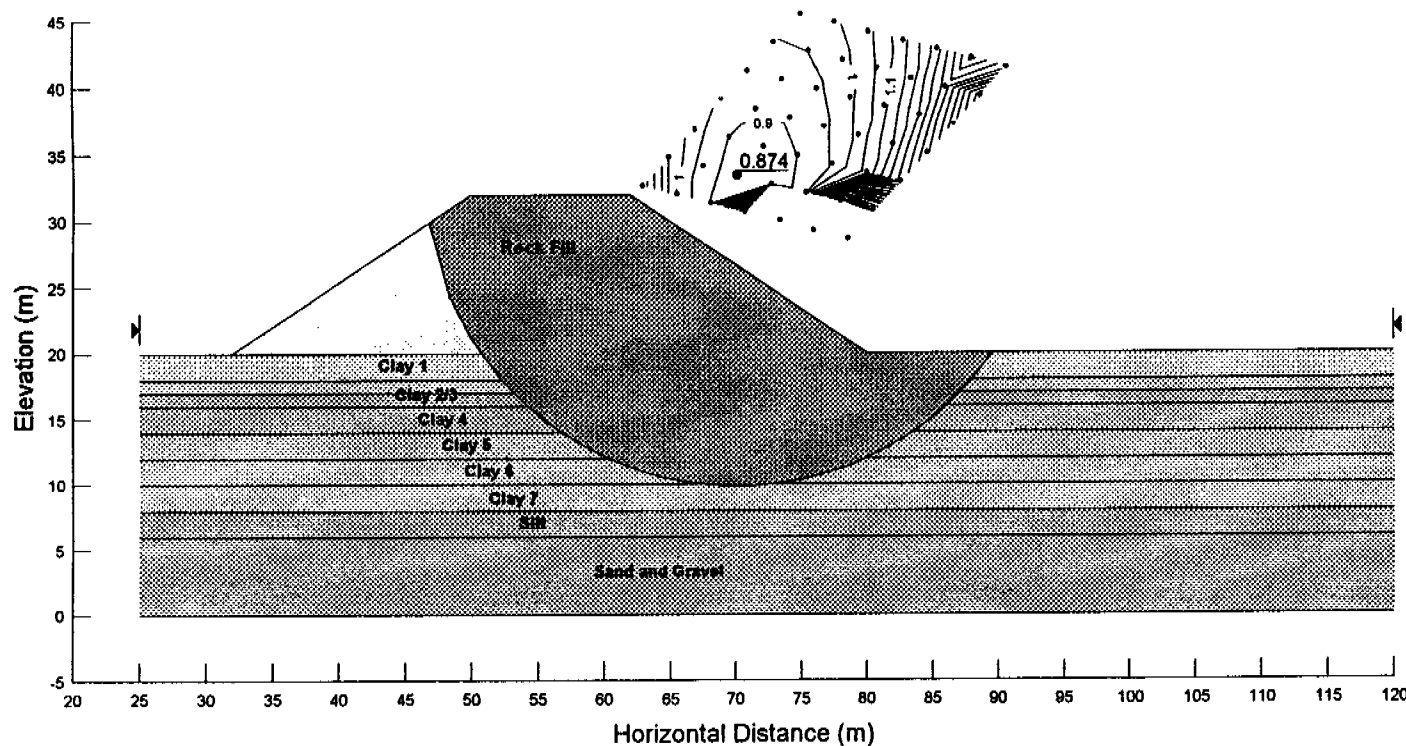
Soil 5 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 6 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 7 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H12T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

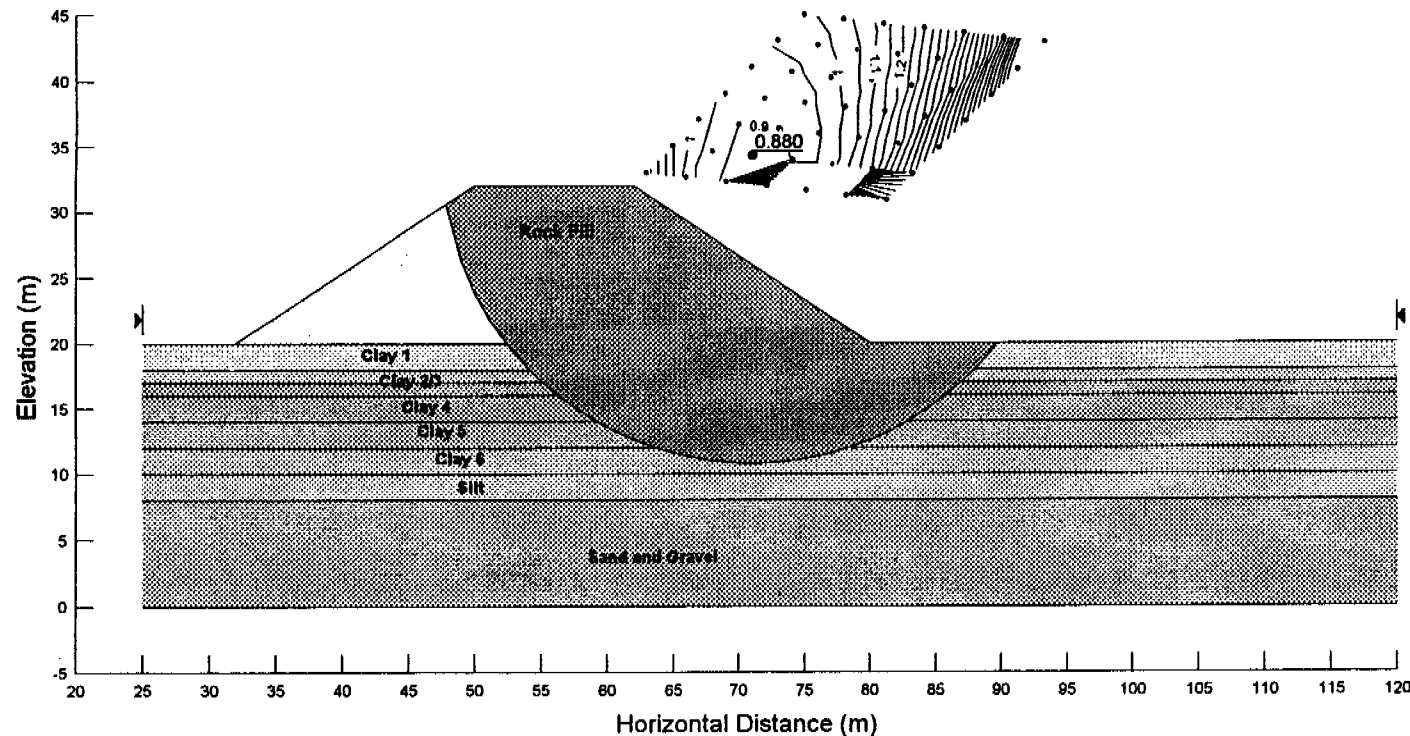
Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H12T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

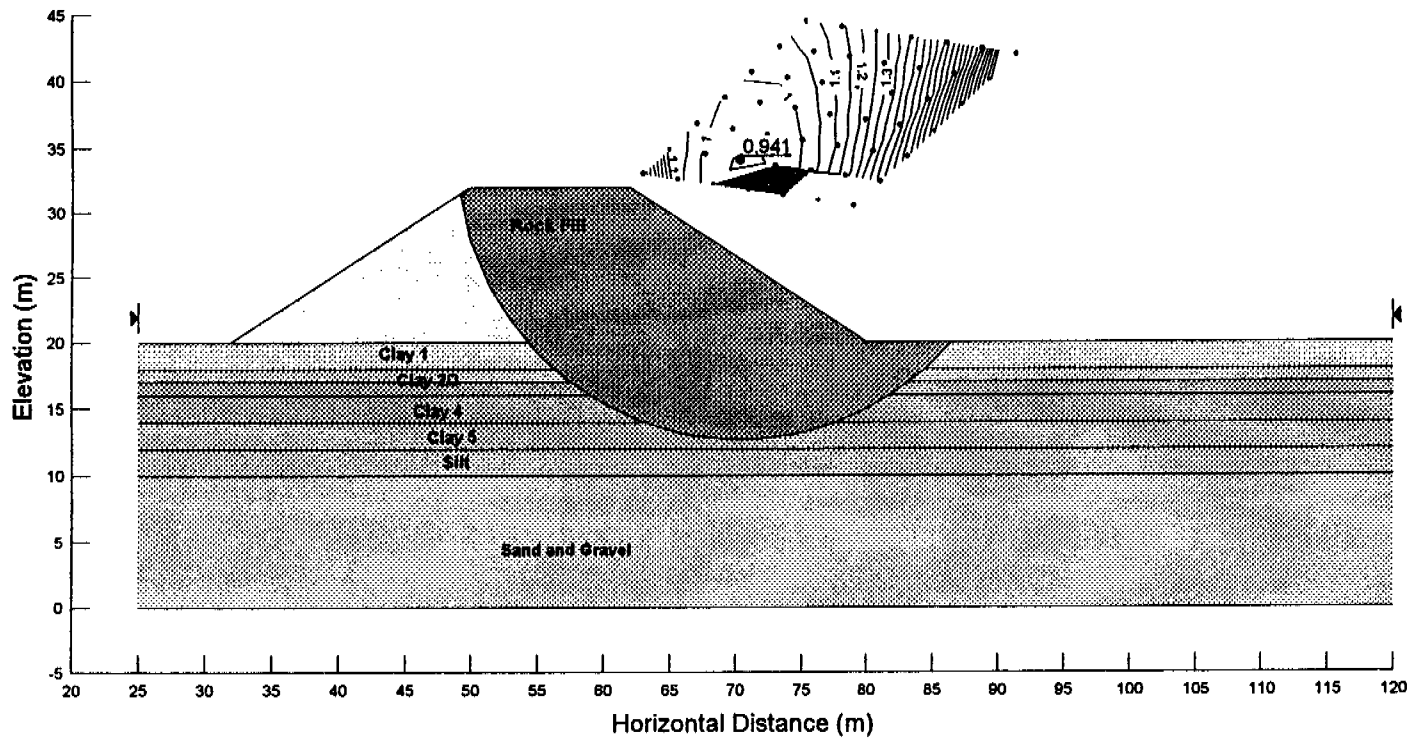
Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H12T08CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

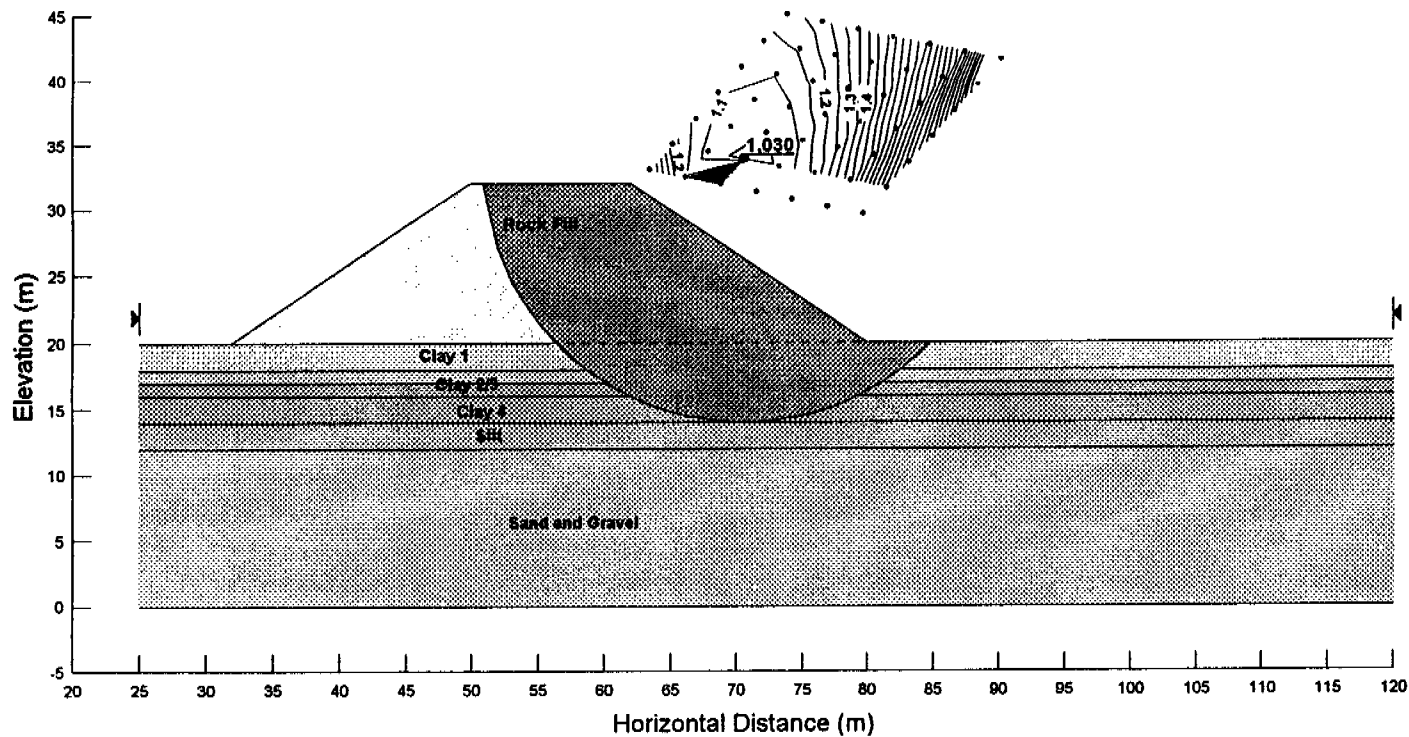
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H12T06CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

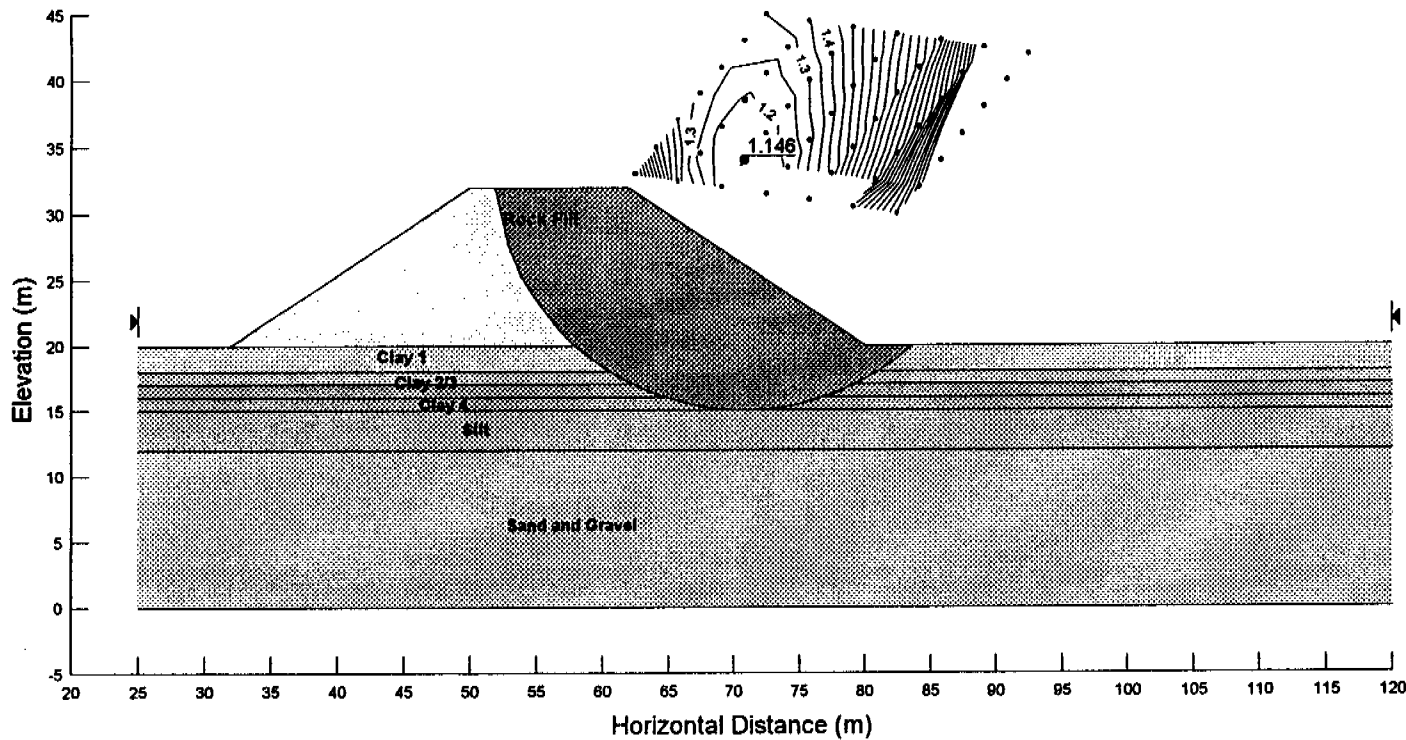
Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 5 metre clay foundation  
 H12T05CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

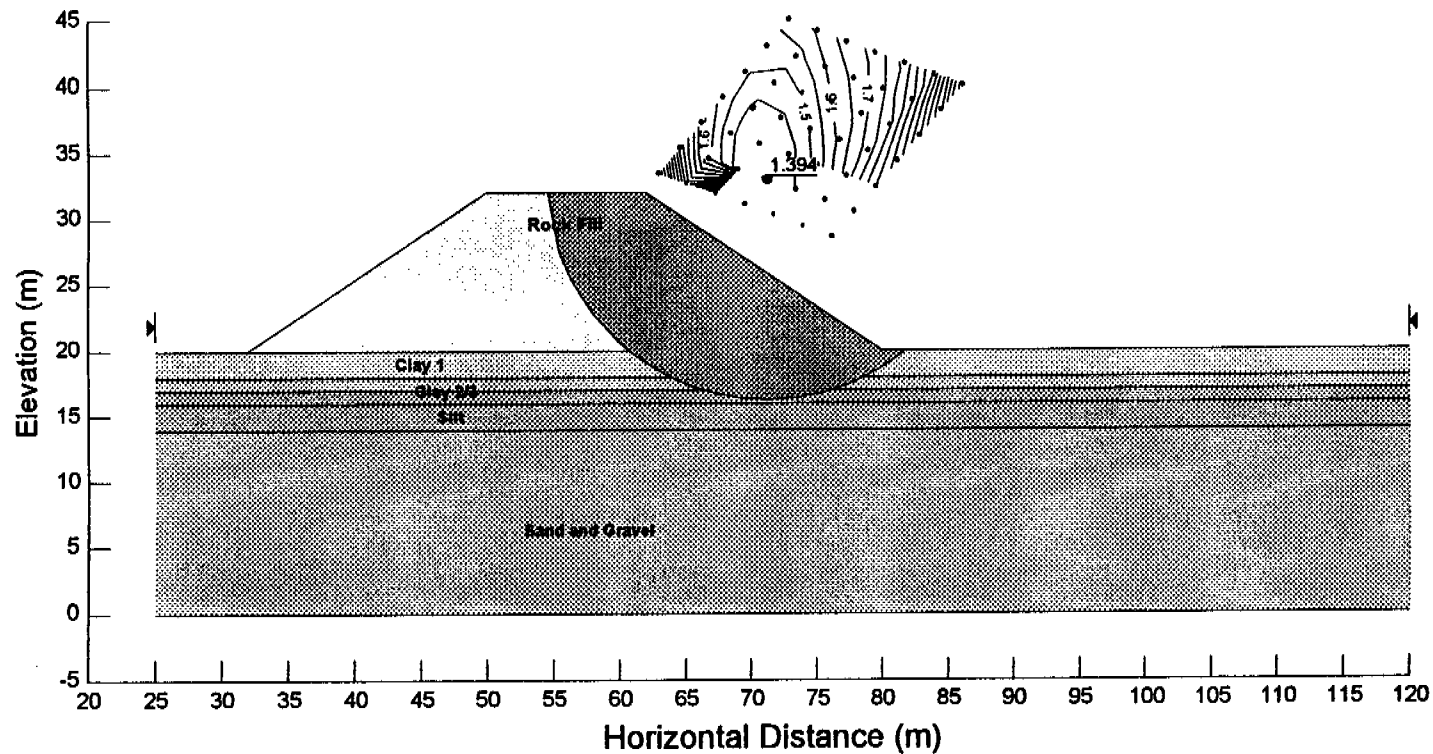
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

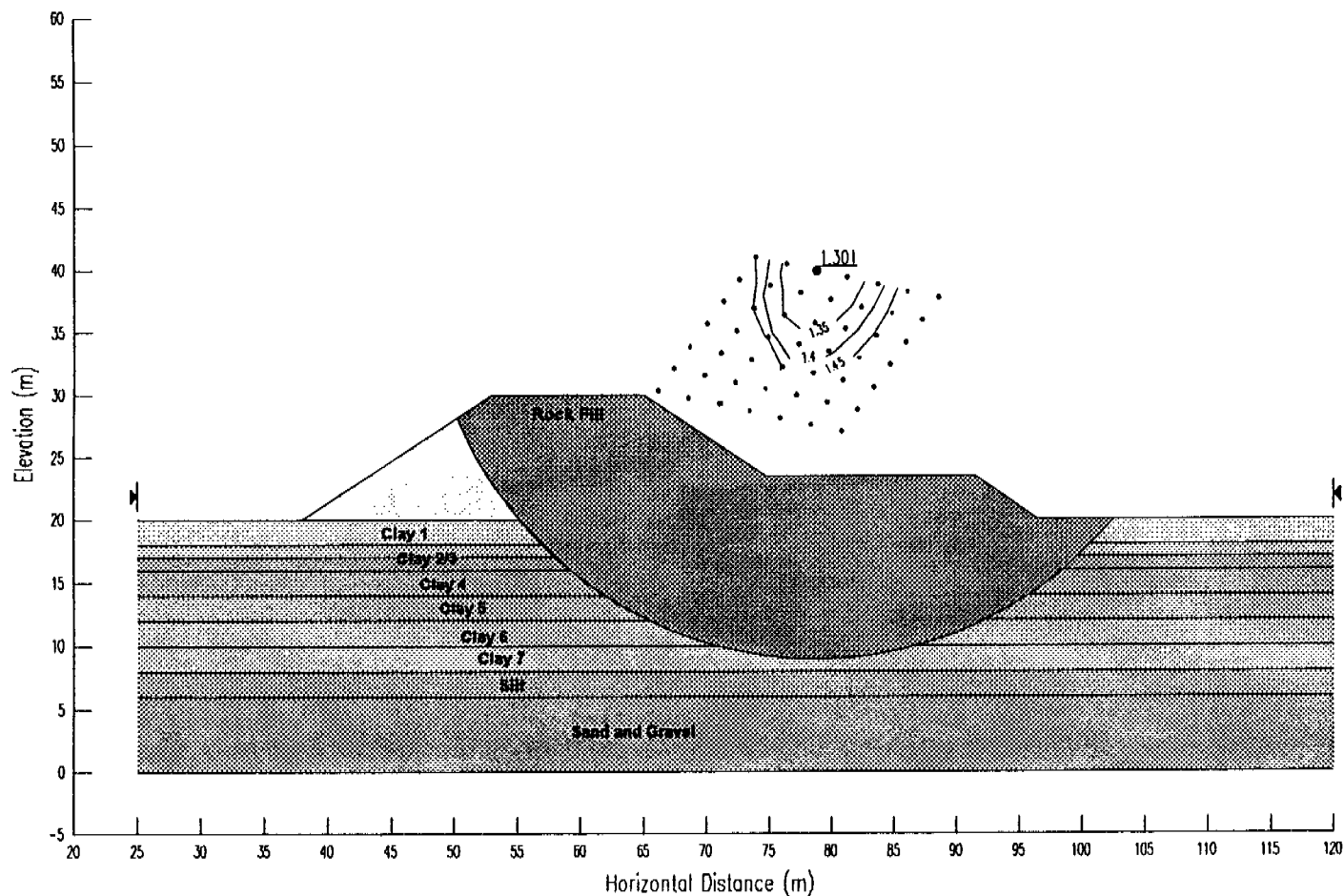
Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 4 metre clay foundation  
 H12T04CU.SLP



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 3.5 metre high, 16.75 metre long toe berm  
 B10T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

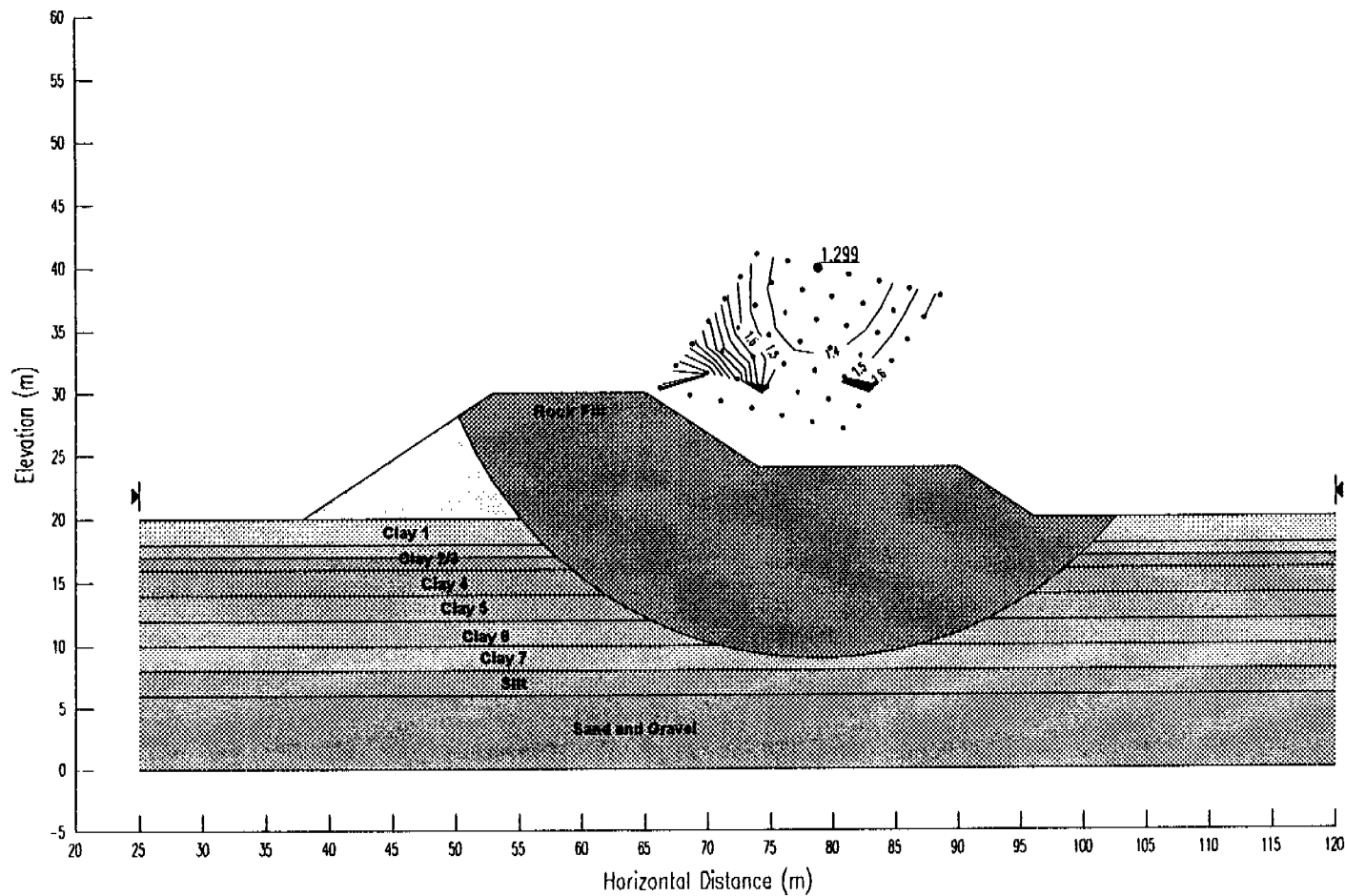
Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 4 metre high, 16 metre long toe berm  
 B10T12C4.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

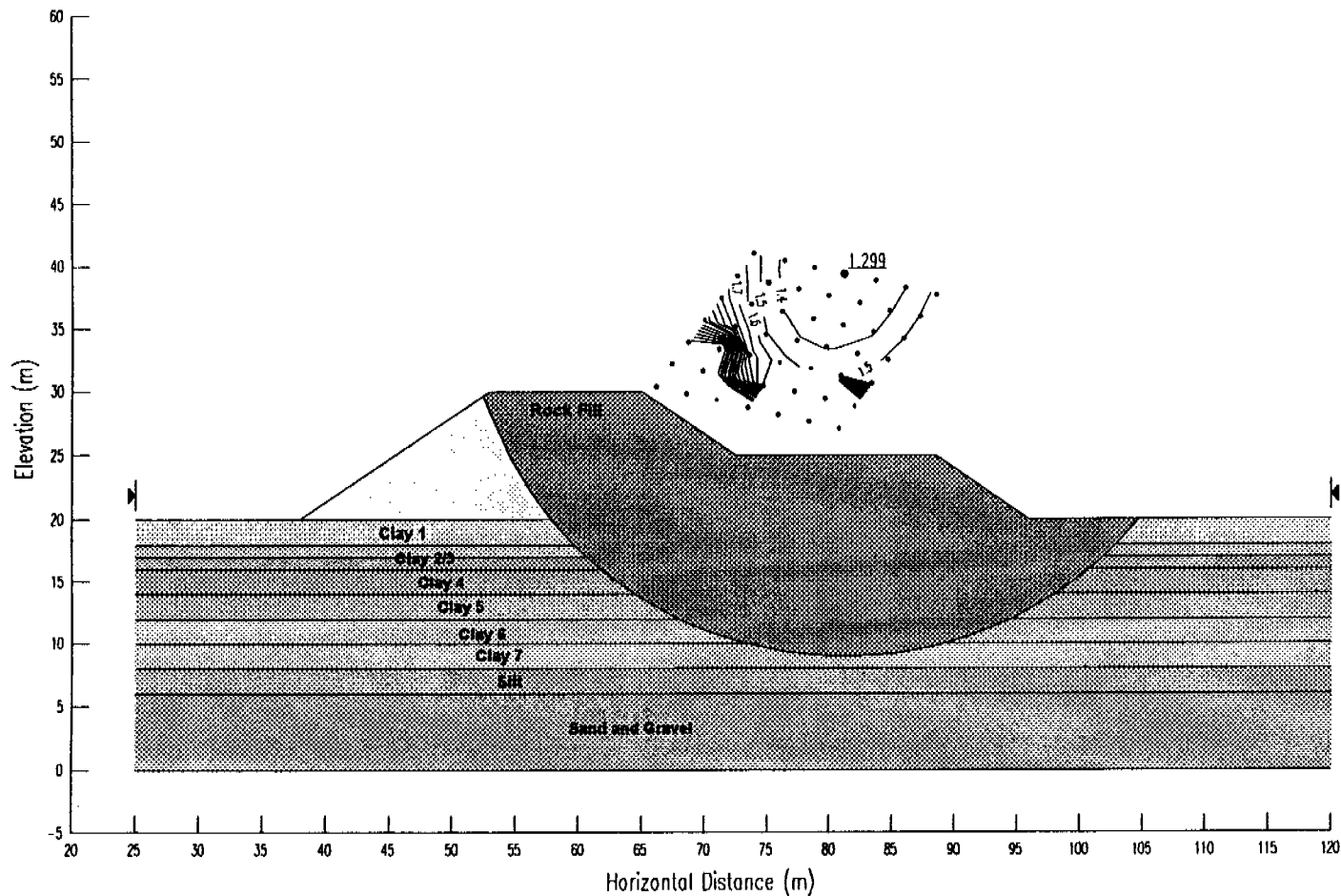
Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 5 metre high, 16 metre long toe berm  
 B10T12C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



# Trout Creek - South Interchange Highway Embankments (F98179)

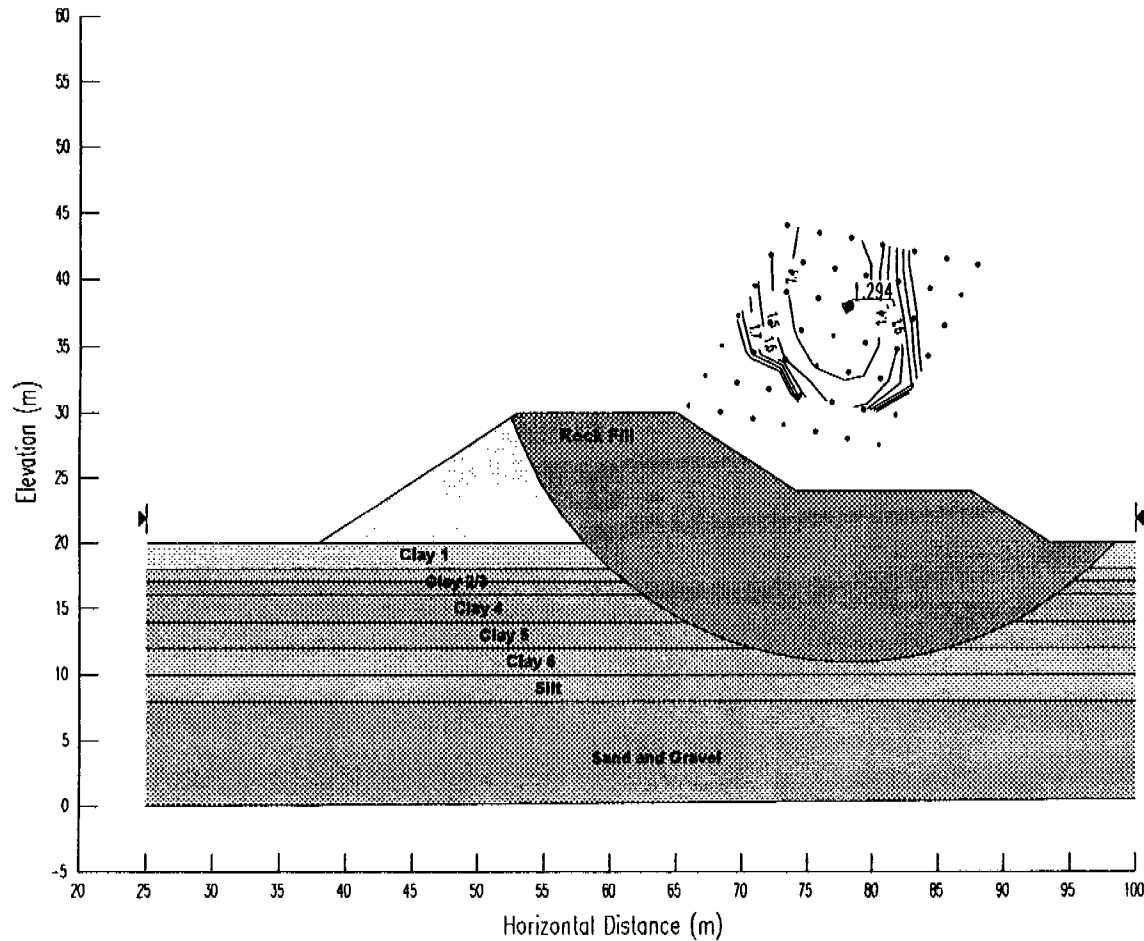
Total Stress Analysis

10 metre embankment height, 1.5:1 overall side slope

10 metre clay foundation

3.5 metre high, 14 metre long toe berm

B10T10CU.SLP



Soil 1 - Rock Fill  
Soil Model Mohr-Coulomb  
Unit Weight 20  
Cohesion 0  
Phi 42

Soil 2 - Clay 1  
Soil Model S=f(depth)  
Unit Weight 20.5  
Cv 120  
Rate of Increase -35  
Cv - Minimum 50  
Ch/Cv Ratio 1

Soil 3 - Clay 2  
Soil Model S=f(depth)  
Unit Weight 18.3  
Cv 50  
Rate of Increase -20  
Cv - Minimum 30  
Ch/Cv Ratio 1

Soil 4 - Clay 3  
Soil Model S=f(depth)  
Unit Weight 18  
Cv 30  
Rate of Increase -5  
Cv - Minimum 25  
Ch/Cv Ratio 1

Soil 5 - Clay 4  
Soil Model Mohr-Coulomb  
Unit Weight 17.3  
Cohesion 25  
Phi 0

Soil 6 - Clay 5  
Soil Model S=f(depth)  
Unit Weight 17.8  
Cv 25  
Rate of Increase 1.25  
Cv - Maximum 27.5  
Ch/Cv Ratio 1

Soil 7 - Clay 6  
Soil Model S=f(depth)  
Unit Weight 17.8  
Cv 27.5  
Rate of Increase 2.5  
Cv - Maximum 32.5  
Ch/Cv Ratio 1

Soil 8 - Silt  
Soil Model Mohr-Coulomb  
Unit Weight 19.5  
Cohesion 0  
Phi 31

Soil 9 - Sand/Gravel  
Soil Model Mohr-Coulomb  
Unit Weight 21.5  
Cohesion 0  
Phi 35

Soil 10 - Bedrock  
Soil Model Bedrock  
Unit Weight -1

# Trout Creek - South Interchange Highway Embankments (F98179)

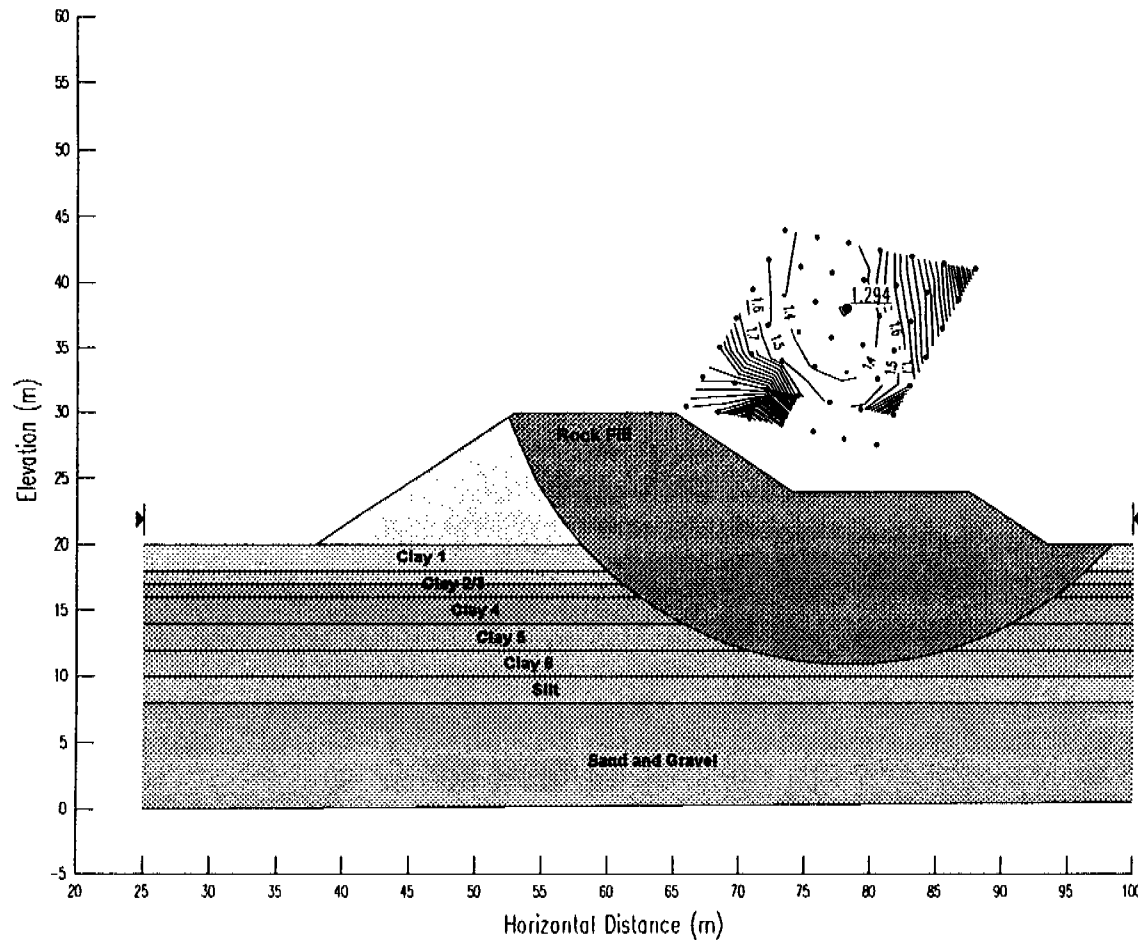
## Total Stress Analysis

10 metre embankment height, 1.5:1 overall side slope

10 metre clay foundation

4 metre high, 13.5 metre long toe berm

B10T10C4.SLP



Soil 1 - Rock Fill  
Soil Model Mohr-Coulomb  
Unit Weight 20  
Cohesion 0  
Phi 42

Soil 2 - Clay 1  
Soil Model S=f(depth)  
Unit Weight 20.5  
Cv 120  
Rate of Increase -35  
Cv - Minimum 50  
Ch/Cv Ratio 1

Soil 3 - Clay 2  
Soil Model S=f(depth)  
Unit Weight 18.3  
Cv 50  
Rate of Increase -20  
Cv - Minimum 30  
Ch/Cv Ratio 1

Soil 4 - Clay 3  
Soil Model S=f(depth)  
Unit Weight 18  
Cv 30  
Rate of Increase -5  
Cv - Minimum 25  
Ch/Cv Ratio 1

Soil 5 - Clay 4  
Soil Model Mohr-Coulomb  
Unit Weight 17.3  
Cohesion 25  
Phi 0

Soil 6 - Clay 5  
Soil Model S=f(depth)  
Unit Weight 17.8  
Cv 25  
Rate of Increase 1.25  
Cv - Maximum 27.5  
Ch/Cv Ratio 1

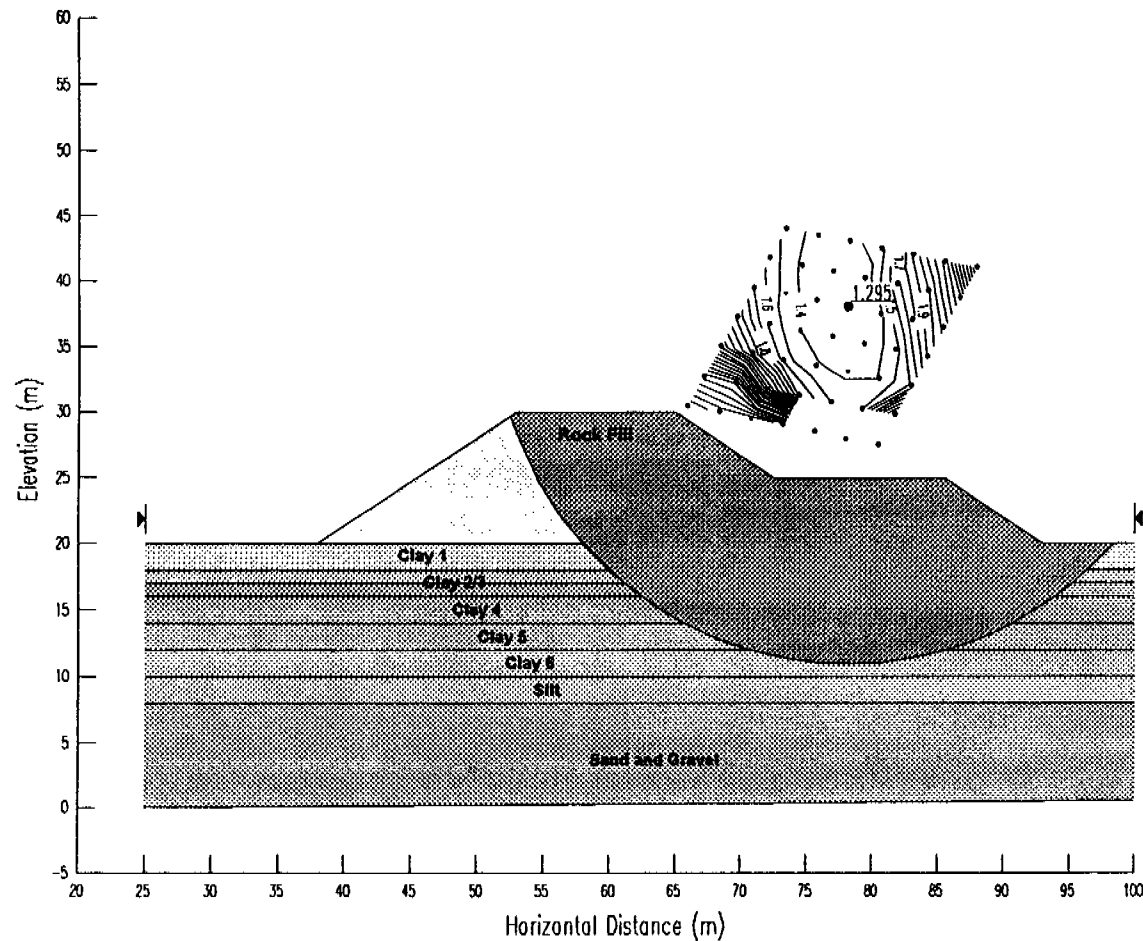
Soil 7 - Clay 6  
Soil Model S=f(depth)  
Unit Weight 17.8  
Cv 27.5  
Rate of Increase 2.5  
Cv - Maximum 32.5  
Ch/Cv Ratio 1

Soil 8 - Silt  
Soil Model Mohr-Coulomb  
Unit Weight 19.5  
Cohesion 0  
Phi 31

Soil 9 - Sand/Gravel  
Soil Model Mohr-Coulomb  
Unit Weight 21.5  
Cohesion 0  
Phi 35

Soil 10 - Bedrock  
Soil Model Bedrock  
Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 5 metre high, 13 metre long toe berm  
 B10T10C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

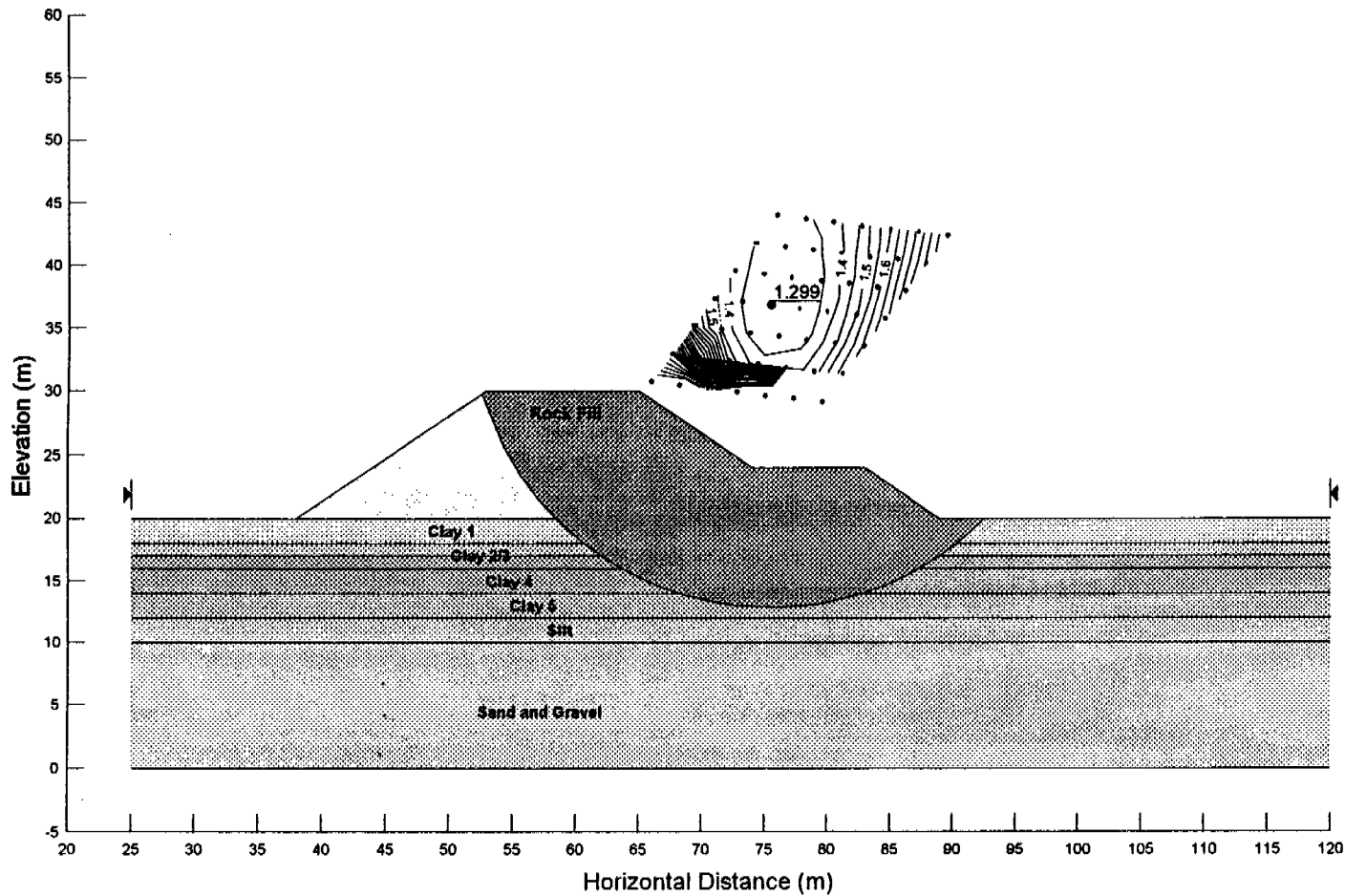
Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 4 metre high, 9 metre long toe berm  
 B10T08C4.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

# Trout Creek - South Interchange Highway Embankments (F98179)

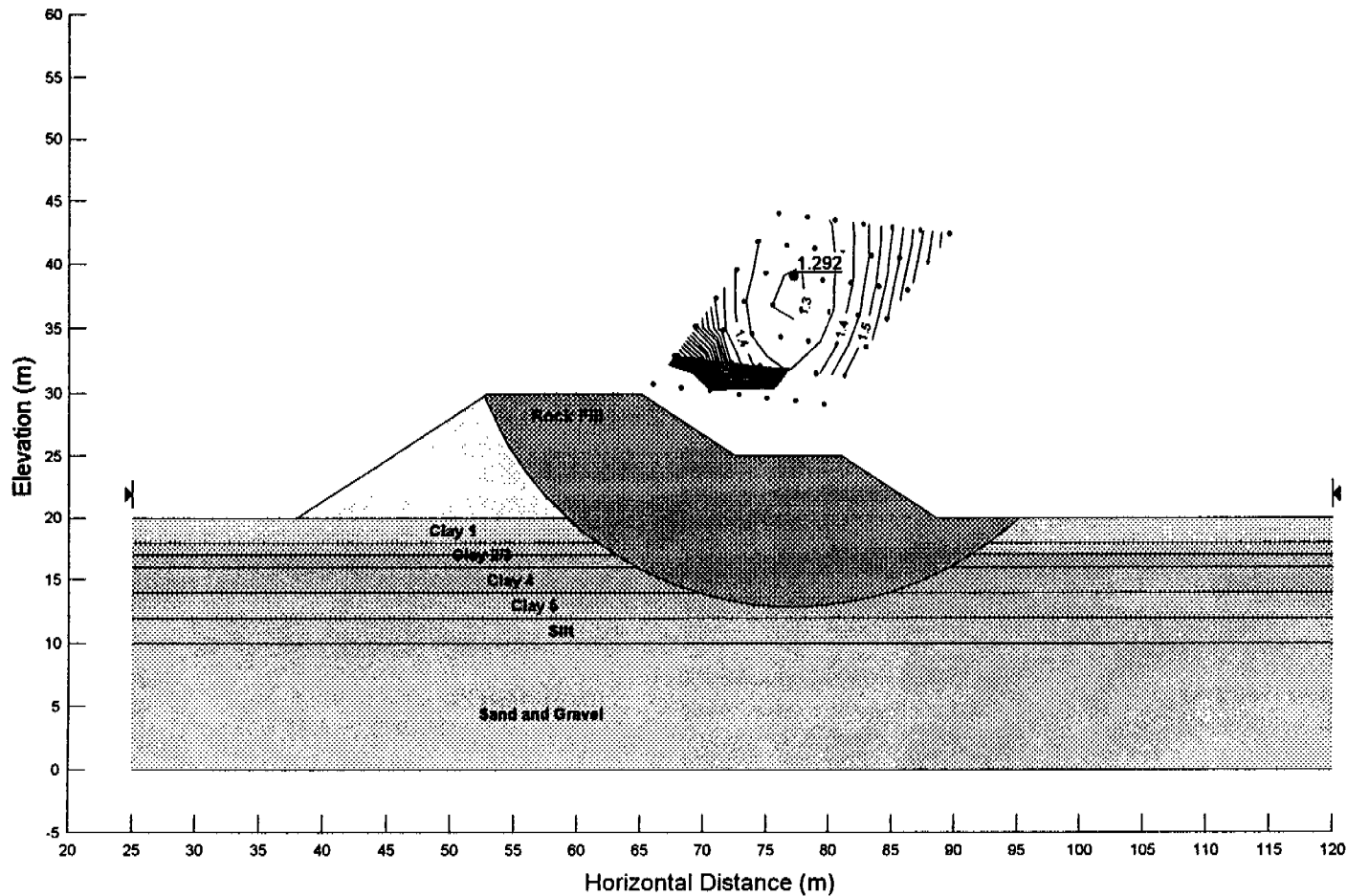
## Total Stress Analysis

10 metre embankment height, 1.5:1 overall side slope

8 metre clay foundation

5 metre high, 8.5 metre long toe berm

B10T08C5.SLP



Soil 1 - Rock Fill  
Soil Model Mohr-Coulomb  
Unit Weight 20  
Cohesion 0  
Phi 42

Soil 2 - Clay 1  
Soil Model S=f(depth)  
Unit Weight 20.5  
Cv 120  
Rate of Increase -35  
Cv - Minimum 50  
Ch/Cv Ratio 1

Soil 3 - Clay 2  
Soil Model S=f(depth)  
Unit Weight 18.3  
Cv 50  
Rate of Increase -20  
Cv - Minimum 30  
Ch/Cv Ratio 1

Soil 4 - Clay 3  
Soil Model S=f(depth)  
Unit Weight 18  
Cv 30  
Rate of Increase -5  
Cv - Minimum 25  
Ch/Cv Ratio 1

Soil 5 - Clay 4  
Soil Model Mohr-Coulomb  
Unit Weight 17.3  
Cohesion 25  
Phi 0

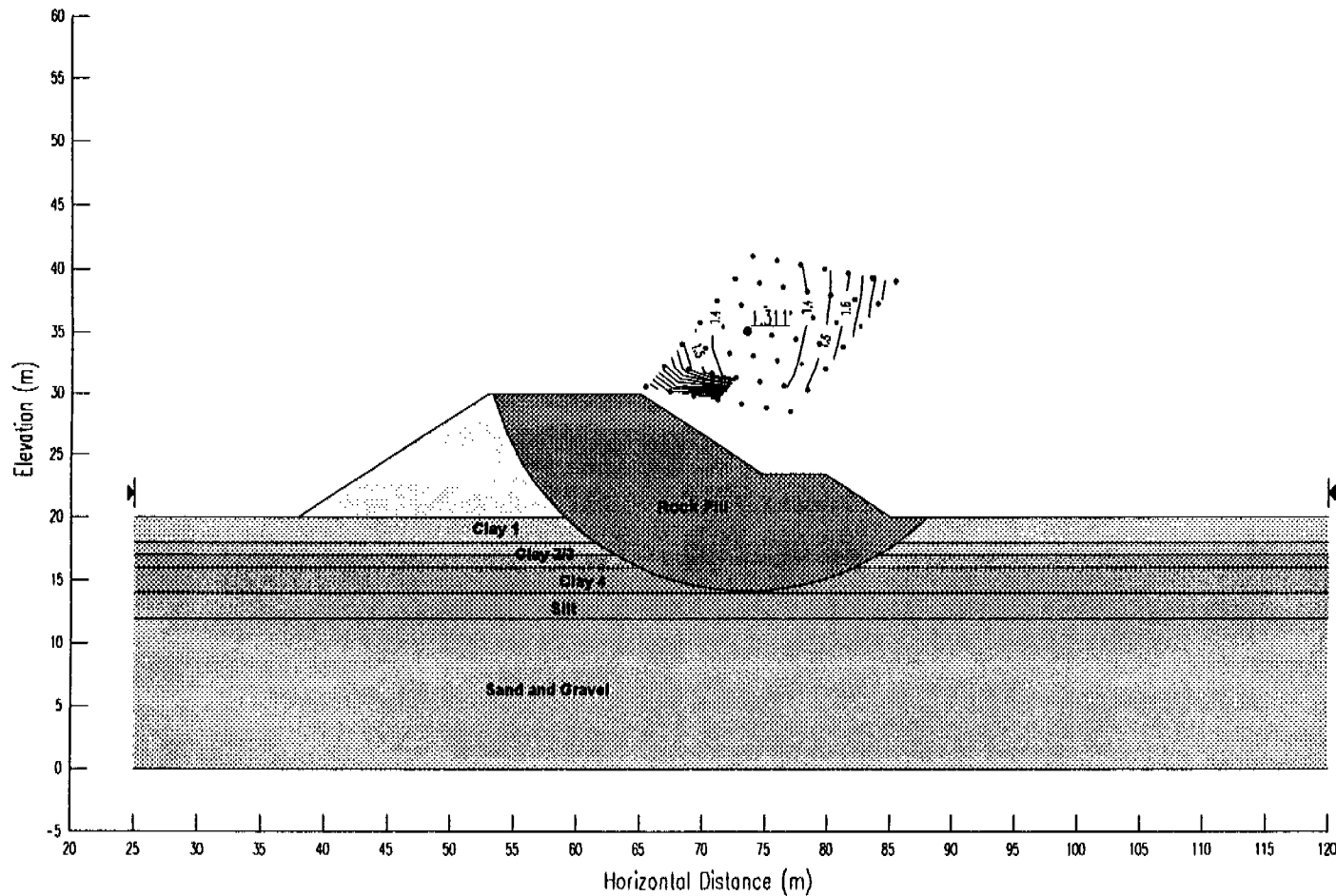
Soil 6 - Clay 5  
Soil Model S=f(depth)  
Unit Weight 17.8  
Cv 25  
Rate of Increase 1.25  
Cv - Maximum 27.5  
Ch/Cv Ratio 1

Soil 7 - Silt  
Soil Model Mohr-Coulomb  
Unit Weight 19.5  
Cohesion 0  
Phi 31

Soil 8 - Sand/Gravel  
Soil Model Mohr-Coulomb  
Unit Weight 21.5  
Cohesion 0  
Phi 35

Soil 9 - Bedrock  
Soil Model Bedrock  
Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 3.5 metre high, 5 metre long toe berm  
 B10T06CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

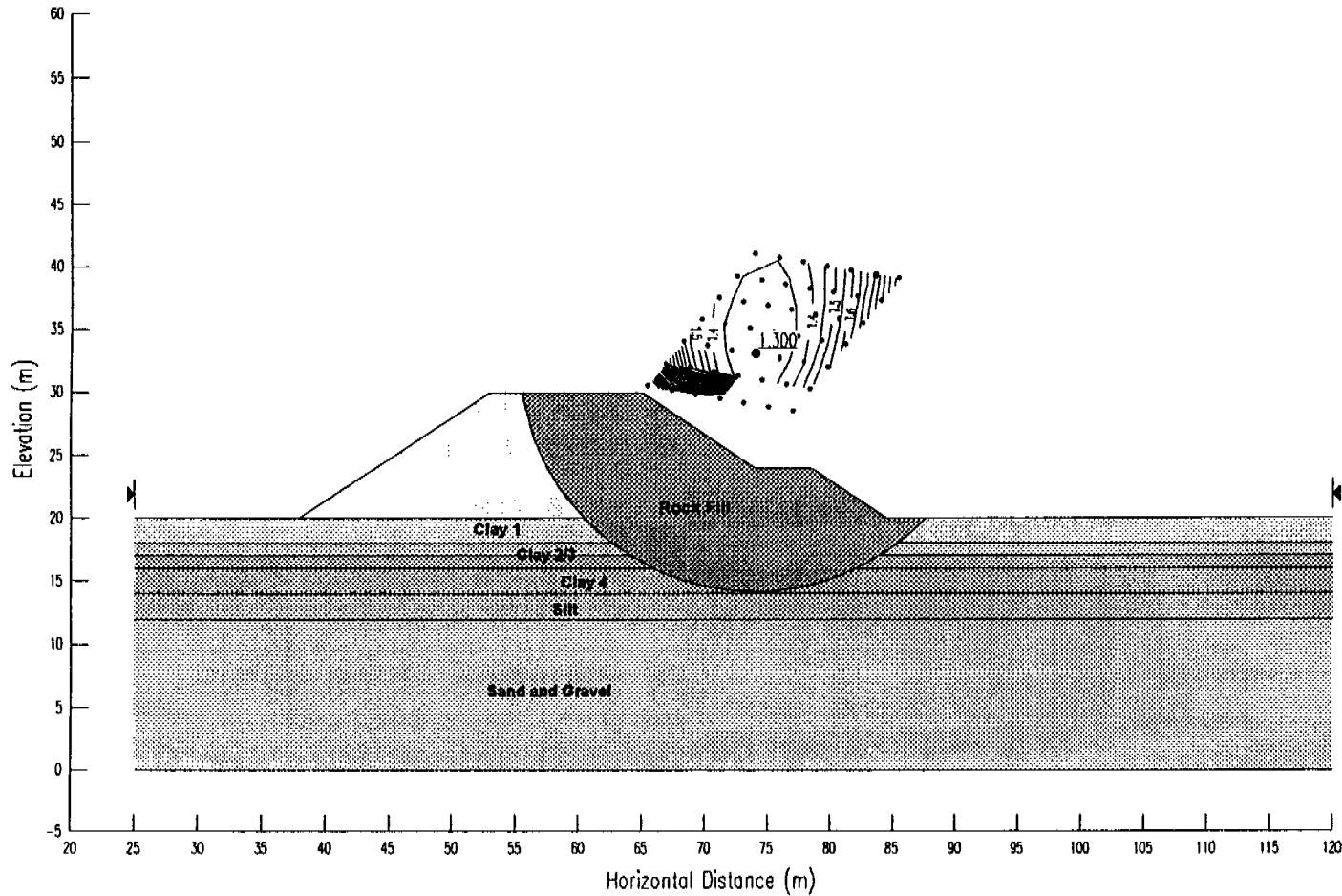
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 4 metre high, 4.5 metre long toe berm  
 B10T06C4.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

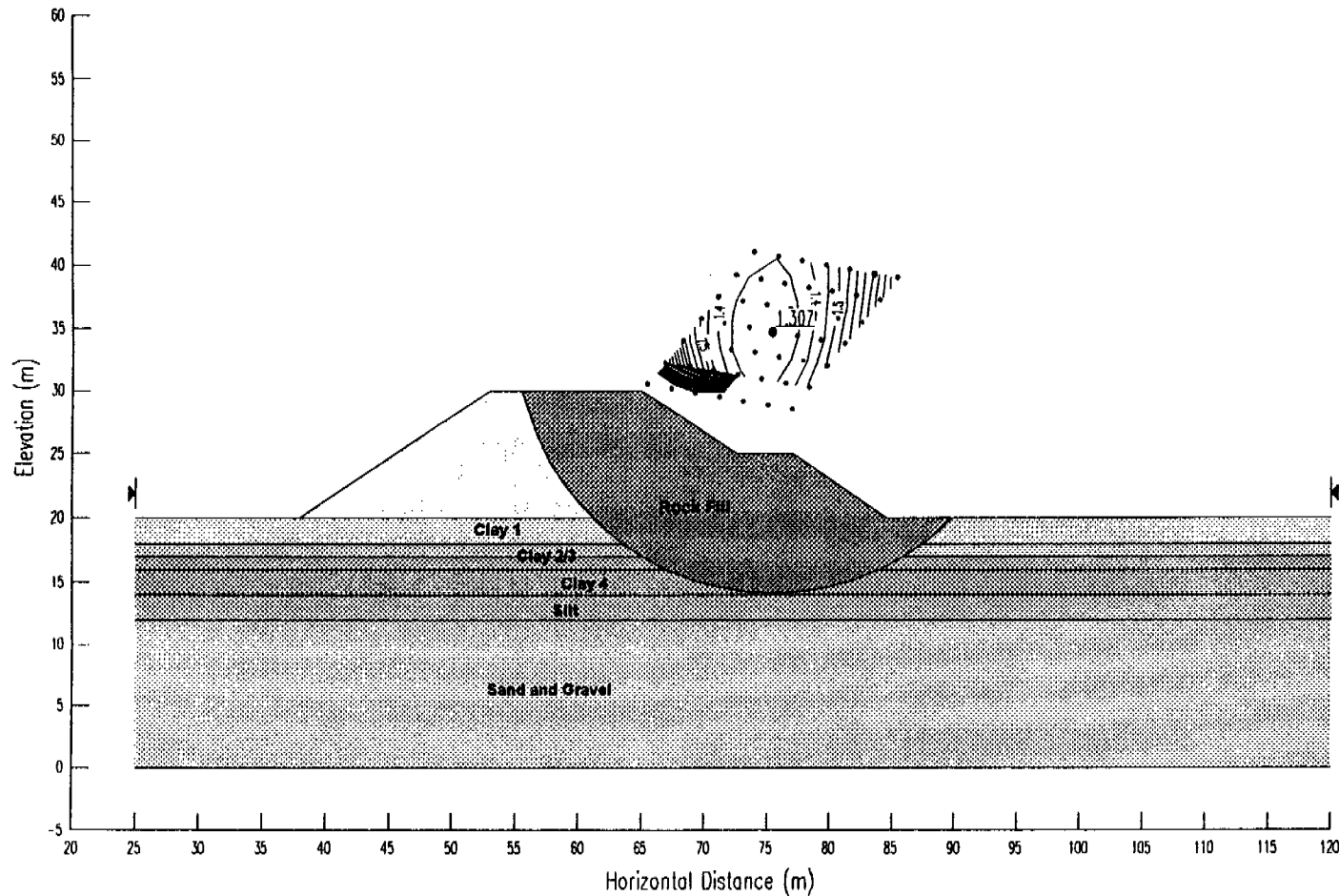
Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 10 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 5 metre high, 4.5 metre long toe berm  
 B10T06C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

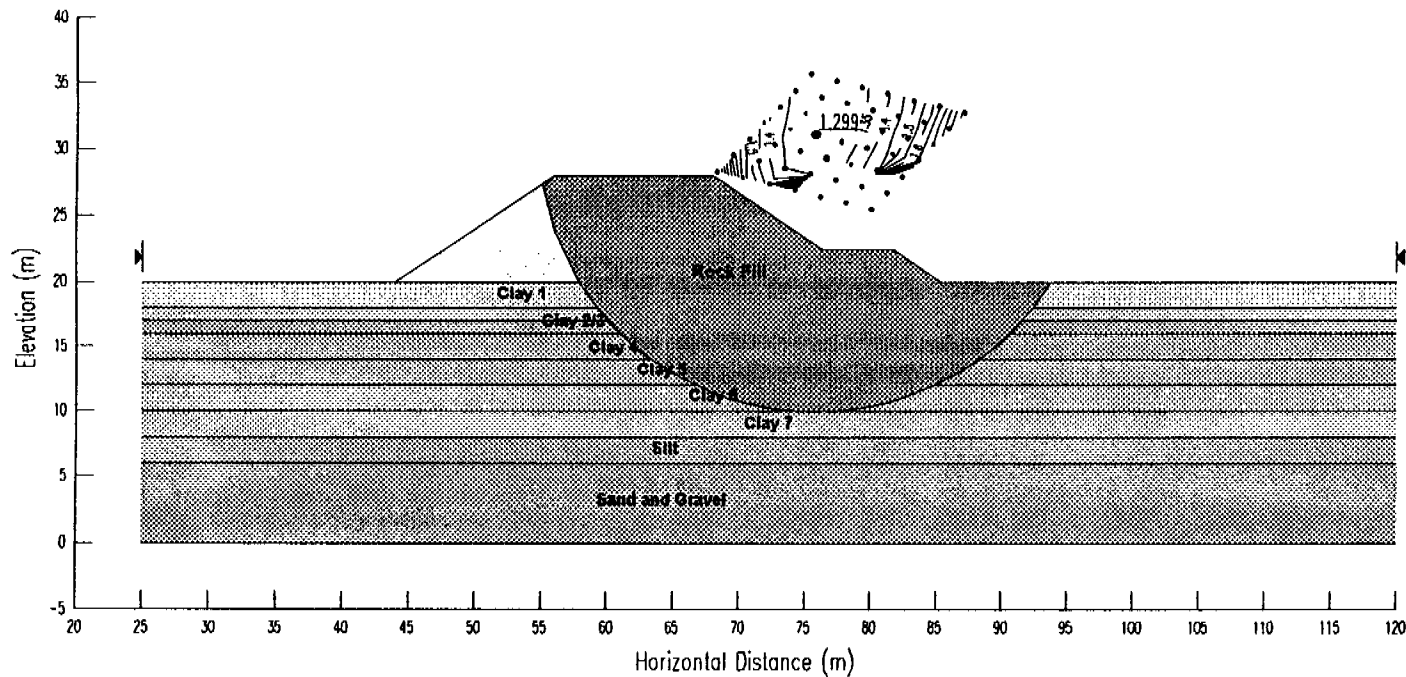
Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 2.5 metre high, 5.5 metre long toe berm  
 B08T12CU.SLP



Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

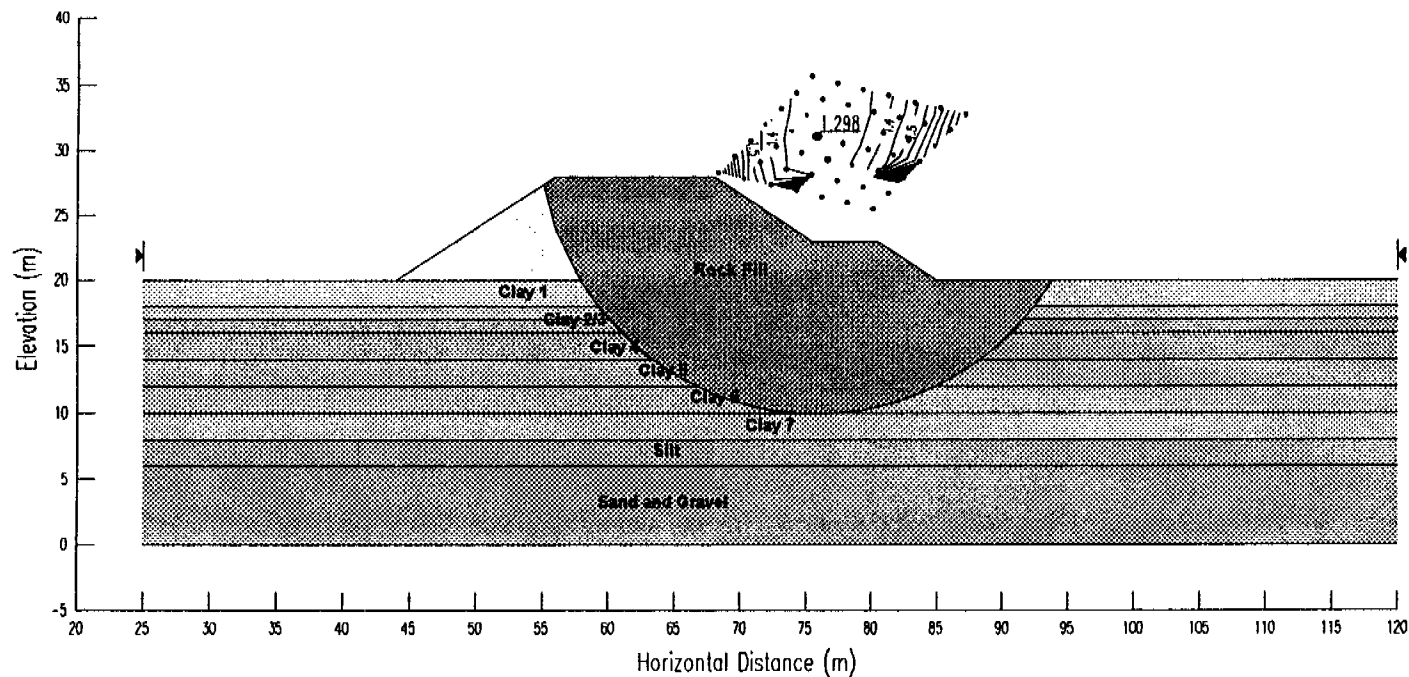
Soil 8 - Clay 7  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 3 metre high, 5 metre long toe berm  
 B08T12C3.SLP



Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

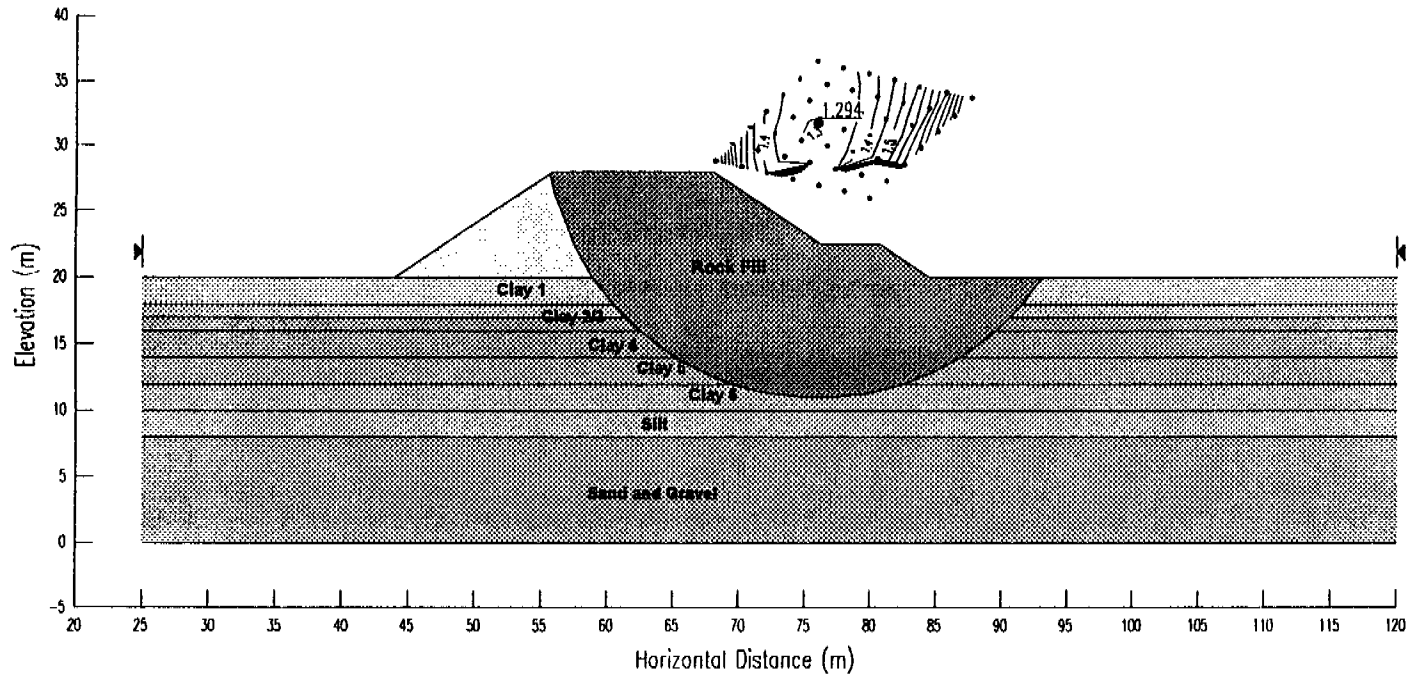
Soil 8 - Clay 7  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 2.5 metre high, 4.5 metre long toe berm  
 B8T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

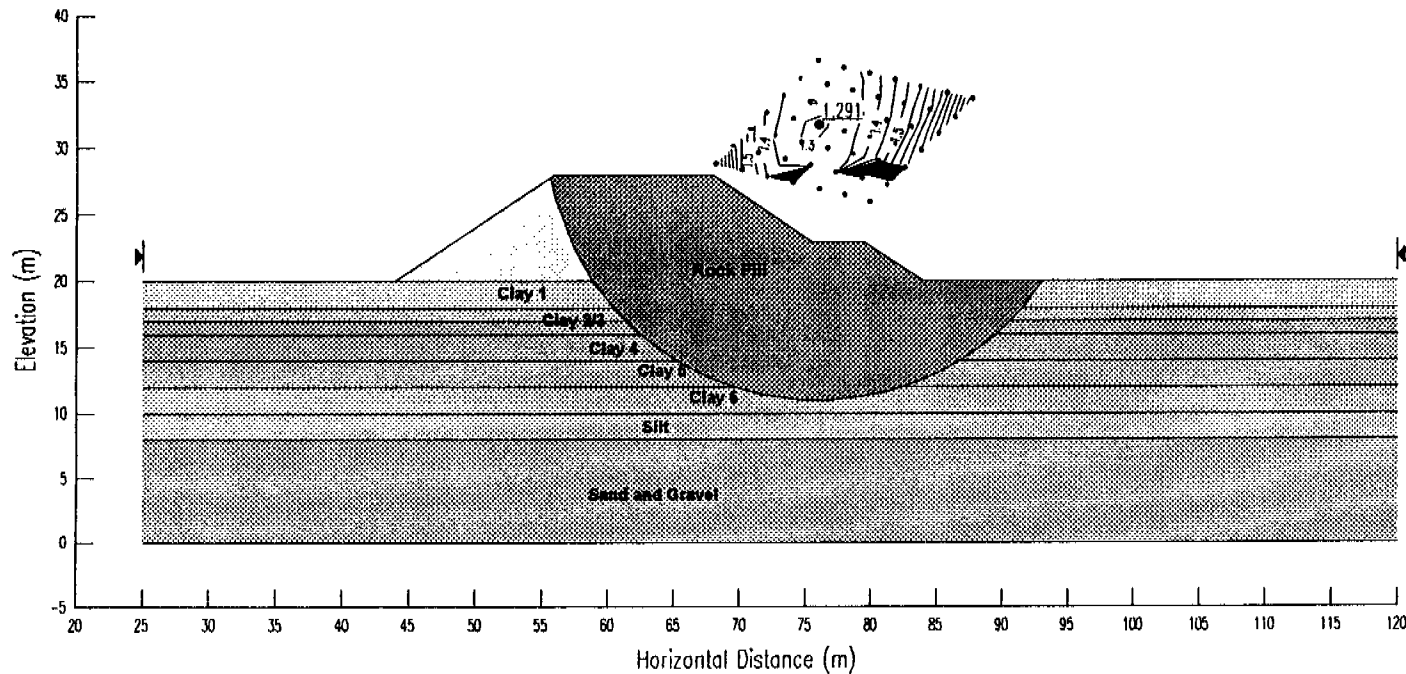
Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 3 metre high, 4 metre long toe berm  
 B8T10C3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

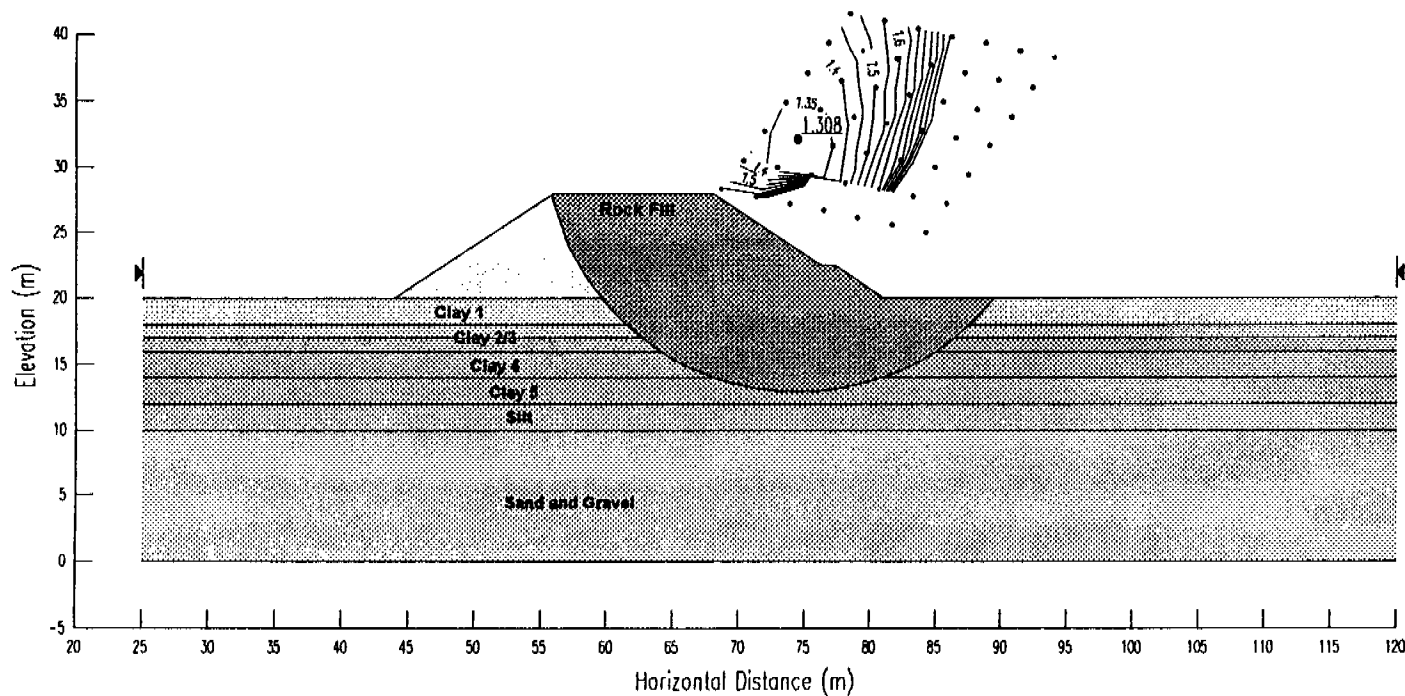
Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 2.5 metre high, 1 metre long toe berm  
 B08T08CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

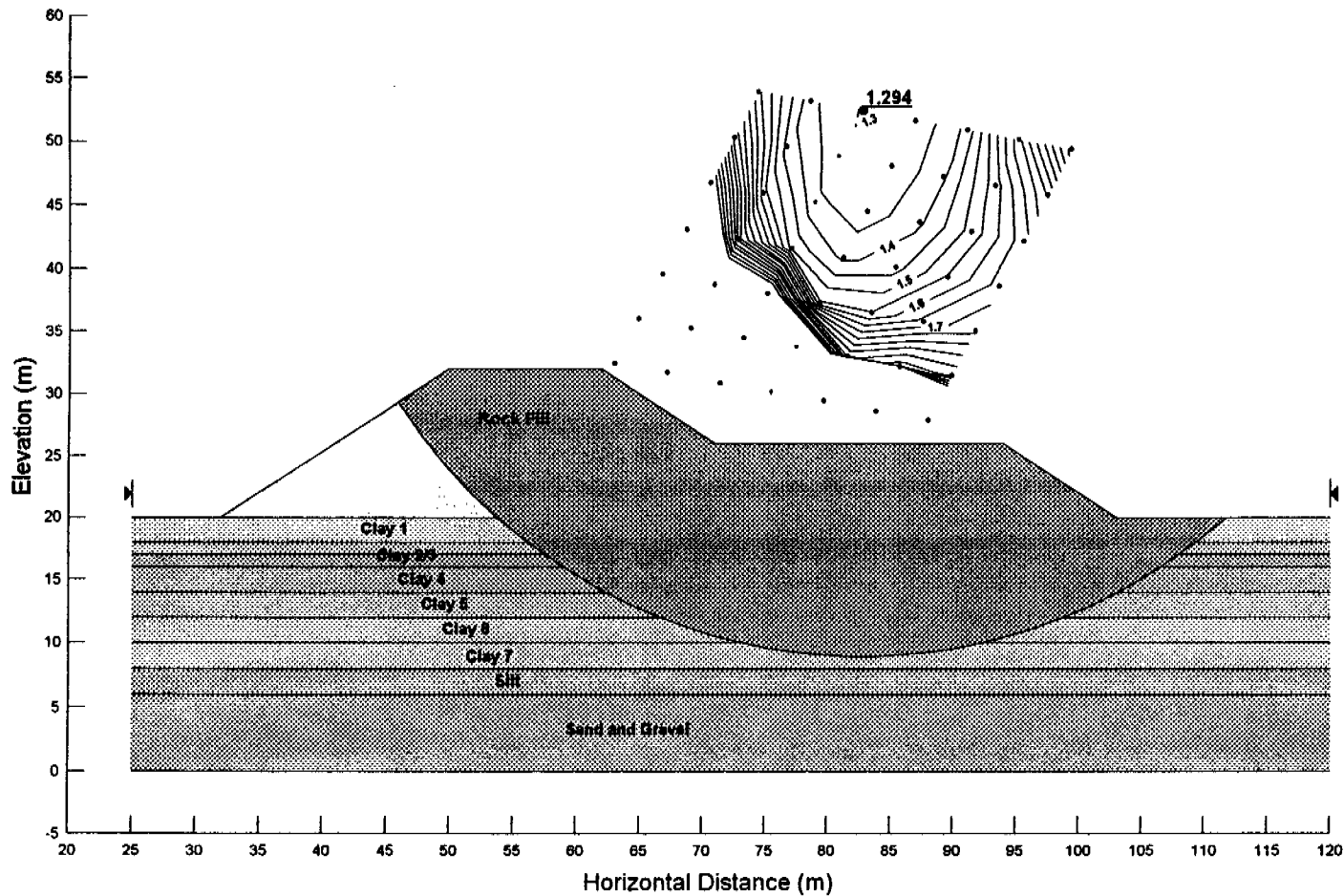
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 6 metre high, 23 metre long toe berm  
 B12T12CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

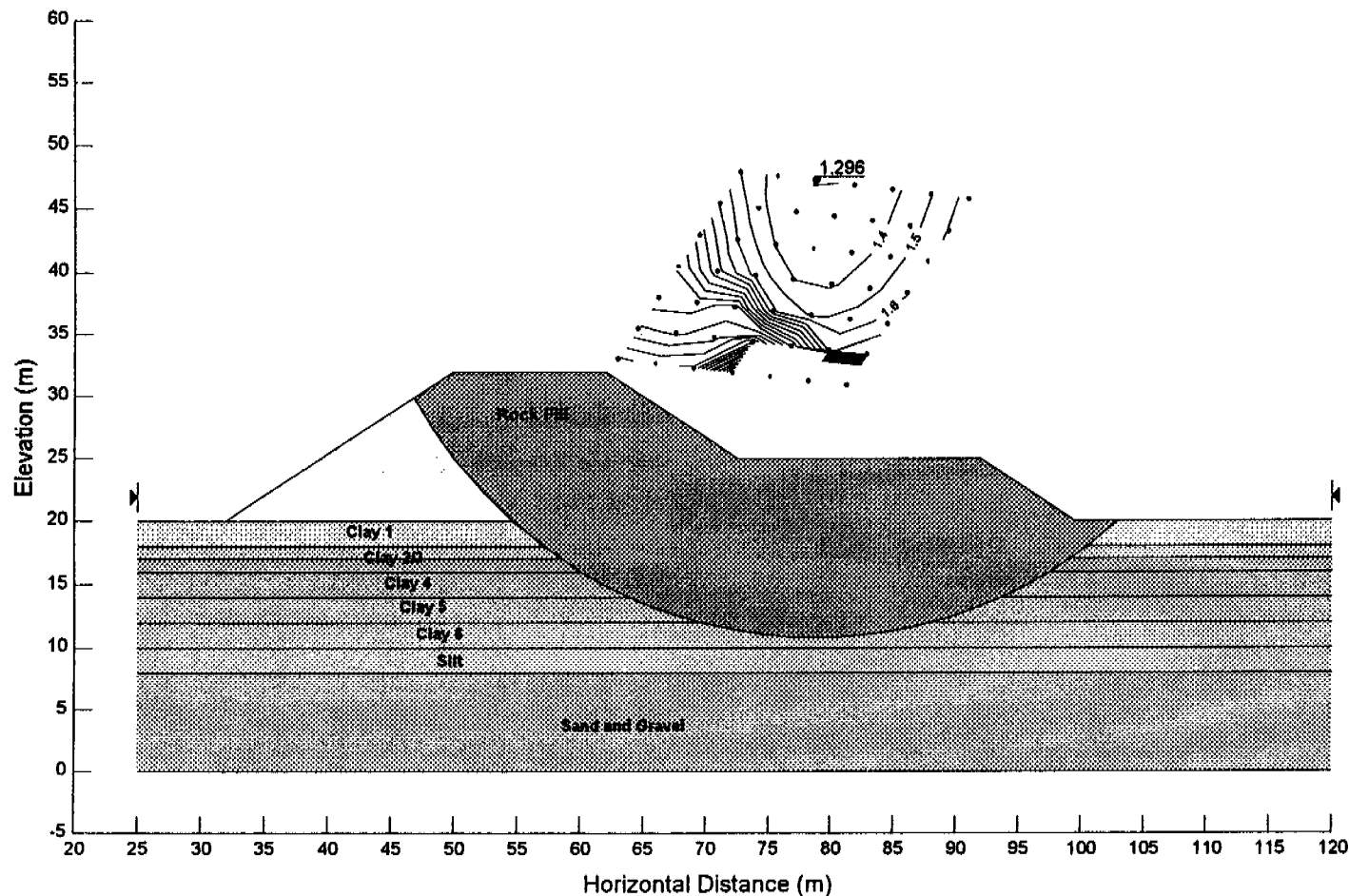
Soil 8 - Clay 7  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 32.5  
 Rate of Increase 2.5  
 Cv - Maximum 37.5  
 Ch/Cv Ratio 1

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 5 metre high, 19.5 metre long toe berm  
 B12T10C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

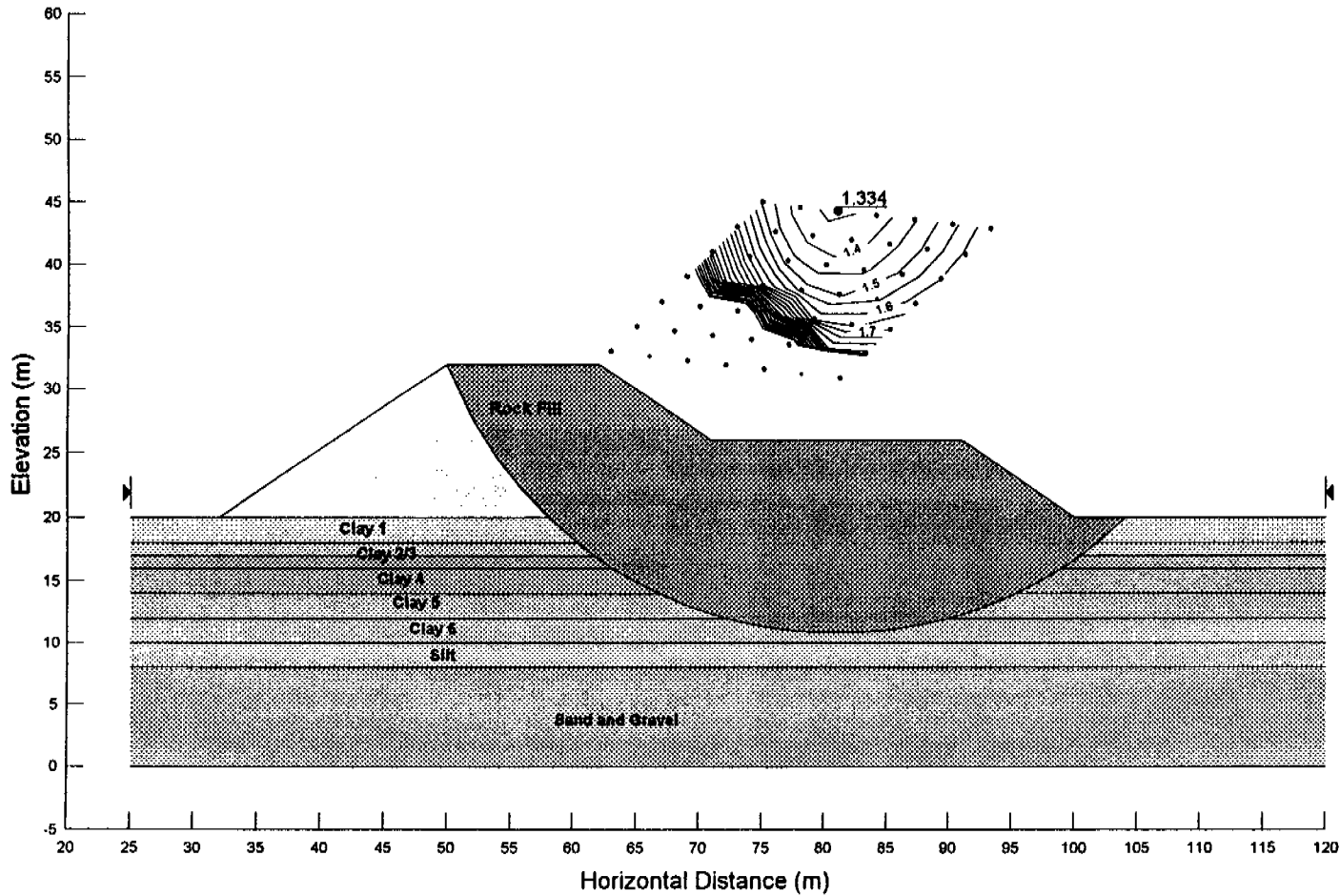
Soil 7 - Clay 6  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 5 metre high, 20 metre long toe berm  
 B12T10CU.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

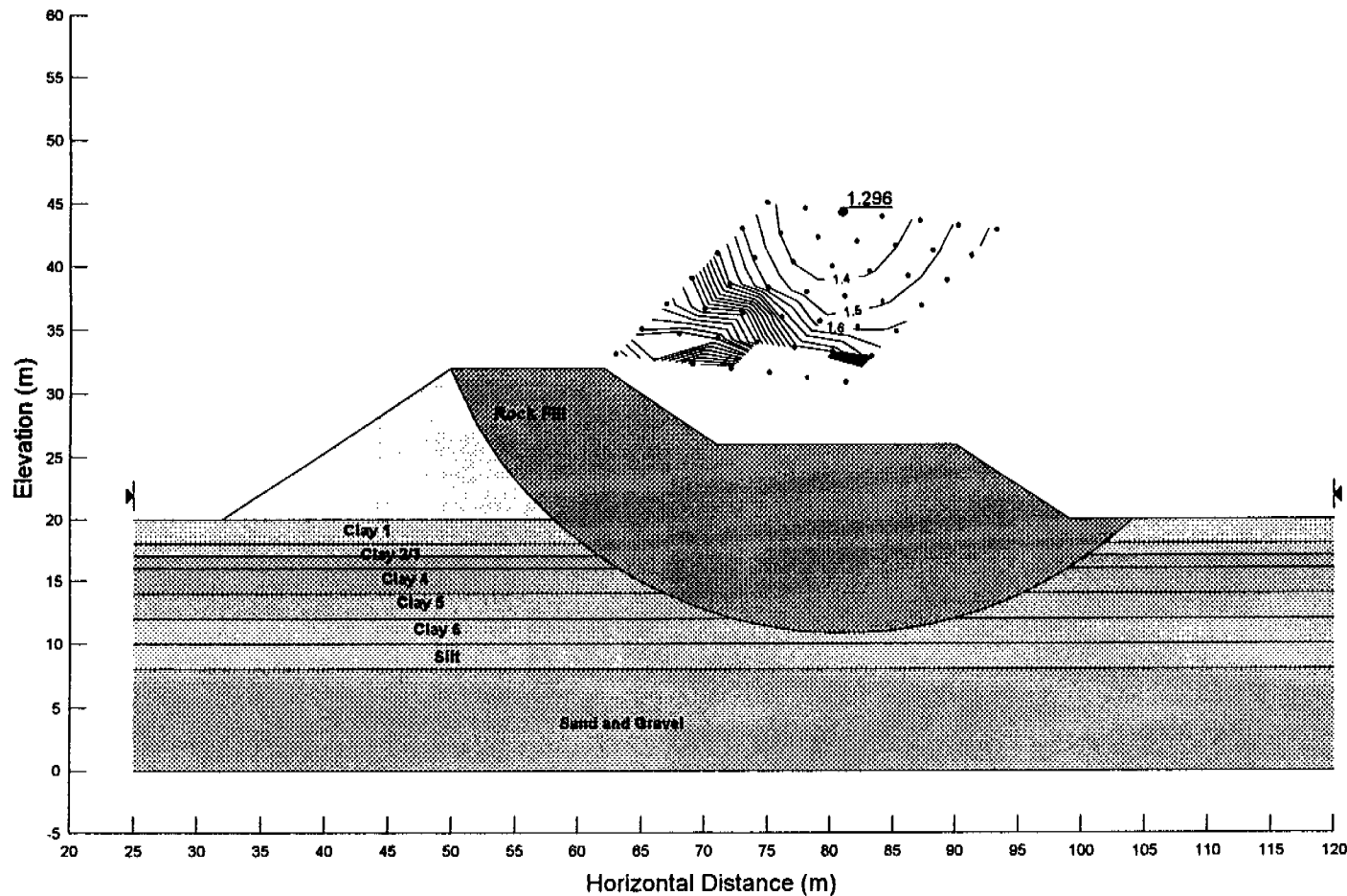
Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 6 metre high, 19 metre long toe berm  
 B12T10C6.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

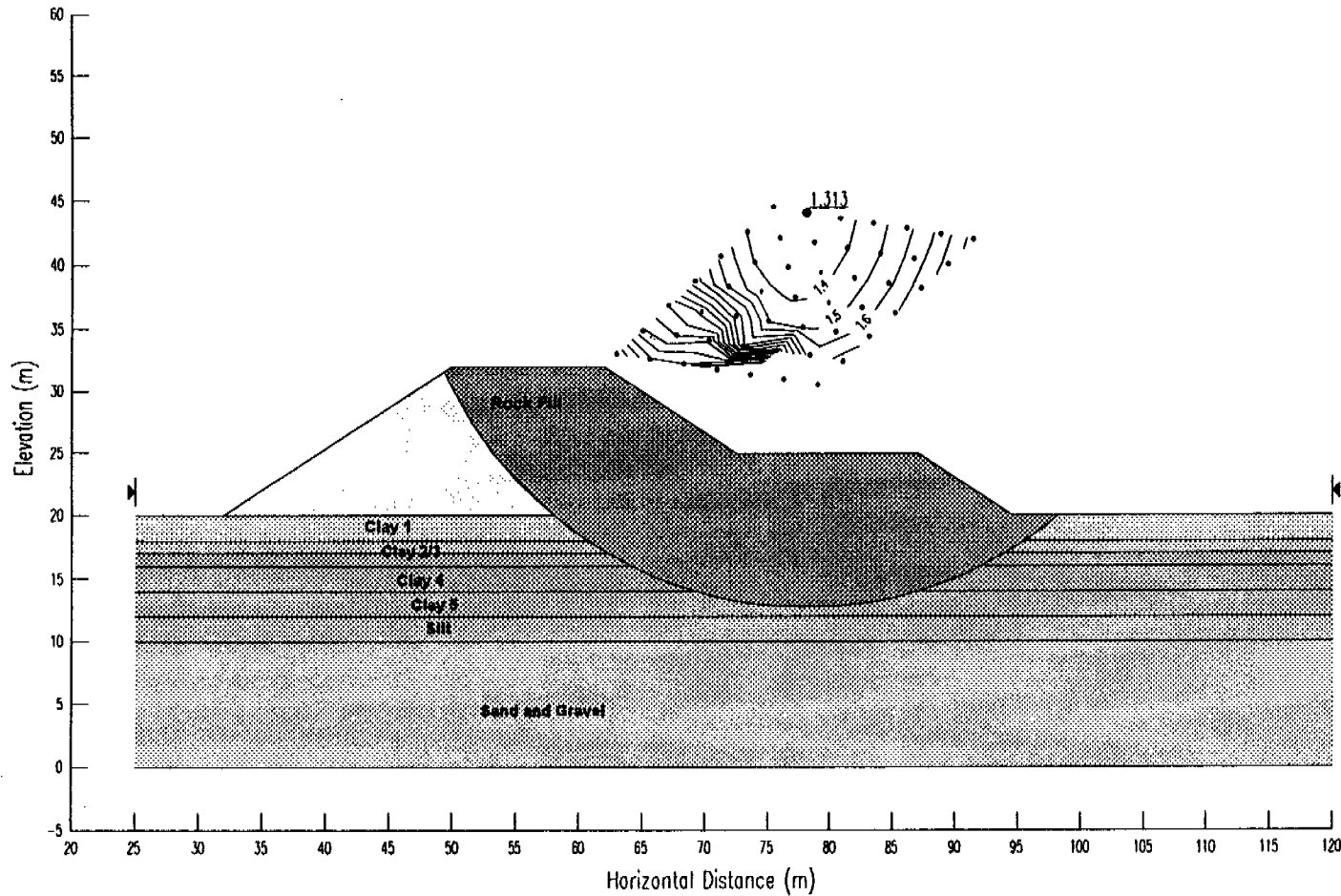
Soil 7 - Clay 6  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 27.5  
 Rate of Increase 2.5  
 Cv - Maximum 32.5  
 Ch/Cv Ratio 1

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 4 metre high, 15 metre long toe berm  
 B12T08C4.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

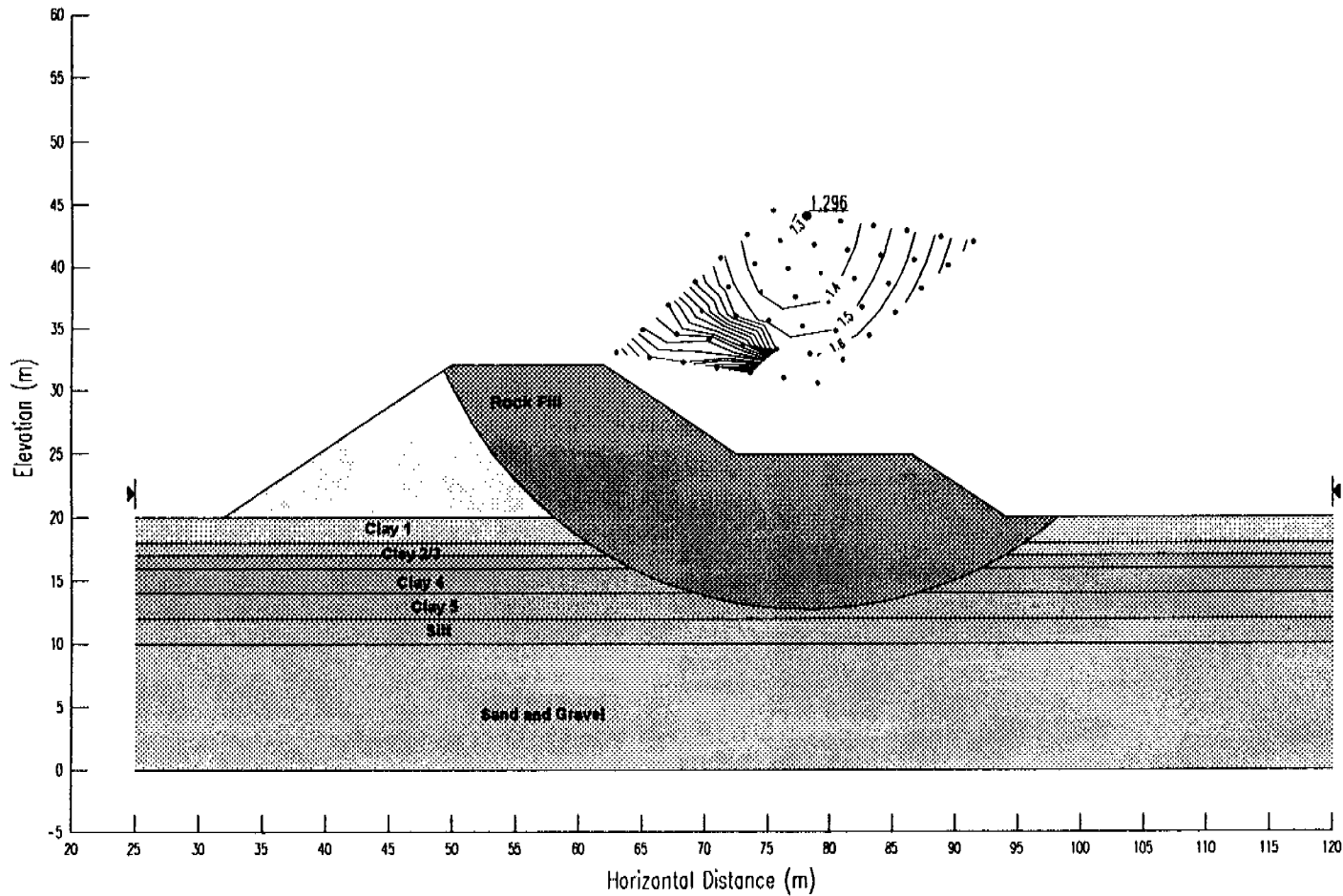
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 5 metre high, 14 metre long toe berm  
 B12T08C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

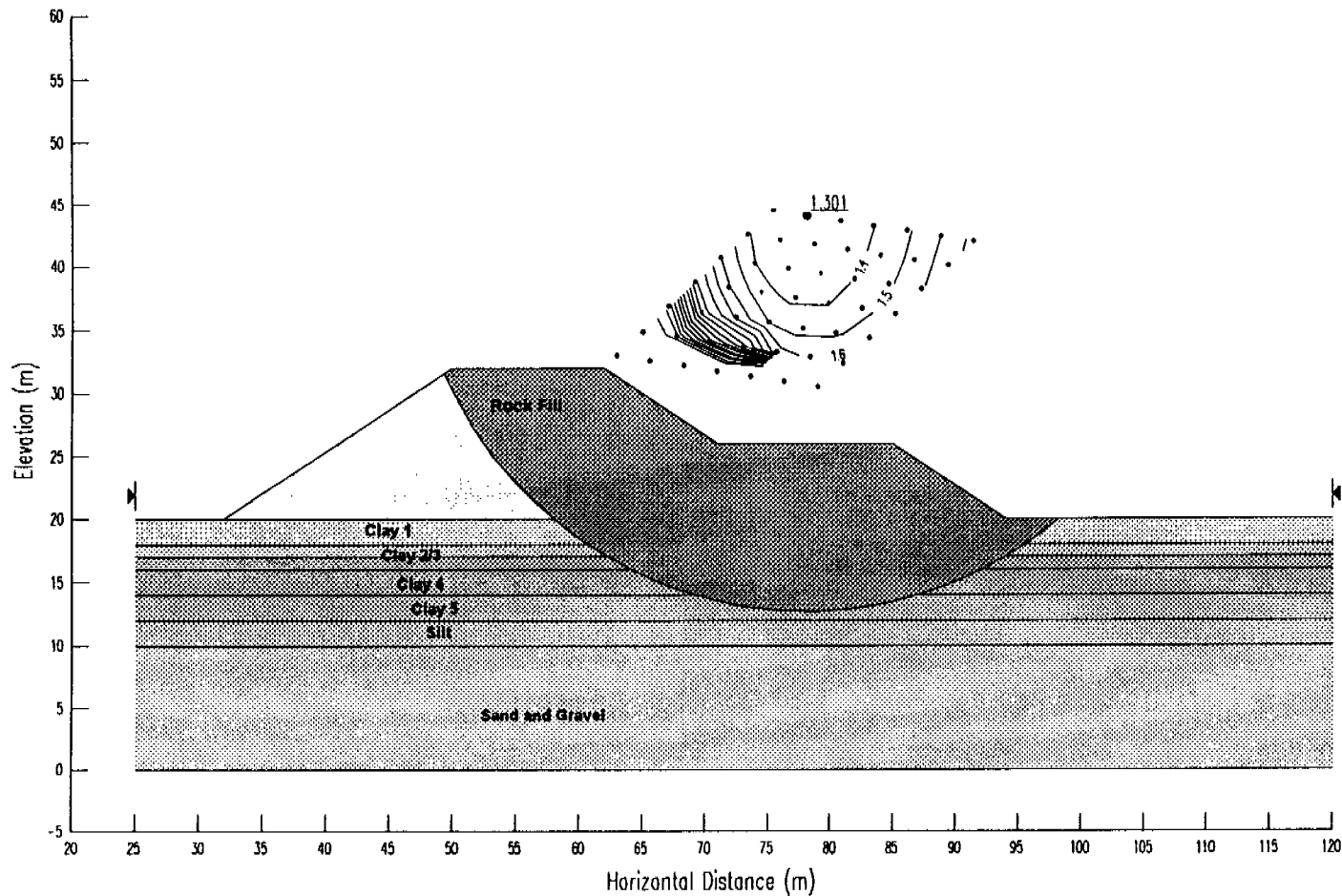
Soil 6 - Clay 5  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 6 metre high, 14 metre long toe berm  
 B12T08C6.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

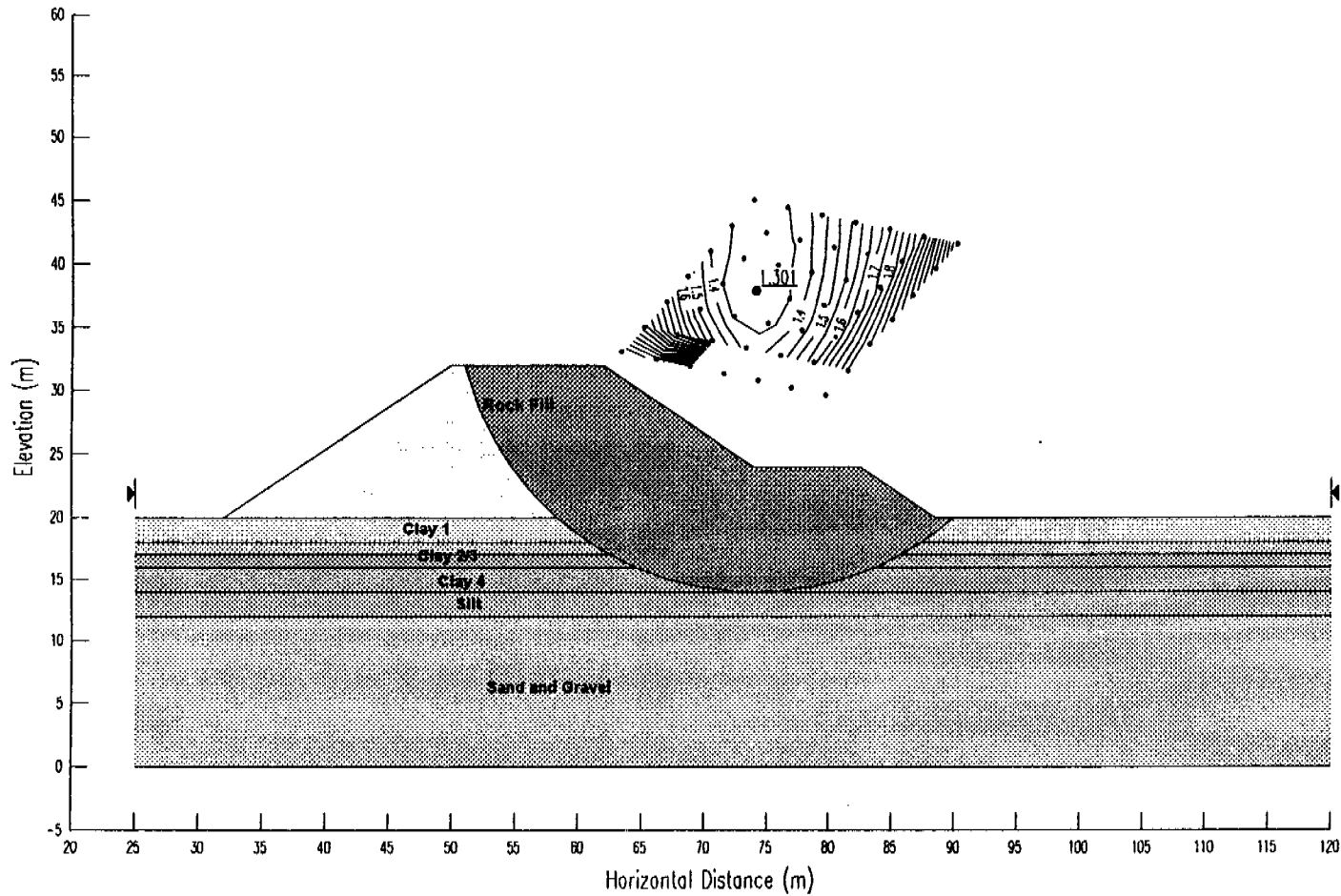
Soil 6 - Clay 5  
 Soil Model S=f(depth)  
 Unit Weight 17.8  
 Cv 25  
 Rate of Increase 1.25  
 Cv - Maximum 27.5  
 Ch/Cv Ratio 1

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

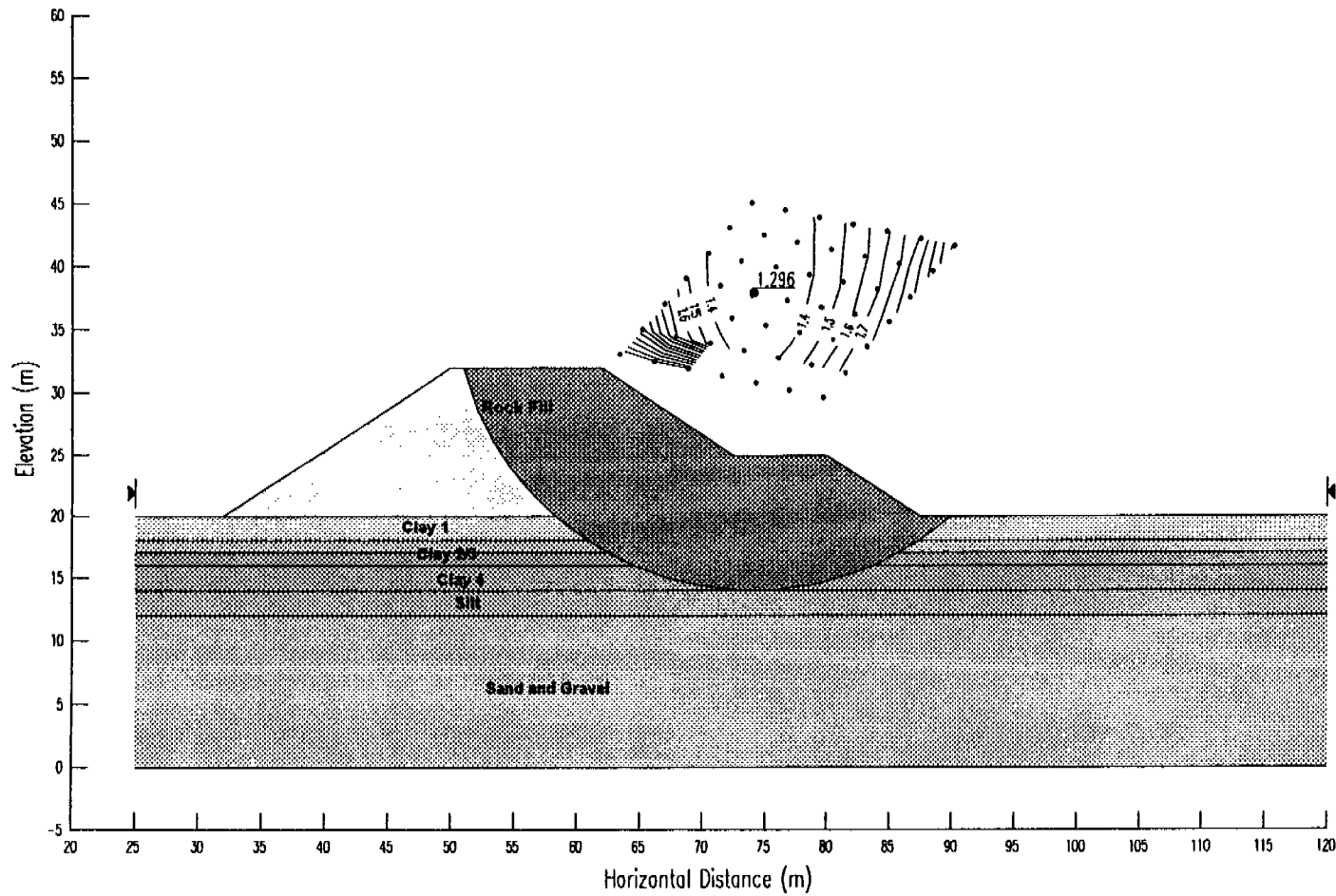
Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 4 metre high, 8.5 metre long toe berm  
 B12T06CU.SLP



Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 5 metre high, 7.5 metre long toe berm  
 B12T06C5.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

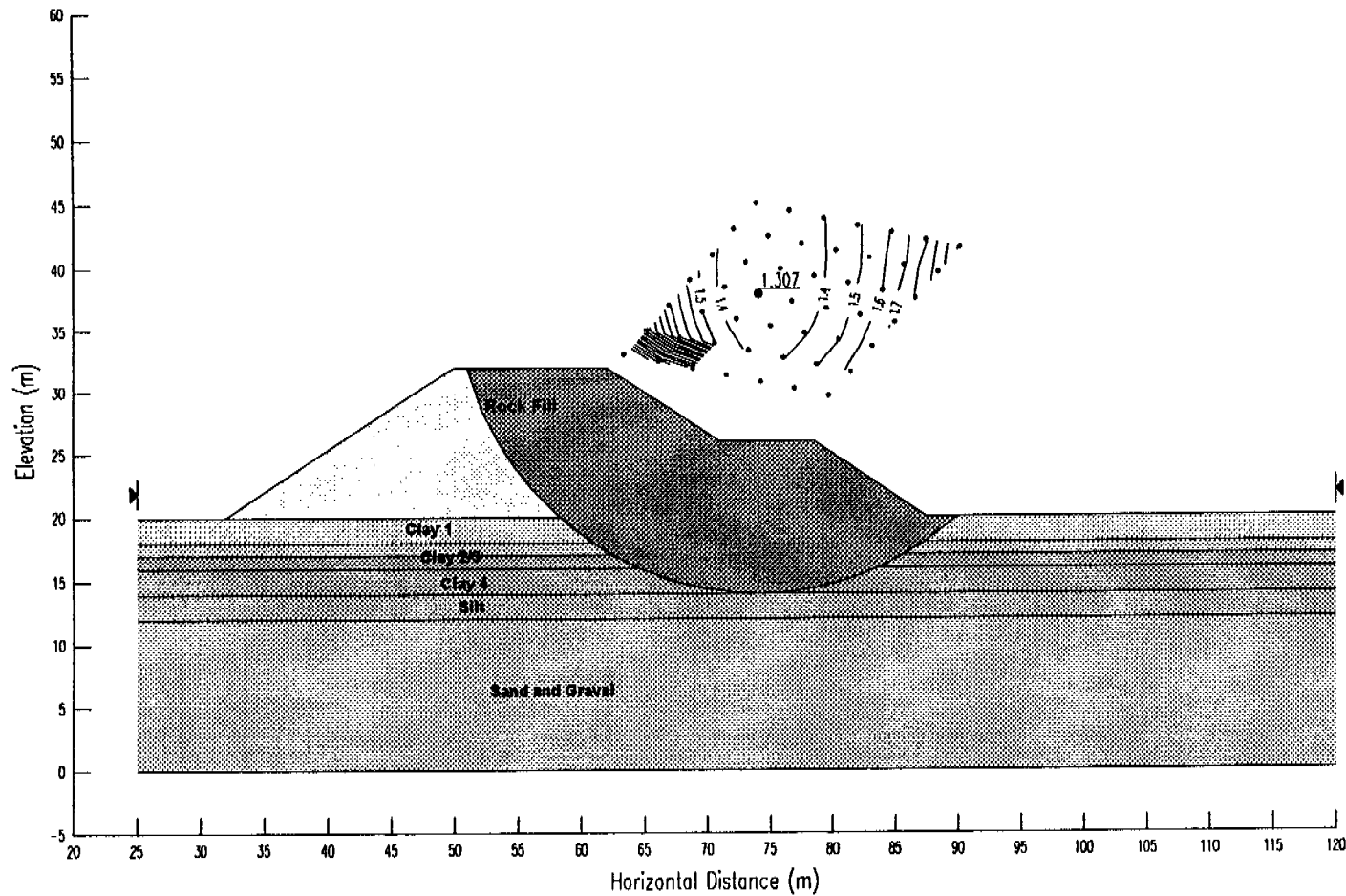
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 6 metre high, 7.5 metre long toe berm  
 B12T06C6.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 2 - Clay 1  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

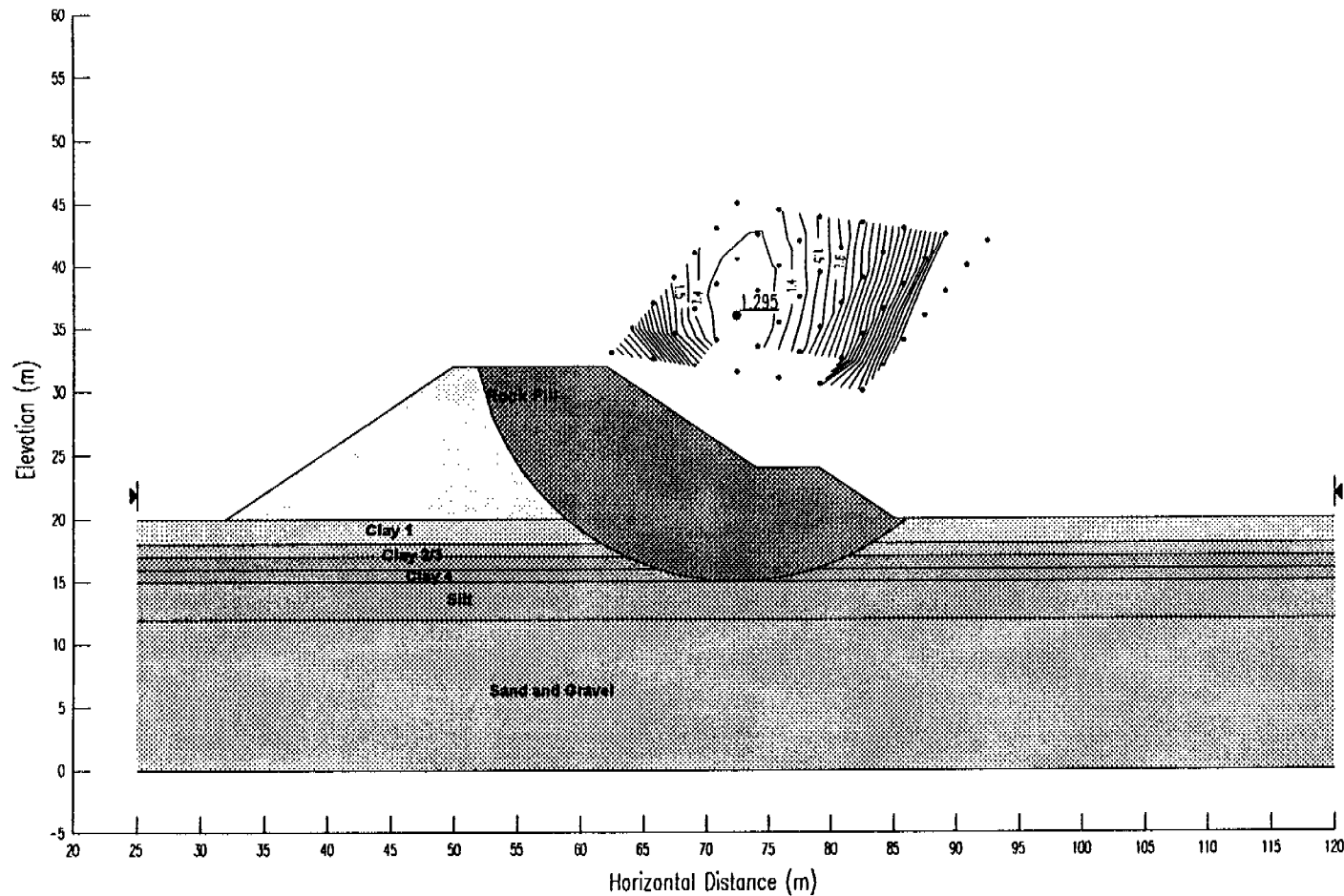
Soil 3 - Clay 2  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Soil 4 - Clay 3  
 Soil Model  $S=f(\text{depth})$   
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

Trout Creek - South Interchange Highway Embankments (F98179)  
 Total Stress Analysis  
 12 metre embankment height, 1.5:1 overall side slope  
 5 metre clay foundation  
 4 metre high, 5 metre long toe berm  
 B12T05CU.SLP



Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model S=f(depth)  
 Unit Weight 20.5  
 Cv 120  
 Rate of Increase -35  
 Cv - Minimum 50  
 Ch/Cv Ratio 1

Soil 3 - Clay 2  
 Soil Model S=f(depth)  
 Unit Weight 18.3  
 Cv 50  
 Rate of Increase -20  
 Cv - Minimum 30  
 Ch/Cv Ratio 1

Soil 4 - Clay 3  
 Soil Model S=f(depth)  
 Unit Weight 18  
 Cv 30  
 Rate of Increase -5  
 Cv - Minimum 25  
 Ch/Cv Ratio 1

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 25  
 Phi 0

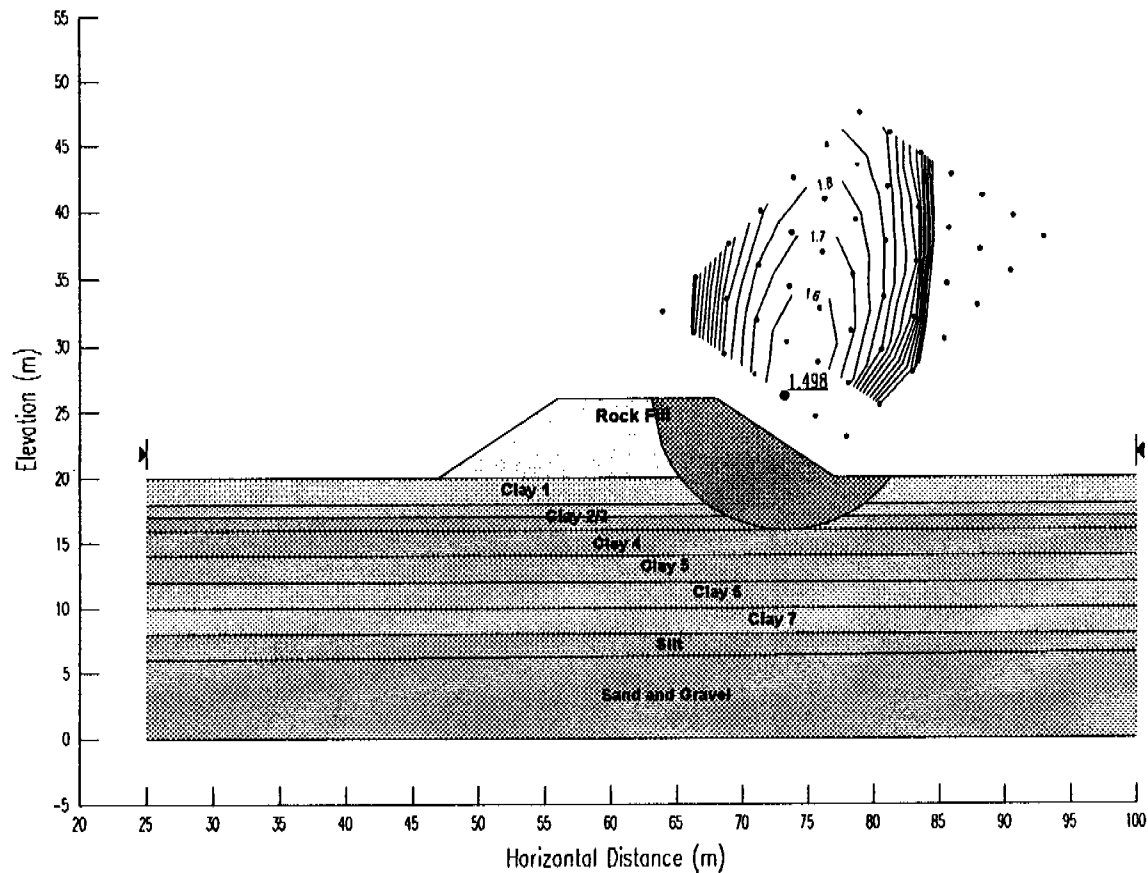
Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 6 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H06T12E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

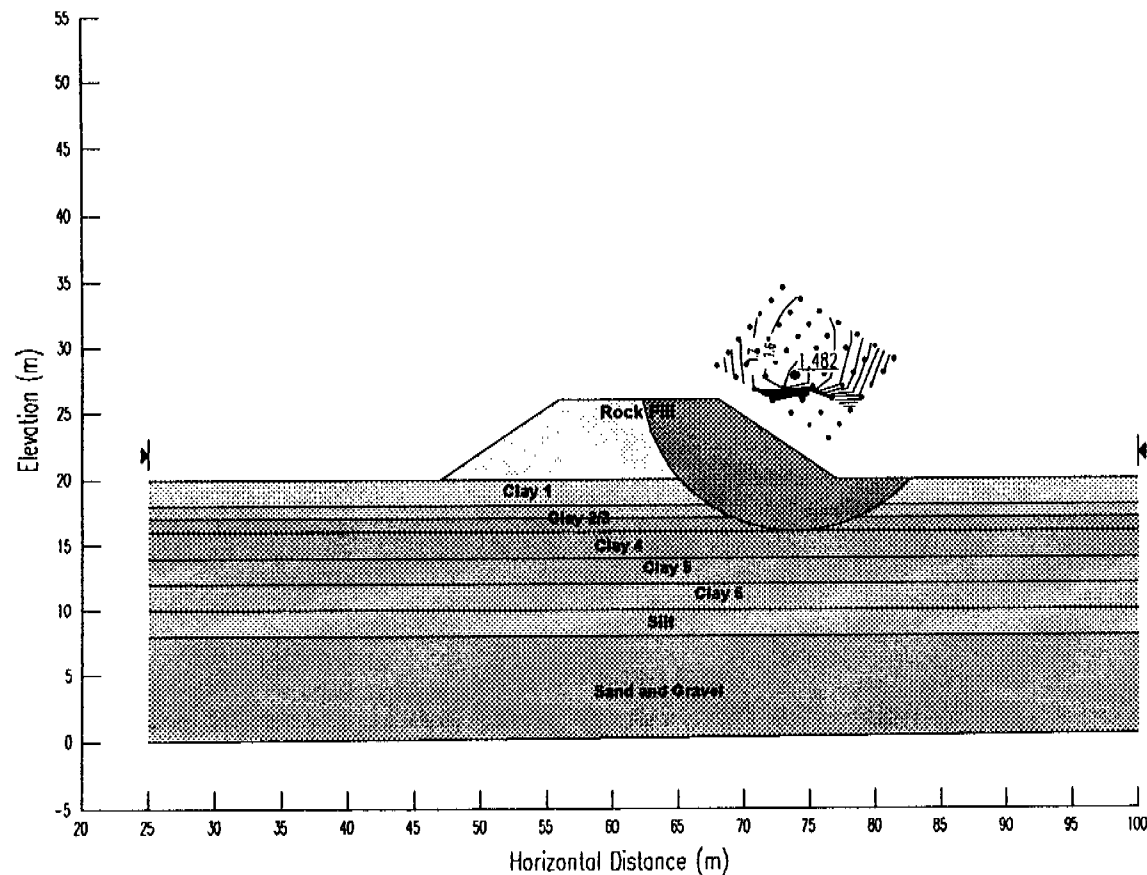
Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 6 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H06T10E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 28

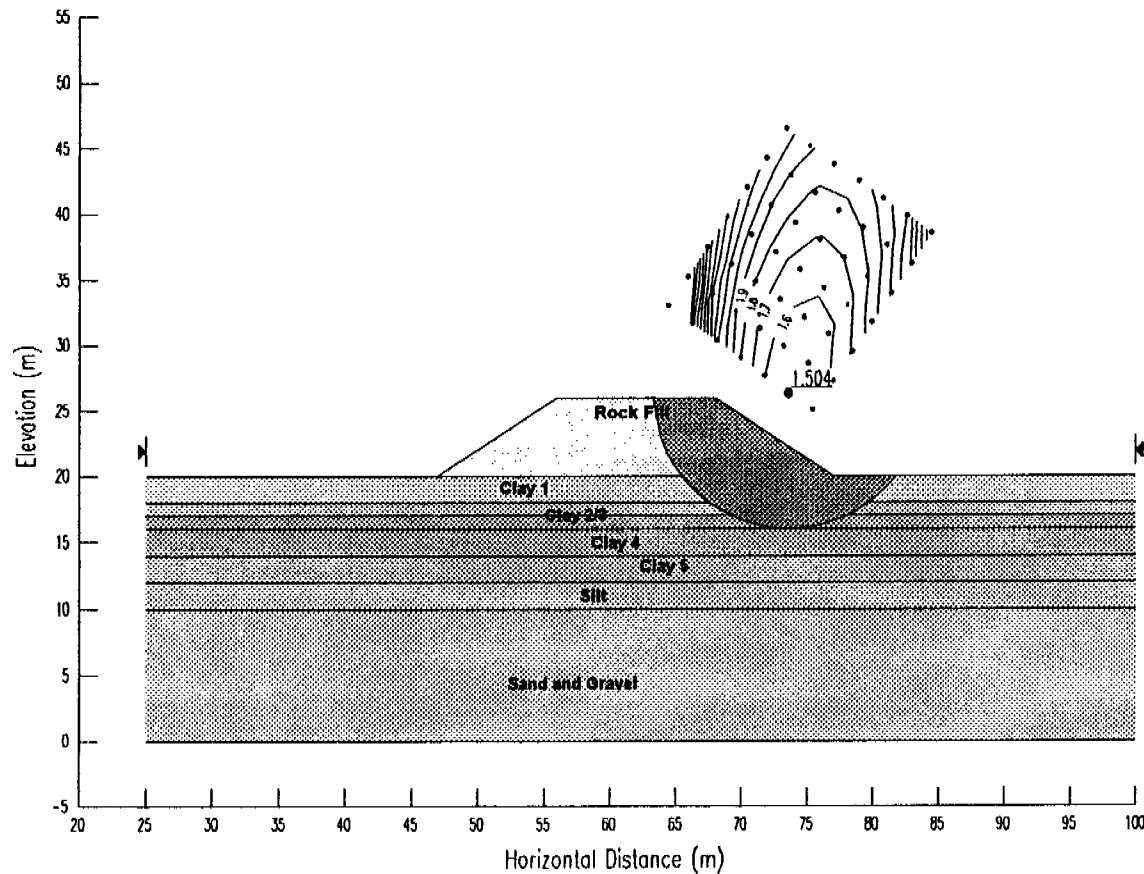
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 6 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H06T08E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

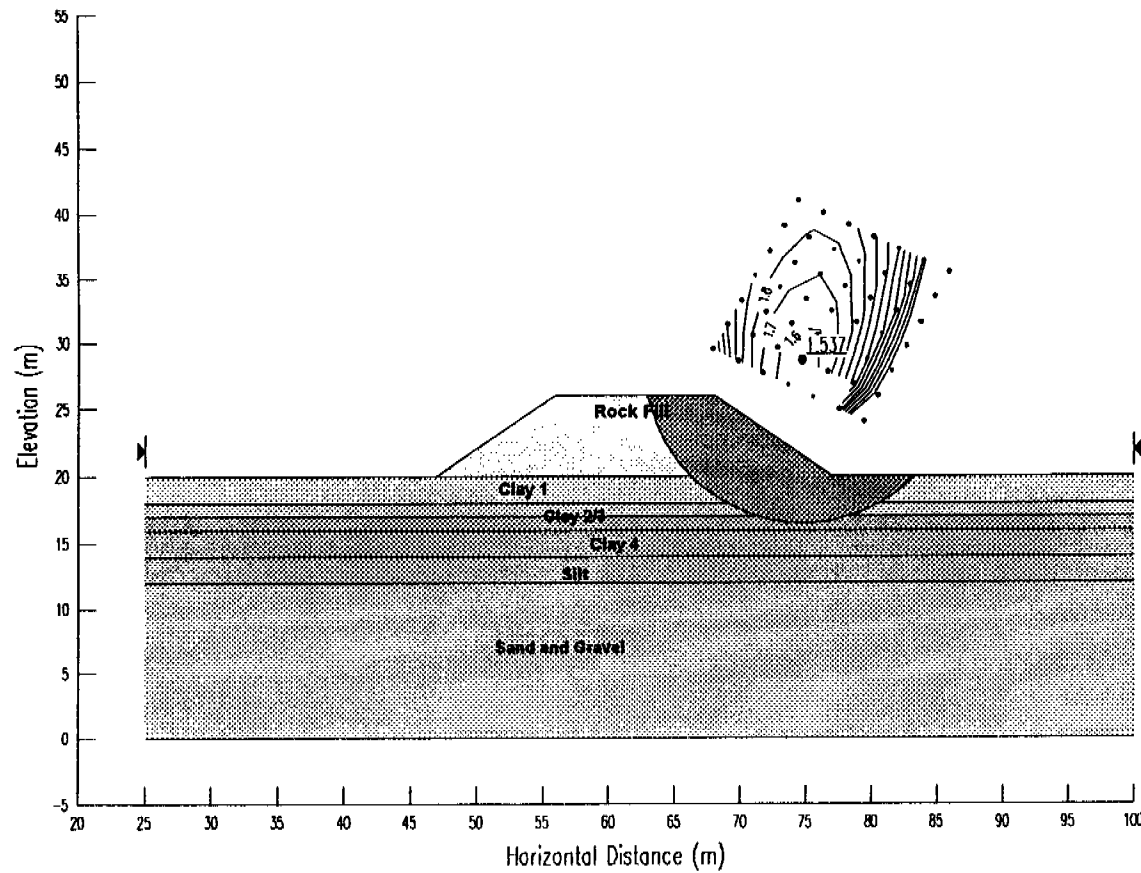
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 6 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H06T06E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

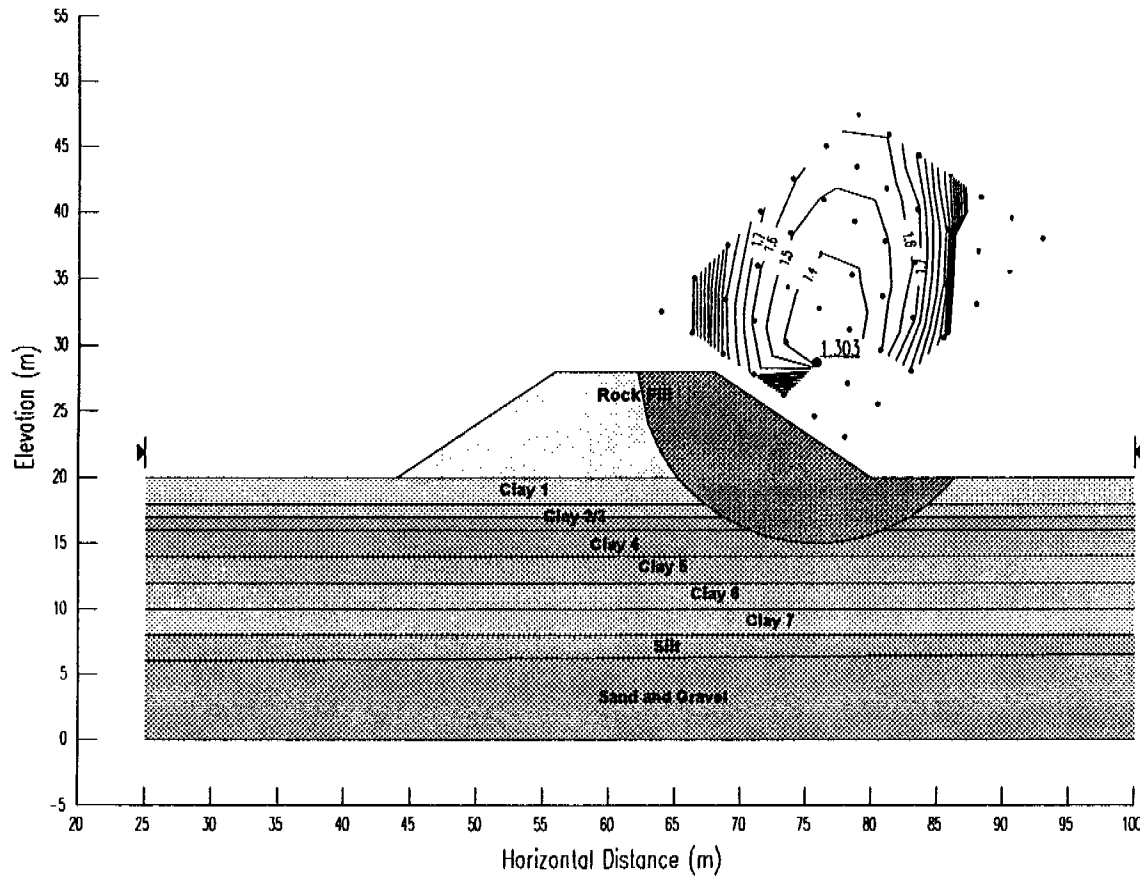
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

**H08T12E3.SLP**



Soil 1 - Rock Fill  
Soil Model Mohr-Coulomb  
Unit Weight 20  
Cohesion 0  
Phi 42

Soil 2 - Clay 1  
Soil Model Mohr-Coulomb  
Unit Weight 20.5  
Cohesion 10  
Phi 28

Soil 3 - Clay 2  
Soil Model Mohr-Coulomb  
Unit Weight 18.3  
Cohesion 8  
Phi 27

Soil 4 - Clay 3  
Soil Model Mohr-Coulomb  
Unit Weight 18  
Cohesion 6  
Phi 26

Soil 5 - Clay 4  
Soil Model Mohr-Coulomb  
Unit Weight 17.3  
Cohesion 6  
Phi 26

Soil 6 - Clay 5  
Soil Model Mohr-Coulomb  
Unit Weight 17.8  
Cohesion 6  
Phi 26

Soil 7 - Clay 6  
Soil Model Mohr-Coulomb  
Unit Weight 17.8  
Cohesion 6  
Phi 26

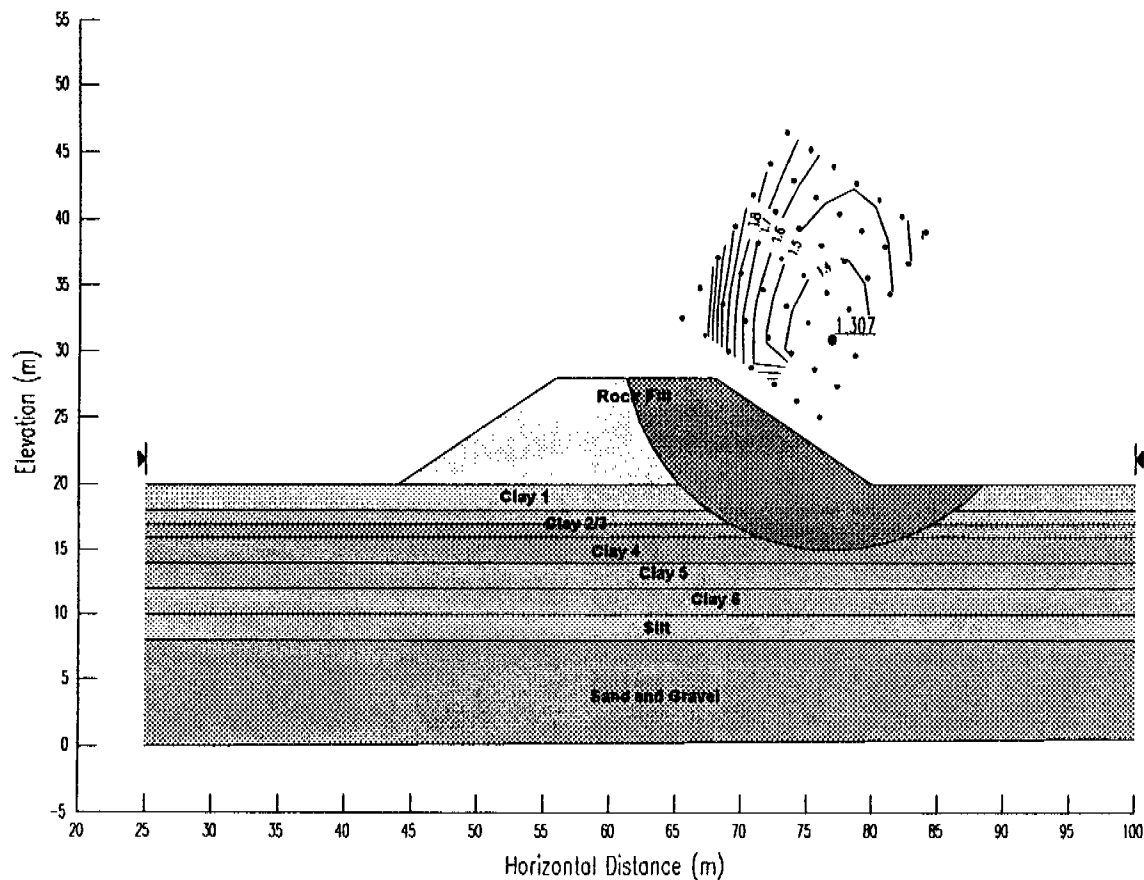
Soil 8 - Clay 7  
Soil Model Mohr-Coulomb  
Unit Weight 17.8  
Cohesion 6  
Phi 26

Soil 9 - Silt  
Soil Model Mohr-Coulomb  
Unit Weight 19.5  
Cohesion 0  
Phi 31

Soil 10 - Sand/Gravel  
Soil Model Mohr-Coulomb  
Unit Weight 21.5  
Cohesion 0  
Phi 35

Soil 11 - Bedrock  
Soil Model Bedrock  
Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H08T10E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

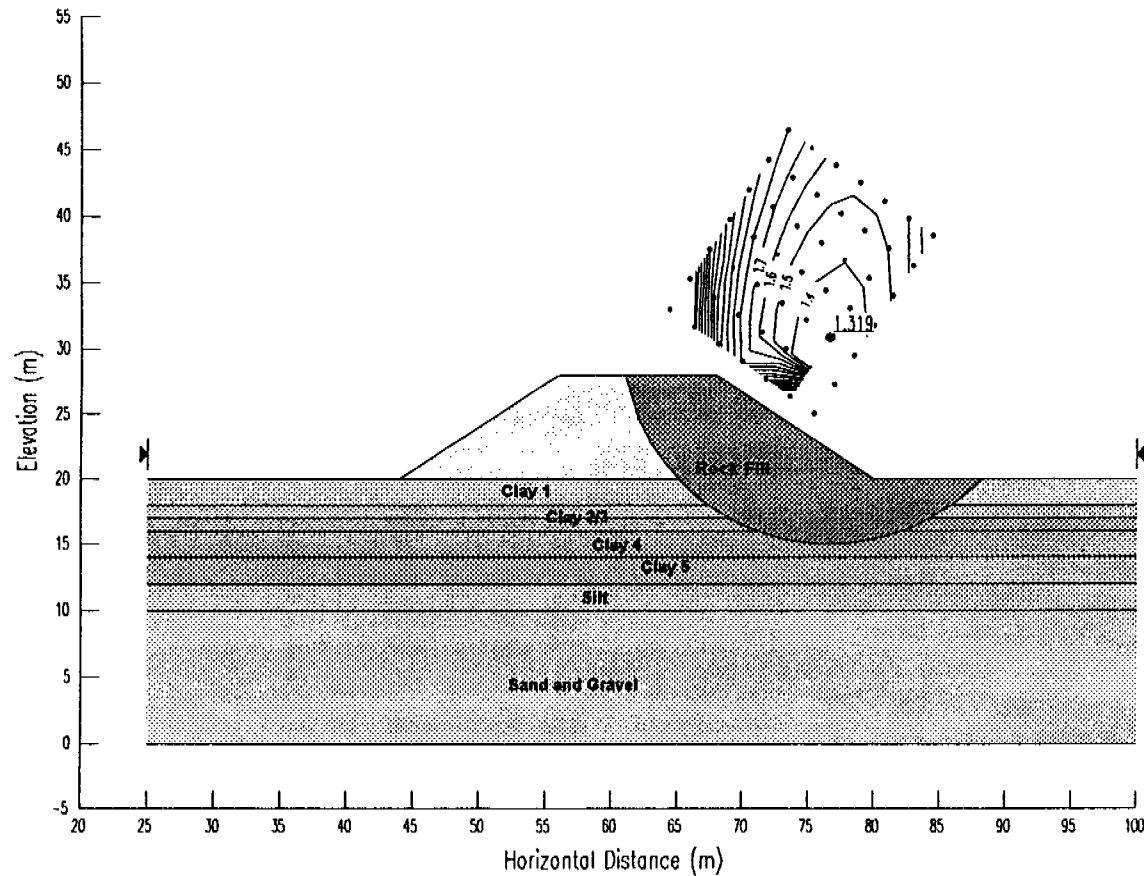
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H08T08E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 10  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

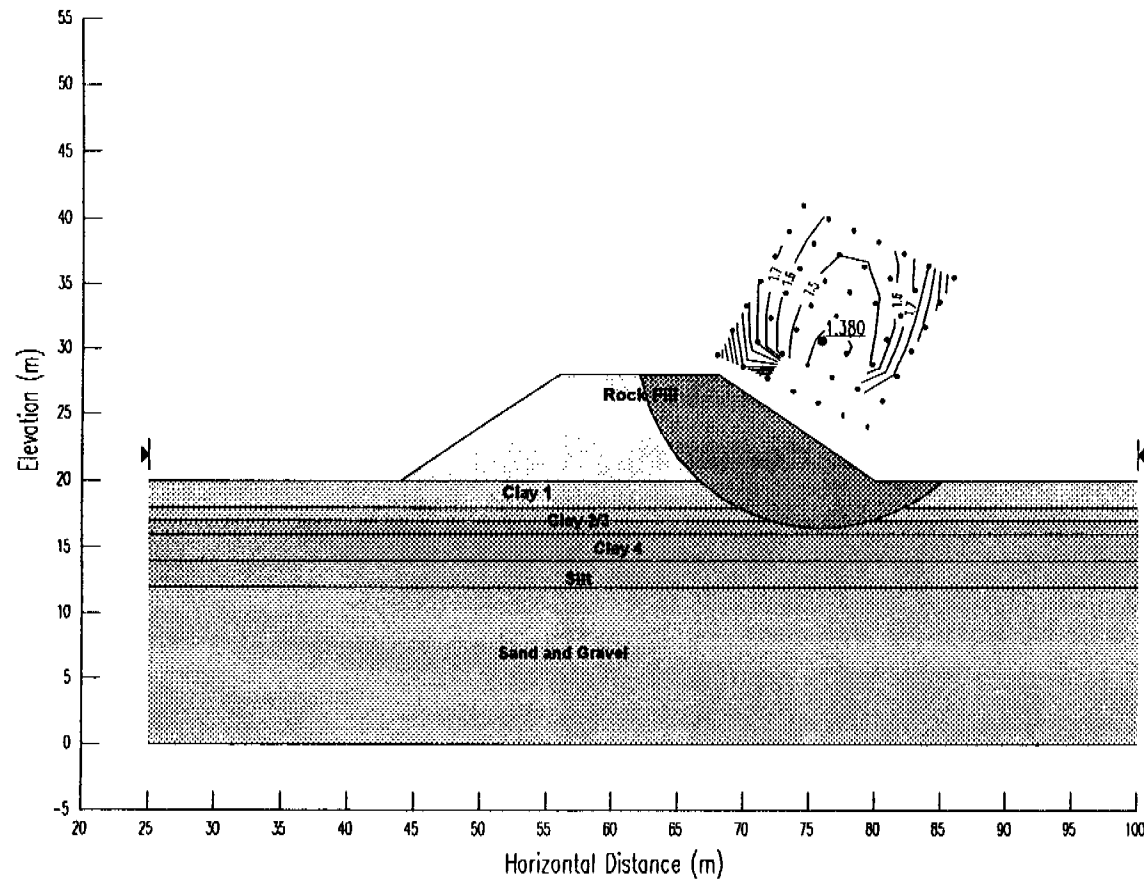
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 8 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H08T06E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

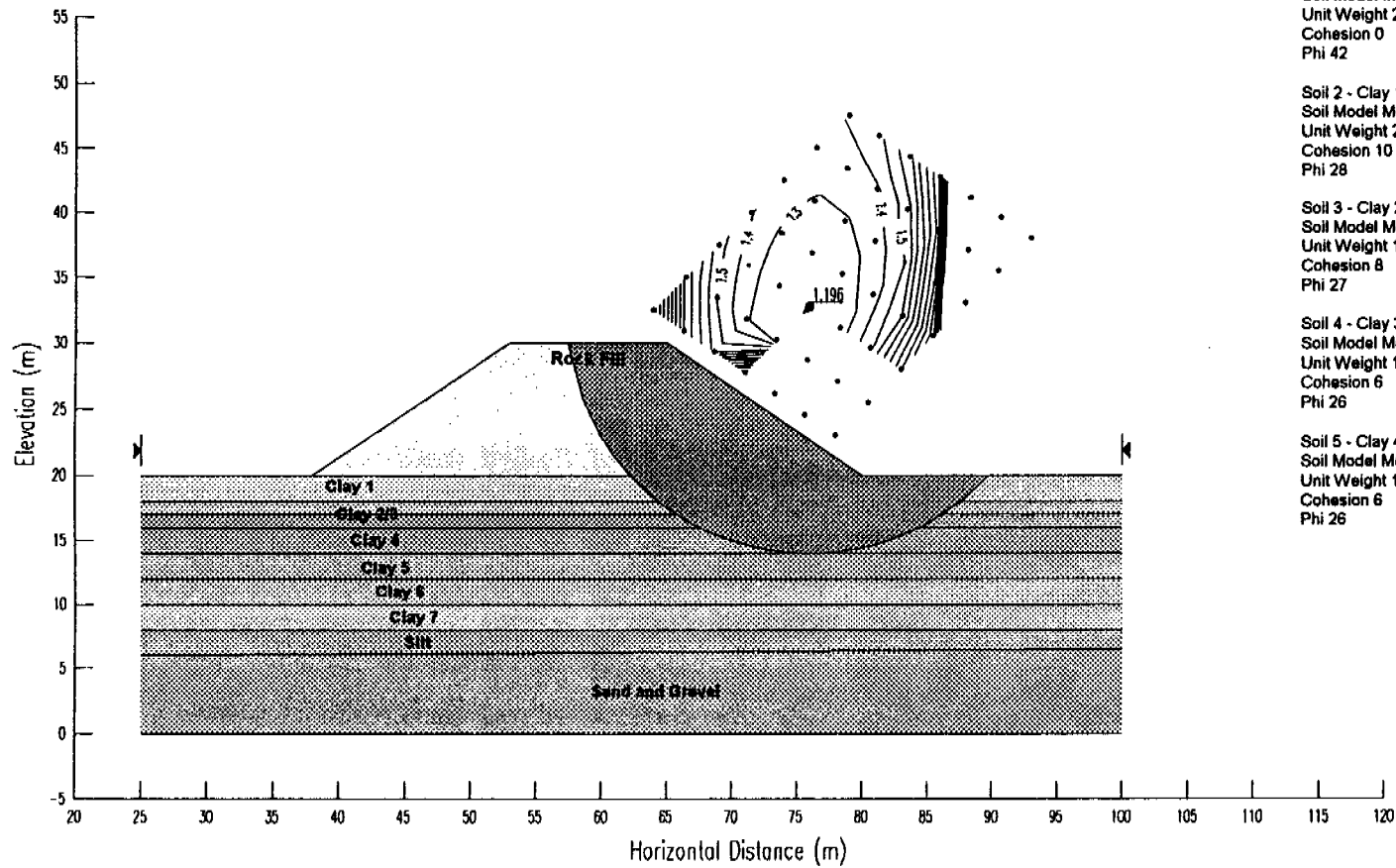
Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H10T12E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

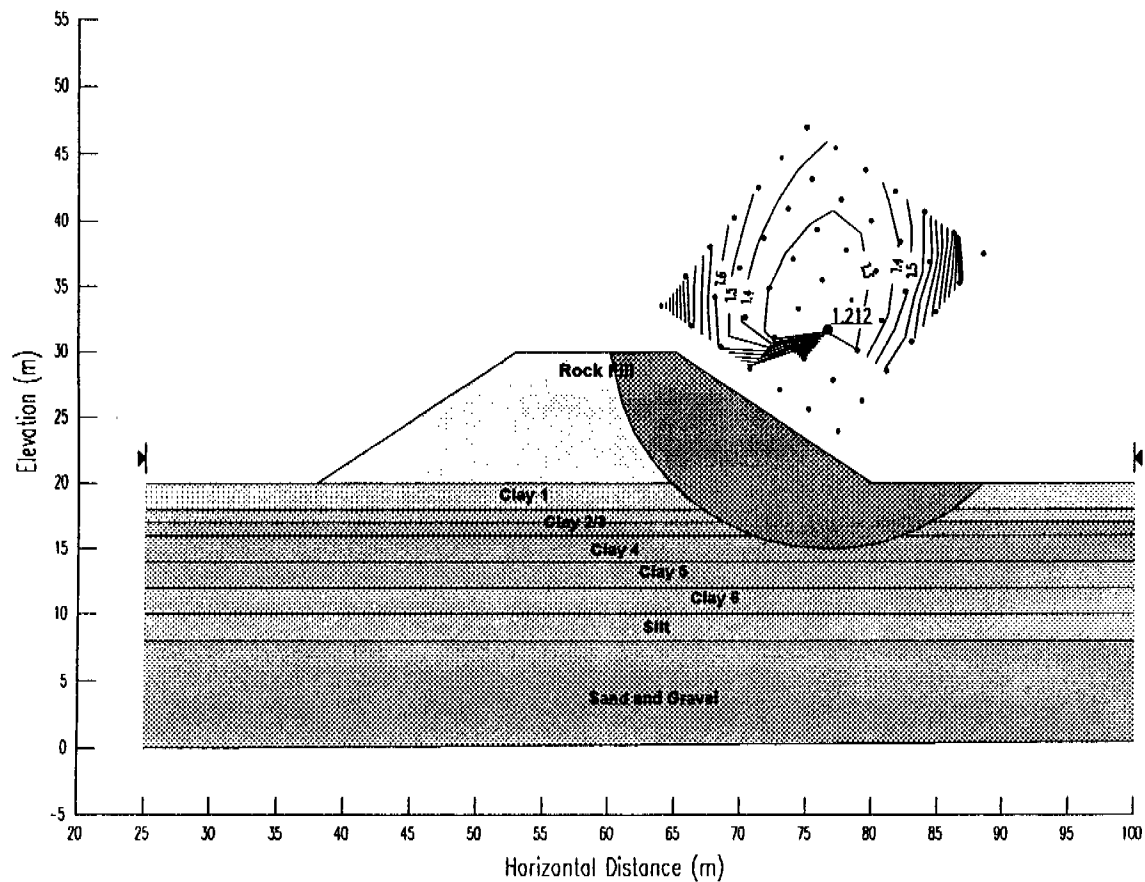
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H10T10E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

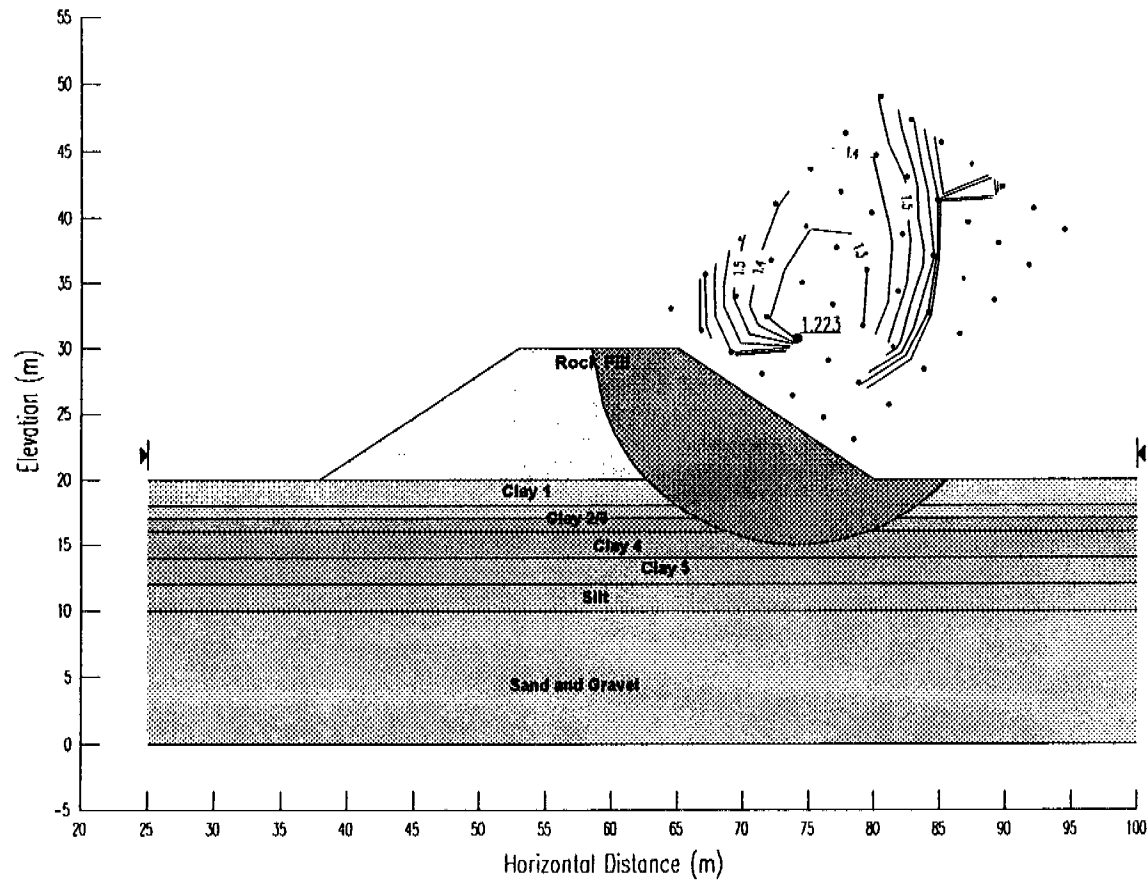
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 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H10T08E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

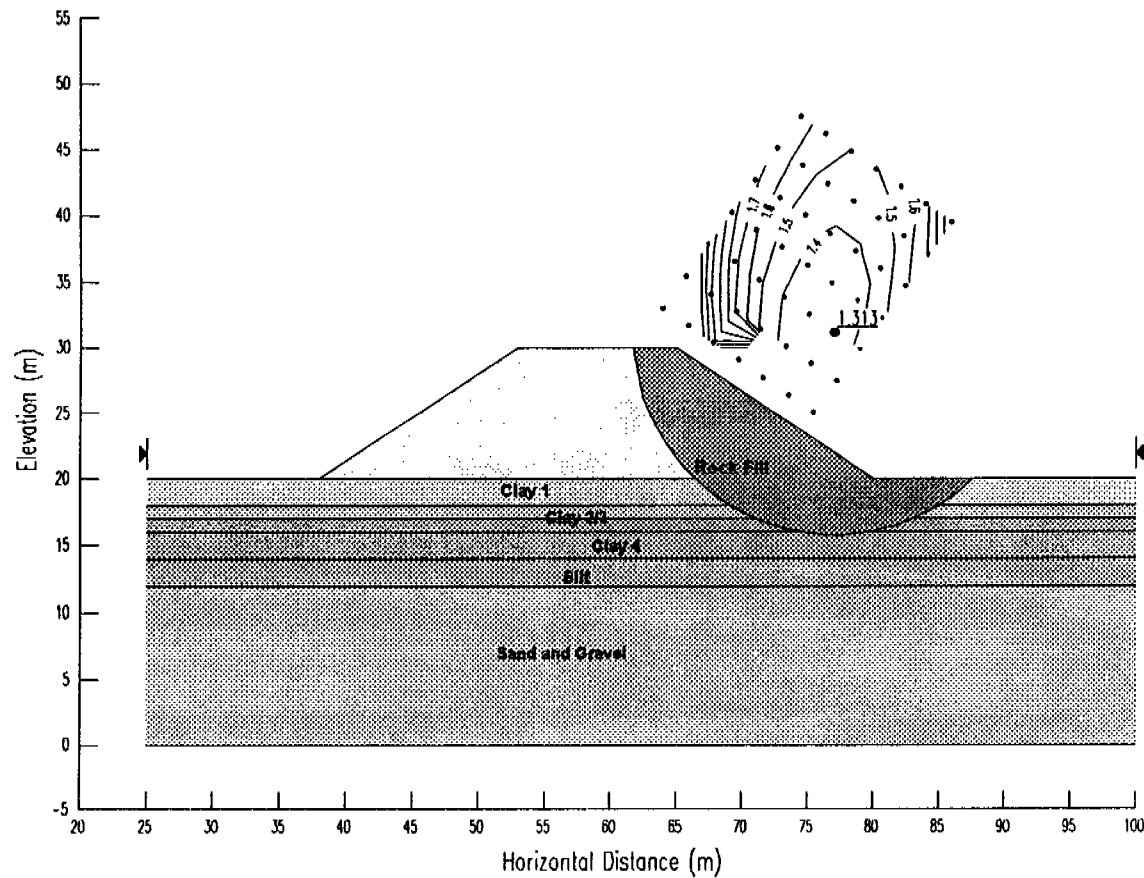
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 10 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H10T06E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

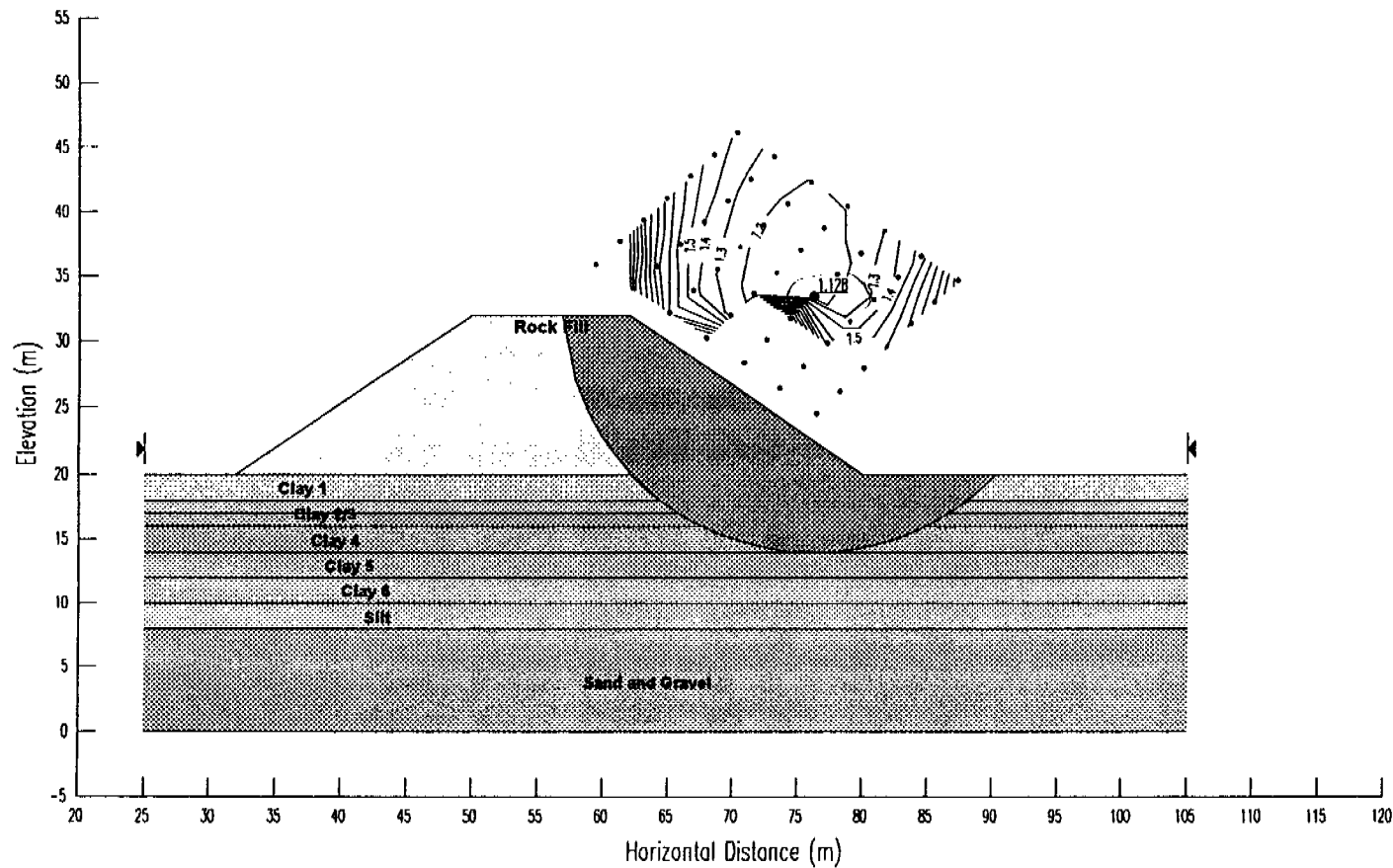
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H12T10E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

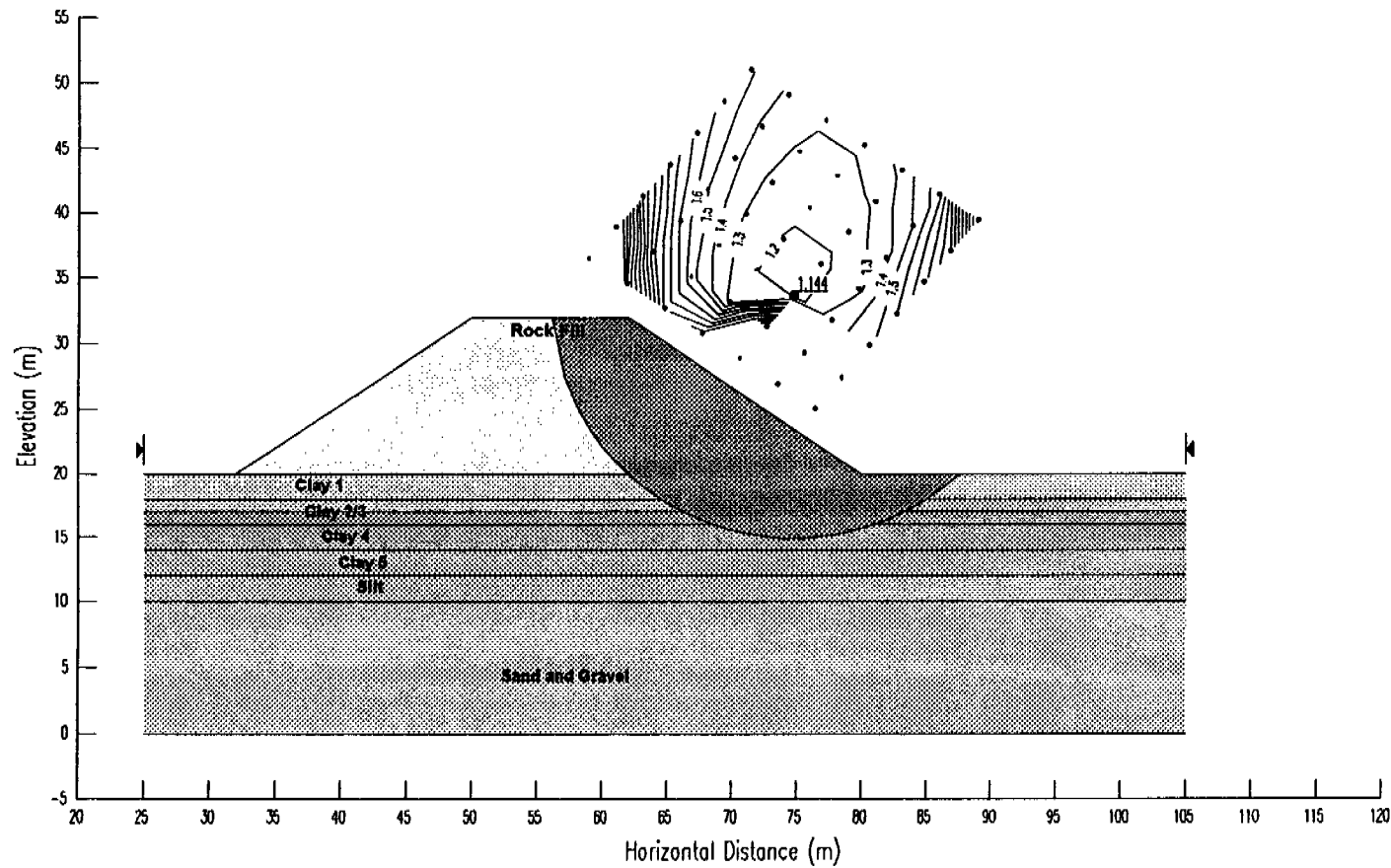
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H12T08E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

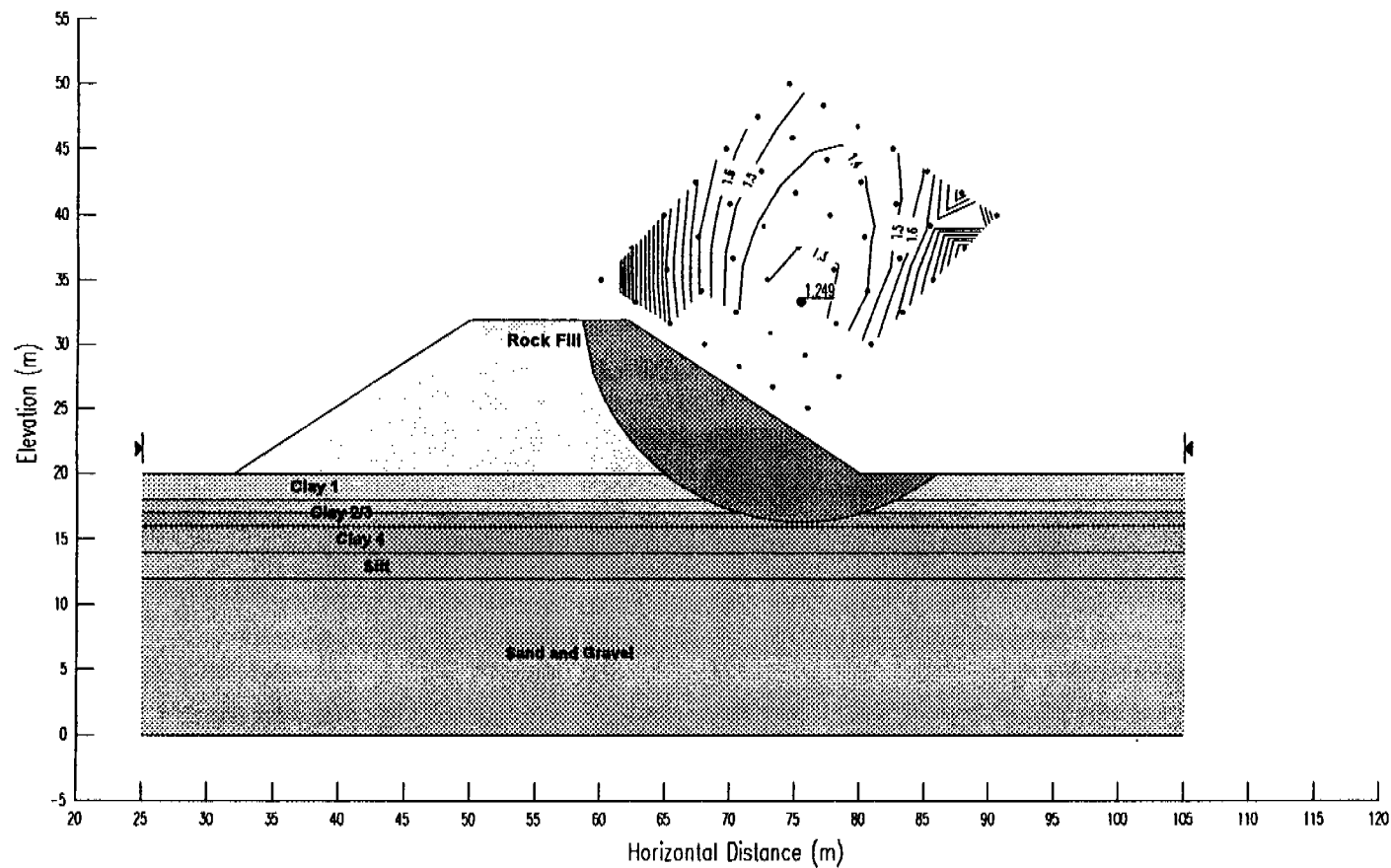
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 12 metre embankment height, 1.5:1 overall side slope  
 6 metre clay foundation  
 H12T06E3.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

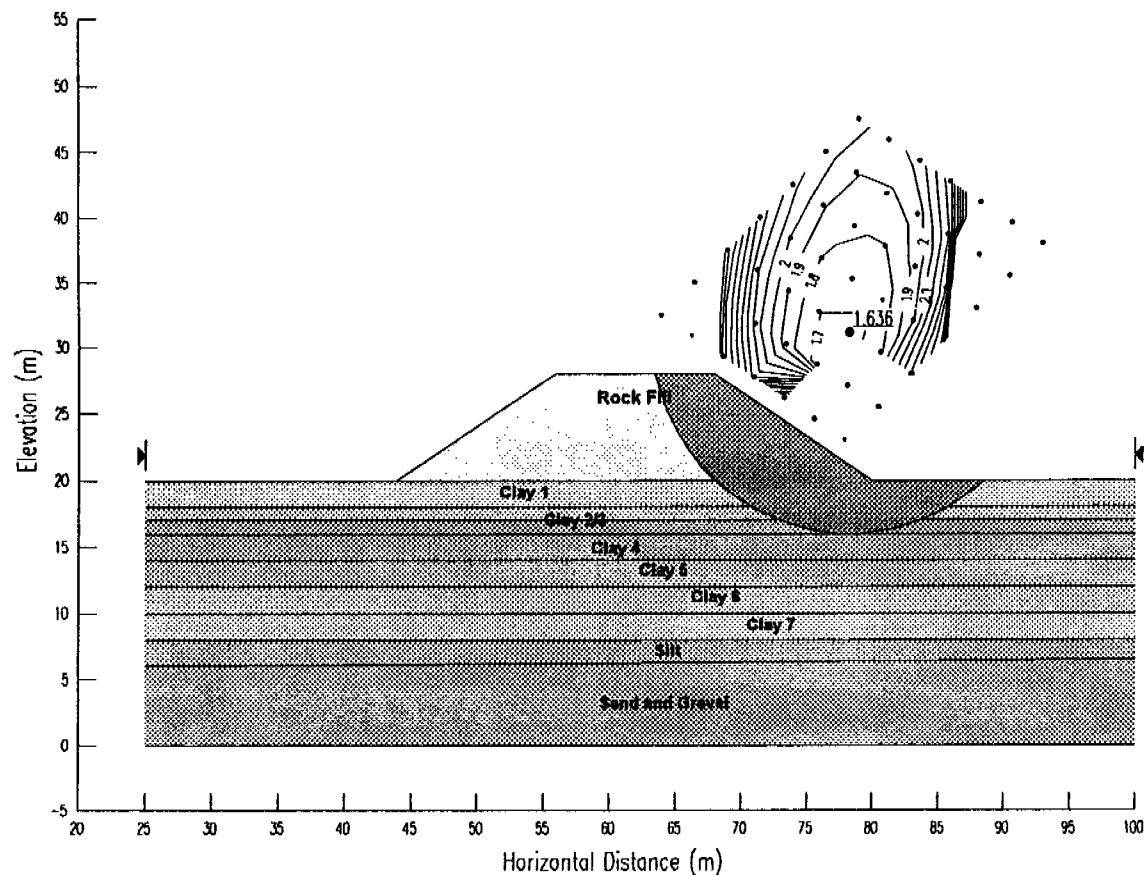
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 7 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 8 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H08T1233.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

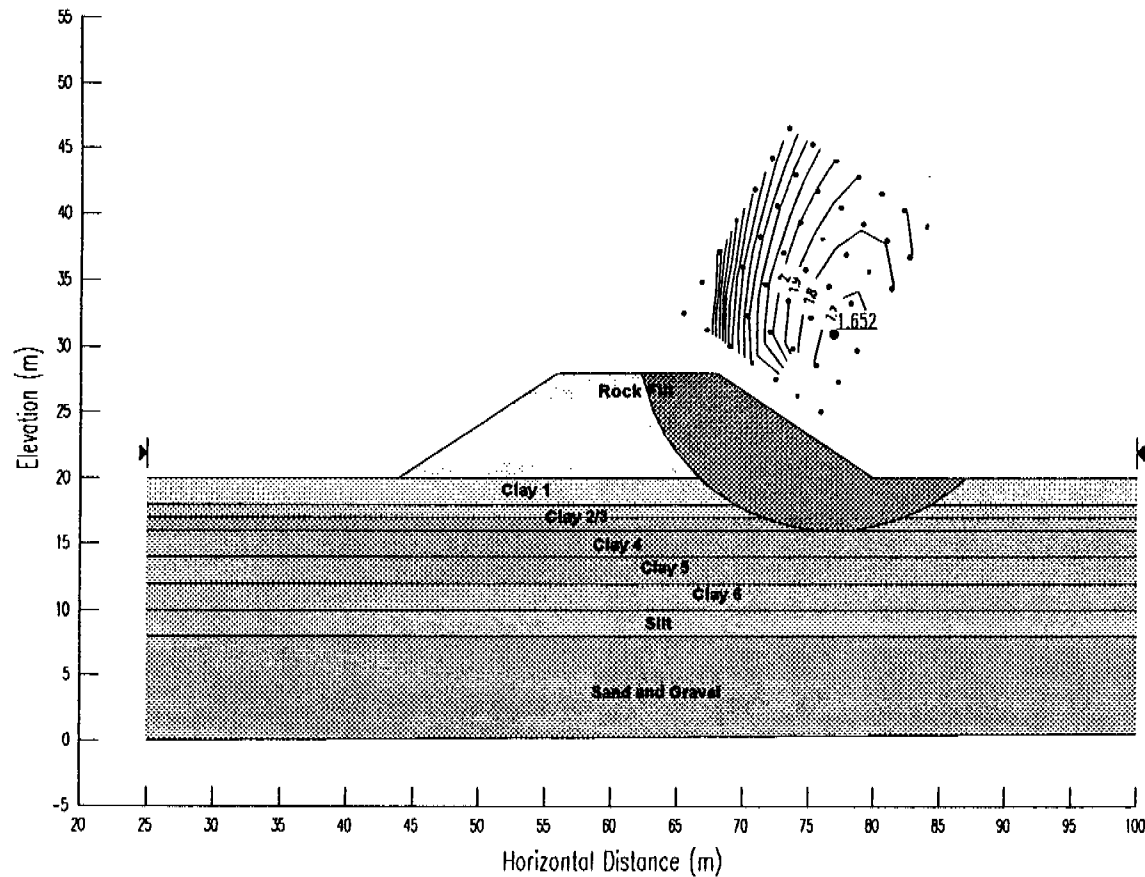
Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179).  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H08T1033.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 28

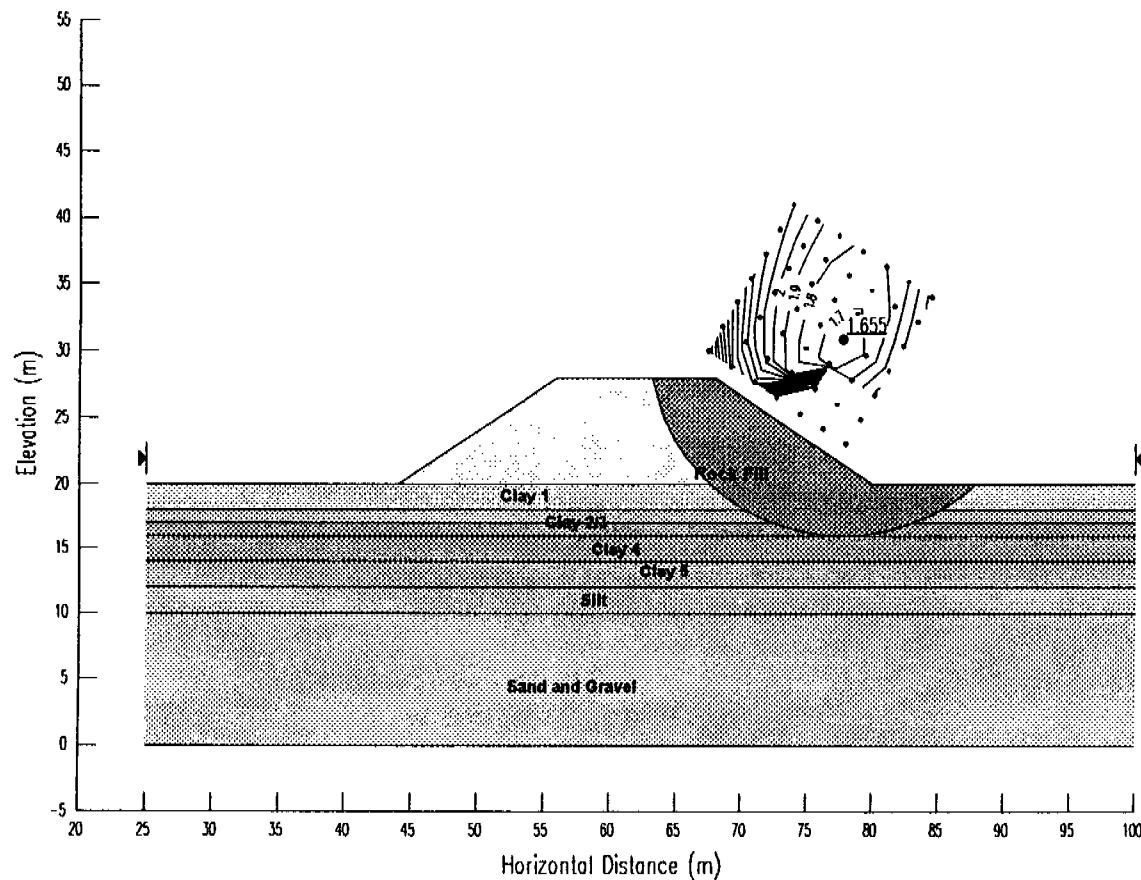
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H08T0833.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

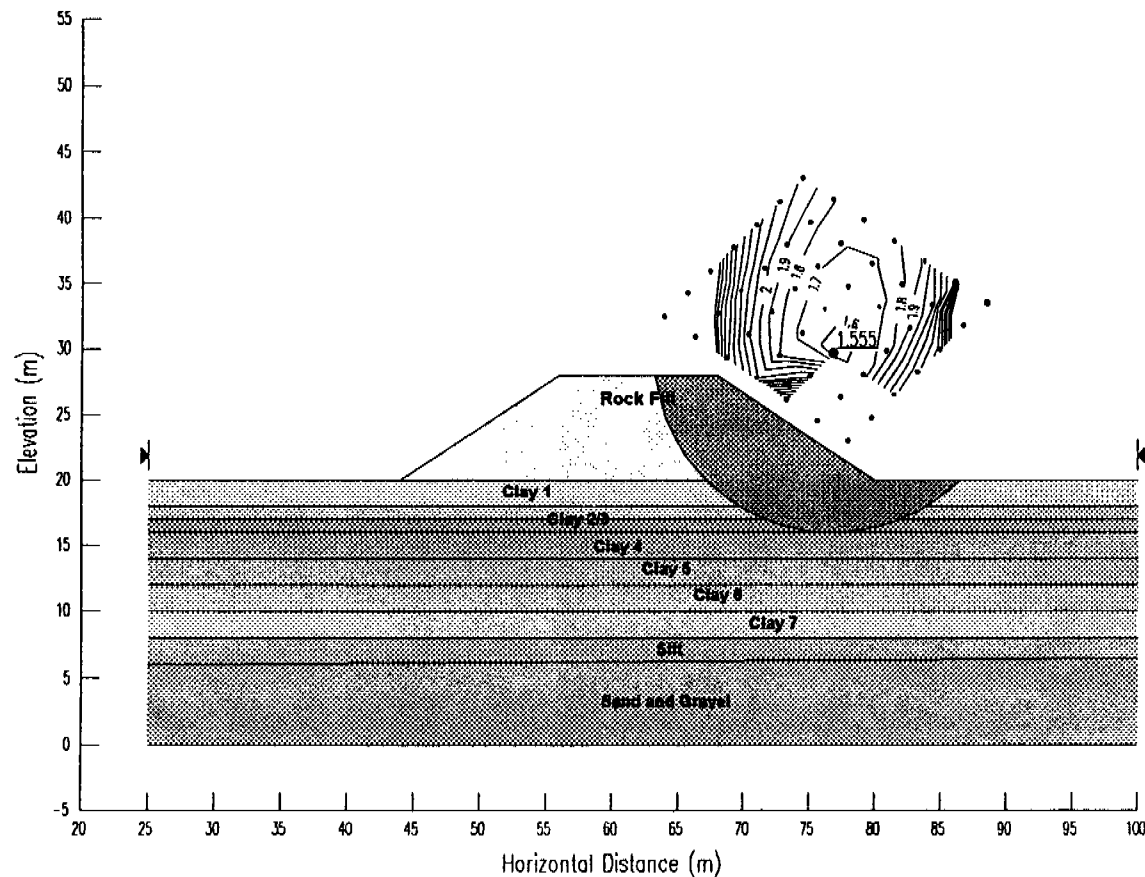
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H08T1243.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

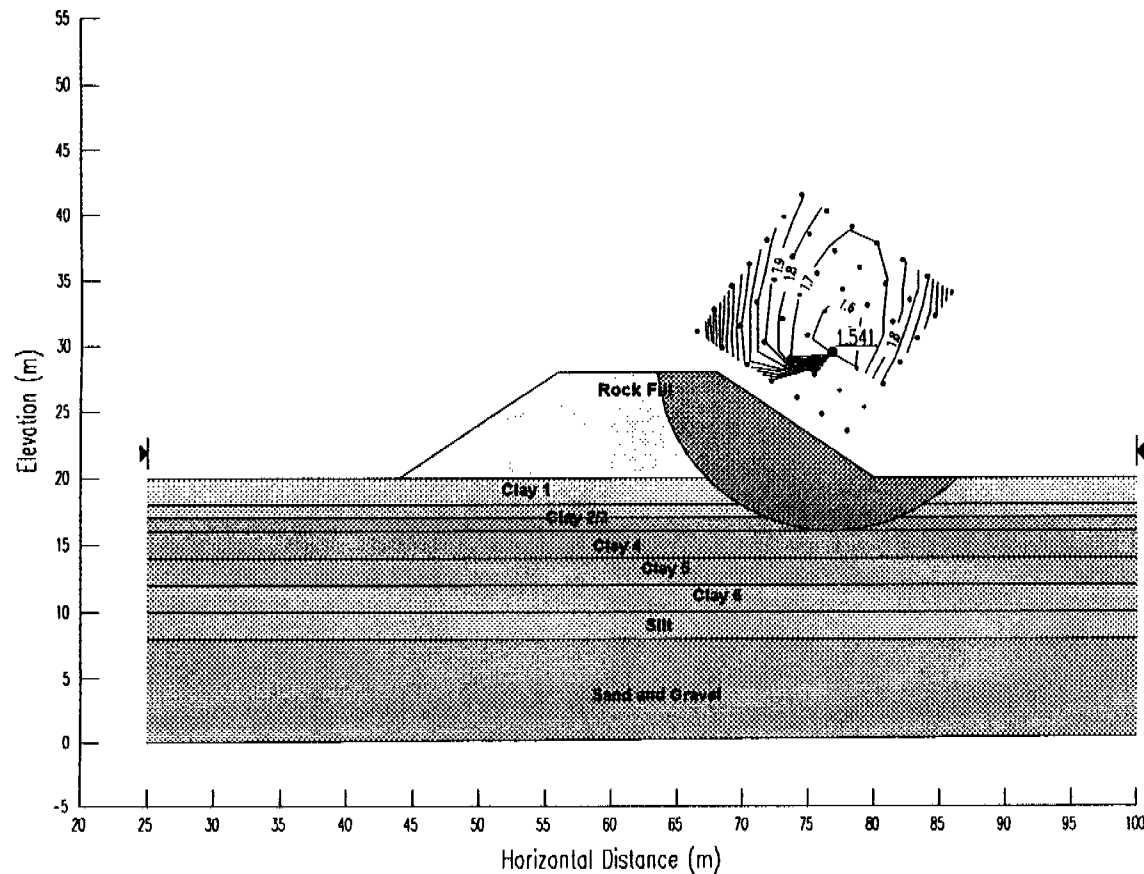
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H08T1043.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

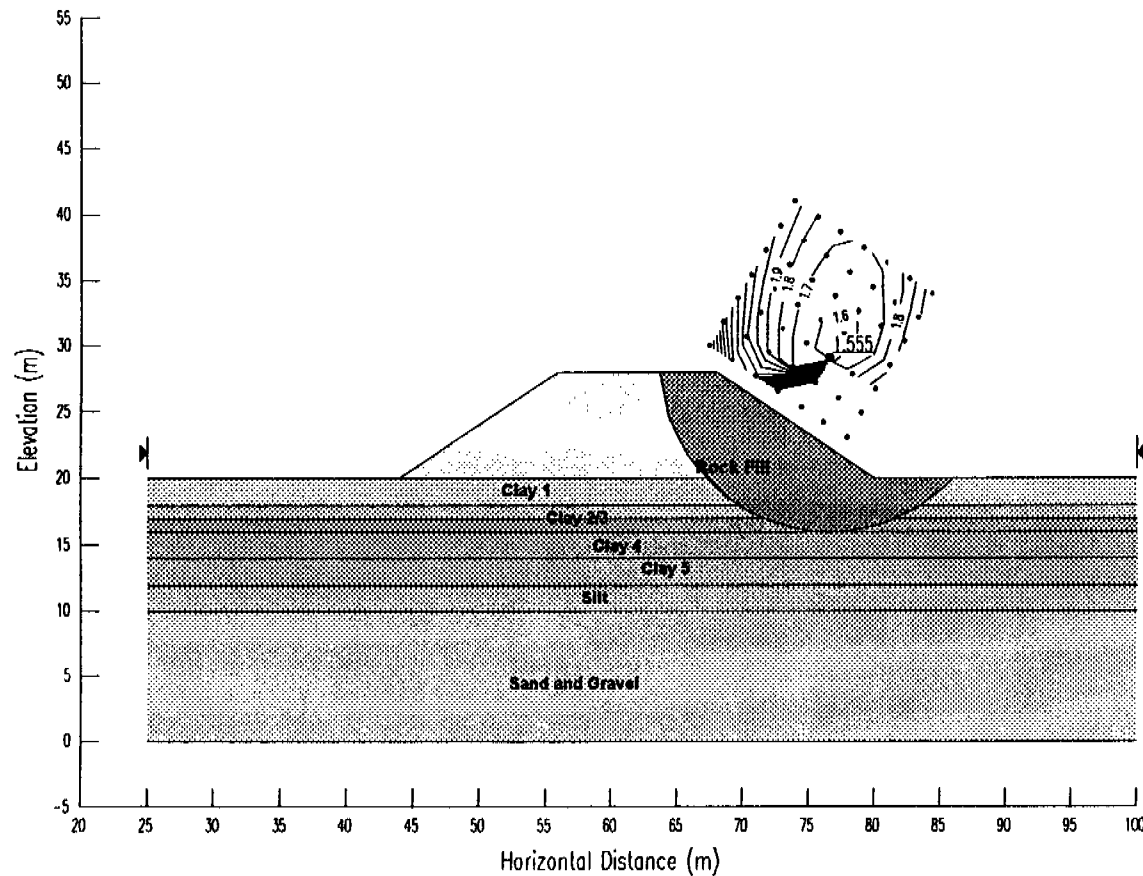
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H08T0843.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

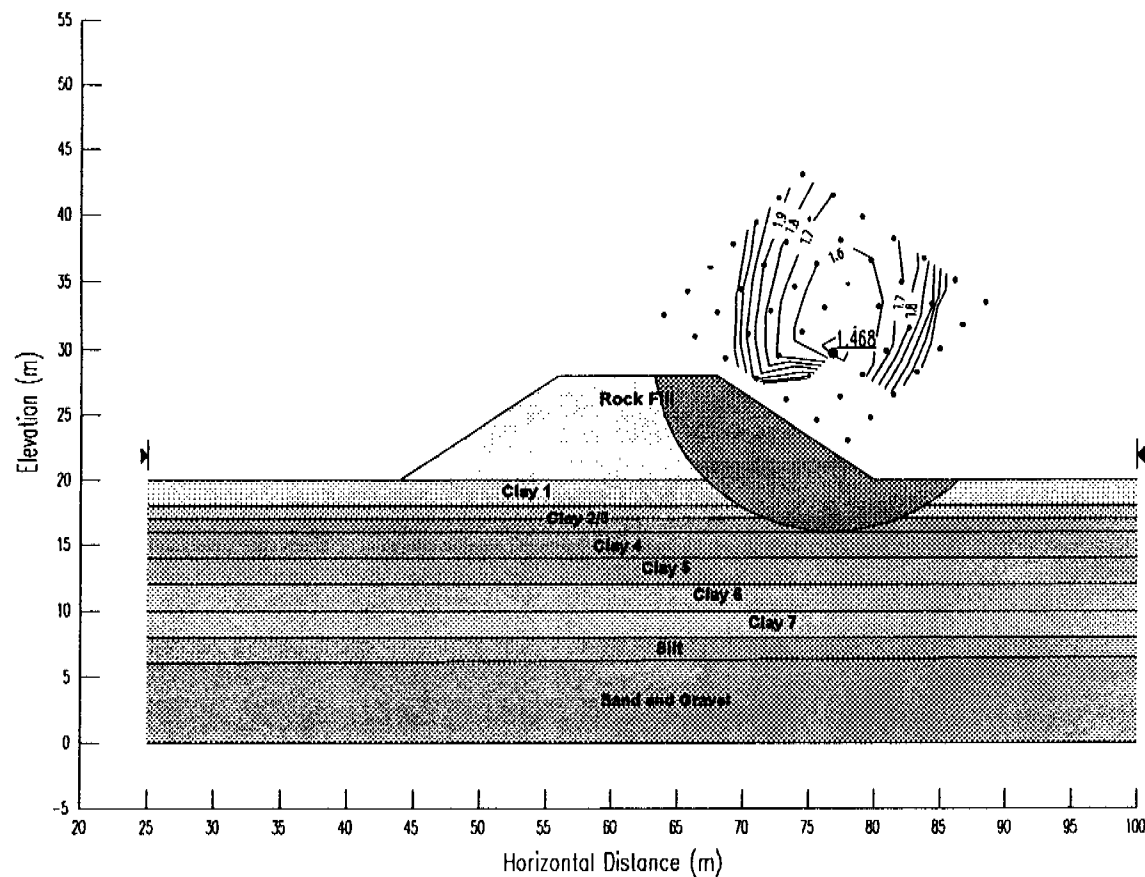
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H08T1253.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

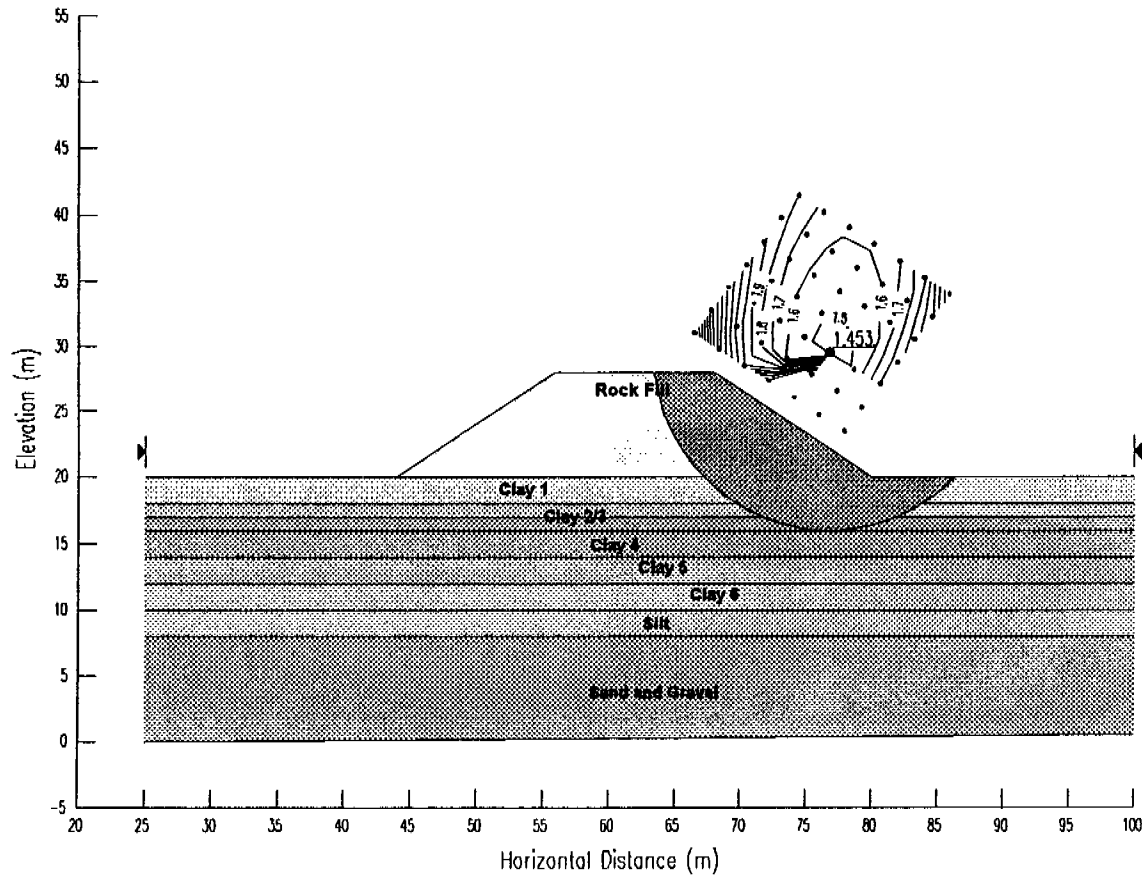
Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H08T1053.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

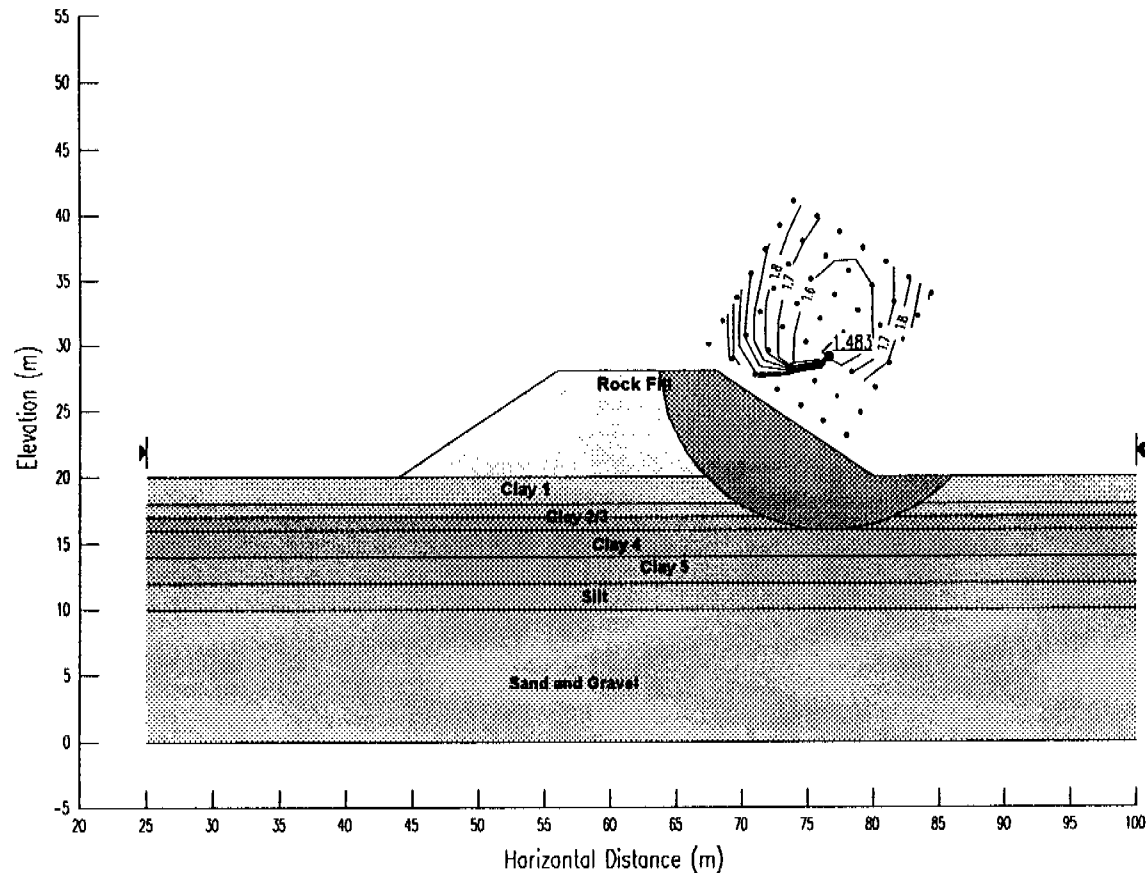
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 8 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H08T0853.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 8  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 8  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

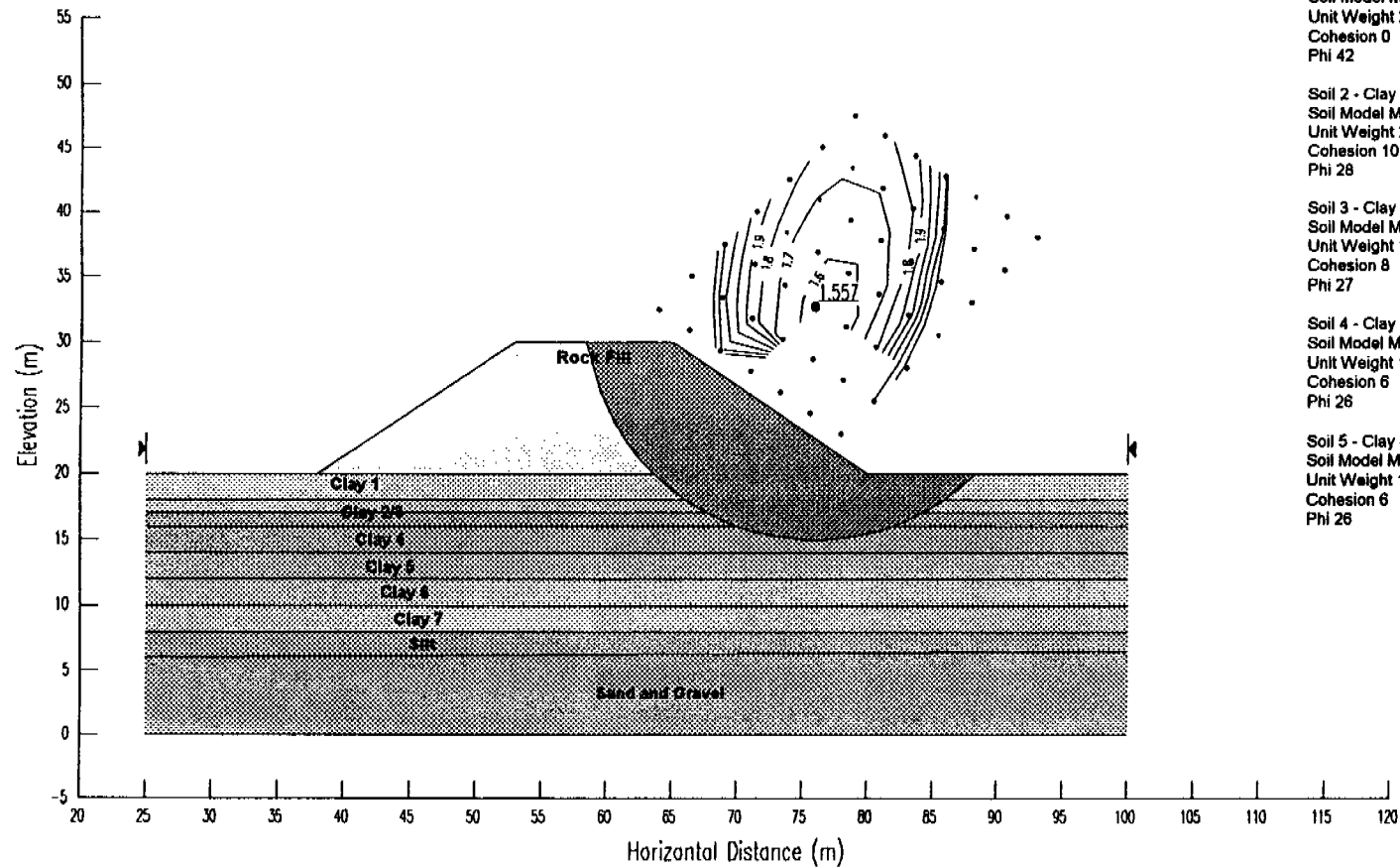
Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H10T1233.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

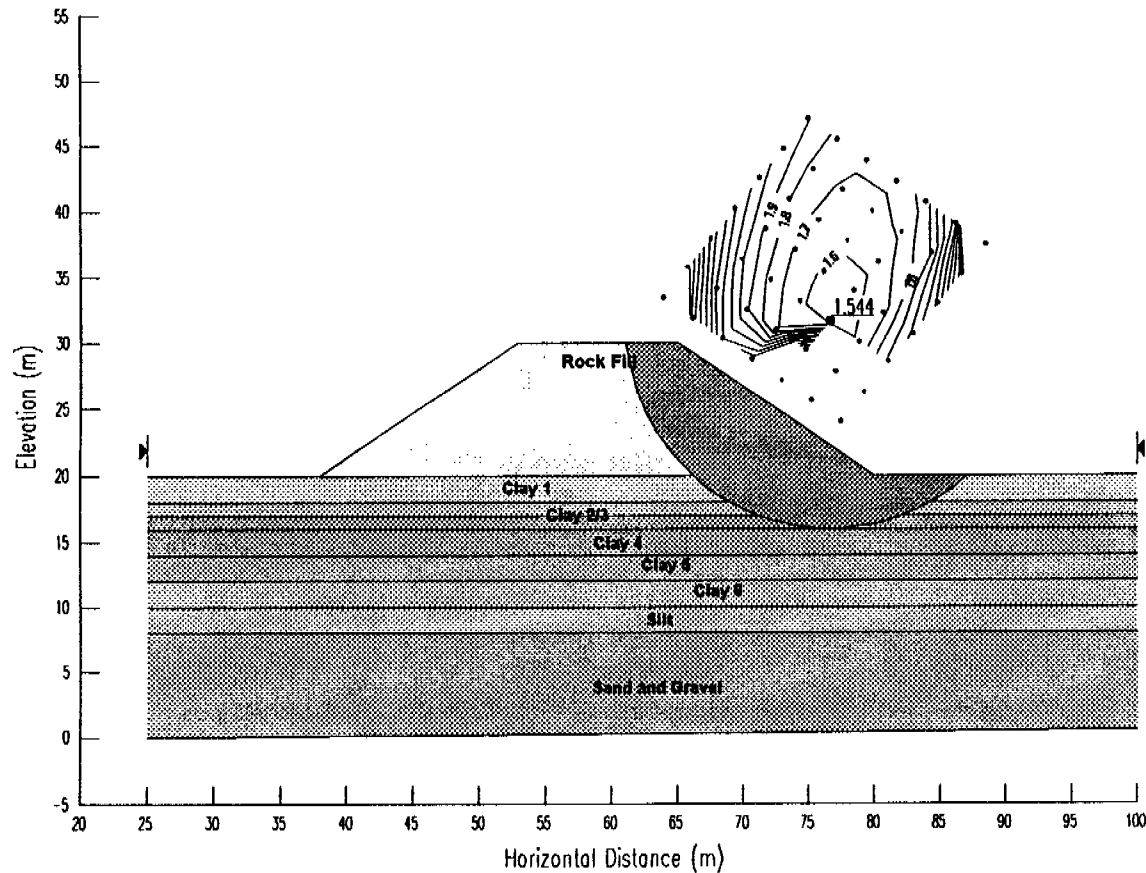
Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H10T1033.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

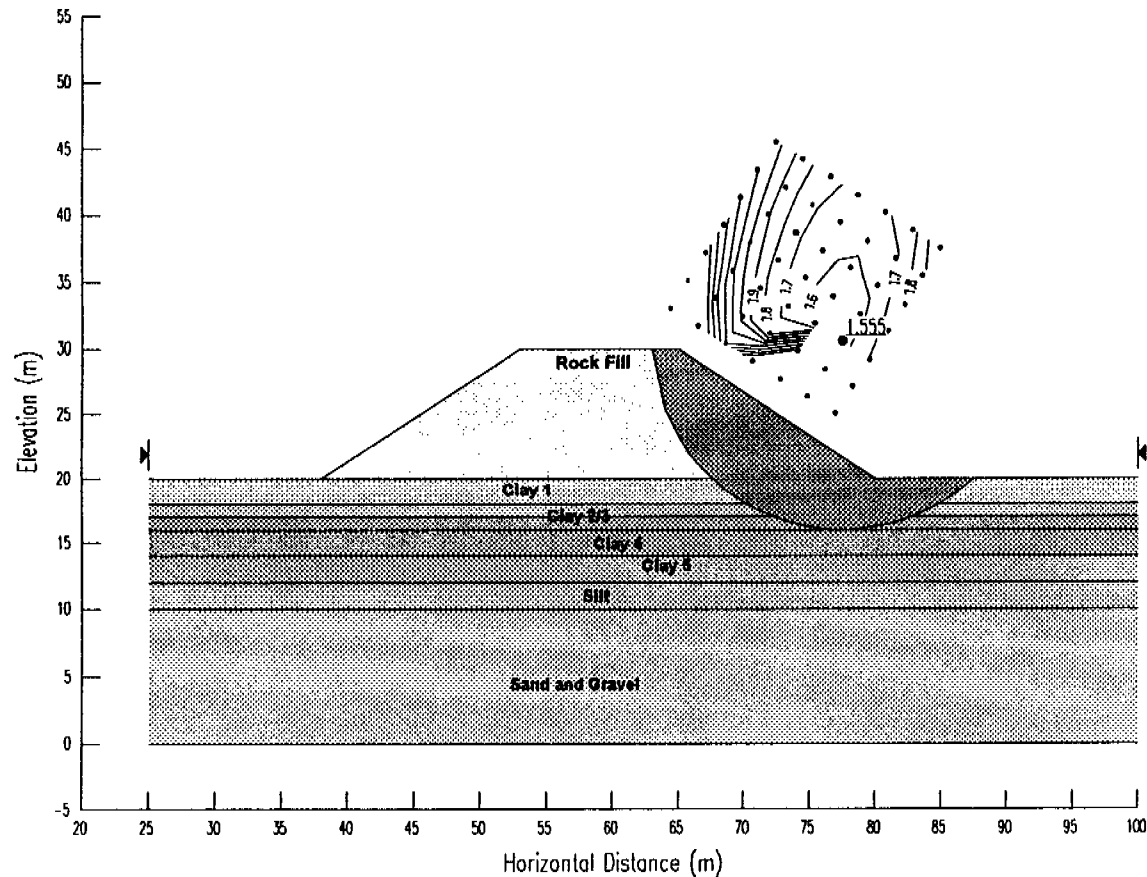
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H10T0833.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

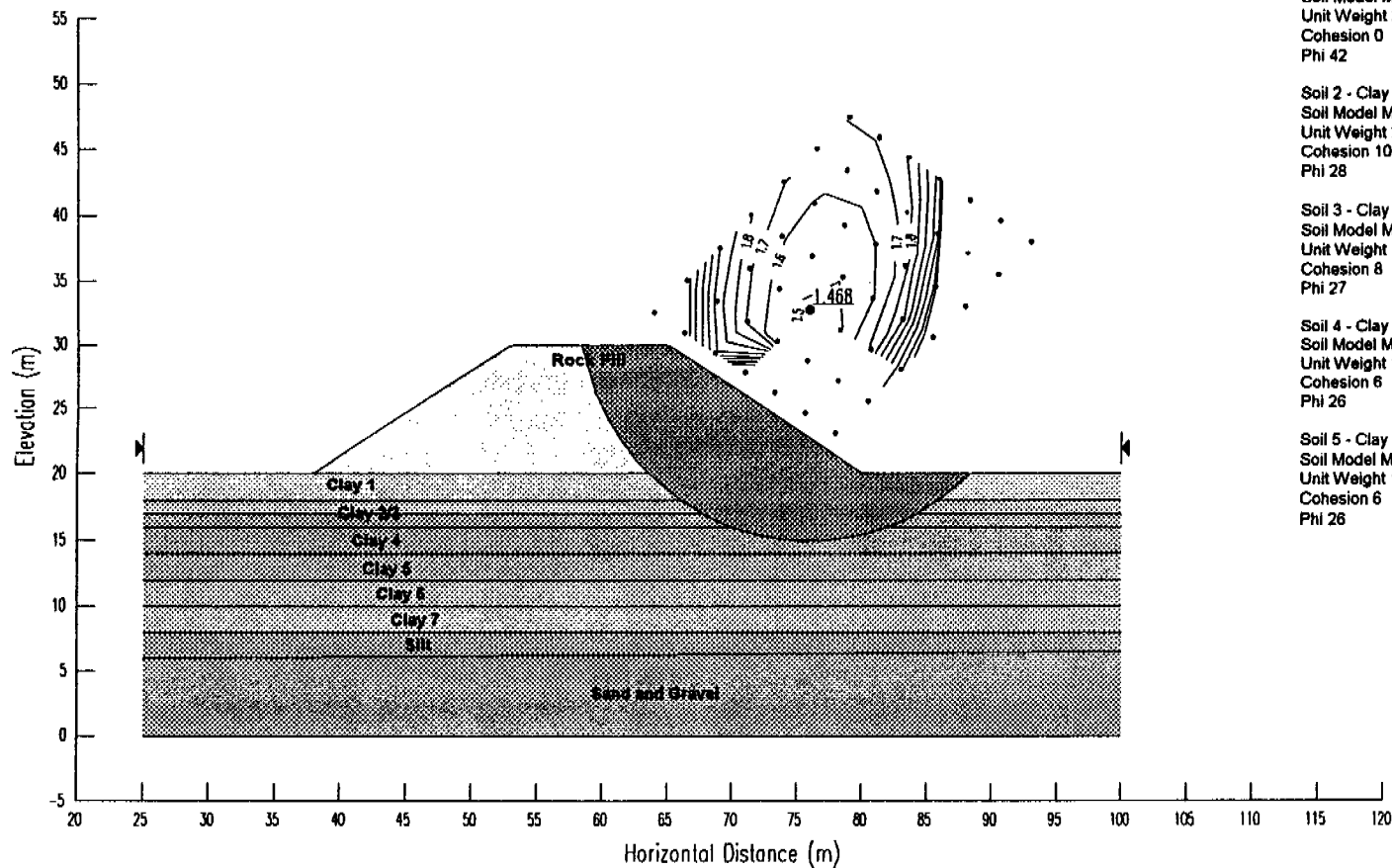
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179) -  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H10T1243.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

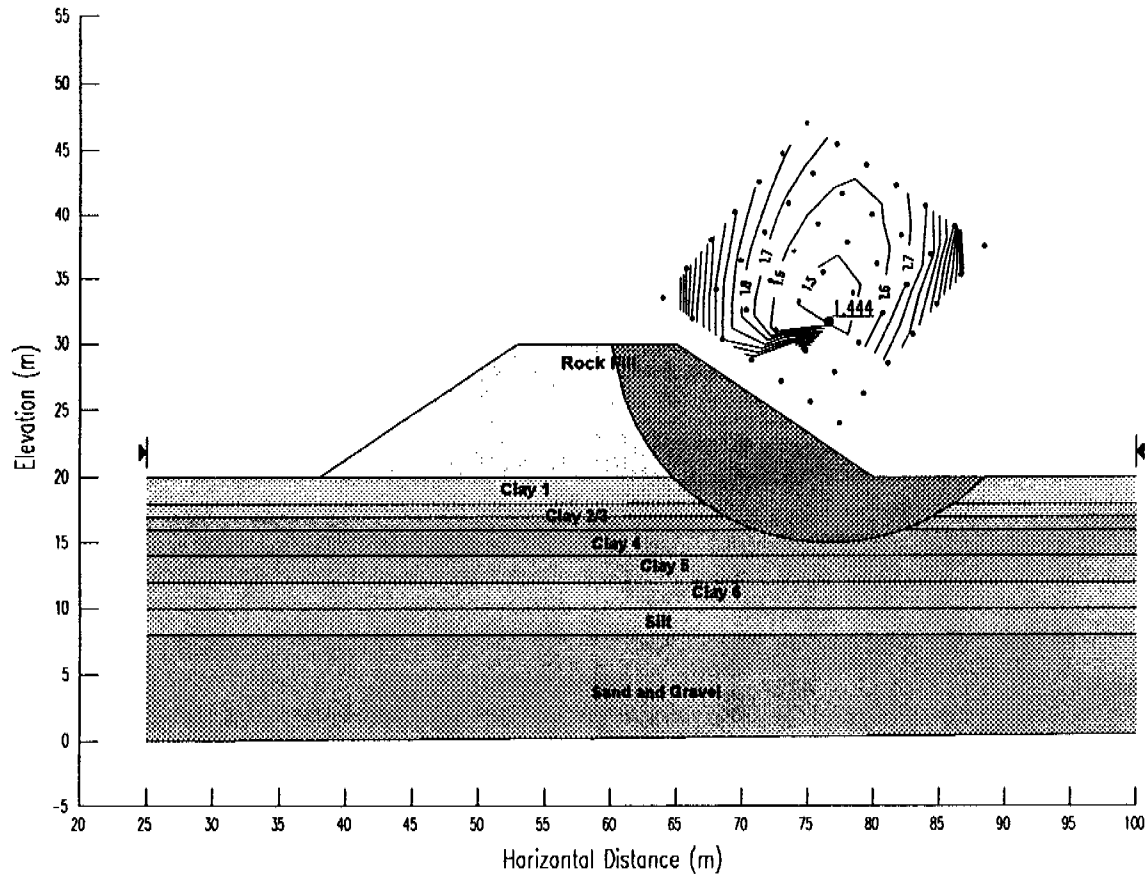
Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H10T1043.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

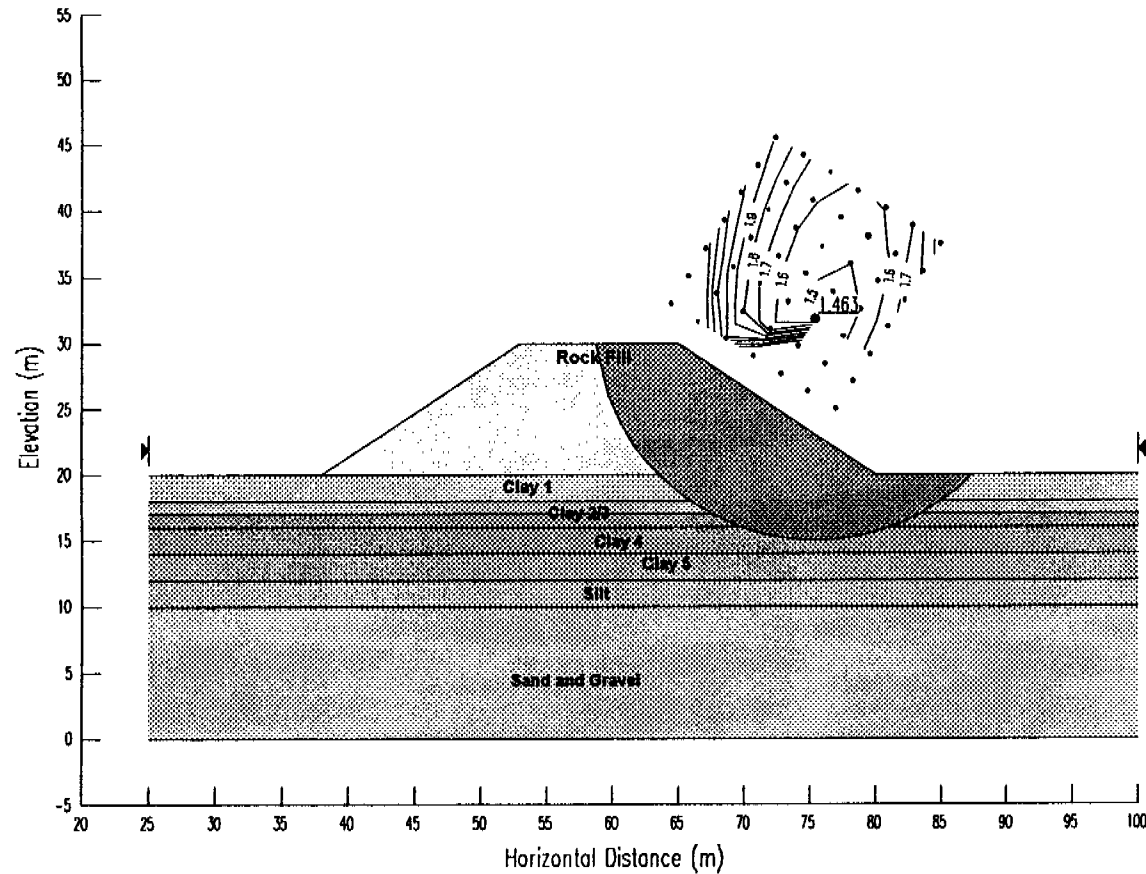
Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H10T0843.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 28

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

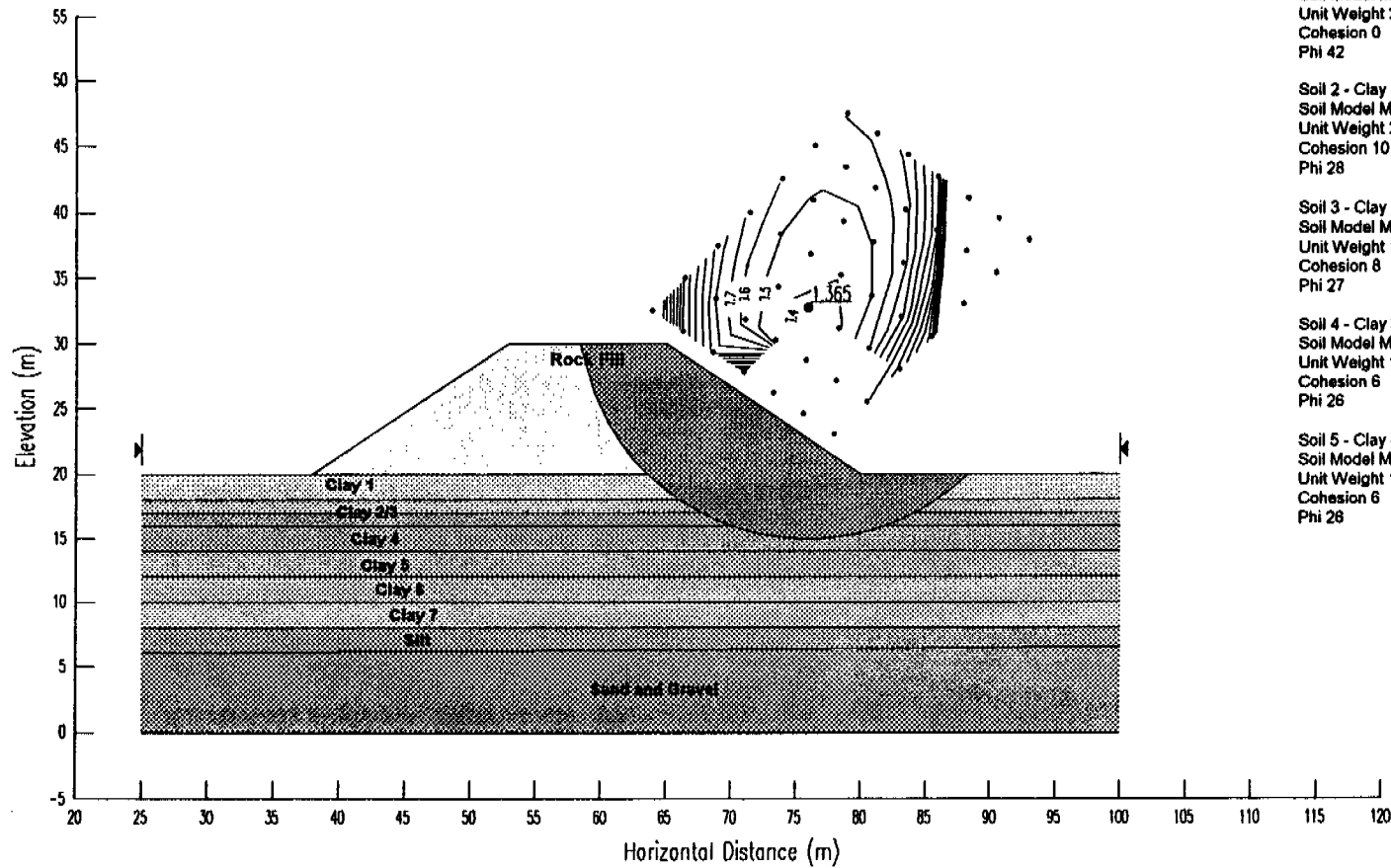
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H10T1253.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 28

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 8  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 8  
 Phi 26

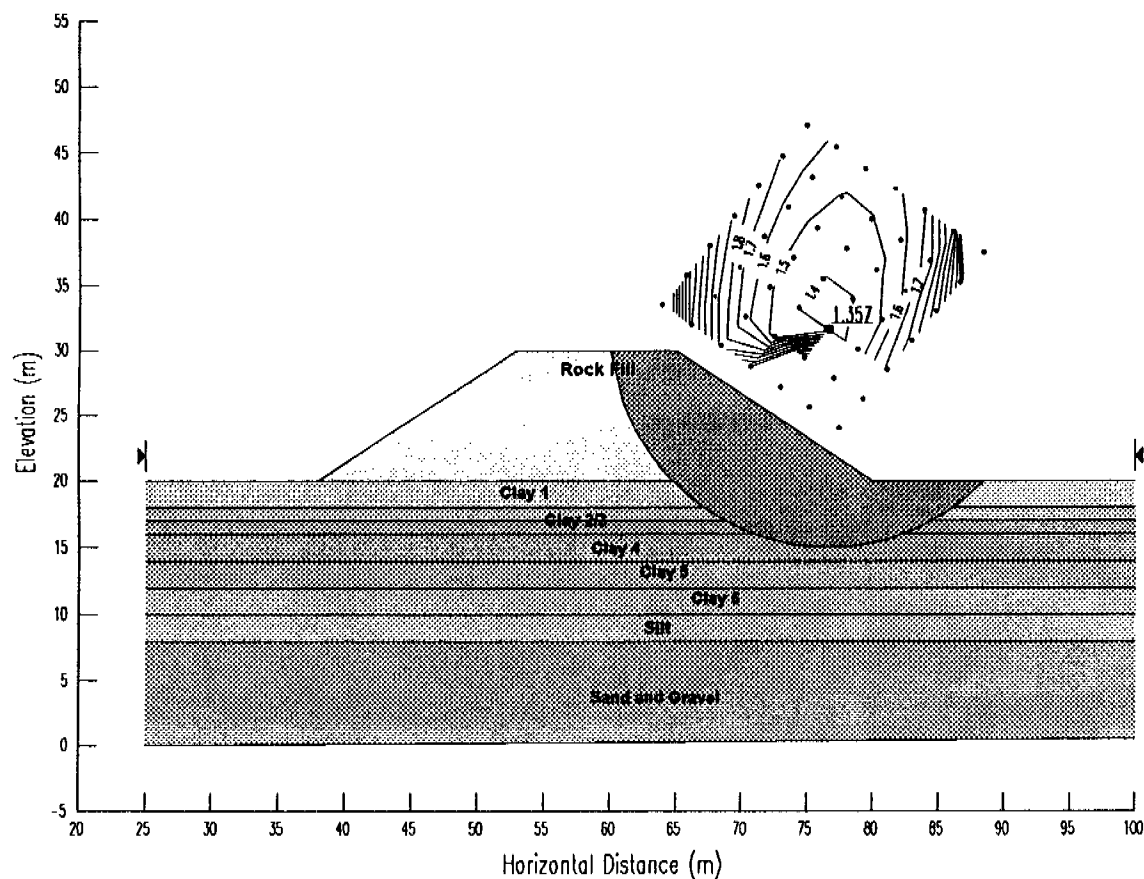
Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 8  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H10T1053.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

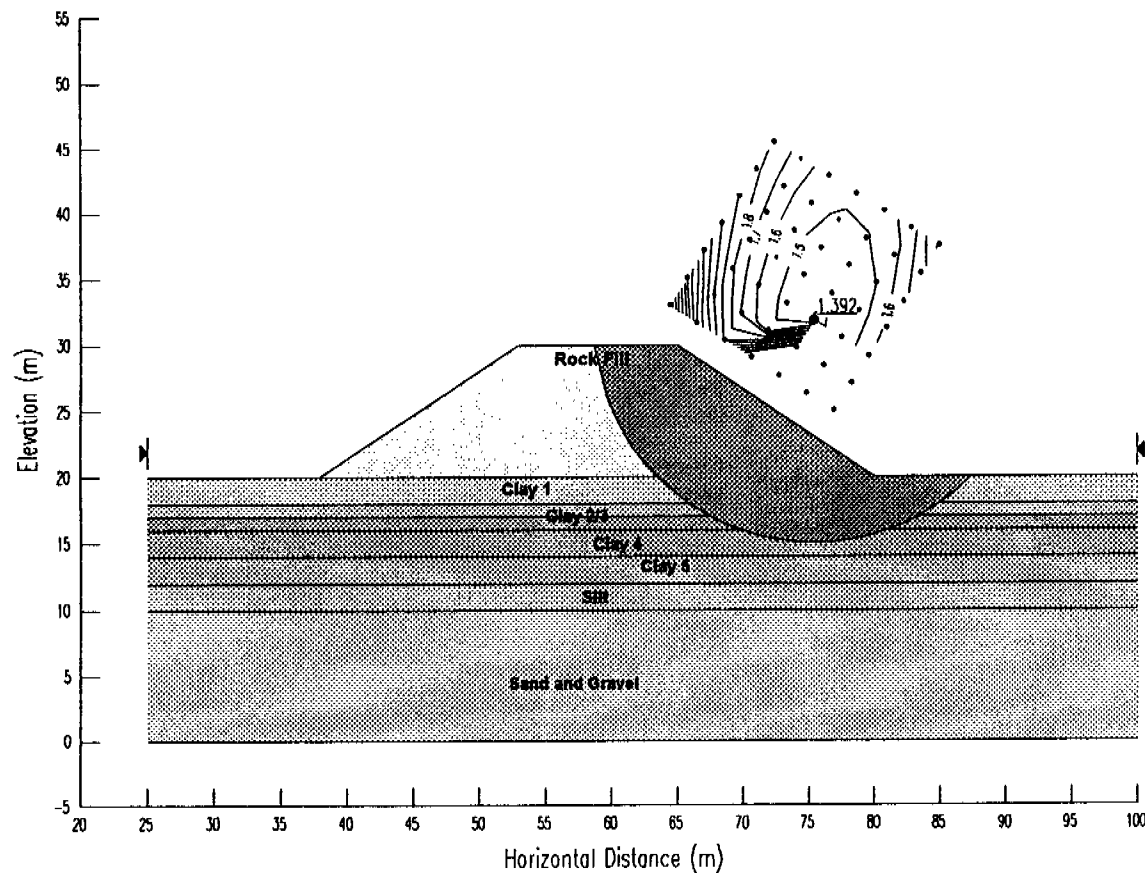
Soil 8 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 9 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 10 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 10 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H10T0853.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 8  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

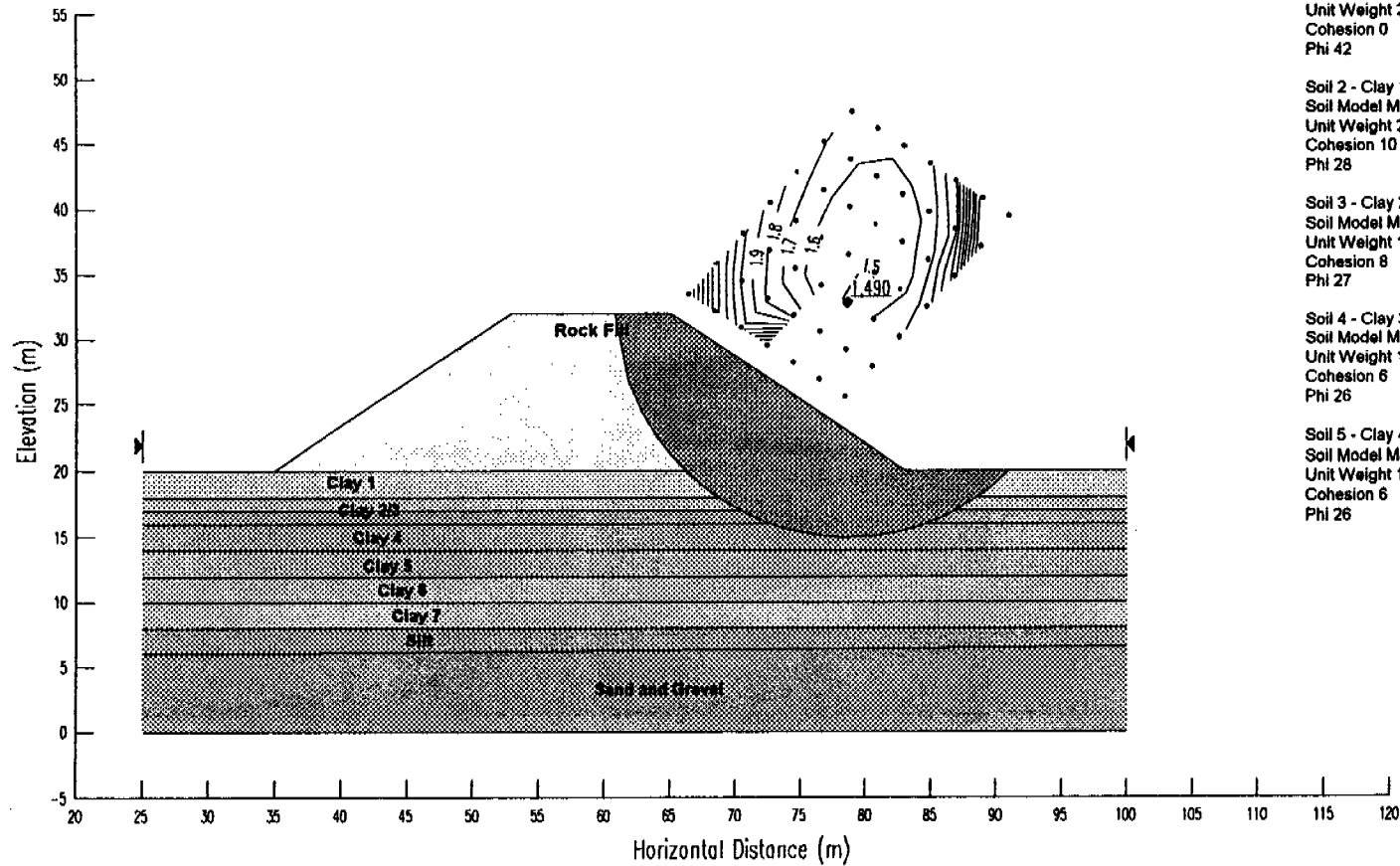
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H12T1233.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 28

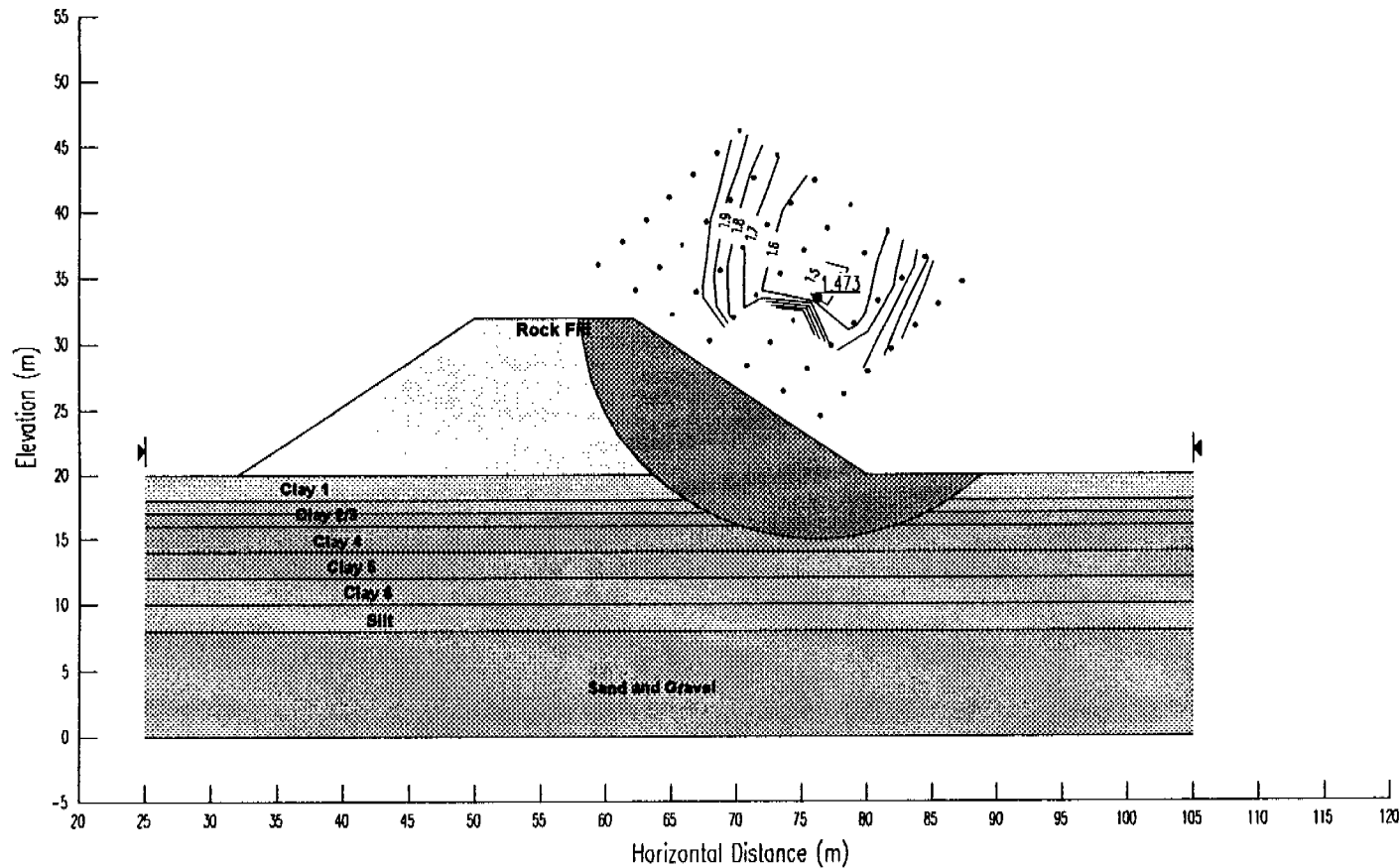
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H12T1033.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 8  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 8  
 Phi 26

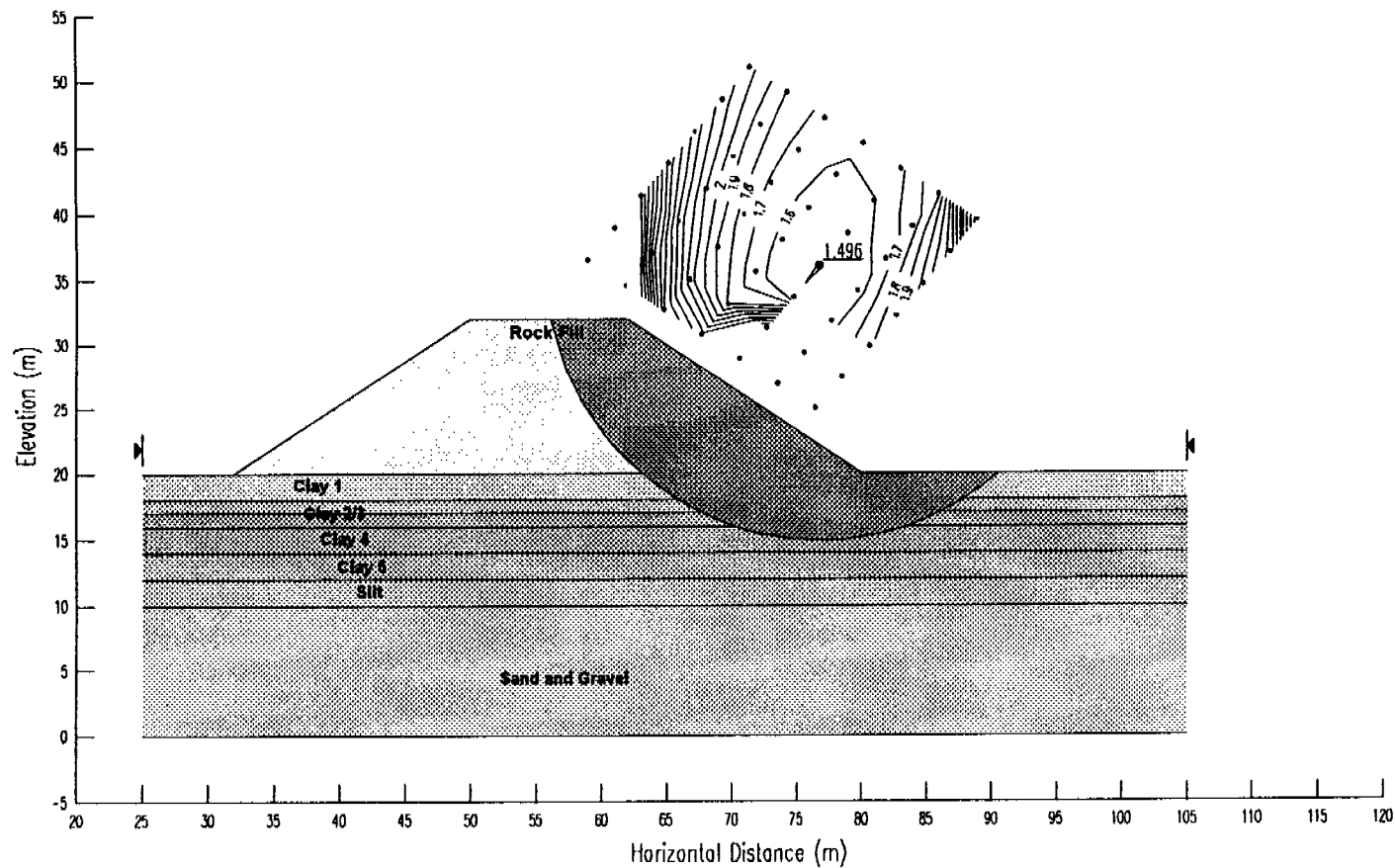
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 8  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 3m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H12T0833.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

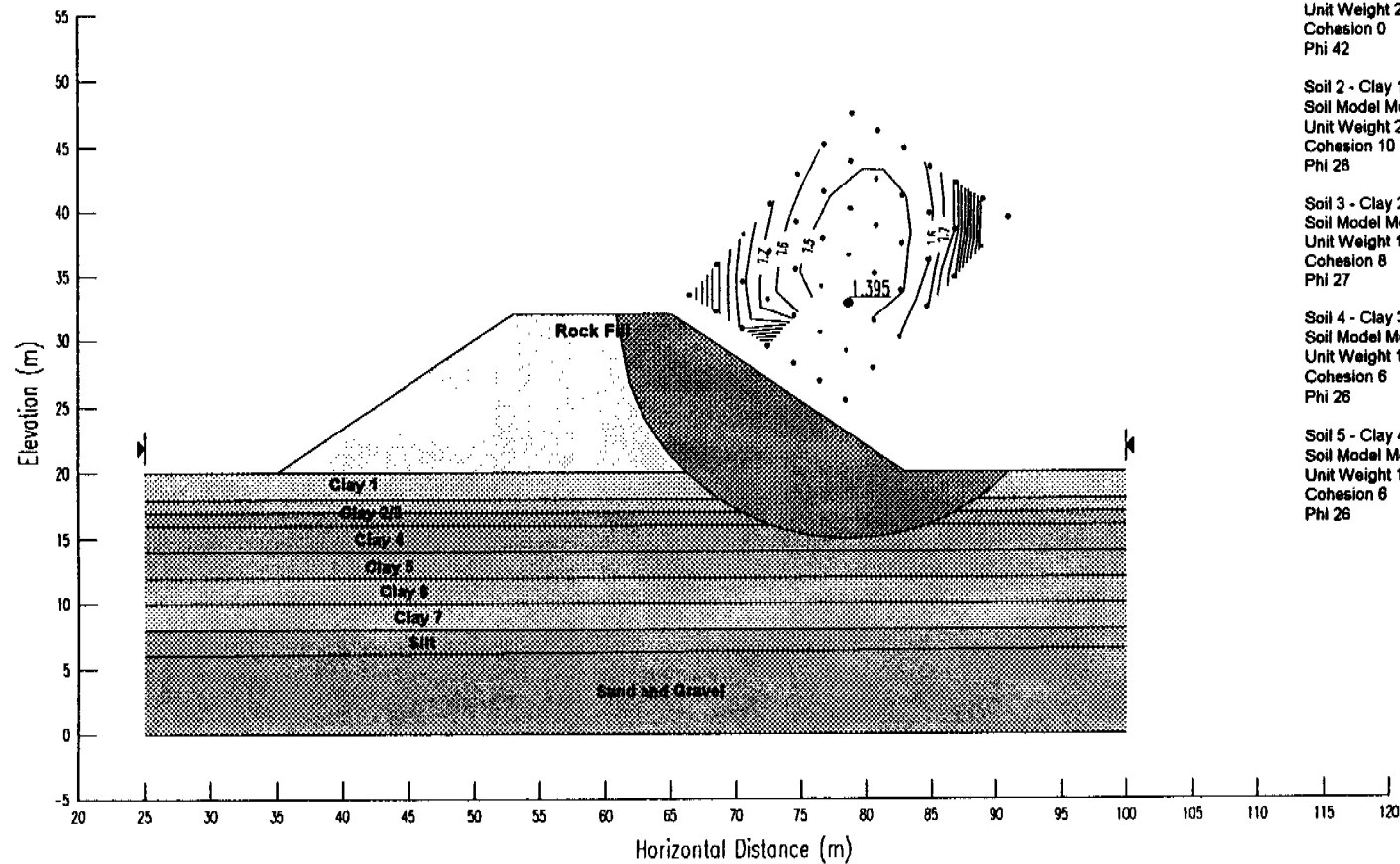
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H12T1243.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

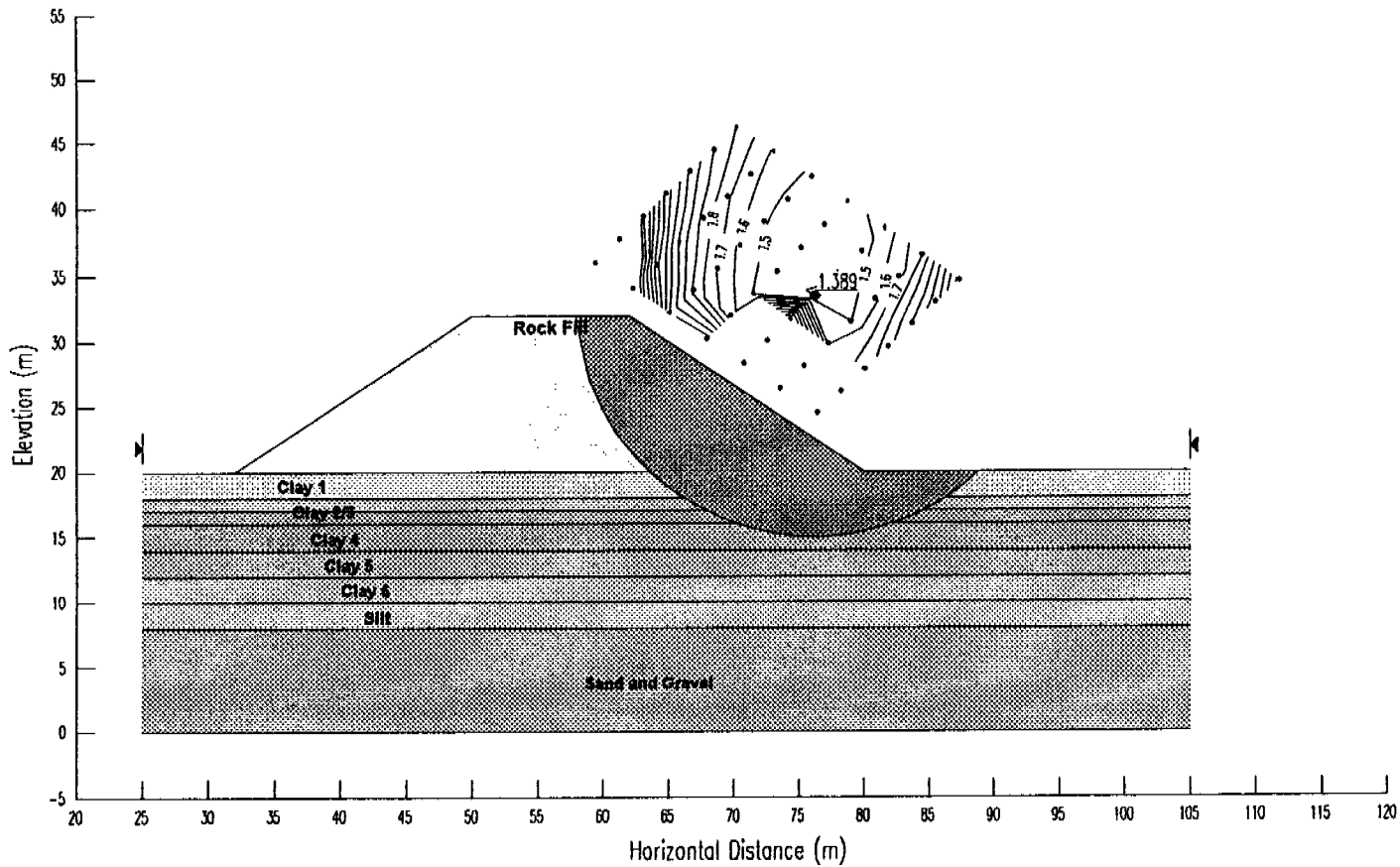
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 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

**H12T1043.SLP**



**Soil 9 - Bedrock**  
**Soil Model Bedrock**  
**Unit Weight -1**

Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 4m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H12T0843.SLP

Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

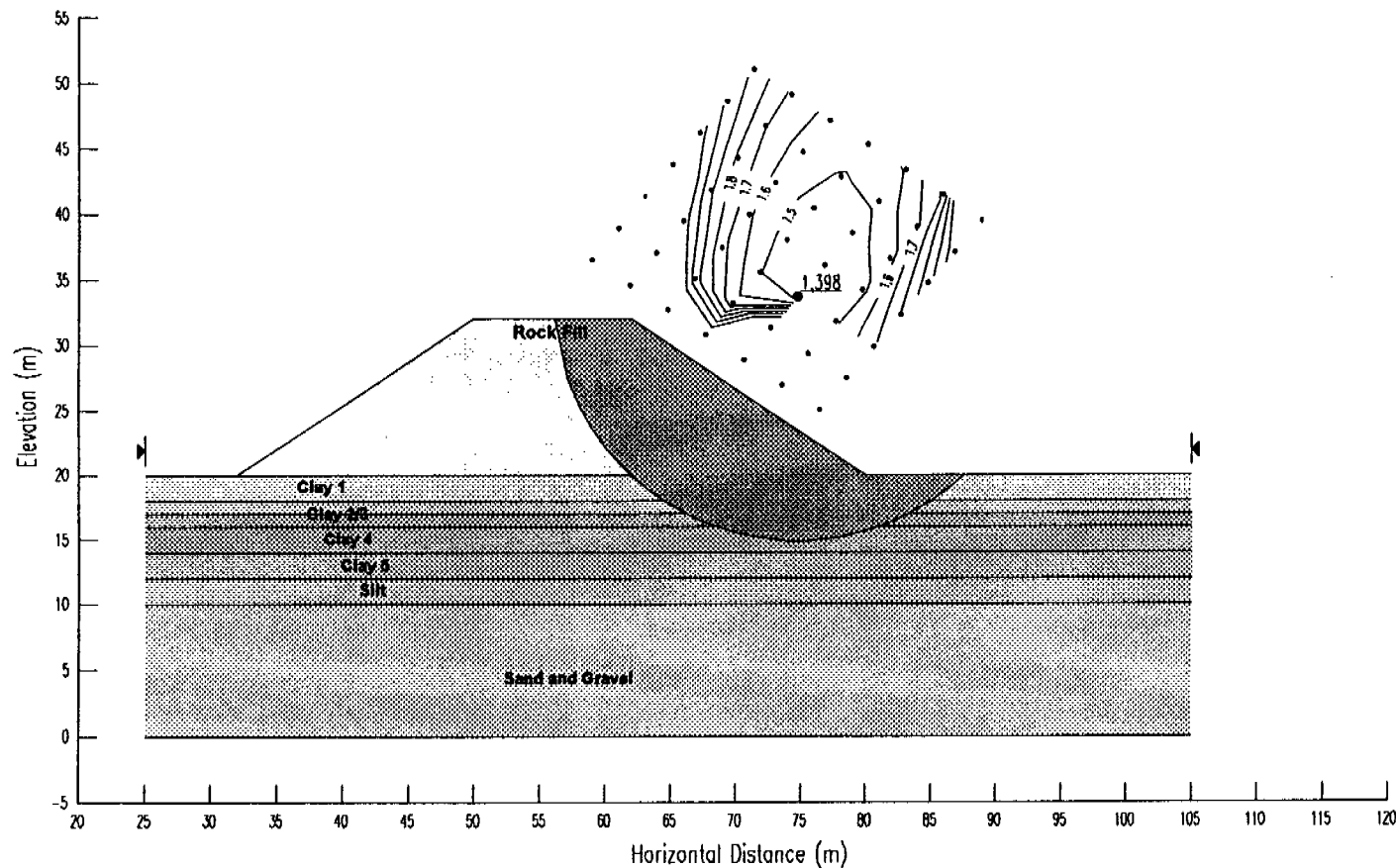
Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

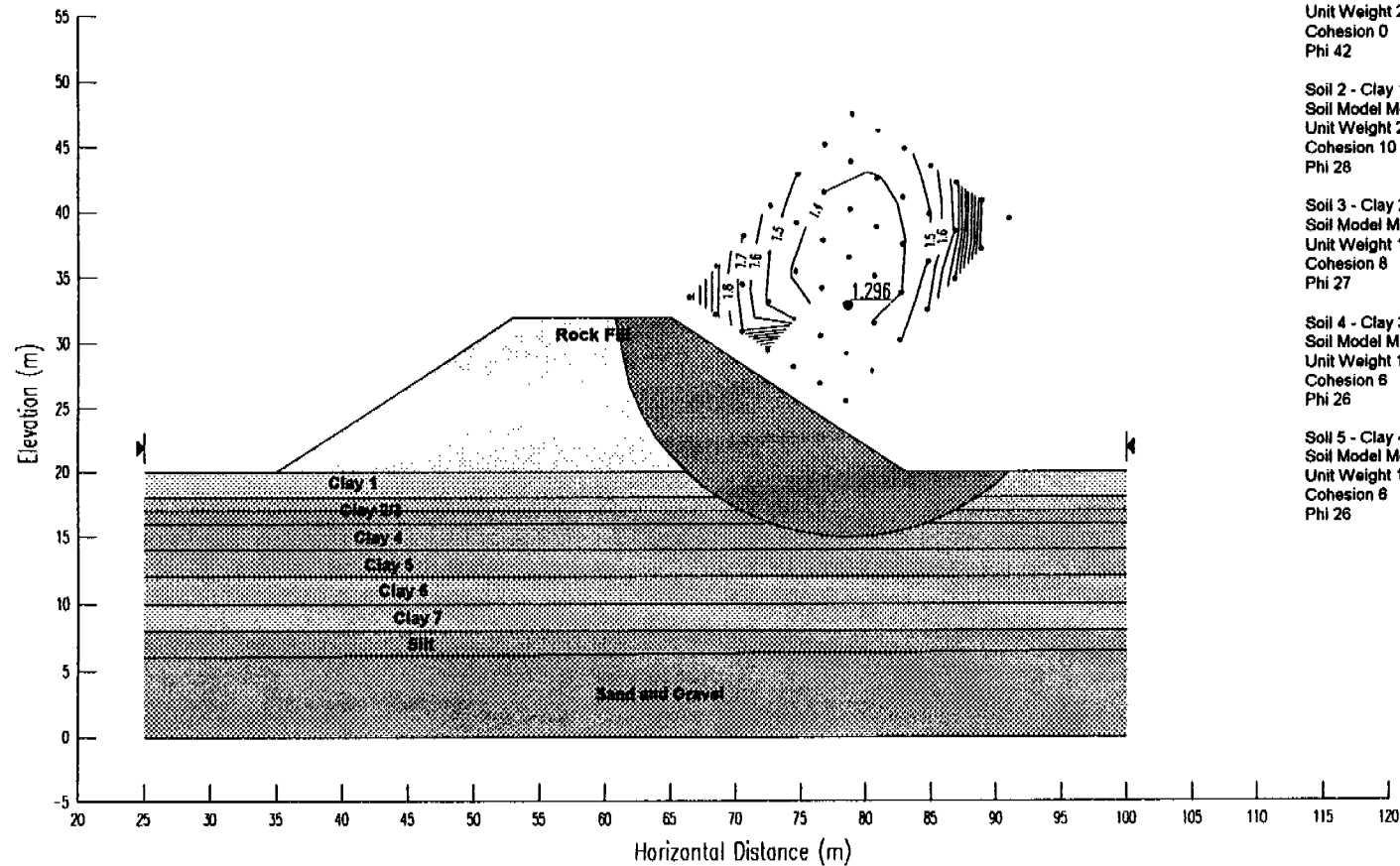
Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 12 metre clay foundation  
 H12T1253.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Clay 6  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 8 - Clay 7  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

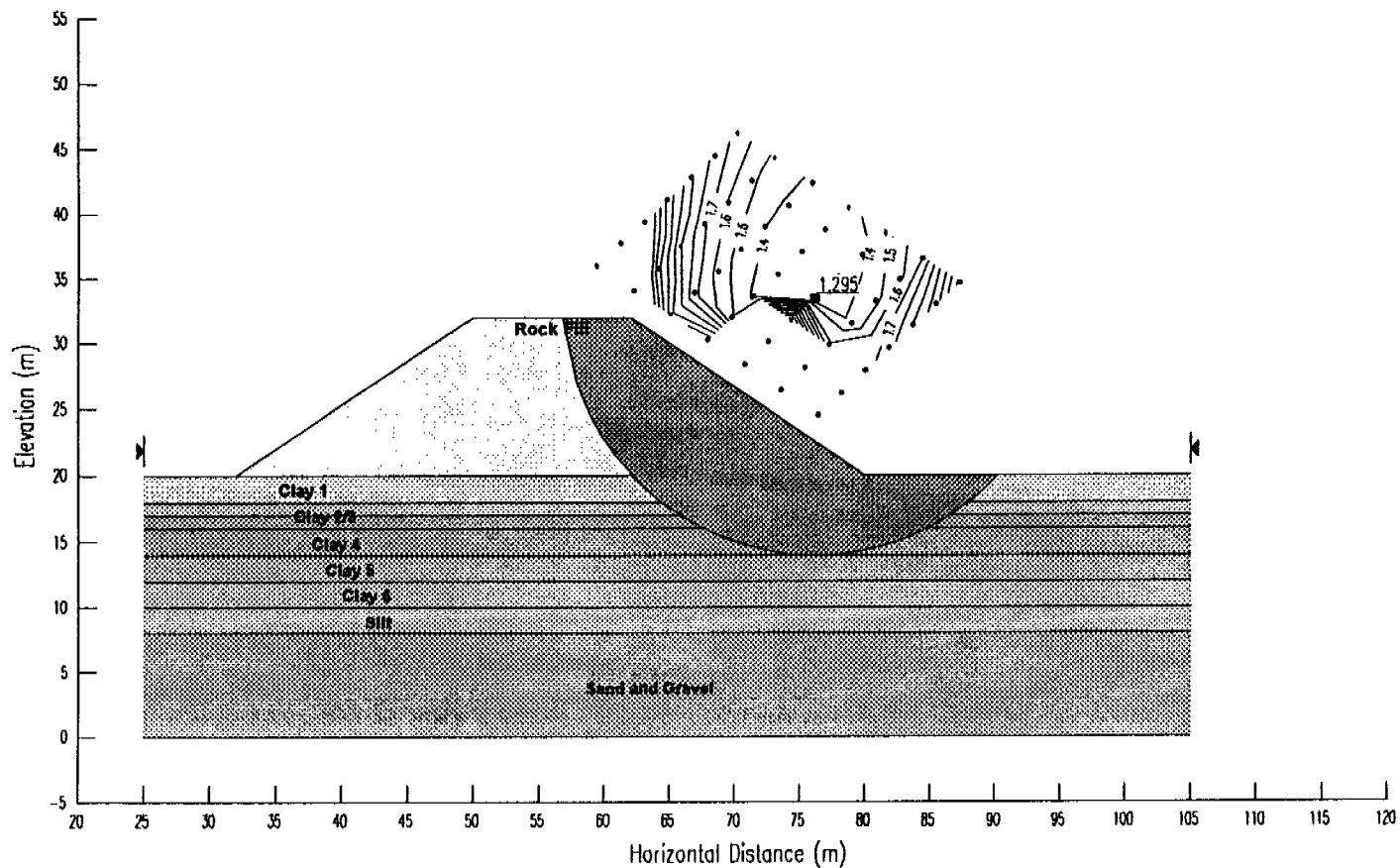
Soil 9 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 10 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 11 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1



Trout Creek - South Interchange Highway Embankments (F98179)  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 10 metre clay foundation  
 H12T1053.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

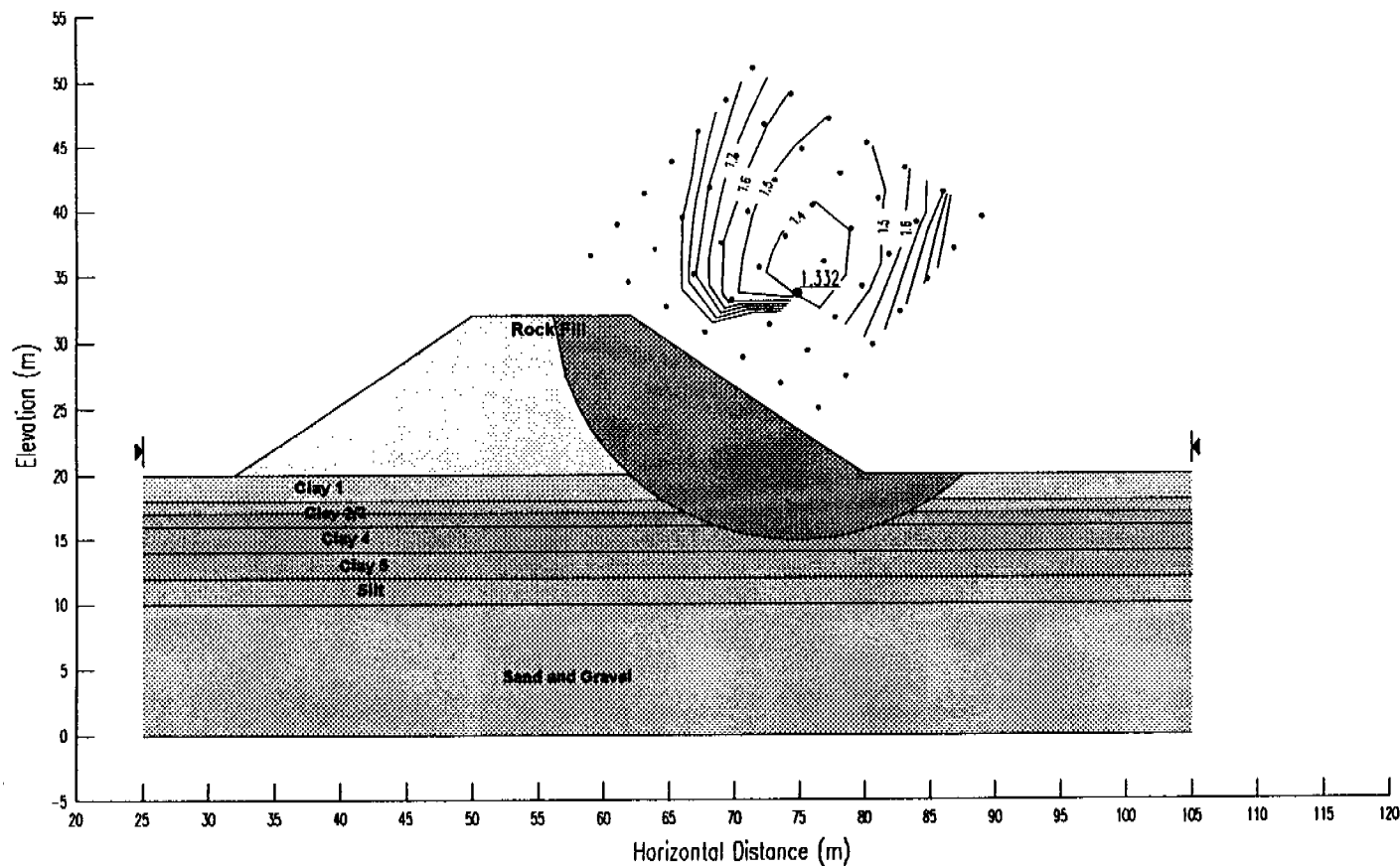
Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

Trout Creek - South Interchange Highway Embankments (F98179) -  
 Effective Stress Analysis - End of Construction at 3 months  
 with 5m spaced Wick Drains  
 12 metre embankment height, 1.5:1 overall side slope  
 8 metre clay foundation  
 H12T0853.SLP



Soil 1 - Rock Fill  
 Soil Model Mohr-Coulomb  
 Unit Weight 20  
 Cohesion 0  
 Phi 42

Soil 2 - Clay 1  
 Soil Model Mohr-Coulomb  
 Unit Weight 20.5  
 Cohesion 10  
 Phi 28

Soil 3 - Clay 2  
 Soil Model Mohr-Coulomb  
 Unit Weight 18.3  
 Cohesion 8  
 Phi 27

Soil 4 - Clay 3  
 Soil Model Mohr-Coulomb  
 Unit Weight 18  
 Cohesion 6  
 Phi 26

Soil 5 - Clay 4  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.3  
 Cohesion 6  
 Phi 26

Soil 6 - Clay 5  
 Soil Model Mohr-Coulomb  
 Unit Weight 17.8  
 Cohesion 6  
 Phi 26

Soil 7 - Silt  
 Soil Model Mohr-Coulomb  
 Unit Weight 19.5  
 Cohesion 0  
 Phi 31

Soil 8 - Sand/Gravel  
 Soil Model Mohr-Coulomb  
 Unit Weight 21.5  
 Cohesion 0  
 Phi 35

Soil 9 - Bedrock  
 Soil Model Bedrock  
 Unit Weight -1

GEOCRES #  
31E-180

**DESIGN REPORT**  
**TROUT CREEK BY-PASS - KING'S HIGHWAY 11**  
**WICK DRAIN DESIGN AND MONITORING PROGRAM**  
**SOUTH INTERCHANGE EMBANKMENTS**  
**DISTRICT 54, SUDBURY, ONTARIO**  
**GWP No. 774-93-00**

Report  
to  
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Project Engineer, Principal  
Paulo Branco, P.Eng.,

June 2, 1999  
File: 19-1104-4

AEQ/C:\jobfile\19\Trow\1104-4 Report South Final 1.wpd



Report reviewed by:  
P.K. Chatterji, P.Eng.,  
Review Principal

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## APPENDICES

Appendix A	Figures
Appendix B	Tables
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**DRAFT DESIGN REPORT  
TROUT CREEK BY-PASS - KING'S HIGHWAY 11  
WICK DRAIN DESIGN AND MONITORING PROGRAM  
SOUTH INTERCHANGE EMBANKMENTS  
DISTRICT 54, SUDBURY, ONTARIO  
GWP No. 774-93-00**

**1. Introduction**

This report presents the results of a supplementary geotechnical investigation and engineering analysis carried out by Thurber Engineering Ltd. (Thurber) for the design of wick drains and monitoring program for the proposed approaches and embankments at the South Interchange located south of Trout Creek, at the proposed King's Highway 11 Trout Creek By-Pass.

Thurber carried out the investigation as a sub-consultant to Trow Consulting Engineers (Trow). The Terms of Reference for this work have been included in a letter by Trow to Thurber dated February 23, 1999. Authorization to proceed with this work was given in a letter by Mr. Eric Gonneau, P.Eng. of Trow, dated March 12, 1999.

**2. Background Information and Scope of Work**

Trow have been retained by Marshall Macklin Monaghan (MMM) to provide geotechnical services as part of the Total Project Management, Detailed Design Services for the above noted project. Trow's scope of work included geotechnical, pavement and foundation investigation and design recommendations for a number of proposed structures along this section of four-laning of Highway 11. The results of Trow's investigation program for the South Interchange were summarized in the following draft report:

- Foundation Investigation: Bridge Structure, Approaches and Embankment Fills - South Interchange (Boundary Road) - Trout Creek by-Pass, King's Highway 11 - District 54, Sudbury, Ontario, GWP No.774-93-00, December 7, 1998

The investigation by Trow at the South Interchange revealed the presence of thick soft foundation clayey deposits. Trow's analysis indicated that a combination of side berms and wick drains are required for successful construction of the high approach embankments, with final design heights up to 11.5 m. The side berms and wick drains are required to prevent a foundation failure during construction and to accelerate the foundation settlements so that most of the settlements are completed prior to bridge foundation construction and paving of the road.

Thurber Engineering Ltd. (Thurber) has been retained by Trow for the detailed design of the wick drains and to design a geotechnical instrumentation monitoring program to control the embankment performance during and after construction. In order to carry out this task Thurber has been provided with the following:

- portions of the above noted report containing the factual geotechnical data, excluding Trow's recommendations for the embankment design;
- drawings including a site plan view, longitudinal profiles and simplified subsurface conditions;
- Boundary Road Bridge General Arrangement and embankment typical cross sections.
- This report should be read in conjunction with Trow's report.

### **3. Methodology**

The work presented herein was developed in the following stages:

- Review of available information;
- Visit to Trow's office in Sudbury for visual inspection of soil samples, on March 18, 1999, by Mr. Scott Peaker, P.Eng. of Thurber. Some soil samples were brought to Thurber's office in Toronto for visual inspection;
- Site visit on March 19, 1999, by Mr. Scott Peaker, P.Eng. of Thurber,

for site reconnaissance and evaluation of site access by a drill rig for piezocone testing

- Piezocone testing on March 25 and 26, 1999
- Engineering Analysis
- Design Recommendations

#### **4. Proposed Interchange**

The South Interchange consists of one bridge structure that will carry the proposed Boundary Road over the proposed realigned and widened Hwy 11, approach embankments to the bridge and access ramp embankments. The proposed bridge consists of a two span structure with integral abutments, with a length of 67.2 m between abutments. A site plan view is shown on Figure A1 in Appendix A.

The embankments at this site will be constructed using blast rock with side slopes of 1.25H:1V and headslopes at the bridge abutments inclined at 2H:1V. The embankments are up to 11.5 m and 10.2 m high at the west and east abutments, respectively.

#### **5. Site Description**

Details about the site location and surface conditions have been included in Trow's report and they will not be repeated herein.

#### **6. Piezocone Testing**

Piezocone testing was carried out with the purpose of:

- confirming the subsurface conditions encountered by Trow
- obtaining continuous strength information at depth
- carrying out pore pressure dissipation tests at selected depths for assessment of the horizontal coefficient of consolidation required for optimizing wick drain design
- measuring the piezometric head at the base of the fine sediments to verify the presence of artesian condition

Piezocone testing (CPTU) was carried out on March 25, 1999, by ConeTec Investigations Ltd. of Vancouver, B.C. The piezocone was pushed using a track mounted CME 75 owned and operated by All Terrain Drilling Ltd. of Waterloo, Ontario.

A total of five CPTUs were carried out at the South Interchange at the approximate locations shown on attached Figure A1. The CPTUs were labelled CPTUS1 through CPTUS5. Table B1 in Appendix B presents approximate coordinates and ground surface elevations at the CPTU locations and the maximum depth of testing where refusal to penetration was encountered.

The results of the CPTUs are summarized in a report by ConeTec included in Appendix C.

Figures A2 to A6 in Appendix A present a summary of both the results of CPTUs and the nearby borehole and laboratory information presented in Trow's report.

## **7. Description of Subsurface Conditions**

### **7.1 Subsurface Soil Conditions**

The subsurface conditions at this site were characterized based on a drilling and laboratory program carried out by Trow and on the results of the CPTUs carried out by ConeTec.

The subsurface conditions at this site consist of a layer of organic soils, to a depth of up to 2 m, overlying interbedded layers of mostly fine sediments with varying percentage of clay, silt and sand content, up to 20 m depth, overlying a layer of sand and sand and gravel, with thickness ranging from 3 m to up to 10 m, overlying bedrock.

Of interest to this project is the sequence of layers containing fine sediments. The fine sediments were encountered with maximum thickness to the south and east of the proposed site. The anticipated location of the western boundary of the soft/loose sediments are shown on Figure A1,



## Appendix A.

The upper portion of the fine sediments, referred to as Upper Silt and Sand, consists mostly of sandy silt to silt which varies in thickness from approximately 1 m to the west of the bridge to 5 m at the eastern boundary of the interchange, close to the existing Hwy 11, where the Upper Silt and Sand consisted mostly of sand and silty sand. The Standard Penetration Test "N" values ranged within a wide range with typical values of 3 in the silt layers and more than 30 in the sand layers, indicating a very loose to dense condition. SPT "N" values interpreted from the CPTUs were generally higher than those measured in the augered holes but both methods indicated approximately the same trend and soil condition. The lower 1 to 1.5 m of the Upper Silt and Sand consisted mainly of silt which appears to be over consolidated with undrained shear strength up to 150 kPa.

Interbedded layers of silty clay and clayey silt, referred to as Clayey Silt, were encountered underlying the Upper Silt and Sand. At the bridge location the Clayey Silt is approximately 8 m thick. The thickness of the Clayey Silt decreases to the north and west of the bridge and it increases to the east and south of the bridge. The maximum depth, 18.3 m, and thickness, 14.0 m, of this layer in the area of interest of this project was encountered south of the EW-N Ramp, in BH31FP.

The CPTUs confirmed the presence of a stiff to very stiff crust of clayey silt to a depth of 3m to 5 m. The undrained shear strength in this crust decreased with depth and ranged typically from 50 kPa to more than 150 kPa. The field vane tests indicated undrained cohesion generally lower than the undrained shear strength ( $S_u$ ) values interpreted from the CPTUs. Pore pressure dissipation tests carried out in the crust indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 180  $\text{m}^2/\text{y}$  (3.5 m depth at CPTU4) to 690  $\text{m}^2/\text{y}$  (3.5 m depth at CPTU3).

Underlying the upper crust, the Clayey Silt was soft to firm with undrained shear strength ranging from 20 kPa to 50kPa. Atterberg Limits presented in Trow's report indicated that this layer can be classified as clay of low plasticity (CL). An inspection of Shelby tube samples collected from this layer indicated that the low plastic clay is interbedded with layers of silt. The

“noisy” variation of tip resistance with depth detected by the CPTU confirms the layering pattern of the Clayey Silt. The CPTU interpretation of the stratigraphy shows that clayey silt and “sensitive fines” constitute most of the Clayey Silt below the upper crust. Based on the visual inspection of a Shelby tube sample collected from BH16FP (TW5 - ~8m depth), near CPTUS5, the “sensitive fines” consist of uniform firm low plastic clay. A few pocket penetrometer tests carried out on this sample revealed a significant loss of resistance to penetration of the probe after a small initial penetration, confirming the sensitive nature of this deposit. Pore pressure dissipation tests carried out on the Clayey Silt, below the upper stiffer crust, indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 130  $\text{m}^2/\text{y}$  (5.5 m depth at CPTUS2) to 270  $\text{m}^2/\text{y}$  (4.5 m depth at CPTU1). One exception to the above measurements was encountered in the “sensitive fines” in CPTUS5, where one pore pressure dissipation test resulted in a  $C_h$  value of 590  $\text{m}^2/\text{y}$ . This measurement is consistent with the high moisture content and sensitivity of this deposit in the proximity of CPTUS5.

In the area south and east of the bridge, at locations where the Clayey Silt is relatively thick, the bottom 2 m to 4 m of the Clayey Silt presented Undrained shear strength ( $S_u$ ) increasing with depth with typical values between 40 kPa and 50 kPa. Pore pressure dissipation tests carried out on the bottom portion of the Clayey Silt, indicated horizontal coefficient of consolidation ( $C_h$ ) values ranging from 340  $\text{m}^2/\text{y}$  (15 m depth at CPTU5) to 400  $\text{m}^2/\text{y}$  (8.5 m depth at CPTUS1).

The  $C_h$  values above were significantly higher than those obtained from oedometer tests as reported in Table 1-1 of Trow's report.

Underlying the Clayey Silt layer a layer of silt, referred to as Lower Silt, was encountered with thicknesses ranging from 1 m to 6 m. The SPT “N” in the Lower Silt, interpreted from the CPTUs, ranged typically from 3 to 6, which is consistent with the SPT “N” values from the augered holes. Locally  $S_u$  values interpreted from the CPTUs ranged from 50 kPa to 150 kPa.

The Lower Silt is underlain by a sequence of layers of sandy silt and sand, referred to as Sandy Silt and Sand, with sand content increasing with

depth. The SPT "N" values both measured and interpreted from CPTUs ranged from 2 to more than 20. One pore pressure dissipation test in the sandy silt at 10.5 m depth in CPTUS1 indicated a  $C_h$  value of 1,310  $\text{m}^2/\text{y}$ .

A more detailed descriptions of the subsoil conditions encountered in the boreholes are presented on the borehole logs in Appendix B of Trow's report. Stratigraphic profiles inferred from the borehole information have been prepared by Trow and are summarized in Appendix A of Trow's report.

## 7.2 Groundwater

The groundwater level observed in the boreholes after completion of drilling carried out by Trow indicated that the groundwater table was within 1 m of the ground surface. The stabilized pore pressure measurements carried out at the bottom of the CPTUs in the Sandy Silt and Sand deposit indicated a piezometric head at or up to 0.3 m above ground surface, implying a small artesian head.

## 7.3 Summary

In summary, the CPTUs confirmed the stratigraphy shown in Trow's report although the soft sediments were detected as mostly clayey silt as opposed to silty clay. The undrained shear strength values were generally higher in the CPTUs.

Of significance importance to the consolidation analysis and wick drain design was the fact that the  $C_h$  values obtained from the CPTUs were significantly higher than those obtained from oedometer tests and that a slight artesian condition was encountered below the soft sediments.

# 8. **Engineering Analysis**

## 8.1 General

The engineering analysis was carried out in the following stages:

- Selection of cross sections for analysis that represent typical subsurface conditions and embankment configurations with respect to embankment height and width;
- Stability analysis to identify the required stabilizing berm dimensions, required construction staging and required gain in strength after each construction stage due to consolidation in the clayey layers, for a minimum factor of safety of 1.3 during construction;
- Settlement analysis to identify the required height of surcharge and the need for and the spacing of wick drains to accommodate the construction schedule.

Based on the analysis of the subsurface conditions and the geometry of the embankments the following testholes and embankment geometries were selected for analysis:

- *Bridge West Approach, West and East Abutments; Boundary Road: 9+800 to 10+070; E-S Ramp: 9+100 to 9+160:*  
Characteristics: High embankment closest to structure  
Subsurface Conditions: CPTUS1  
Embankment Height (excluding surcharge): typically 10.0m to 11.5m  
Embankment Width (at the top): 17.4 m  
Berm Elevation: 6 m below the top of the embankment
- *Region east of the East Abutment; Boundary Road: 10+070 to 10+150; EW-N Ramp: 8+313 to 8+420; S-EW Ramp: 8+760 to 8+890*  
Characteristics: High to intermediate embankment height, thick soft deposits  
Subsurface Conditions: CPTUS3  
Embankment Height (excluding surcharge): 5 m to 10 m  
Embankment Width (at the top): 17.4 m to ~ 40 m  
Berm Elevation: 6 m below the top of the embankment
- *Boundary Road: 10+150 to 10+310; EW-N Ramp: 8+420 to 8+500; S-EW Ramp: 8+670 to 8+760*  
Characteristics: Intermediate to low embankment height, thick soft deposits

Subsurface Conditions: CPTUS5

Embankment Height (excluding surcharge): 3 m to 5 m

Embankment Width (at the top): 17.4 m to ~ 40 m

Berm Elevation: No berm

- *EW-N Ramp: Sta. > 8+500; S-EW Ramp: Sta. < 670; Hwy 11 south of the Interchange:*

Characteristics: Low embankment, very thick soft deposits

Subsurface Conditions: BH31FP

Embankment Height (excluding surcharge): less than 3 m

Embankment Width (at the top): 14 m to ~ 60 m

Berm Elevation: no berm

- *Hwy 11 and Access Ramps north of the Interchange:*

Characteristics: Low to intermediate embankment height, thick soft deposits

Subsurface Conditions: BH23FP

Embankment Height (excluding surcharge): 3 m to 5 m

Embankment Width (at the top): ~ 60 m

Berm Elevation: no berm

Table B2, Appendix B, presents a summary of the soil properties used in the stability and settlement analysis for each of the testholes above. The soil properties presented in Table B2 were selected based on the interpretation of the field and laboratory data. In order to avoid an extensive parametric analysis the following criteria was used for the selection of soil properties:

- *Strength:*  
select most likely values in view of the slight conservatism inherent to the undrained analysis and the selected factor of safety during constructions (F.S. ~ 1.3)
- *Pore Pressure Generation:*  
select conservative values of  $B_{bar}$  equal to 1 for silt and clayey deposits.

- *Time Independent Deformation:*

Elastic Properties:

select most likely to conservative values since these parameters, with the exception of selection of the minimum required height of surcharge, have only a minor impact on the cost and performance of the embankment

Compression Ratio:  $\{Cc/(1+e_o)$  and  $Cs/(1+e_o)\}$  - same as above.

Pre-Consolidation Pressure ( $P_c$ ):

This parameter impacts both the time-independent and time-dependent settlements. The latter occurs because the coefficient of consolidation ( $C_v$  and  $C_h$ ) values are significantly impacted by the over-consolidation ratio.  $P_c$  values obtained from oedometer tests provided in Trow's report (Figures C9 to C11) indicate an Over-consolidation ratio ranging from 1.2 to 3.1 for  $P_c$  values ranging from 90 kPa to 110 kPa. Due to the importance of properly assessing the  $P_c$  values Two values of pre-consolidation pressures were selected:

- Most Likely Value:  $P_c = Su/0.235$  ( $S_u$  is the undrained shear strength)<sup>1</sup>
- Reduced Values: 50% of the Most Likely Value above and not lower than the anticipated in situ vertical effective stress

- *Time Dependent Deformation:*

Coefficient of Consolidation:

$C_h$ (horizontal):	Over-consolidated: select values interpreted from the CPTUs Normally Consolidated: select the minimum $C_h$ value interpreted from the CPTUs in that deposit;
$C_v$ (vertical):	20% of $C_h$ above (lower bound values <sup>2</sup> )

---

<sup>1</sup> Ladd, C.C. (1991). "Stability Evaluation During Staged Construction", ASCE Journal of Geotechnical Engineering, Vol.17, No.4, 1991

<sup>2</sup> Hansbo, S. (1979). "Consolidation of clay by band-shaped prefabricated drains". Ground Engineering, July, Vol.12, NO.5, 16-25, 1979

### Secondary Compression Ratio ( $C_{\alpha}$ ):

Select the values measured in the pre-consolidated range of oedometer tests assuming that the surcharge will be removed after 100% completion of primary consolidation.

## 8.2 Stability Analysis

The stability analysis was carried out based on the following assumptions:

- Embankment Geometry:
  - Side slopes: 1.25H:1V
  - The width of the embankment at the top of the surcharge will be the same as the final design width. Hence, the embankment side slopes above the berm will be temporarily steeper than 1.25H:1V. This is required to maintain the minimum required embankment width at the top after settlements due to primary consolidation take place.
  - When possible the berm height was maintained 6 m below the top of the final embankment height
- Surcharge: Up to 1.5 m above the embankment design height. Actual height of surcharge to be verified based on the settlement analysis
- Site Preparation: All organic soils will be removed within the footprint of the embankment
- Limit Equilibrium Analysis: Bishop Modified using G-Slope, developed by Mitre Software.
- Soil Shear Strength: Undrained shear strength ( $S_u$ ) for cohesive soils; Drained ( $\phi'$ ) for cohesionless soils.  $S_u$  increases with vertical stress; for vertical stress larger than the pre-consolidation pressure ( $P_c$ ):

use  $S_u = 0.235 \cdot \sigma'_v$ , for  $\sigma'_v > P_c$ .

- Groundwater Table: At the original ground surface

The results of the stability analysis are summarized in Table B3. The analysis of Table B3 indicates the following:

*Location: West Approach, West and East Abutments - CPTUS1*

- The construction of the embankment with a berm width of 2 m is not feasible with an end of construction FS of 1.3;
- The construction of the embankment to a height of 13 m, including surcharge, with a berm width of 7 m is feasible in two construction stages:
  - Stage 1: from 0 m to 10 m
  - Stage 2: from 10 m to 13 m with 50% dissipation of excess pore pressure (EPP) after Stage 1
- The embankment temporary headslopes at the abutment locations will be constructed according to the above schedule. The headslope crest will be located at the abutment location, with maximum height of 13 m, sloping towards Hwy 11 inclined at 1H:1V, provided that the Hwy 11 embankments under the bridge are constructed prior to the temporary abutment embankments.

*Location: East Approach to Bridge - CPTUS3*

- The construction of the embankment with a berm width of 2 m is not feasible with a FS of 1.3;
- The construction of the embankment, with a berm width of 6 m, to a height of 11.5 m, including 1.5 m surcharge, is feasible in three construction stages:
  - Stage 1: from 0 m to 8.5 m
  - Stage 2: from 8.5 m to 9.5 m with 40% dissipation of EPP after Stage 1
  - Stage 3: From 9.5 to 11.5 m with 100% dissipation of EPP after Stage 2

Due to the fact that it is not practical to wait for 100% consolidation between Stages 2 and 3, a berm width of 8 m was considered in the analysis, as follows:

- The construction of the embankment with a berm width of 8 m to a



maximum height of 11.5 m, including 1.5 m surcharge, will require the following construction stages maintaining a FS of 1.3 :

Design Height (m)	Target Height (m) (Incl. 1.5 m Surcharge)	Berm Height (m)	Height at Stage 1 (m)	EPP Dissipation after Stage 1	Additional Fill at Stage 2 (m)
10	11.5	4	9.5	75%	2
9	10.5	3	9	75%	1.5
8	9.5	2	8.5	75%	1
7	8.5	1	8	75%	0.5
6	7.5	0	7.5	-	-

*Location: EW-N Ramp and Boundary Road - CPTUS5*

- The construction of the embankment to a target height of 6 m, including 1 m of surcharge, is feasible in one stage without side berms.

### 8.3 Settlement Analysis

#### 8.3.1 General

The settlement analysis was carried out in the following steps:

- One dimensional primary consolidation analysis: no wick drains
- Pseudo three dimensional consolidation analysis: with wick drains
- One dimensional secondary consolidation analysis

#### 8.3.2 One Dimensional Consolidation - No Wick Drains

The one dimensional consolidation analysis was carried out in order to:

- establish the required height of surcharge;
- establish the need for wick drains;
- provide input for the vertical consolidation component in the wick

### drain design

The analysis was carried out using the finite difference software Consol Version 2.0, developed at Virginia Polytechnic Institute and State University. The program allows the one dimensional consolidation analysis of multilayered soil masses, taking into account non-linear constitutive law, variable parameters as a function of the over-consolidation ratio, impeded drainage and variable boundary conditions. The ability to model impeded drainage was considered a key factor in the selection of this software, due to the presence of layers of silt above and below and a harder, over-consolidated crust above the softer clayey silt deposit.

The vertical stress distribution under the embankment was estimated using Gray's<sup>3</sup> (1936) derivation for the area represented by CPTUS1 and Boussinesq's stress distribution under an infinite strip loaded area for the remaining areas. The latter method was the preferred method for this analysis since it is easier to use with Consol and both methods provide very similar vertical stresses under the centreline and at the crest of the embankment.

The following simplified embankment construction schedule was used in our analysis:

- Stage 1: the embankment load was applied instantly at time zero
- Stage 2: the additional load was applied instantly at the time after the EPP had dissipated enough for a minimum FS of 1.3 against global stability according to the stability analysis presented in the preceding section.

This is a simplified model of the actual construction process in which several days or weeks will be required to construct the embankment to the specified height. The adopted approach predicts larger settlements and lower EPP in the soft sediments at any point in time provided the time

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<sup>3</sup> Gray, H. (1936), "Stress Distribution in Elastic Solids", First International Conference, ISSFME

elapsed between the construction stages is adopted as the time elapsed between the end of the embankment construction at Stage 1 and beginning of Stage 2.

Figures A13 to A18B and Tables B4 to B13 present a summary of the results of the one dimensional consolidation analysis. The bottom portion of Tables B4 to B13 show the minimum amount of time after the end of the embankment construction when the surcharge may be removed for stabilization of settlements due primary consolidation. However, in order to minimize long term settlements due to secondary consolidation it is desirable to achieve stabilization of settlements due to primary consolidation for an embankment height 0.5 to 1.0 m higher than the final embankment height. Therefore the elapsed times shown in the bottom part of Tables B4 to B13 should be treated as the minimum and not necessarily the ideal elapsed times after the end of construction for removal of the surcharge and reshaping of the embankment.

The construction schedules that Thurber has been requested to analyse are:

Schedule 1:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including surcharge: 3 months
- Waiting period for primary consolidation: 12 months

Schedule 2:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including surcharge and stabilization of settlements: 12 months

Schedule 3:

- Site Preparation: 2 months (removal of organics, wick drain installation)
- Embankment construction to the final target height including

surcharge and stabilization of settlements: 6 months

Based on this schedule and on the analysis of Figures A13 to A18B and Tables B4 to B13, the following can be concluded:

- *General:* The pre-consolidation pressure has a significant impact on the magnitude and the time required for the dissipation of EPP
- *Location: West Approach West and East Abutments and East Approach (CPTUS1 and CPTUS3); high embankments; Figures A13 to A15*
  - The maximum settlement is approximately 0.5 m to 1.0 m for the most likely (M.L.) and reduced  $P_c$  values, respectively. Hence, the 1.5 m surcharge is suitable for compensation of settlements and also allows for some surplus surcharge which is desirable in order to minimize long term settlements due to secondary consolidation. At these locations, a time delay of 60 to 180 days will be required prior to Stage 2, for dissipation of EPP generated during Stage 1. Also, settlements due to primary consolidation are not anticipated to stabilize before 360 days after the end of the embankment construction. Based on this analysis wick drains will be required to accommodate Construction Schedules 1 and 3. For Most Likely (M.L.)  $P_c$  values, Schedule 2 is feasible without wick drains. For Reduced  $P_c$  values, wick drains are required for Schedule 2.
- *Location: EW-N Ramp and Boundary Road (CPTUS5), embankments 3 m to 5 m high (excluding surcharge), Figure A16 and Tables B4 to B7*
  - For a 6 m high embankment, which includes a surcharge of 1m, more than 720 days are required for the stabilization of settlements due to primary consolidation for M.L. and Reduced  $P_c$  values. Therefore wick drains will be required to accommodate the proposed construction schedules.

- For embankment heights lower than 6 m and variable embankment width, a settlement analysis was carried out in order to assess the required height of surcharge to accommodate the proposed construction schedule without wick drains. Tables B4 to B7 summarize the results of this analysis. The analysis of these tables indicate that for most likely  $P_c$  and for embankment heights up to 3.7 m, a 1.3 m surcharge is required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction without wick drains. For reduced  $P_c$ , very large surcharges and extended periods of time are required for the stabilization of settlements due to primary consolidation within 12 months of the end of construction. The analysis of Tables B4 and B5 also indicate that the anticipated immediate elastic settlements are small and in the order to 20mm to 75 mm for the range of embankment heights analysed.
- *Location: EW-N Ramp, S-EW Ramp and Hwy 11 south of the Interchange (BH31FP); embankment less than 3 m high; Tables B8 to B11*
  - Tables B8 to B11 show that for embankment heights up to 3.0 m (excluding surcharge) and M.L.  $P_c$  values no wick drains will be required for all proposed construction schedules. However, a minimum of 1.2 m surcharge will be required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction. For Reduced  $P_c$ , very large surcharges and/or extended periods of time are required for the stabilization of settlements due to primary consolidation. Therefore, for Reduced  $P_c$ , wick drains are required to comply with the requirements of all proposed construction schedules.
- *Hwy 11 north of the Interchange and EW-S Ramp (BH23FP); Figure A18 and Tables B12 and B13:*

- Figure A18 and Tables B12 and B13 show that, for embankment heights up to 3.0 m (excluding surcharge) and M.L.  $P_c$  values, no wick drains are required for the construction schedules considered herein. However, a minimum of 1.2 m surcharge will be required for the stabilization of settlements due to primary consolidation within 12 months after the end of the embankment construction. For reduced  $P_c$  values, very large surcharges and/or extended periods of time are required for the stabilization of settlements due to primary consolidation. In this case, wick drains would be required to comply with Construction Schedules 1, 2 and 3.

### 8.3.3 Settlements due to Primary Consolidation - With Wick Drains

The one-dimensional consolidation analysis above identified the following areas where wick drains will be required to accelerate dissipation of EPP (for M.L.  $P_c$  values):

- West and East Abutments (CPTUS1)
- East Approach (CPTUS3), high embankments
- EW-N Ramp (CPTUS5), embankments higher than 4 m

The presence of slight artesian pressures in the sandy deposits underlying the Clayey Silt deposit poses a potential for loss of fines due to the continuous flow of water around the wick drains. In order to minimize this potential, the wick drains should be terminated within the Lower Silt, within 1 to 1.5 m above the underlying layer of Sandy Silt and Sand. The one-dimensional consolidation analysis indicated that the pore pressures within the Lower Silt dissipate quickly due to the relatively high coefficient of consolidation values and due to the proximity of the underlying Sandy Silt and Sand that provides a free draining boundary .

The wick drain spacing was selected based on the percentage consolidation required within the clayey silt layer, determined from the stability analysis, for the construction schedule presented in the preceding

section.

Two methods were used for the wick drain design:

- Hansbo (1979, opt.cit.)
- Robertson, Campanella and Brown<sup>4</sup> (1988)

The former method includes well resistance and disturbance factors due to the wick drain installation. The latter method uses the original derivation by Hansbo<sup>5</sup> (1960) adjusted for wick drain design based on Ch values interpreted from the CPTU. EPP dissipation due to vertical drainage was coupled with EPP due to horizontal drainage into the wick drains according to the following equation:

$$U = 1 - (1 - U_v)(1 - U_h)$$

where U is the combined total percentage consolidation and U<sub>v</sub> and U<sub>h</sub> are the percentage consolidation values due to vertical and horizontal drainage only, respectively, divided by 100.

The design parameters and required percentage consolidation at specific times used in the analysis are summarized in Table B14. It has been assumed that the wick drains will be installed in a triangular pattern. Because the wick drains will be terminated within the layer of lower silt, the wick drain drainage length has been assumed equal to the entire length of the wick drain.

The results of the wick drain analysis are presented in Tables B15 to B30. A summary of the embankment configurations and required wick drain spacing is presented below. The wick drain spacing has been selected as the smallest of the two spacings provided by the methods described above.

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<sup>4</sup> Robertson, P.K., Campanella, R.G., and Brown, P.T. (1988). "Prediction of wick drain performance using piezometer cone data". Canadian Geotechnical Journal 25, 56-61 (1988)

<sup>5</sup> Hansbo, S. (1960). "Consolidation of clay, with special reference to influence of vertical sand drains. Swedish Geotechnical Institute, Proceedings No.18 (1960)

- West Approach, West and East Abutments and East Approach (CPTUS1 and CPTUS2), high embankments (Tables B15 to B18)

Embankment Height: 11.5m+1.5m surcharge (West Abutment)  
10.2m+1.5m surcharge (East Abutment)

Berm Width: 7 m

Berm Height: 6 m below design height

Wick Drain Spacing: 3.5 m

Construction Sequence: Stage 1 to 10m; wait for 50% dissipation of EPP:  $EPP < 100$  kPa (~1 month); Stage 2 to 11.7m or 13m; wait for 100% consolidation (~3 months); trim surcharge.

- East Approach (CPTUS3), (Tables B19 to B26)

*Alternative 1 - 6 m wide berm*

Embankment Height: 6 m to 10 m + 1.5 m surcharge

Berm Width: 6 m

Berm Height: 6 m below design height

Wick Drain Spacing: 2.2 m

Construction Sequence: Stage 1 to 8.5m; wait for EPP to dissipate to 40%:  $EPP < 68$  kPa (~2 weeks); Stage 2 to 9.5m; wait for 100% dissipation of EPP (~2 months); Stage 3 to 11.5 m; wait for 100% consolidation (~2 months); trim surcharge.

Since it is not practical to wait for 100 % dissipation of EPP during the embankment construction, the following berm width was analysed:

*Alternative 2 - 8 m wide berm*

Embankment Height: 6 m to 10 m + 1.5 m surcharge

Berm Width: 8 m

Berm Height: 6 m below design height

Wick Drain Spacing: 3.5 m

Construction Sequence: Stage 1 to 9.5m; wait for 75% dissipation of EPP:  $EPP < 48$  kPa (~1 month); Stage 2 to 11.5 m; wait for 100% consolidation (~5 months); trim surcharge.



- EW-N Ramp and Boundary Road (CPTUS5), embankments higher than 4 m (Tables B27 to B30)  
 Embankment Height: 4m to 6m + 1.5 m surcharge  
 Berm Width: N/A  
 Berm Height: N/A  
 Wick Drain Spacing: 3.5 m  
 Construction Sequence: Stage 1 to 6m; wait for 100% consolidation (~11 months); trim surcharge.

#### 8.3.4 Settlements due to Secondary Consolidation

Settlements due to secondary consolidation have been assessed based on the following equation:

$$\Delta T_{cs} = C\alpha\epsilon \cdot T \cdot \text{Log } t_{sc}/t_p,$$

where:

$\Delta T_{cs}$  = settlement due to secondary consolidation

$C\alpha\epsilon$  = secondary compression ratio

$T$  = initial thickness of compressible layer

$t_{sc}$  = time over which secondary consolidation is to be calculated

$t_p$  = time to complete primary consolidation

As indicated in Table B2, a value of 0.002 has been selected for  $C\alpha\epsilon$ . This value reflects the fact that upon completion of primary consolidation, a minimum of 0.5 m to 1.0 m will be removed from the embankment top and the compressible soils will be slightly over-consolidated.

The following are the settlements due to secondary consolidation anticipated at the interchange embankments:

### Secondary Consolidation Analysis

Location	T (m)	$t_{sc}$ (years)	$t_p$ (years)	$\Delta T_{cs}$ (mm)
West and East Abutments (CPTUS1)	7	35	1	25
East Approach (CPTUS3)	6	35	1	20
EW-N Ramp and Boundary Rd. (CPTUS5), embankments higher than 3 m	11	35	1	35
EW-N Ramp (BH31FP), embankments lower than 3 m	14	35	1	45

The above settlements indicate that the design requirement of maximum long term settlement of 25 mm, after removal of the surcharge, is met only at the two abutments and east approach embankment. At the lower embankments away from the abutments, in the south and east portion of the interchange, where thicker soft deposits are present, the maximum additional long term settlement is anticipated to be up to 45 mm. In view of the extended period of time considered in the calculations (35 years) and the fact that the embankments where the design specifications, for on going secondary settlements, are exceeded are not in the proximity of the bridge, these anticipated long term settlements may be acceptable to MTO. This should be discussed with MTO.

#### 8.4 Lateral Displacement at Depth at the East Abutment

Provided that the abutment piles are installed after most of the settlements due to primary consolidation have taken place, relatively small time dependent lateral displacements are anticipated to occur along the piles. For monitoring purposes and verification of the structural capacity of the abutment piles, the maximum outstanding pile lateral deflection should be equal to 20% (Ladd, opt.cit.) of the maximum outstanding settlement of the embankment at the centre of the clayey silt layer, at EL. 308. The lateral deflections can be assumed decreasing to zero above and below the point of maximum deflection, at ground surface and at El. 297 (point below which the Sand and Sand with Gravel layer, in BH-6FP, becomes dense), respectively.

## **9. Embankment Design Recommendations**

### **9.1 Embankment Geometry and Construction Schedule**

Based on the analysis presented in the preceding sections, the embankment design, wick drain location and spacing and construction sequence summarized in Table B31 is proposed. For simplicity of construction, we have provided uniform berm width and excess pore pressure dissipation requirements for the embankments.

### **9.2 Site Preparation**

All organic soils should be removed within the footprint of the embankments, including side berms. Due to the relatively high groundwater table at this site, a NSSP should be included in the contract documents warning the contractor that the removal of organic soils will probably be carried out below water at most locations. Where unwatering of excavation is required, it shall comply with the requirements of OPSS 517

Following the removal of organic soils, at locations where wick drains will be installed, free draining material, complying with the NSSP included in Appendix D, should be placed to an elevation at least 0.5 m above the groundwater table with minimum thickness of 0.5 m.

### **9.3 Wick Drain Specifications**

In order to satisfy the design requirements for discharge capacity, soil retention, permeability and clogging criteria, and installation, the wick drains should be supplied and installed according to the NSSP included in Appendix D.

## 9.4 Monitoring Program

### 9.4.1 Types of Instruments

The performance of the embankment will be monitored using the following instruments:

- **Slope Indicator (SI):** to monitor horizontal displacements at depth at the abutment locations. Due to the potential for large settlements at the abutment locations telescopic casings should be used and selected to accommodate settlements of up to 1 m;
- **Vibrating Wire Settlement Cells with Pressurized Reservoir (SC):** for the remote monitoring of settlements of the embankment base at the abutment locations;
- **Settlement Rods (SR):** anchored on a steel plate at ground surface, at the base of the embankment, extended to the top of the embankment for monitoring of settlements of the embankment base with conventional survey methods. The rods should be protected by a PVC or ABS pipe of larger diameter, to minimize the development of friction along the rods, and by a 400 mm CMP, for protection against damage during the embankment construction. The rods and protection pipes should be erected in 3 m increments as the embankment increases in height.
- **Settlement Pins (SP):** standard steel pins anchored in a concrete block cast on top of the embankment surcharge.
- **Vibrating Wire Piezometers (VWP):** installed in the compressible clayey silt and silty clay deposits and underlying sand deposit. The VWPs should be installed as close as possible to the centre of the triangle defined by the nearby three wick drains.
- **Shallow Standpipe (SSP):** installed near each of the monitoring sections to monitor the near surface groundwater table
- **Read-out Unit:** depending on the economics of the monitoring program, the vibrating wire instruments may be read automatically at specified time increments by an automatic acquisition system

### 9.4.2 Monitoring Sections

The instruments will be installed in the following three typical monitoring sections:

#### ***Monitoring Section Type A***

- Location: at the Abutment locations, 3 m behind the line of piles
- One SI: at the embankment centreline
- Two SC: at the centreline of the E/B and W/B lanes
- Two SR: at the centreline of the E/B and W/B lanes (1.0 m from the SC)
- Four SP: Two at the top of the surcharge: at the centreline of the E/B and W/B lanes (1.0 m from the SR);  
Two: one on each side berm, near the side slope of the main embankment.
- Two strings of VWP: at the centreline of the E/B and W/B lanes.  
One string will include three VWP installed at the following elevations: In the Middle of, 1.5 m above the bottom of and 1.5 m below the top of the clayey silt layer.  
The other string of VWPs should include the VWPs above plus one VWP installed in the Sand and Gravel layer, at EL. 301.
- One Standpipe: Installed to 3 m depth and slotted in the bottom 1 m

#### ***Monitoring Section Type B***

- Location 50 m behind the Abutment locations
- Two SR: at the centreline of the E/B and W/B lanes
- Four SP: Two at the top of the surcharge: at the centreline of the E/B and W/B lanes (1.0 m from the SR);  
Two: one on each side berm, near the side slope of the main embankment
- Two strings of VWP: at the centreline of the E/B and W/B lanes.  
Each string will include three VWP installed at the following elevations: In the Middle of, 1.5 m above the bottom of and 1.5 m below the top of the clayey silt layer.

One Standpipe: Installed to 3 m depth and slotted in the bottom 1 m

***Monitoring Section Type C:***

Locations: Boundary Road - Sta. 10+160  
W-N Ramp - Sta. 8+360  
EW-N, E-N, SW and S-E Ramps-Sta. 8+420 at EW-N  
EW-N and SE-W Ramps - Sta. 8+480 at EW-N  
EW-N and SE-W Ramps - Sta. 8+540 at EW-N  
EW-N Ramp - Sta. 8+540  
Hwy 11 - Sta. 8+620  
Hwy 11 - Sta. 8+670  
Hwy 11 - Sta. 8+733 (Bridge)  
Hwy 11 - Sta. 8+780  
Hwy 11 - Sta. 8+830

One SR: at the embankment centreline

Two SPs: each at 3 m from the embankment crest

**9.4.3 Installation of Instruments**

With the exception of the Settlement Pins, all instruments should be installed after the site preparation, construction of the drainage blanket and installation of wick drains. It would be preferable to have the instruments installed before the wick drains but the potential for damaging the instruments during installation of the wick drains is too high.

The Settlement Pins should be installed immediately after the embankment target height (top of surcharge) is reached.

**9.4.4 Frequency of Readings**

All instruments should be initialized and read at least three times in three different days before placement of any rock fill.

During construction the instruments should be read at least once immediately before the placement of 1 m high fill lifts and at least once a week between construction 1 m lifts and between Stage 1 and Stage 2.

Upon completion of Stage 2 the instruments should be read:

- weekly for the period of 2 months
- monthly thereafter until the removal of the surcharge
- weekly for the period of 1 months after the removal of surcharge
- monthly for a period of one year following the removal of surcharge
- once every three months following the paving of the roads for a period of three years

#### 9.4.5 Monitoring Levels

There are basically three parameters that should be monitored closely during and after construction:

- Excess Pore Pressures (EPP)
- Embankment Base Settlement
- Lateral Displacements at Depth

The EPP requirements for stability purposes during construction are shown in Table B31. The EPP shown have priority over the estimated times shown in Table B31.

The monitoring of settlements after the end of construction of the embankment to top of surcharge, allows the assessment of long term settlements due to primary consolidation and when the surcharge can be removed for the pavement construction. It is recommended that the Rectangular Hyperbola Method<sup>6</sup> be used for reduction of and prediction of long term settlements due to primary consolidation.

Lateral deflections at the abutment pile locations should also be monitored in order to confirm that the lateral displacements due to primary consolidation have mostly stabilized prior to installation of piles.

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Sridharan, A., Murthy, N.S. and Prakash, K (1987). "Rectangular hyperbola method of consolidation analysis". Geotechnique 37, No. 3, 355-368 and, Tan, S.A., (1993). "Ultimate Settlement by Hyperbolic Plot for Clays with Vertical Drains". ASCE Journal of Geotechnical Engineering, Vol. 119, No.5, May, 1993, 950-956

### 9.5 Trial Embankment

Although the CPTUs provided a significant increase in confidence about the material properties and expected performance of the embankment, some issues regarding the pre-consolidation pressures and time required for stabilization of settlements in areas where wick drains are not required remain unanswered.

In order to confirm the design assumptions and possibly further optimize the wick drain design, it is recommended that portion of the proposed embankment be constructed in an advance contract.

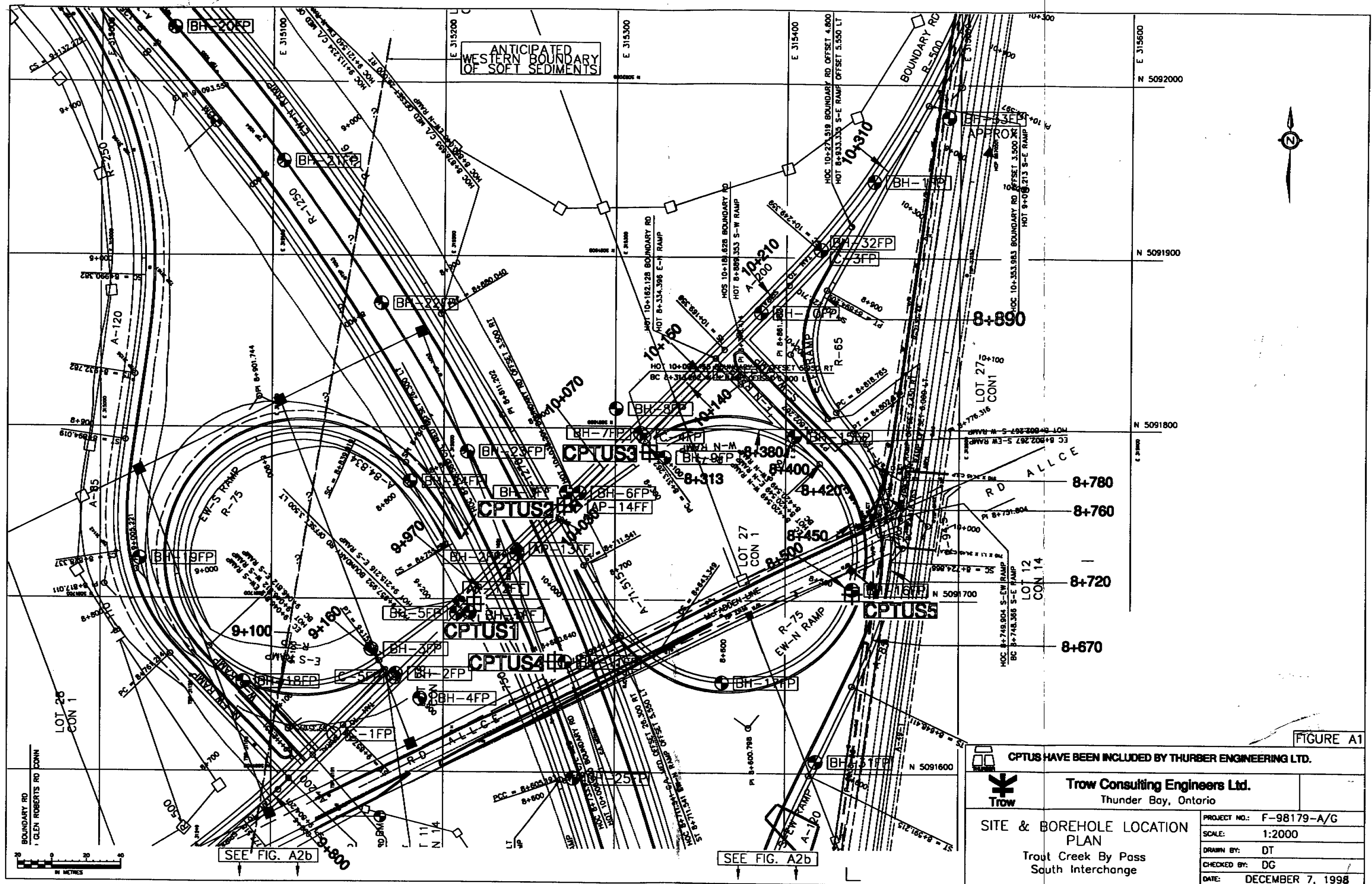
In our opinion, the trial embankment is a prudent investment that should minimize the potential for construction schedule delays.



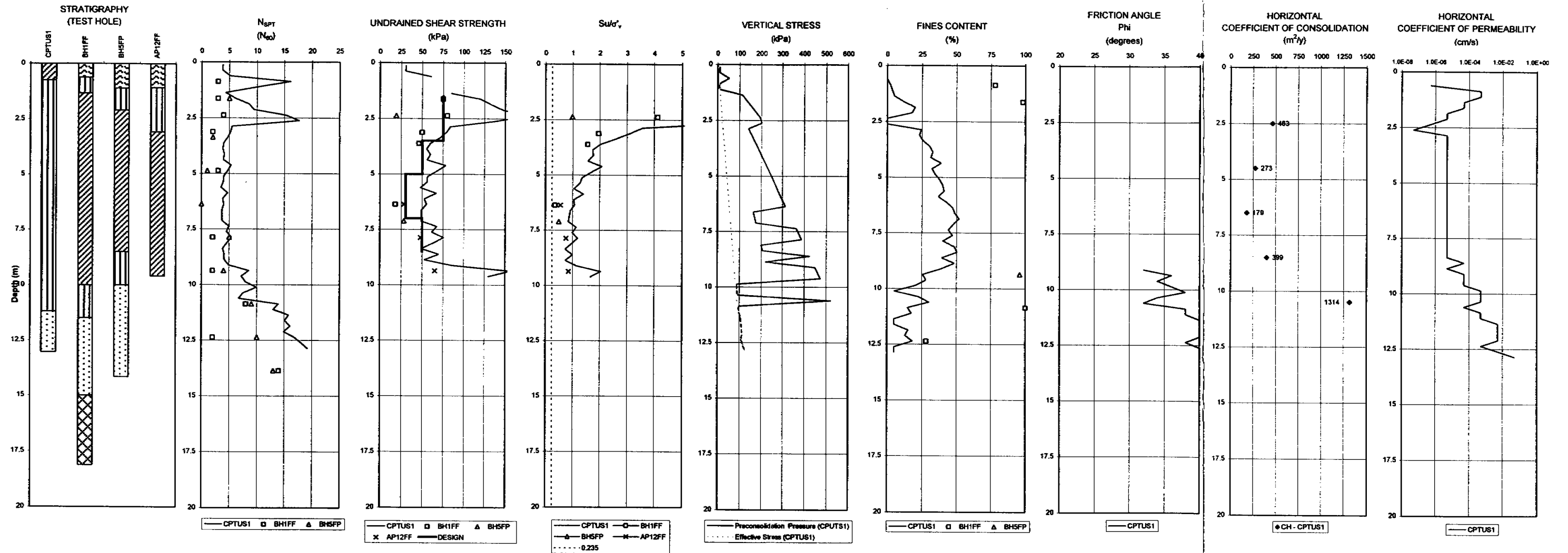


**APPENDIX A**

**FIGURES**



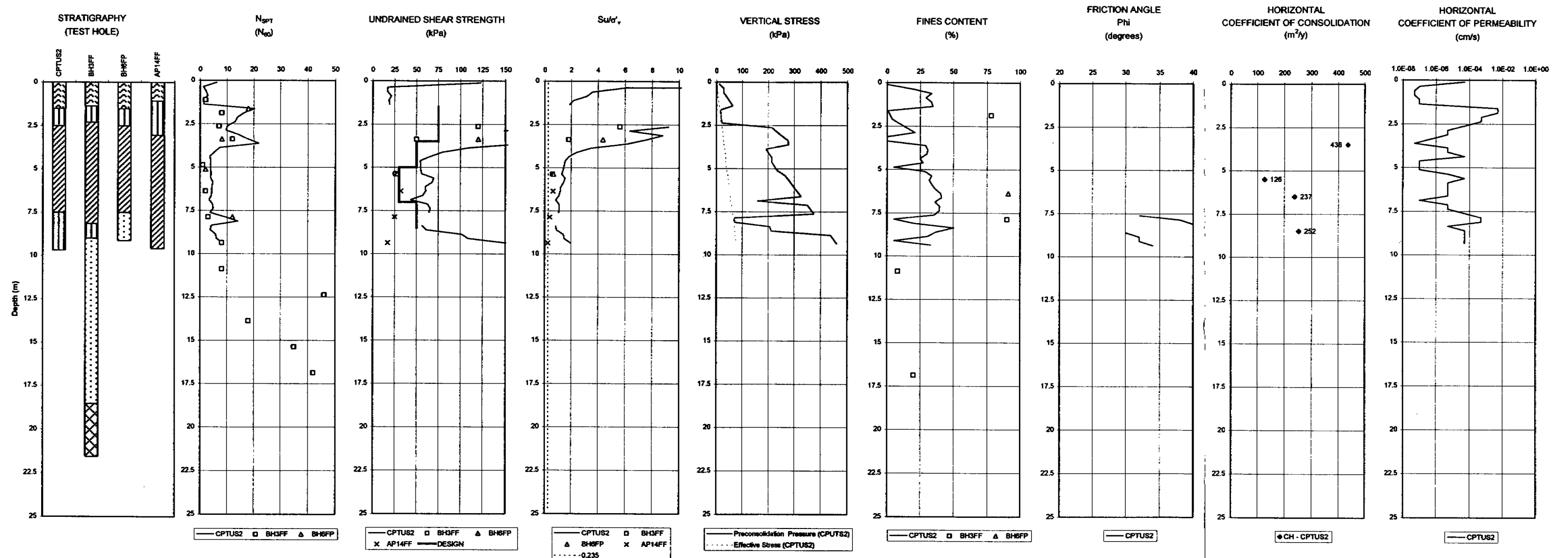
HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
 SUMMARY OF SUBSURFACE CONDITIONS  
 BOUNDARY ROAD - WEST ABUTMENT - APPROXIMATE STATION 9+760



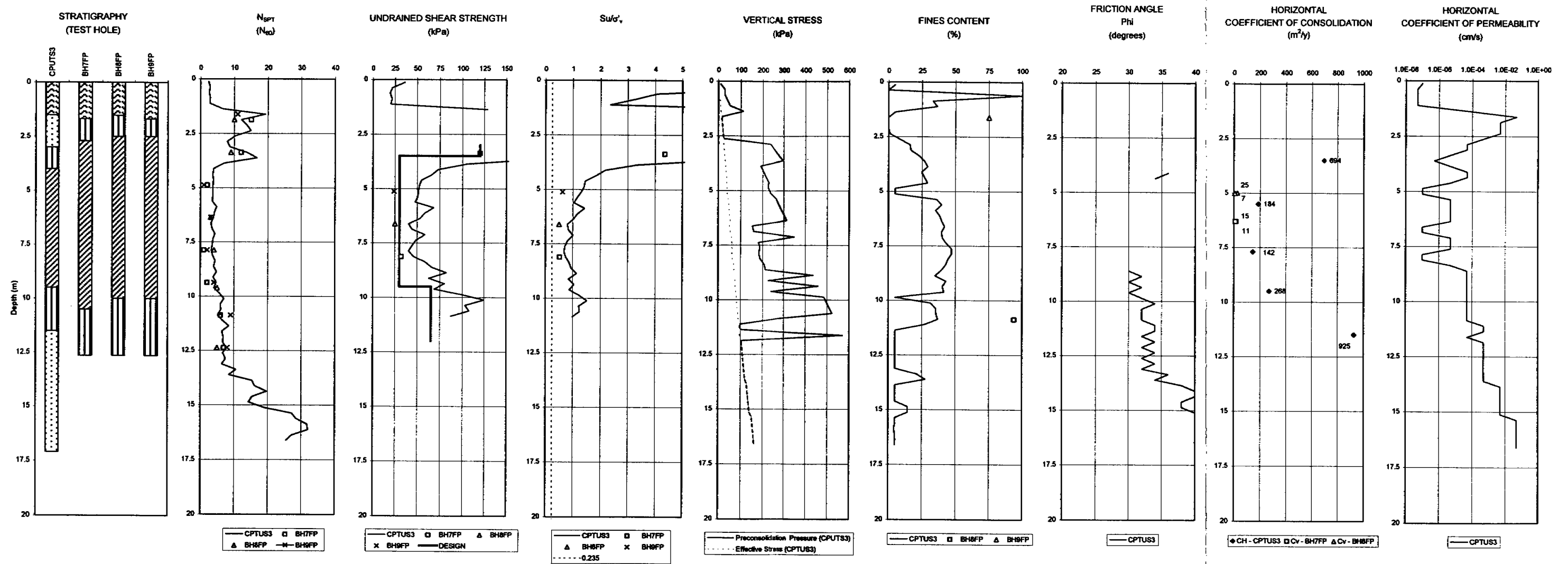
MASTER PLOT

FIGURE A2

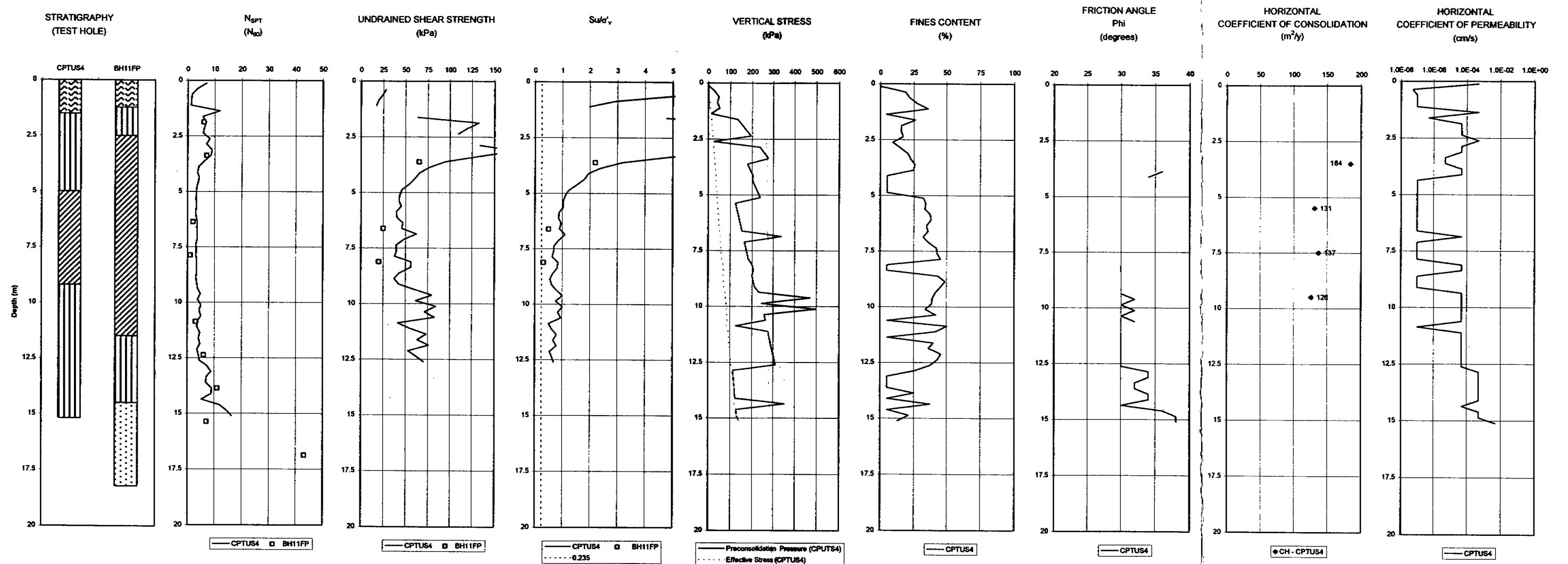
**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
BOUNDARY ROAD - EAST ABUTMENT - APPROXIMATE STATION 10+041**



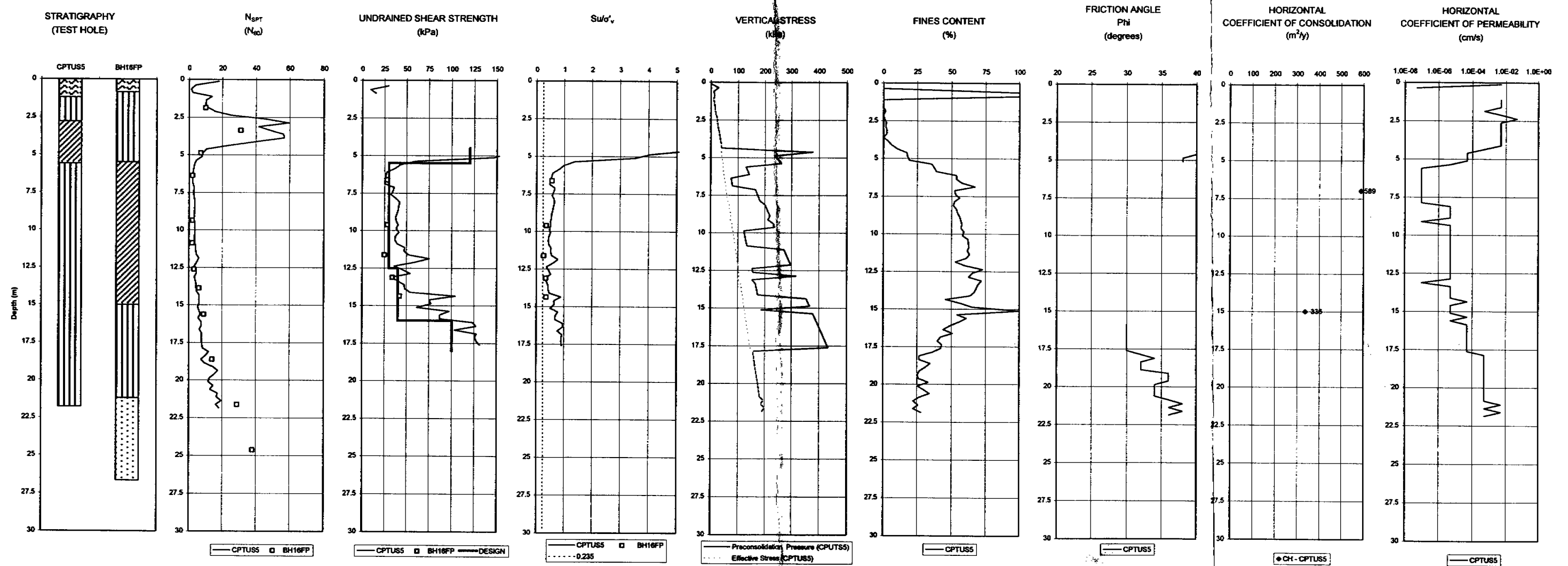
**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
RAMP FROM BOUNDARY ROAD EAST TO HWY 11 NORTH - APPROXIMATE STATION 8+310**



**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE**  
**SUMMARY OF SUBSURFACE CONDITIONS**  
**HIGHWAY 11 - CENTRELINE - APPROXIMATE STATION 8+665**



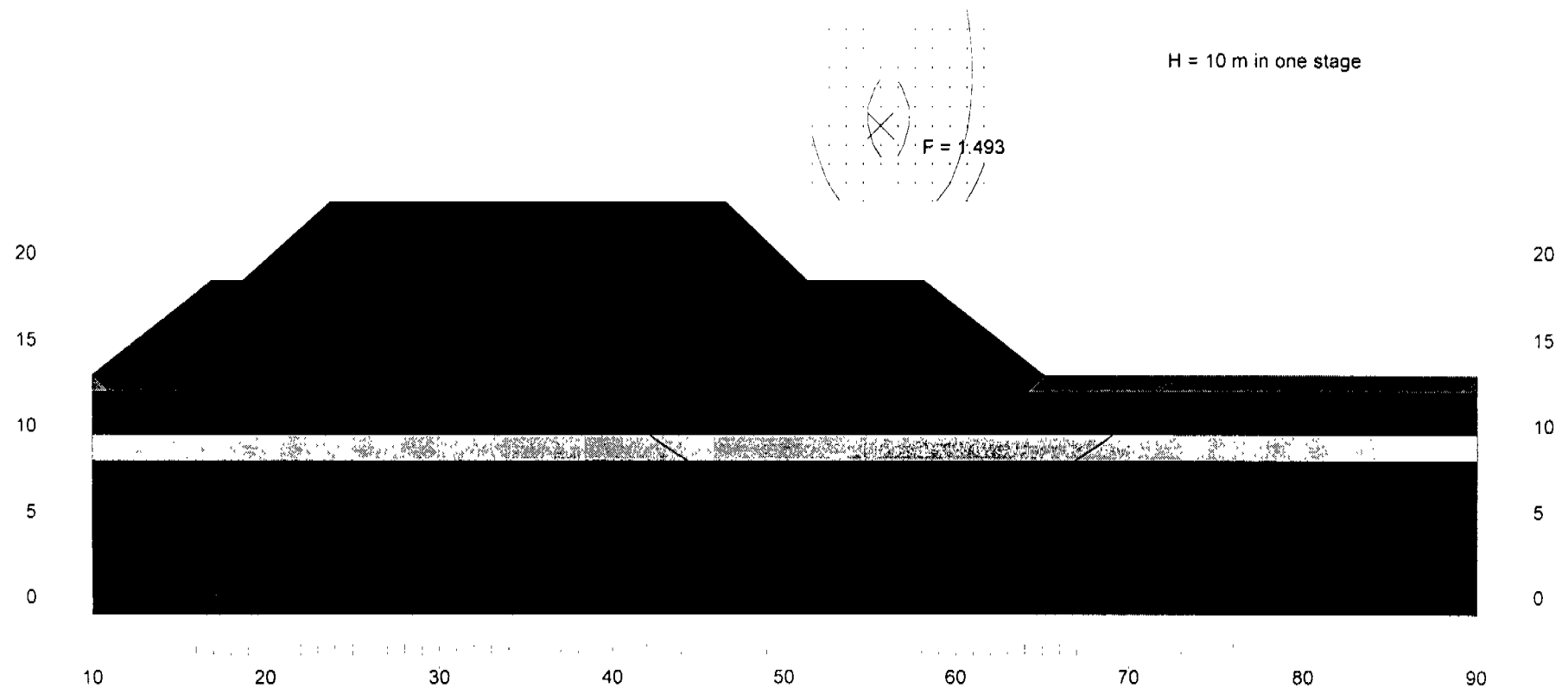
**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
SUMMARY OF SUBSURFACE CONDITIONS  
HIGHWAY 11 AND MCFADDEN LANE - APPROXIMATE STATION 8+500**





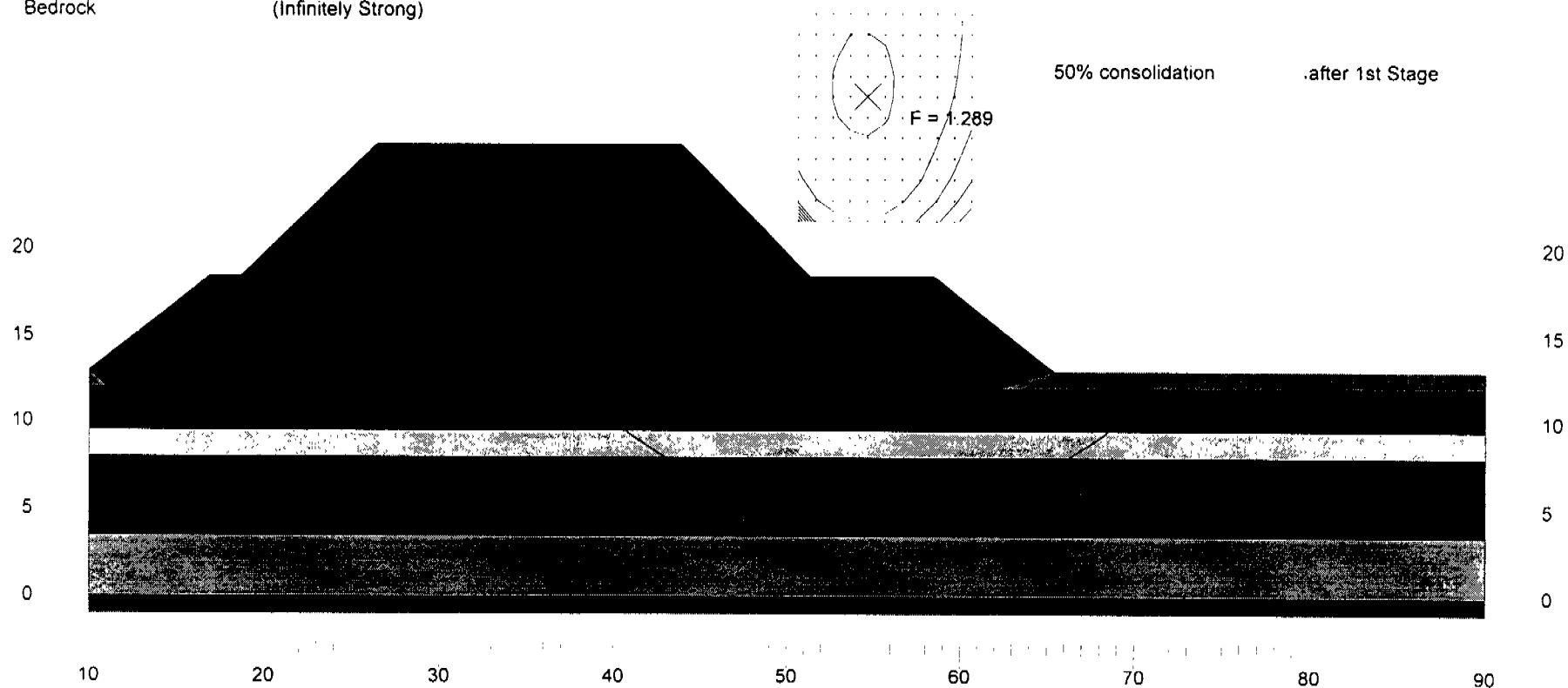
	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	50	0	1	0
Clayey Silt C	17.5	30	0	1	0
Clayey Silt D	18	50	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto  
19-1104-4  
Hwy 11 - Trout Creek By-Pass  
April 2, 1999  
South Interchange/West Abut  
Third Trial - First Stage for F.S=1.3



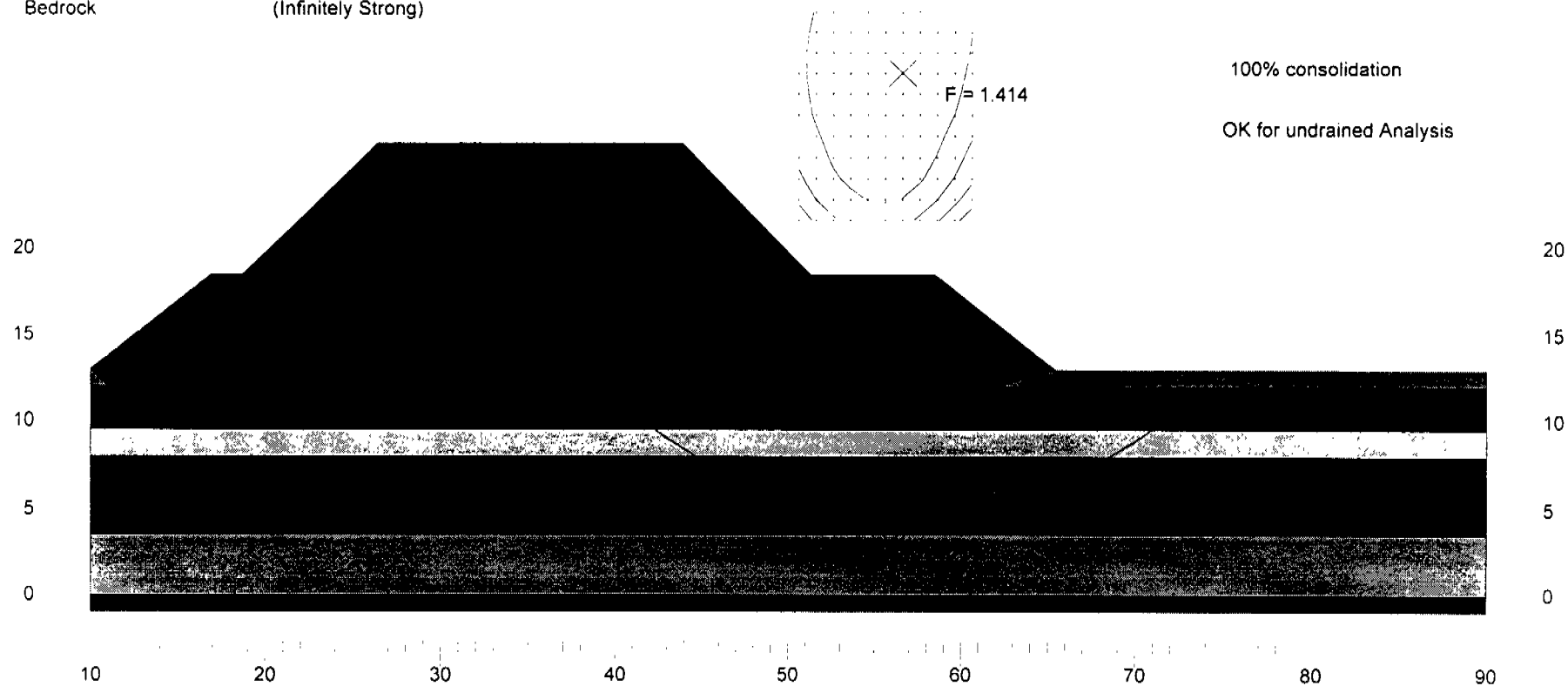
Thurber Engineering Ltd. - Toronto  
 19-1104-4  
 Hwy 11 - Trout Creek By-Pass  
 April 2, 1999  
 South Interchange/West Abut  
 First Trial - Second Stage for F.S=1.3

	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	50	0	1	0
Clayey Silt C1	17.5	30	0	1	0
Clayey Silt C2	17.5	37	0	1	0
Clayey Silt C3	17.5	44	0	1	0
Clayey Silt D1	18	50	0	1	0
Clayey Silt D2	18	52	0	1	0
Clayey Silt D3	18	55	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				



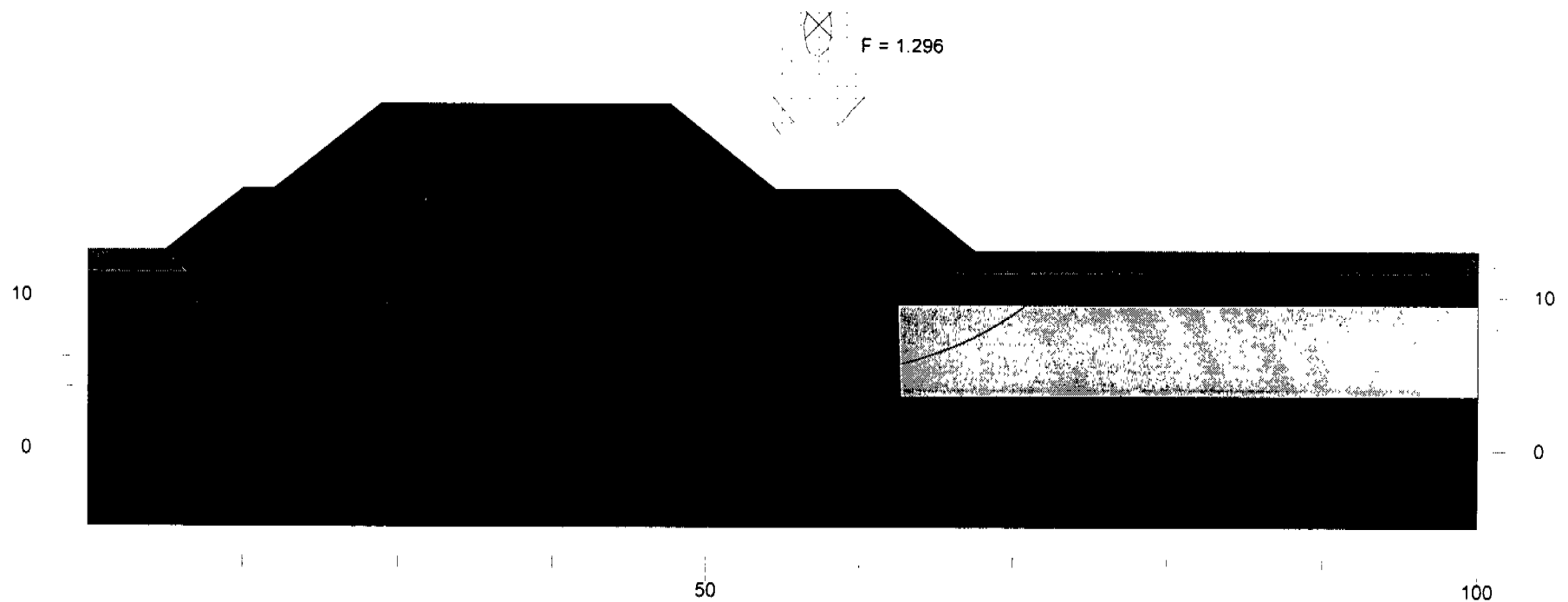
	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Silt	18	0	28	1	0
Clayey Silt A	18	75	0	1	0
Clayey Silt B	18	52	0	1	0
Clayey Silt C1	17.5	30	0	1	0
Clayey Silt C2	17.5	50	0	1	0
Clayey Silt C3	17.5	71	0	1	0
Clayey Silt D1	18	50	0	1	0
Clayey Silt D2	18	62	0	1	0
Clayey Silt D3	18	74	0	1	0
Lower Silt	18	0	30	1	0
Silty Sand	19	0	32	1	0
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto  
19-1104-4  
Hwy 11 - Trout Creek By-Pass  
April 2, 1999  
South Interchange/West Abut  
Long Term Stability



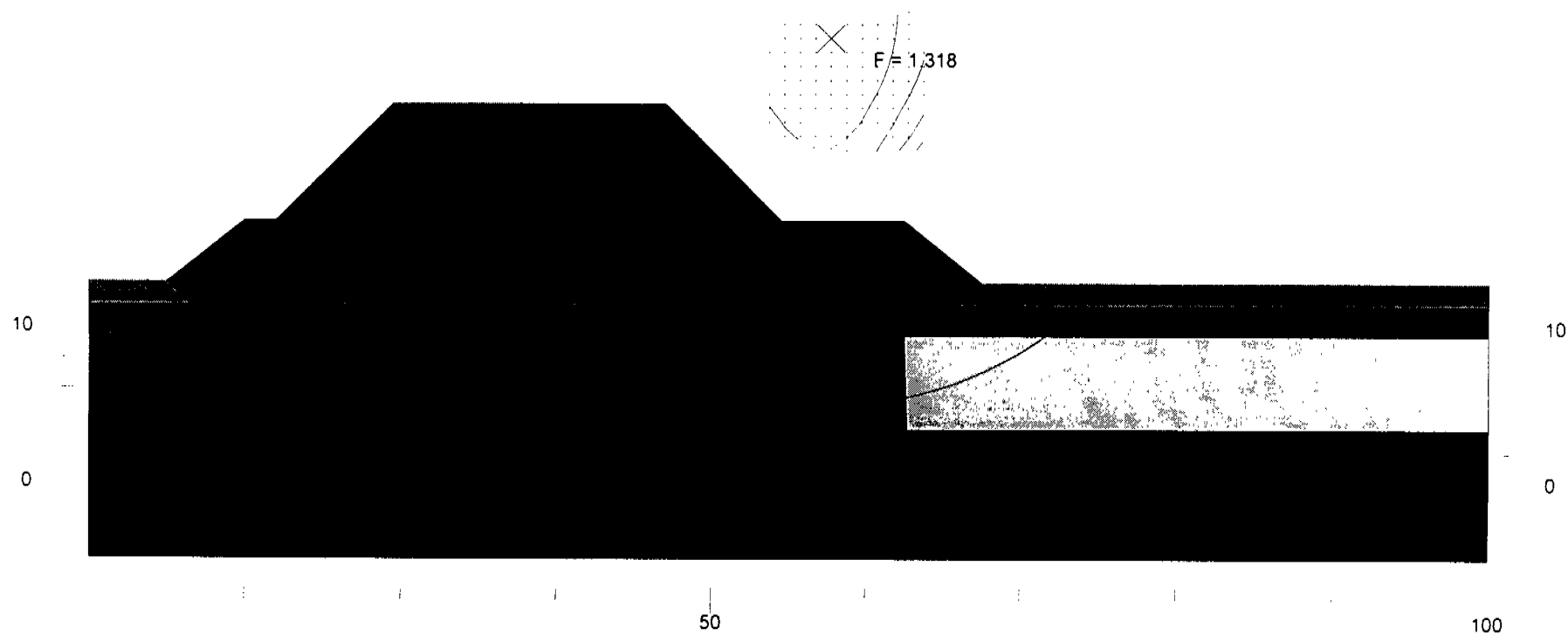
	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Sand	19	0	30	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	18	30	0	1	0
Clayey Silt B	18	30	0	1	0
Clayey Silt C	18	30	0	1	0
Lower Silt	18	65	0	1	0
Sandy Silt	18.5	0	30	1	0
Sand	19	0	33	1	0
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto  
 19-1104-4  
 Hwy 11 - Trout Creek By-Pass  
 April 5, 1999  
 South Interchange/CPTUS3/8+310  
 8m berm-0% Consolidation 1st Stage; H=9.5 m



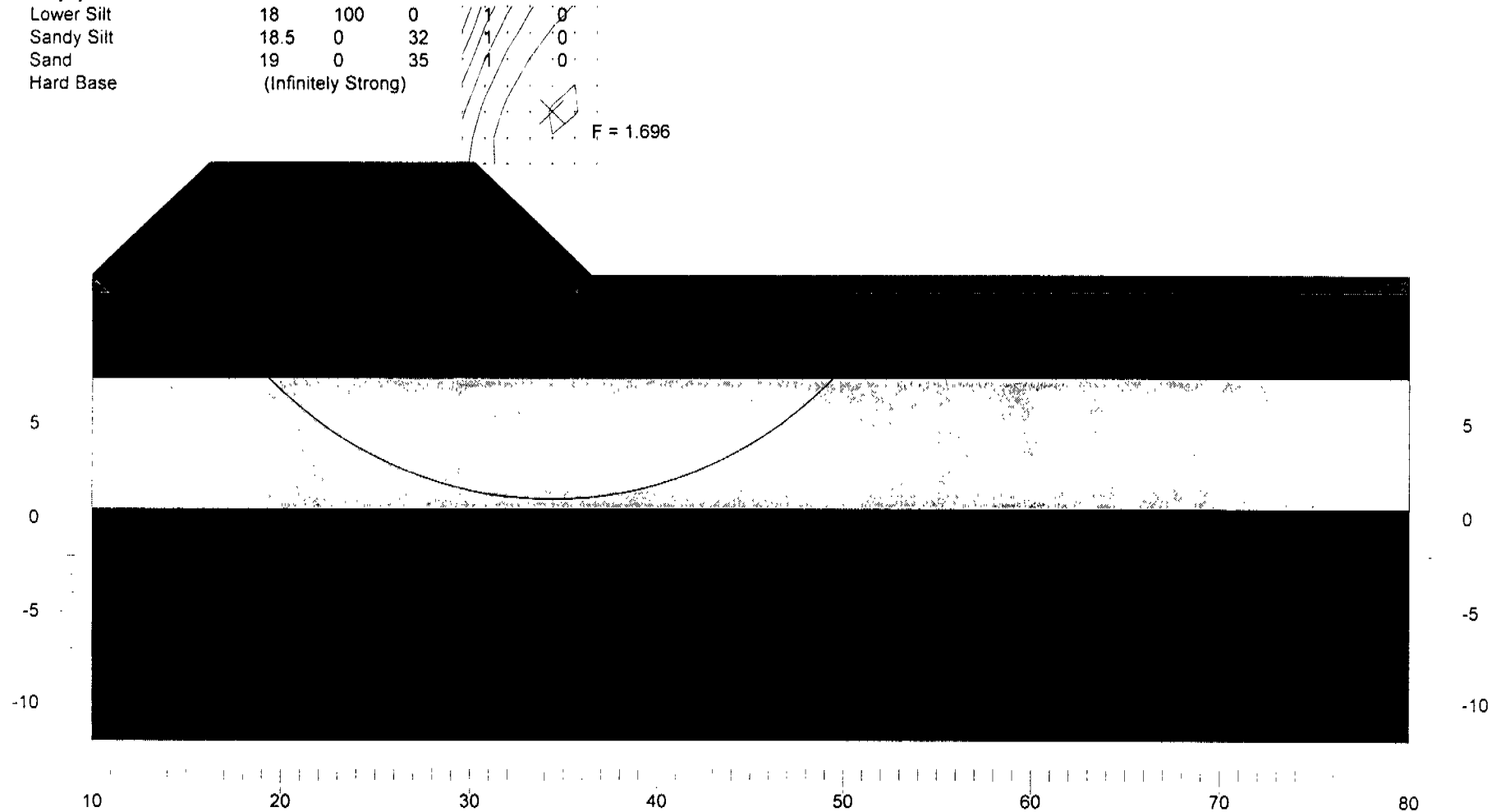
	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Upper Sand	19	0	30	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	18	30	0	1	0
Clayey Silt B	18	40	0	1	0
Clayey Silt C	18	50	0	1	0
Lower Silt	18	65	0	1	0
Sandy Silt	18.5	0	30	1	0
Sand	19	0	33	1	0
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto  
 19-1104-4  
 Hwy 11 - Trout Creek By-Pass  
 April 5, 1999  
 South Interchange/CPTUS3/8+310  
 8m berm-75% Consolidation after 2nd Stage(H=9.5 m);H=11.5 m

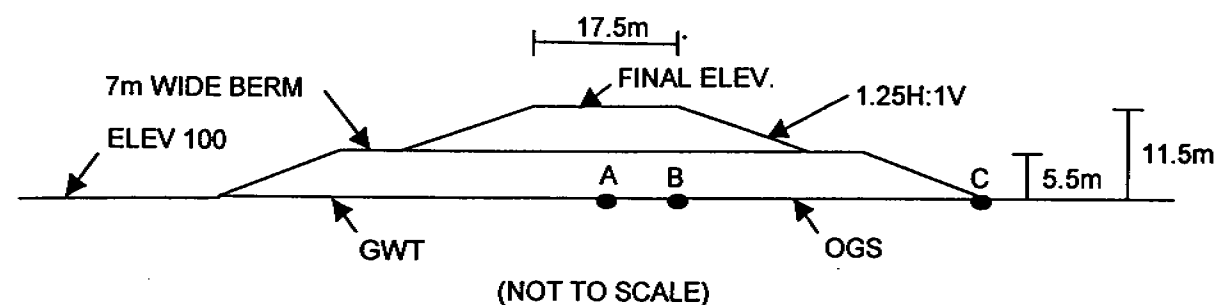


	Gamma kN/m <sup>3</sup>	C kPa	Phi deg	Piezo Surf.	Ru
Rock Fill	20	0	42	1	0
Peat	16	10	0	1	0
Sand	19	0	33	1	0
Upper Silt	18	120	0	1	0
Clayey Silt A	17.5	30	0	1	0
Clayey Silt B	18	40	0	1	0
Lower Silt	18	100	0	1	0
Sandy Silt	18.5	0	32	1	0
Sand	19	0	35	1	0
Hard Base	(Infinitely Strong)				

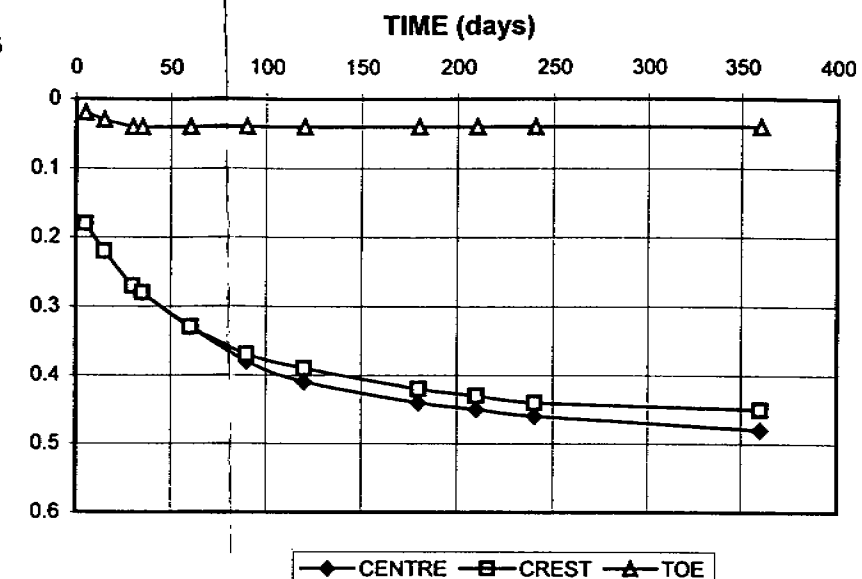
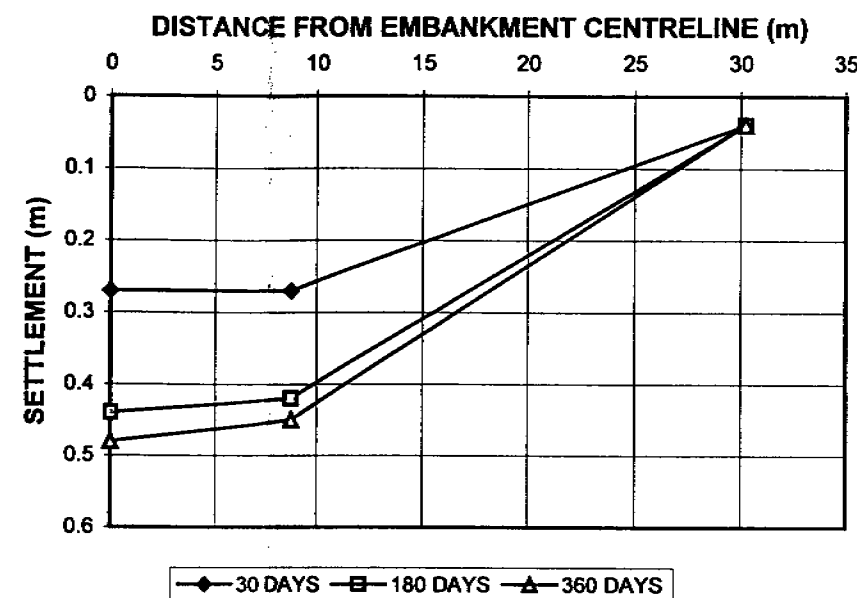
Thurber Engineering Ltd. - Toronto  
19-1104-4  
Hwy 11 - Trout Creek By-Pass  
April 6, 1999  
South Interchange - CPTU5  
(5+1) m embankment



**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(MOST LIKELY PRECONSOLIDATION PRESSURES)**



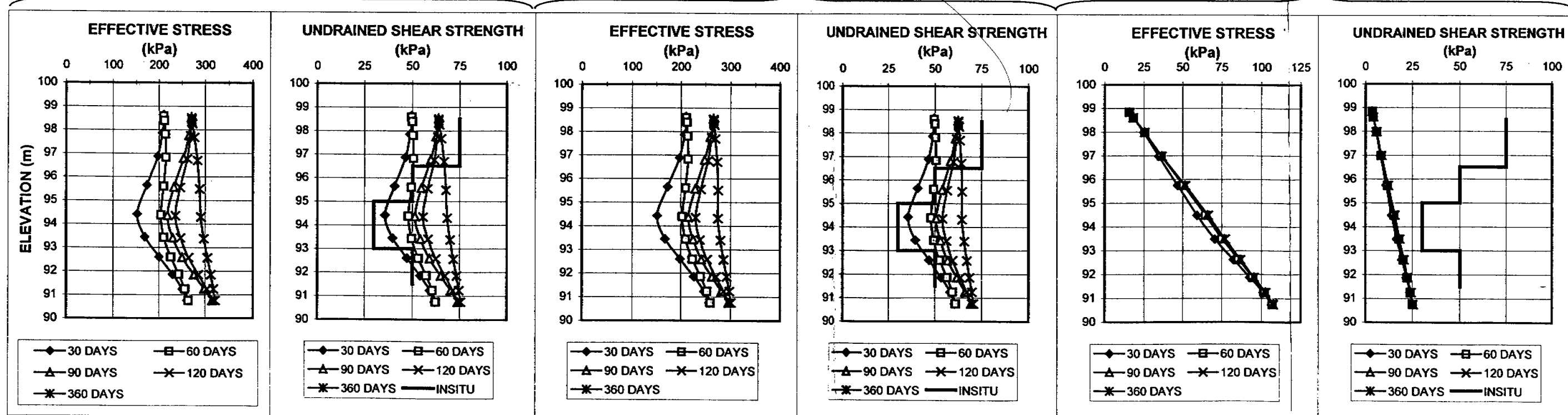
CONSTRUCTION STAGES		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	10	0
2	13	60



CENTRELINE (A)

CREST (B)

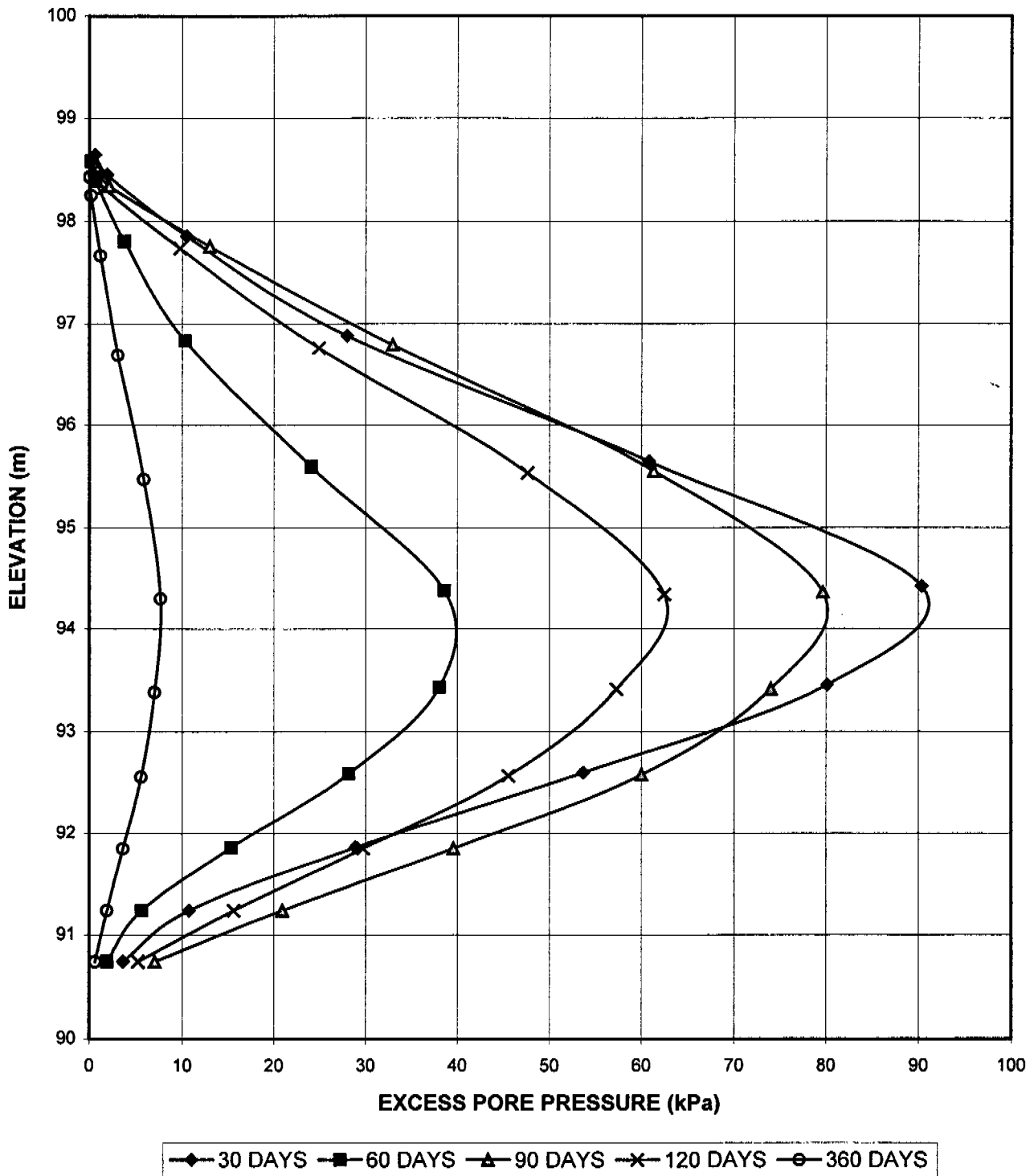
TOE (C)



MASTER PLOT

FIGURE A13

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)**

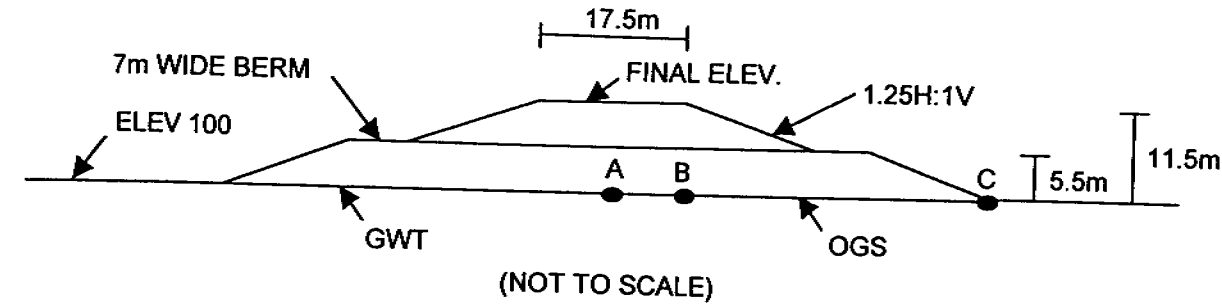


EPP - CHART

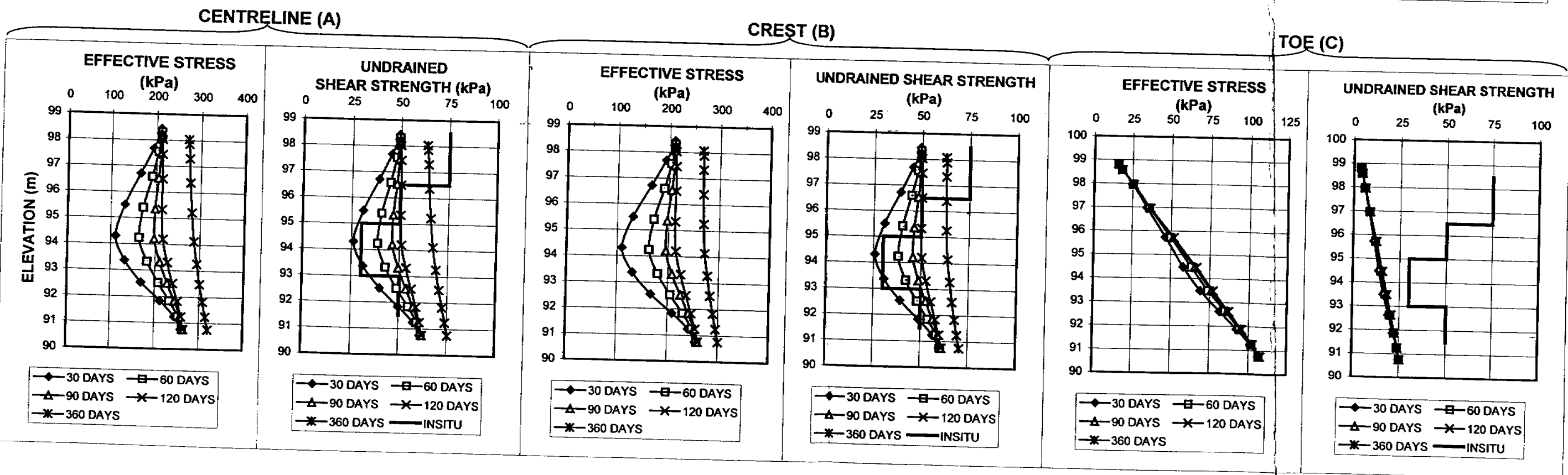
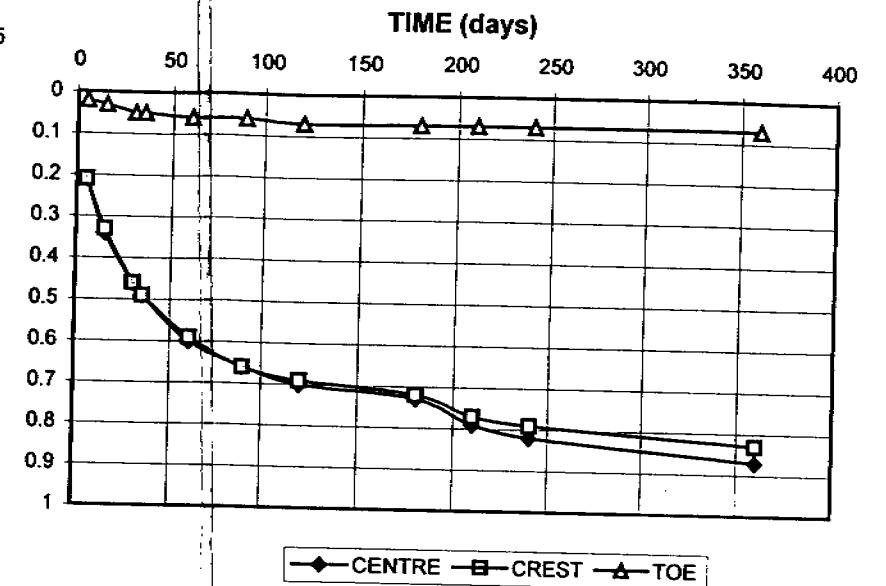
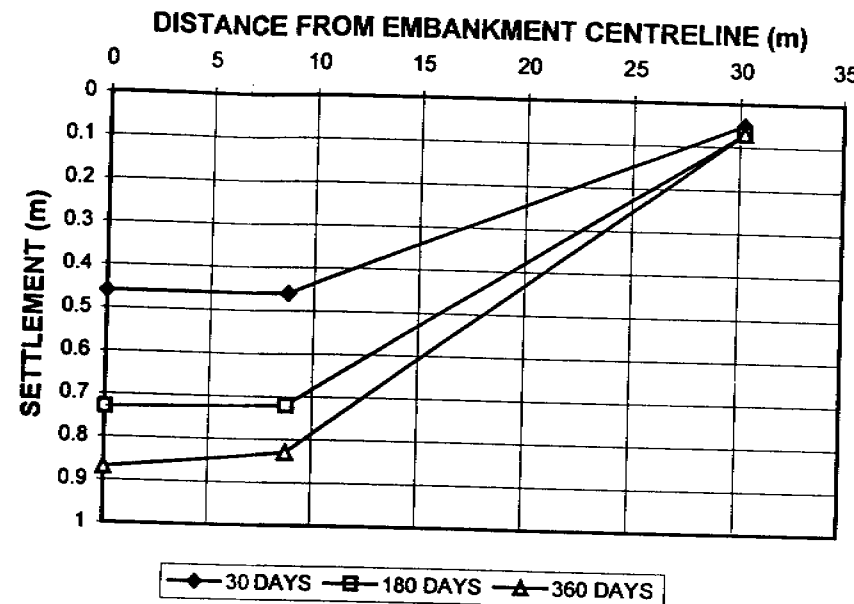
FIGURE A13-B



HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - WEST ABUTMENT (CPTUS1)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(REDUCED PRECONSOLIDATION PRESSURES)



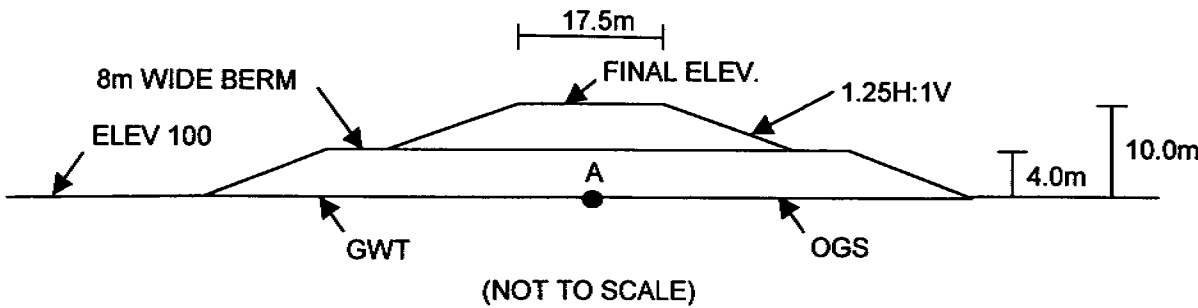
CONSTRUCTION STAGES		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	10	0
2	13	180



MASTER PLOT

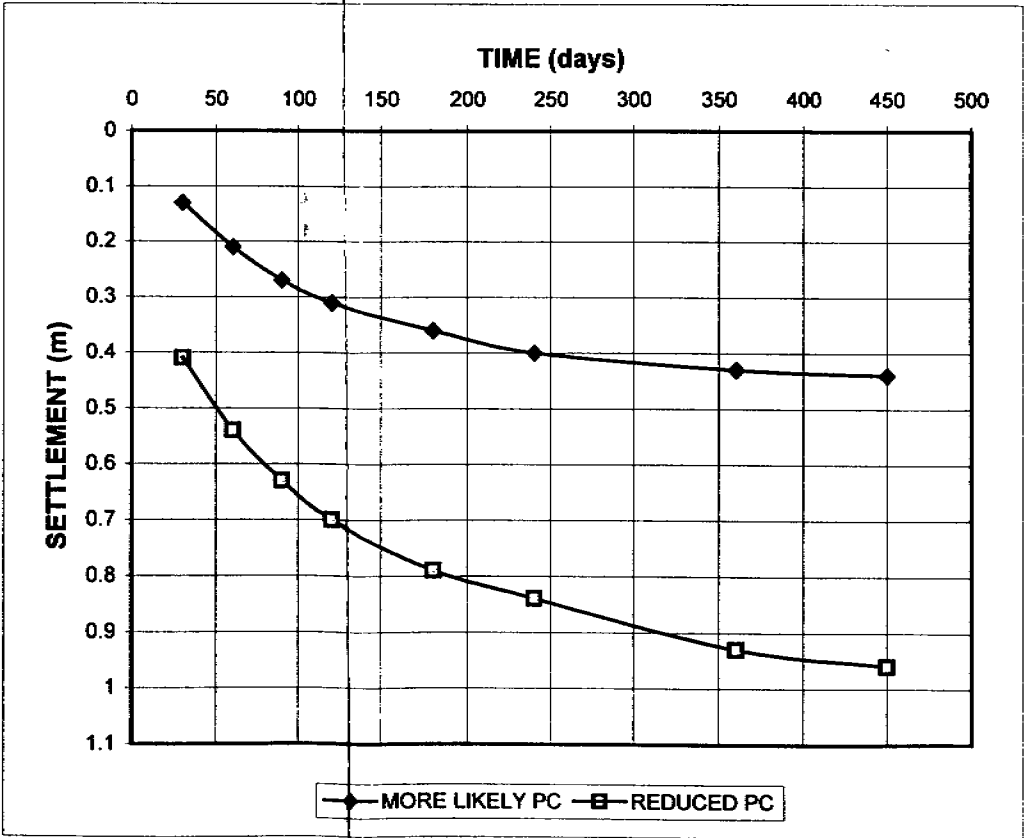
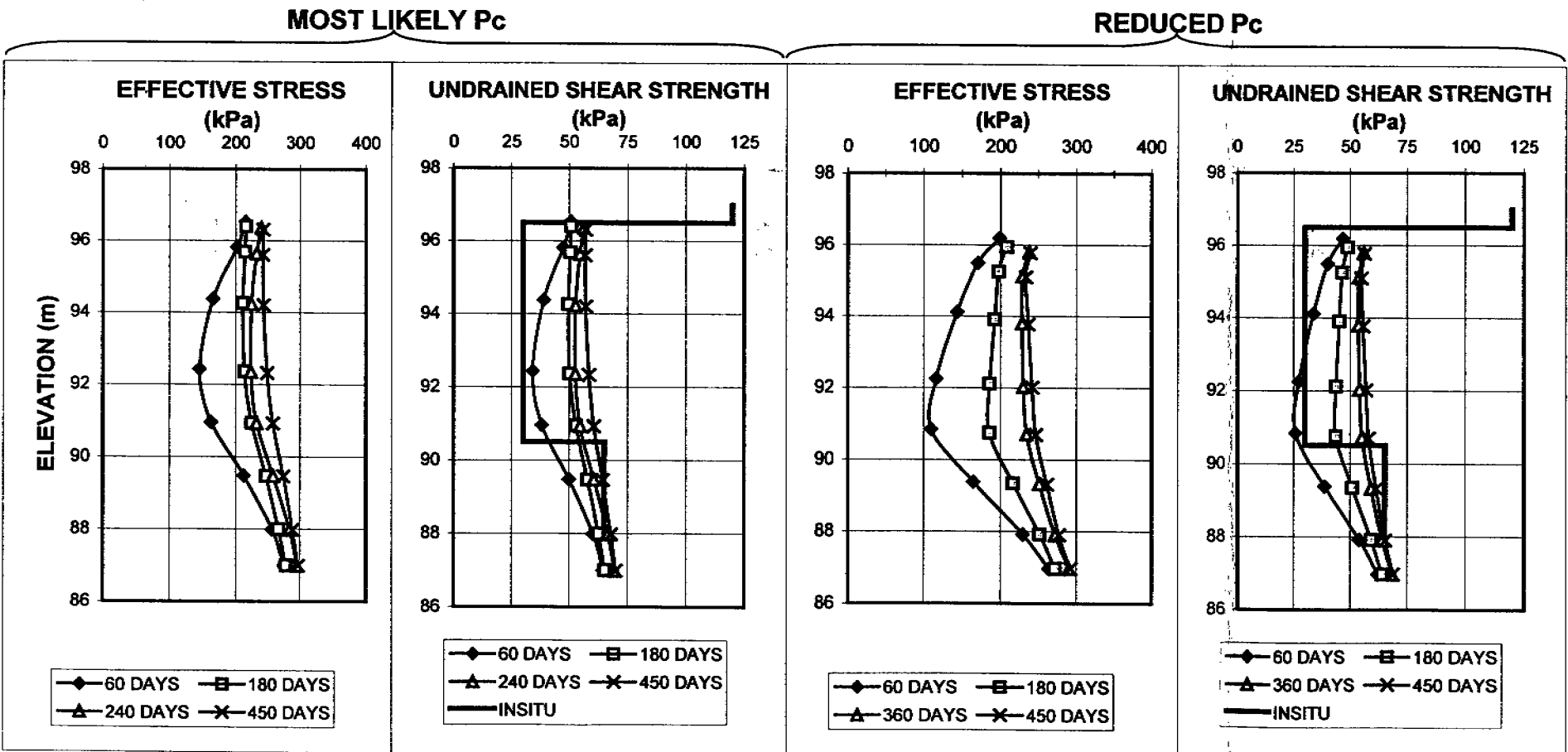
FIGURE A14

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - STATION 8+310, RAMP FROM BOUNDARY ROAD EAST TO HWY 11 NORTH (CPTUS3)**  
**SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS**  
**(AT THE CENTRELINE OF THE EMBANKMENT)**

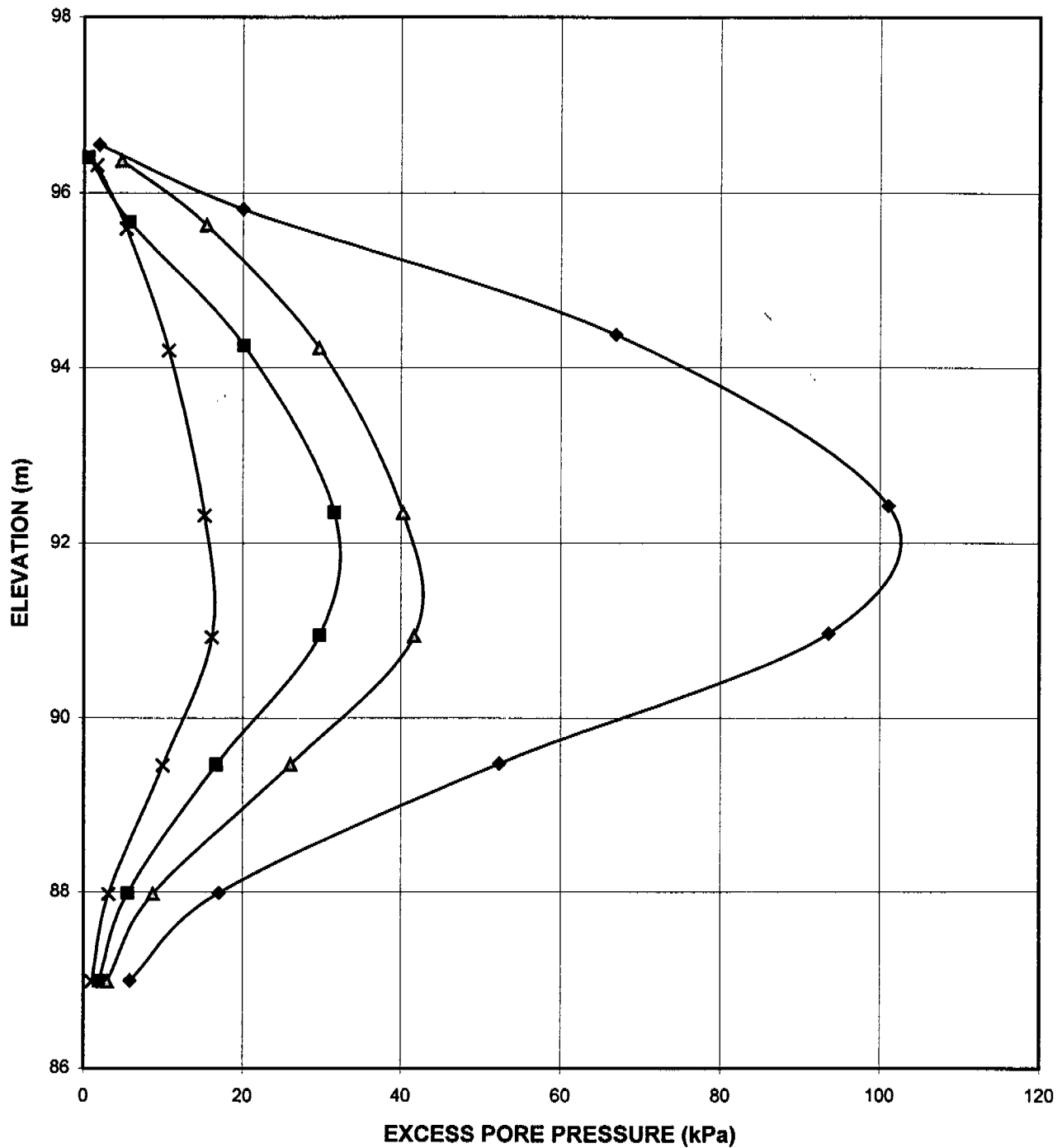


CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	9.5	0
2	11.5	180

CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	9.5	0
2	11.5	240

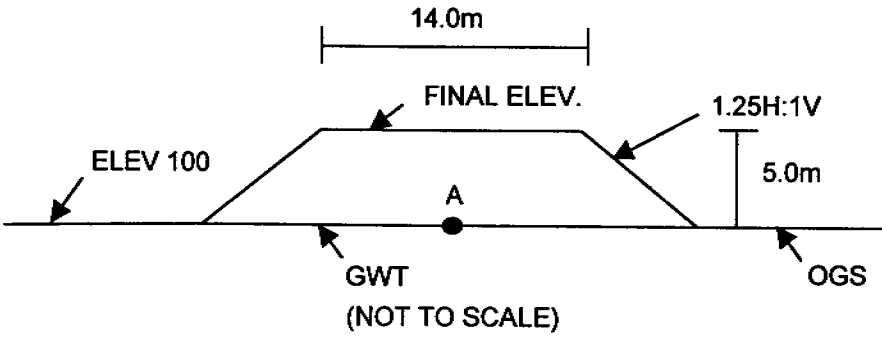


HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE  
APPROX. STATION 8+310 RAMP FROM BOUNDARY RD E TO HWY 11 N (CPTUS3)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



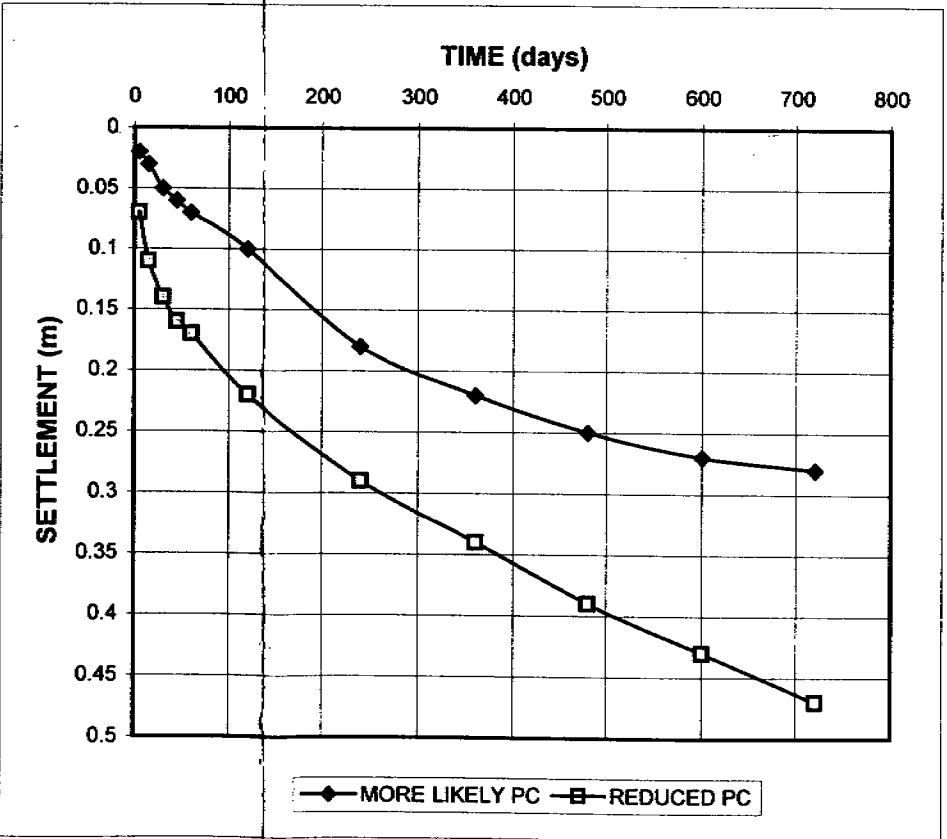
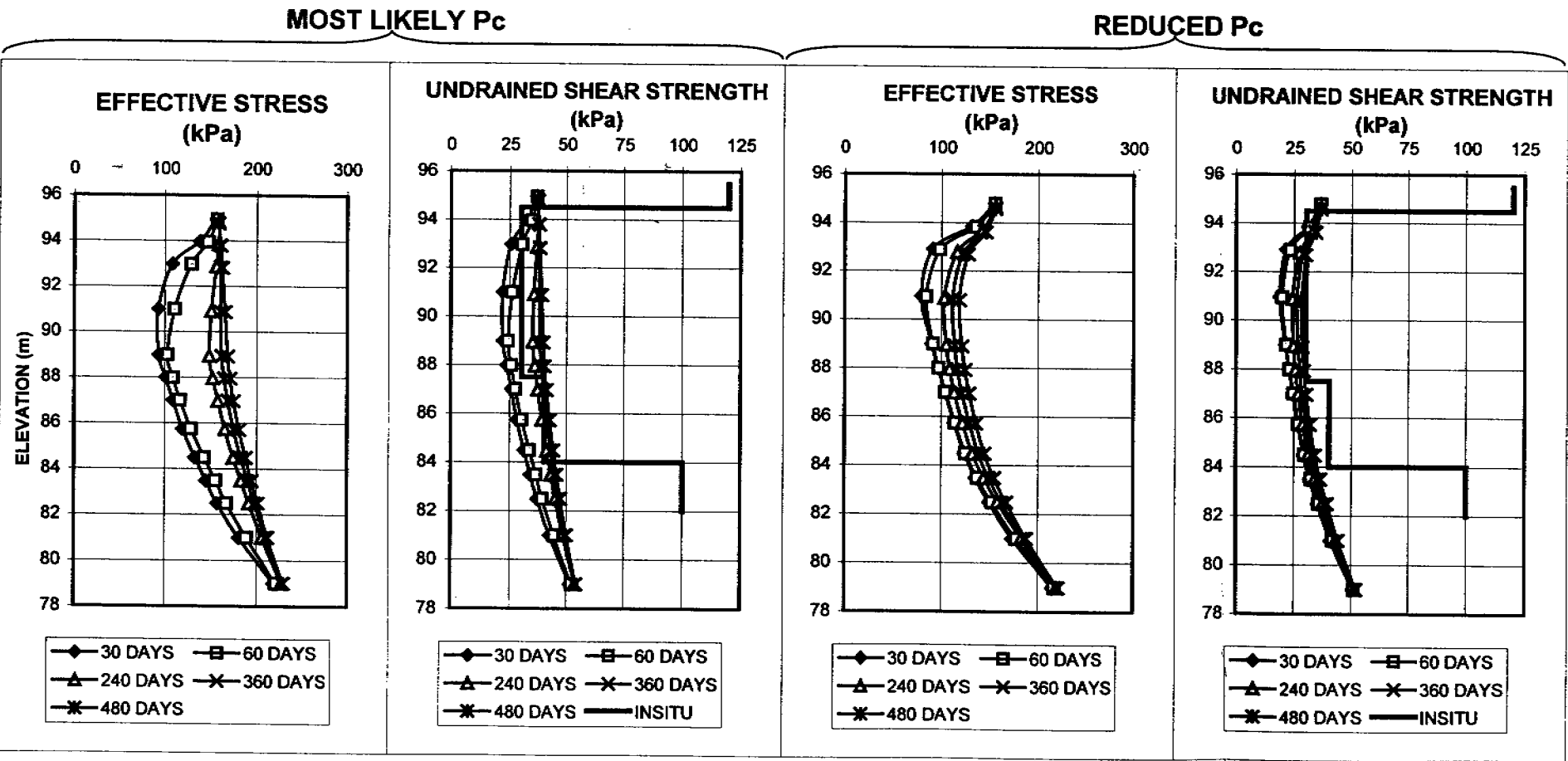
—◆— 60 DAYS —■— 180 DAYS —▲— 240 DAYS —×— 450 DAYS

HIGHWAY 11 - TROUT CREEK BY-PASS  
 SOUTH INTERCHANGE - STATION 8+500, EASTWEST-NORTH RAMP (CPTUS5)  
 SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
 (AT THE CENTRELINE OF THE EMBANKMENT)

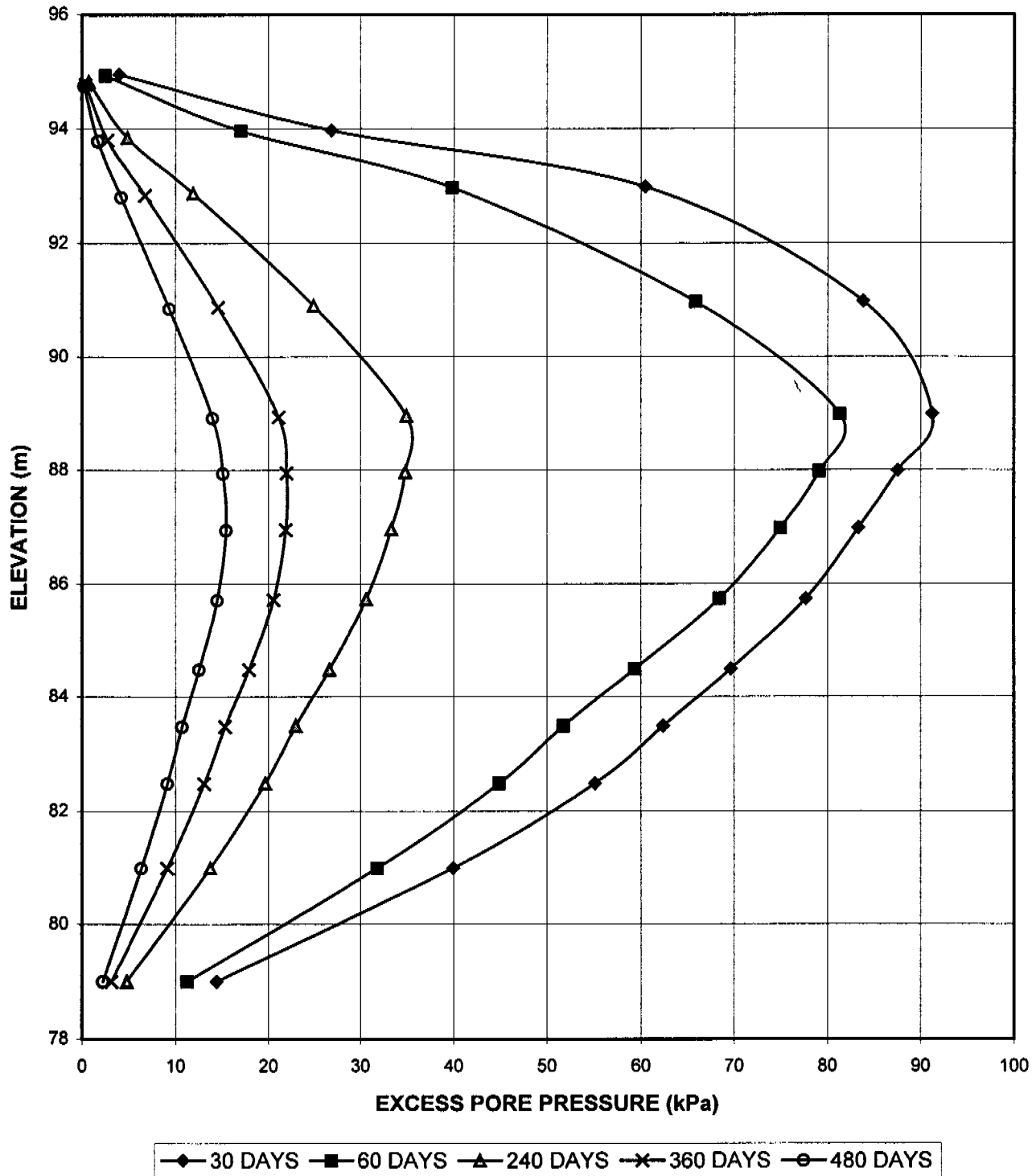


CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0

CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0



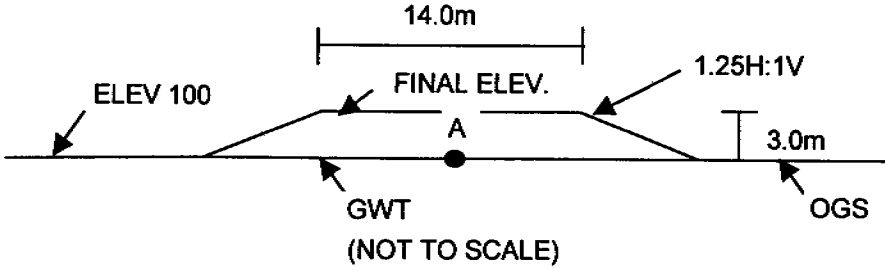
HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+500 EW-N RAMP (CPTUS5)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



EPP - CHART

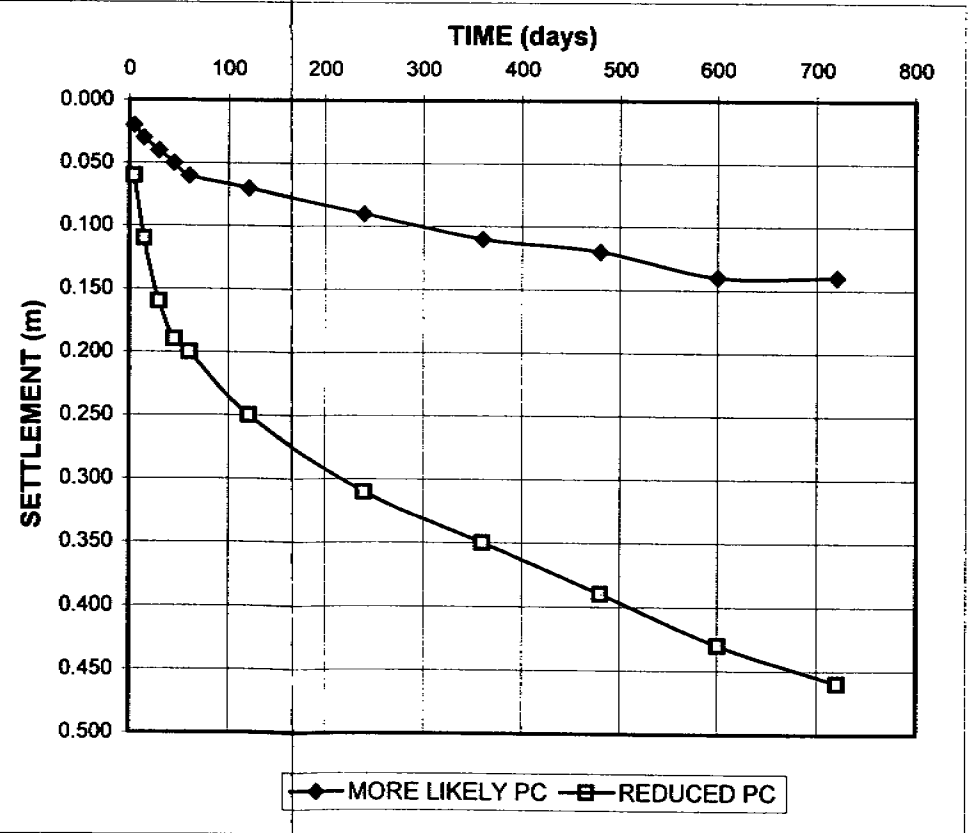
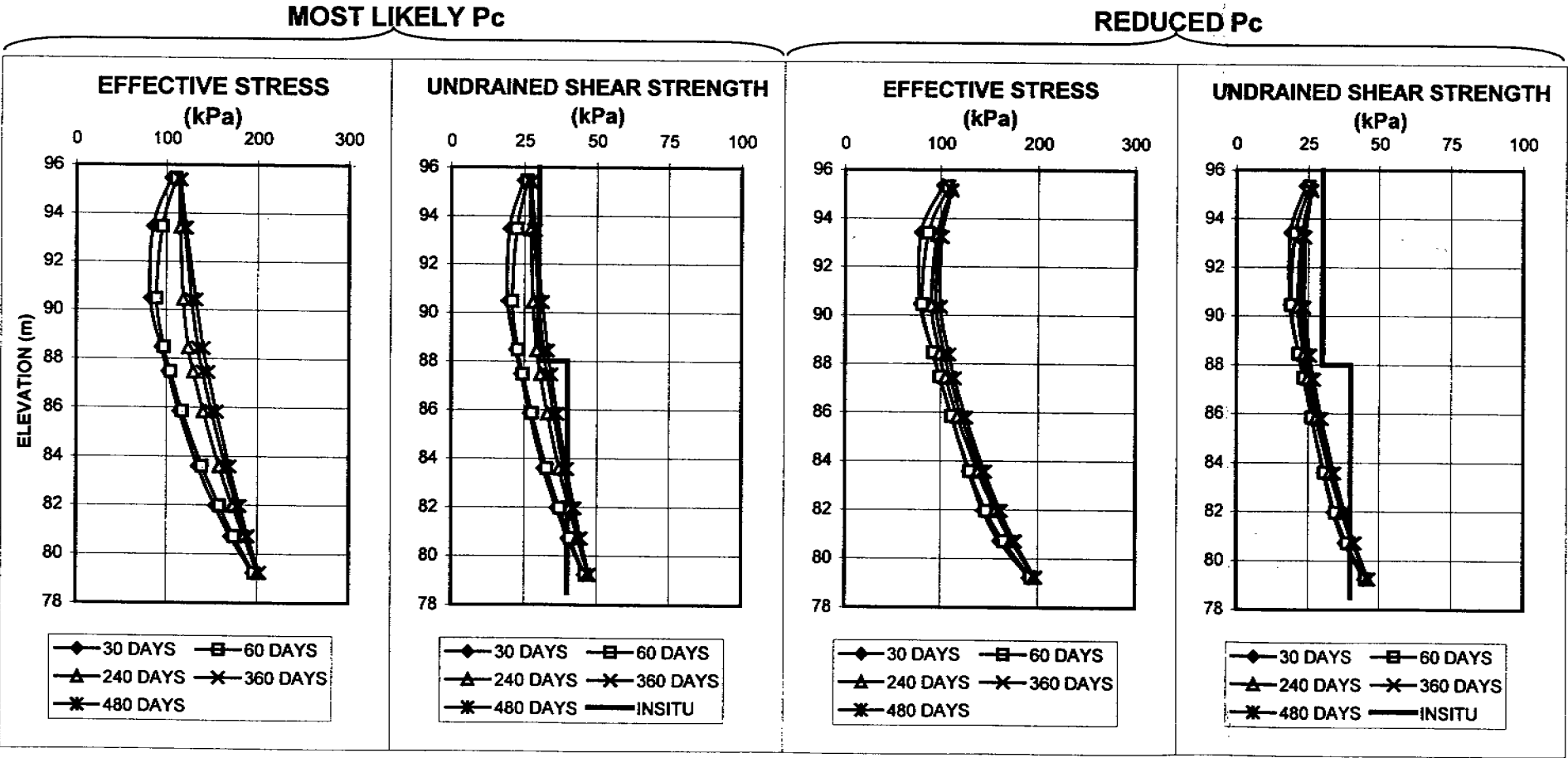
FIGURE A16-B

HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - STATION 8+600, S-EW RAMP (BH31FP)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(AT THE CENTRELINE OF THE EMBANKMENT)



CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	4	0

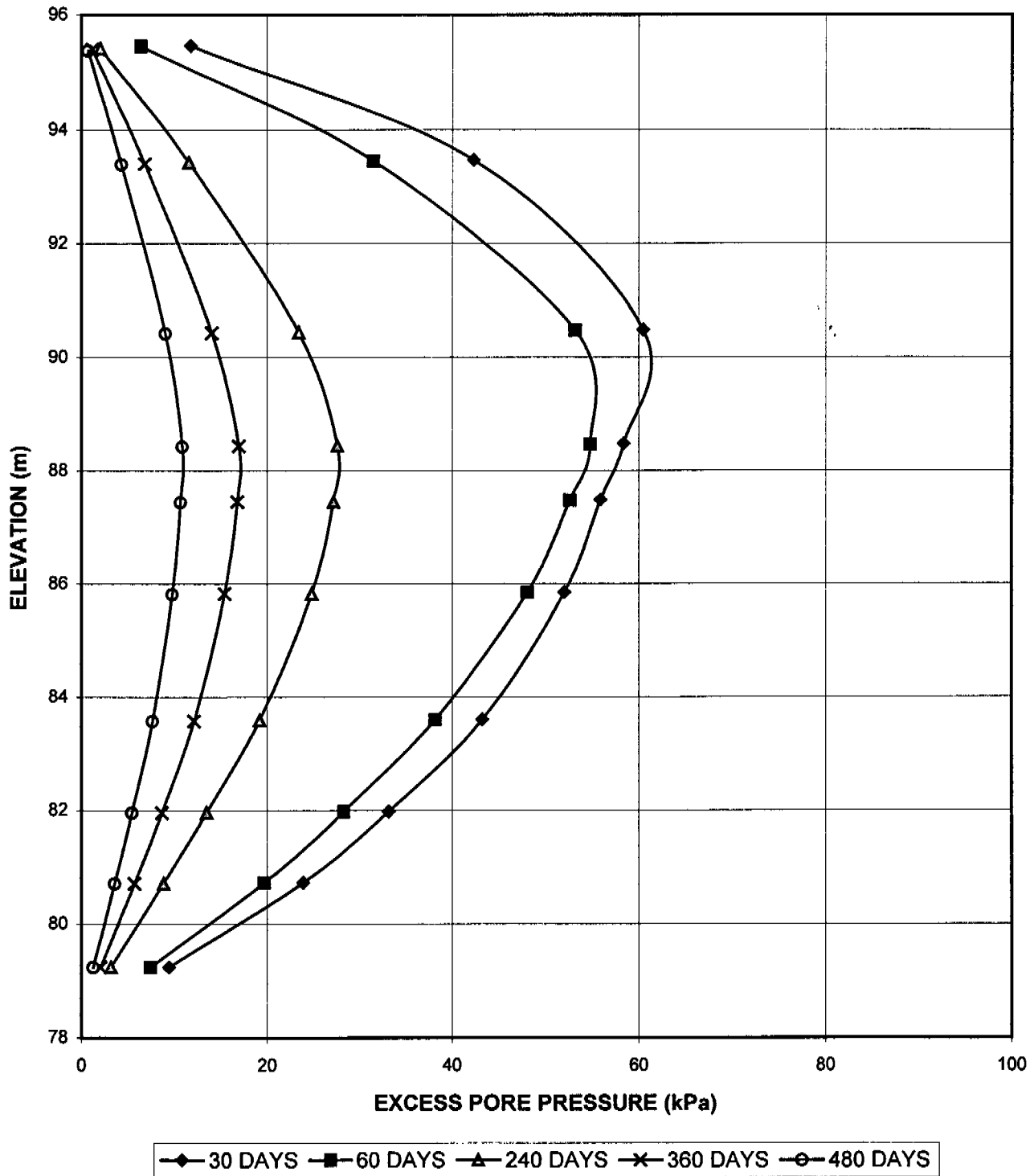
CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	4	0



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FIGURE A17

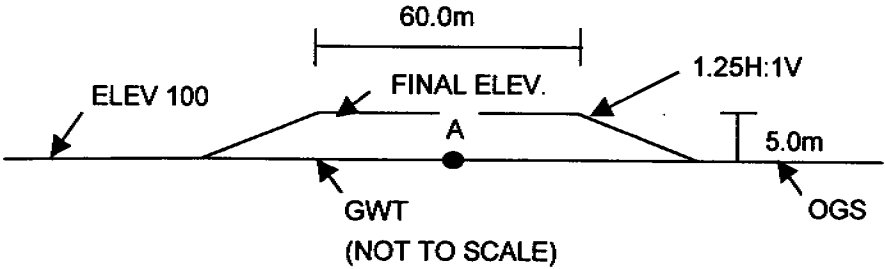
HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+600 S-EW RAMP (BH31FP)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)



EPP - CHART

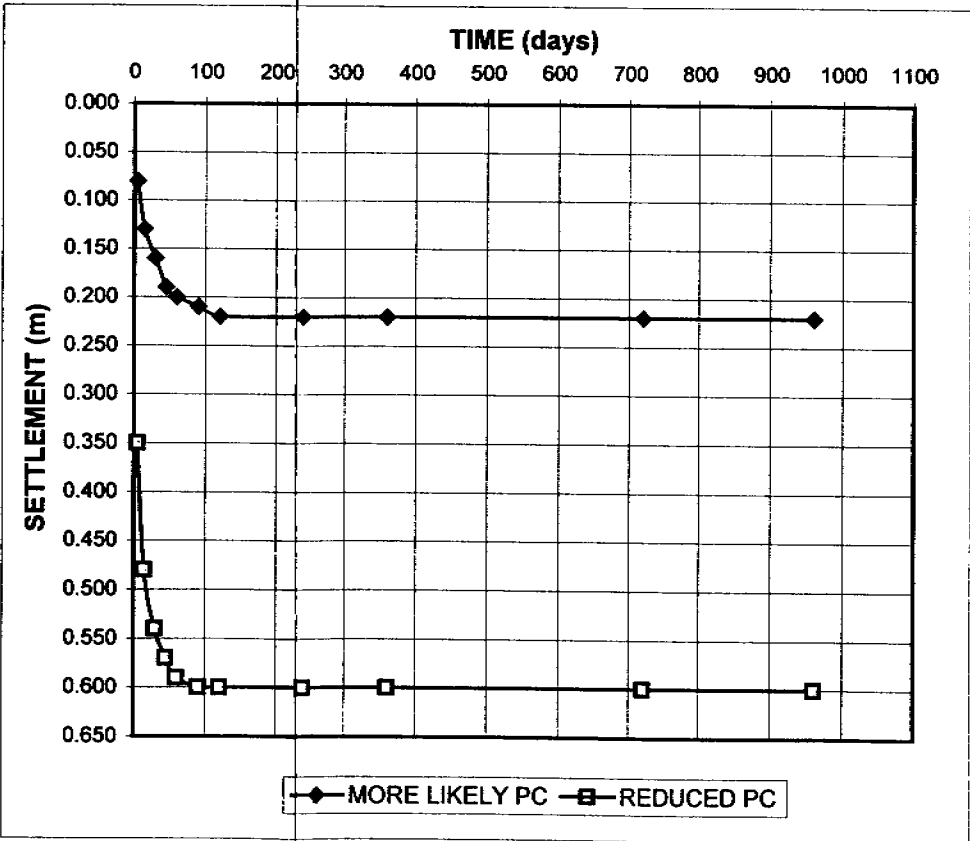
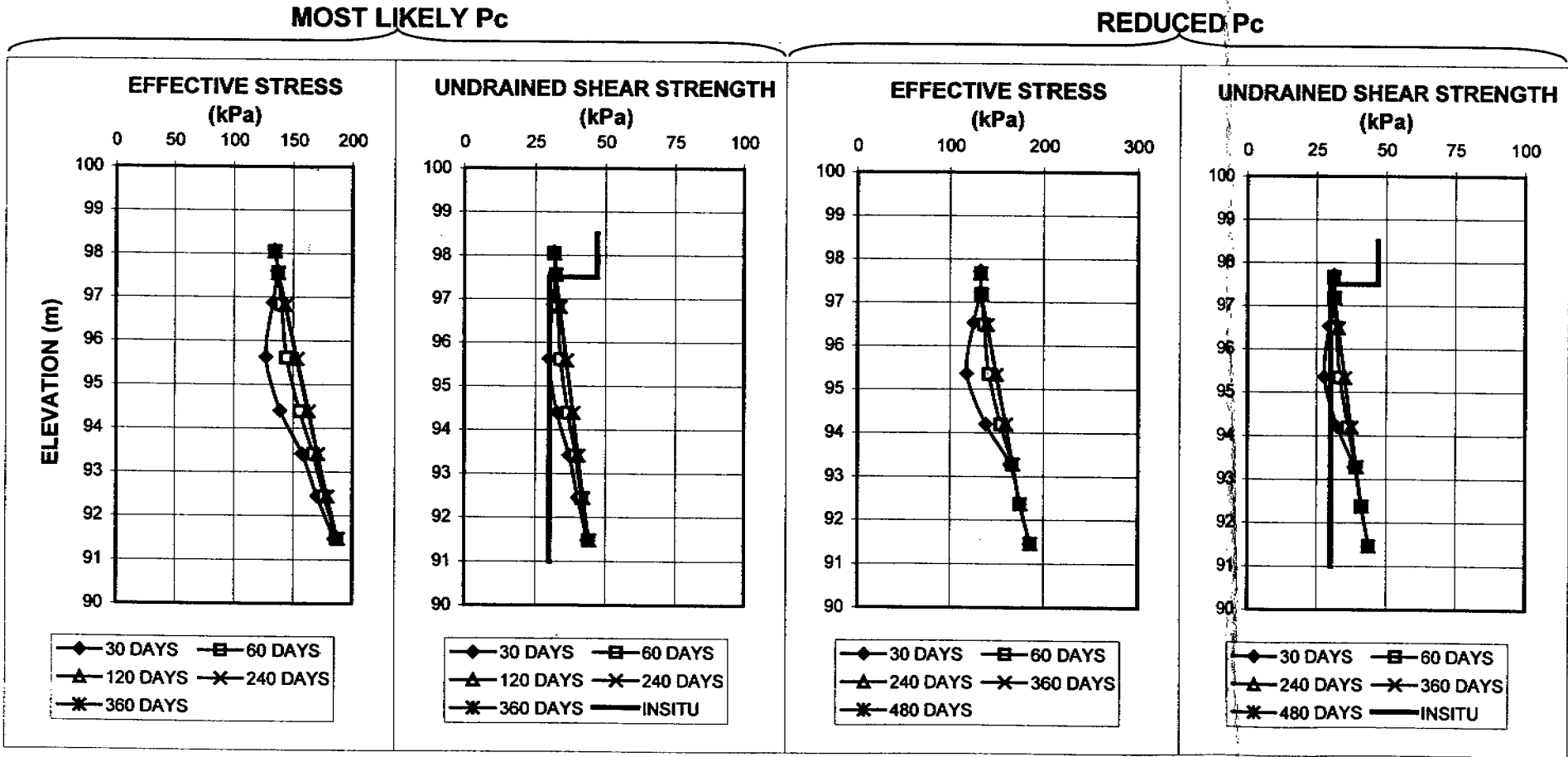
FIGURE A17-B

HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - STATION 8+800, HIGHWAY 11 (BH23FP)  
SETTLEMENTS DUE TO PRIMARY CONSOLIDATION - NO WICK DRAINS  
(AT THE CENTRELINE OF THE EMBANKMENT)



CONSTRUCTION STAGES FOR MOST LIKELY $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0

CONSTRUCTION STAGES FOR REDUCED $P_c$		
STAGE	EMBANKMENT HEIGHT (m)	TIME (DAYS)
1	6	0

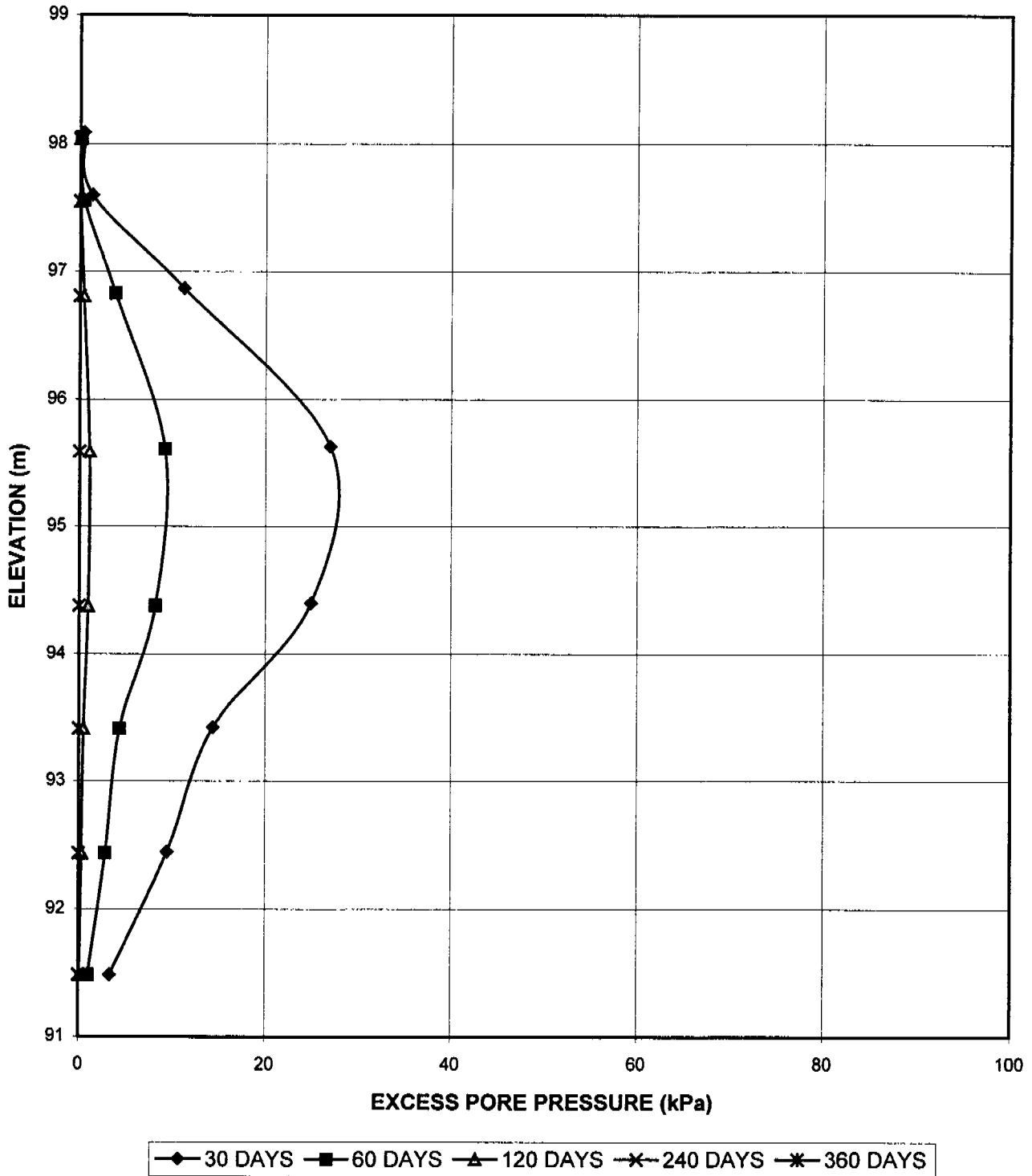


MASTER PLOT

FIGURE A18



**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - APPROX. STATION 8+800 HIGHWAY 11 (BH23FP)  
EXCESS PORE PRESSURES - NO WICK DRAINS - MOST LIKELY  $P_c$   
(AT THE CENTRELINE OF THE EMBANKMENT)**



EPP - CHART

FIGURE A18-B



**APPENDIX B**

**TABLES**

**Table B1 - Piezocone Test Locations and Depths**

Piezocone No.	Coordinates		Ground Surface Elevation (m)	Maximum Testing Depth (m)
	N	E		
CPTUS1	5091695	315187.5	313.3	13.05
CPTUS2	5091753	315239.7	313.1	9.75
CPTUS3	5091783.6	315289.1	313.2	16.93
CPTUS4	5091661.8	315234.3	313.2	15.28
CPTUS5	5091701.5	315407.5	312.3	22.08

TABLE B2

HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE  
SOIL PROPERTIES FOR STABILITY AND SETTLEMENT ANALYSIS

Location	Soil Layer	Depth Interval		Unit Weight (kN/m <sup>3</sup> )	Undrained Shear Strength (kPa)	Friction Angle (deg)	Poisson's Ratio	Young's Modulus (MPa)	Compression Ratio		Pre-Consolidation Pressure		Coeff. Of Consolidation (m <sup>2</sup> /y)				Secondary Compression Ratio
		From (m)	To (m)						C <sub>c</sub> /(1+e <sub>o</sub> )	C <sub>r</sub> /(1+e <sub>o</sub> )	Most Likely (kPa)	Reduced (kPa)	C <sub>v</sub>		C <sub>h</sub>		
CPTUS1 West and East Abutments	Rock Fill	top of fill	1	20	---	42	0.3	150	N/A	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	N/A	N/A	N/A	---	---	---	---	---	---	---	---
	Upper Silt	1	1.5	18	---	28	0.3	22.5	0.2	0.02	O.C.	O.C.	93	20	463	100	0.002
	Clayey Silt	1.5	3.5	18	75	---	0.4	22.5	0.2	0.02	319	150	93	20	463	100	0.002
		3.5	5	18	50	---	0.4	15	0.2	0.02	212	100	55	20	273	100	0.002
		5	7	17.5	30	---	0.45	9	0.2	0.02	128	60	36	20	179	100	0.002
		7	8.5	18	50	---	0.4	15	0.2	0.02	212	100	80	20	399	100	0.002
	Lower Silt	8.5	9.5	18	---	30	0.35	22.5	0.2	0.02	600	300	120	20	600	100	0.002
	Silty Sand/Sandy Silt	9.5	13	19	---	32	0.3	30	---	---	---	---	---	---	---	---	---
Bedrock	13	>13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
CPTUS3 East Approach to Bridge	Rock Fill	top of fill	1.5	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1.5	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Sand	1.5	3	19	---	30	0.3	30	---	---	---	---	---	---	---	---	---
	Upper Silt	3	4	18	120	---	0.3	22.5	0.2	0.02	500	250	139	20	694	100	0.002
	Clayey Silt	4	9.5	18	30	---	0.45	9	0.2	0.02	128	N.C.	37	20	184	100	0.002
	Lower Silt	9.5	12	18	65	---	0.3	20	0.2	0.02	277	140	54	20	268	100	0.002
	Sandy Silt	12	13.5	18.5	---	30	0.3	20	0.2	0.02	277	140	---	---	925	---	---
	Silty Sand/Sand	13.5	17.5	19	---	33	0.3	30	---	---	---	---	---	---	---	---	---
	Bedrock	17.5	>17.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CPTUS5 EW-N Ramp	Rock Fill	top of fill	1	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Sand	1	4.5	19	---	33	0.3	30	---	---	---	---	---	---	---	---	---
	Upper Silt	4.5	5.5	18	120	---	0.3	22.5	0.2	0.02	500	250	118	20	589	100	0.002
	Clayey Silt	5.5	12.5	17.5	30	---	0.45	9	0.2	0.02	128	N.C.	27	20	137	100	0.002
		12.5	16	18	40	---	0.45	12	0.2	0.02	170	N.C.	67	20	336	100	0.002
	Lower Silt	16	18	18	100	---	0.3	30	0.2	0.02	425	210	118	20	589	100	0.002
	Sandy Silt	18	22	18.5	---	32	0.3	20	0.2	0.02	425	210	---	---	589	---	---
	Silty Sand/Sand	22	24	19	---	35	0.3	30	---	---	---	---	---	---	---	---	---
Bedrock	24	>24	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
BH31FP EW-N Ramp	Rock Fill	top of fill	1	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Silty Sand	1	4	19	---	32	0.3	30	---	---	---	---	---	---	---	---	---
	Clayey Silt	4	12	17.5	30	---	0.45	9	0.2	0.02	128	N.C.	27	20	137	100	0.002
		12	18.5	17.5	40	---	0.45	12	0.2	0.02	170	N.C.	67	20	336	100	0.002
	Lower Silt	18.5	21.5	18	40	---	0.3	12	0.2	0.02	170	N.C.	118	20	589	100	0.002
	Silt to Silty Sand	21.5	26.5	18.5	---	32	0.3	20	---	---	---	---	---	---	---	---	---
Bedrock	26.5	>26.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
BH23FP Hwy 11 - north of Bridge	Rock Fill	top of fill	1.5	20	---	42	0.3	150	---	---	---	---	---	---	---	---	---
	Peat	0	1.5	16	10	---	---	---	---	---	---	---	---	---	---	---	---
	Upper Silt	1.5	2.5	18	---	32	0.3	30	---	---	200	100	263	20	1314	100	0.002
	Clayey Silt	2.5	6	18	30	---	0.45	9	0.2	0.02	128	N.C.	35	20	173	100	0.002
	Lower Silt	6	9	18	30	---	0.3	9	0.2	0.02	128	N.C.	263	20	1314	100	0.002
	Lower Sand	9	11	19	---	32	0.3	20	---	---	---	---	---	---	---	---	---
	Bedrock	11	>11	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes: O.C.: Over Consolidated Soil  
N.C.: Normally Consolidated Soil

**TABLE B3**  
**HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE**  
**SUMMARY OF STABILITY ANALYSIS**

Location	Design Height (m)	Target Height (m)	Berm Height (m)	Berm Width (m)	Height at this Stage (m)	Height at Previous Stage (m)	EPP dissipation before this stage	Factor of Safety	Reference Figure
CPTUS1 West and East Abutments	11.5	13	5.5	2	10	0	0%	1.37	
					13	10	50%	1.13	
					13	10	100%	1.18	
				7	10	0	0%	1.49	A7
					13	10	50%	1.29	A8
					13	13	100%	1.41	A9
CPTUS1-Head Slopes	11.5	13	0	0	13	10	50%	1.33	
(Final Configuration)	11.5	11.5	0	0	11.5	11.5	100%	1.55	
CPTUS3 East Approach to Bridge	10	11.5	4	2	7.5	0	0%	1.33	
					9.5	7.5	100%	1.31	
					11.5	9.5	100%	1.21	
				6	8.5	0	0%	1.32	
					9.5	8.5	40%	1.33	
					11.5	9.5	100%	1.32	
				8	9.5	0	0%	1.30	A10
					11.5	9.5	75%	1.32	A11
				8	9	0	0%	1.33	
					9.5	0	0%	1.21	
					8.5	0	0%	1.33	
					9.5	8.5	75%	1.33	
				8	8	0	0%	1.33	
				6	7.5	0	0%	1.28	
CPTUS5-EW-N Ramp	5	6	0	0	6	0	0%	1.70	A12

Note: EPP - Excess Pore Pressure

TABLE B4

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+500 - EW-N Ramp - CPTUS5  
Most Likely Pre-Consolidation Pressures - 14 m wide embankment top**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	19 mm	29 mm	40 mm	51 mm	62 mm	73 mm
Primary Consol. Settl. (mm)	37 mm	71 mm	134 mm	236 mm	331 mm	418 mm
Total Settlement (mm) (*)	56 mm	100 mm	174 mm	287 mm	393 mm	491 mm
Final Height above O.G.S. (m)	1.944 m	2.9 m	3.826 m	4.713 m	5.607 m	6.509 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	6.3	21	1.979	33	2.967	48	3.952	66	4.934	83	5.917	99	6.901
15	0.50	9.4	22	1.978	36	2.964	53	3.947	73	4.927	93	5.907	112	6.888
30	1.00	15.6	25	1.975	40	2.960	61	3.939	88	4.912	114	5.886	138	6.862
45	1.50	18.8	26	1.974	42	2.958	65	3.935	95	4.905	124	5.876	152	6.848
60	2.00	21.9	27	1.973	45	2.955	69	3.931	103	4.897	134	5.866	165	6.835
120	4.00	31.3	31	1.969	51	2.949	82	3.918	125	4.875	166	5.834	204	6.796
240	8.00	56.3	40	1.960	69	2.931	115	3.885	184	4.816	248	5.752	308	6.692
360	12.00	68.8	44	1.956	78	2.922	132	3.868	213	4.787	290	5.710	361	6.639
480	16.00	78.1	48	1.952	84	2.916	145	3.855	235	4.785	321	5.679	399	6.601
600	20.00	84.4	50	1.950	89	2.911	153	3.847	250	4.750	341	5.659	426	6.574
720	24.00	87.5	51	1.949	91	2.909	157	3.843	258	4.743	352	5.648	439	6.561

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.944	> maximum time above	> 4.00	> 0.50	#N/A	#N/A	#N/A
2.9		> maximum time above	> 4.00	> 1.50	> 0.50	> 0.17
3.826			> maximum time above	> 4.00	> 4.00	> 2.00
4.713				> maximum time above	> 8.00	> 4.00
5.607					> maximum time above	> 12.00
6.509						> maximum time above

TABLE B5

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+500 - EW-N Ramp - CPTUS5**

Reduced Pre-Consolidation Pressures - 14 m wide embankment top

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	19 mm	29 mm	40 mm	51 mm	62 mm	73 mm
Primary Consol. Settl (mm)	272 mm	392 mm	505 mm	617 mm	733 mm	851 mm
Total Settlement (mm) (*)	291 mm	421 mm	545 mm	668 mm	795 mm	924 mm
Final Height above O.G.S. (m)	1.709 m	2.579 m	3.455 m	4.332 m	5.205 m	6.076 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	9.3	44	1.956	65	2.935	87	3.913	108	4.892	130	5.870	152	6.848
15	0.50	14.7	59	1.941	87	2.913	114	3.886	142	4.858	170	5.830	198	6.802
30	1.00	18.7	70	1.930	102	2.898	134	3.866	166	4.834	199	5.801	232	6.768
45	1.50	21.3	77	1.923	112	2.888	148	3.852	182	4.818	218	5.782	254	6.746
60	2.00	22.7	81	1.919	118	2.882	155	3.845	191	4.809	228	5.772	266	6.734
120	4.00	29.3	99	1.901	144	2.856	188	3.812	232	4.768	277	5.723	322	6.678
240	8.00	38.7	124	1.876	181	2.819	235	3.765	290	4.710	346	5.654	402	6.598
360	12.00	45.3	142	1.858	207	2.793	269	3.731	331	4.669	394	5.606	459	6.541
480	16.00	52	160	1.840	233	2.767	303	3.697	372	4.628	443	5.557	516	6.484
600	20.00	57.3	175	1.825	254	2.746	329	3.671	405	4.595	482	5.518	561	6.439
720	24.00	62.7	190	1.810	275	2.725	357	3.643	438	4.562	522	5.478	607	6.393

Note (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.709	> maximum time above	> maximum time above	Approximate Time for 100% Consolidation (months)			
2.579		> maximum time above	> 12.00	> 8.00	> 4.00	> 2.00
3.455		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
4.332			> maximum time above	> maximum time above	> maximum time above	> 16.00
5.205				> maximum time above	> maximum time above	> maximum time above
6.076					> maximum time above	> maximum time above



TABLE B6

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS**

Station 8+500 - EW-N Ramp - CPTUS5

Most Likely Pre-Consolidation Pressures - 40 m wide embankment top

Initial Fill Height (m)		2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)		24 mm	36 mm	48 mm	61 mm	73 mm	85 mm
Primary Consol. Settl (mm)		54 mm	116 mm	228 mm	334 mm	429 mm	516 mm
Total Settlement (mm) (*)		78 mm	152 mm	276 mm	395 mm	502 mm	601 mm
Final Height above O.G.S. (m)		1.922 m	2.848 m	3.724 m	4.605 m	5.498 m	6.399 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	8.3	27	1.973	43	2.957	62	3.938	82	4.918	100	5.900	118	6.882
15	0.50	9.4	29	1.971	47	2.953	69	3.931	92	4.908	113	5.887	134	6.866
30	1.00	15.6	32	1.968	54	2.946	84	3.916	113	4.887	140	5.860	165	6.835
45	1.50	18.8	34	1.966	58	2.942	91	3.909	124	4.876	154	5.846	182	6.818
60	2.00	21.9	36	1.964	61	2.939	98	3.902	134	4.866	167	5.833	198	6.802
120	4.00	31.3	41	1.959	72	2.928	119	3.881	166	4.834	207	5.793	247	6.753
240	8.00	56.3	54	1.946	101	2.899	176	3.824	249	4.751	315	5.685	376	6.624
360	12.00	68.8	61	1.939	116	2.884	205	3.795	291	4.709	368	5.632	440	6.560
480	16.00	78.1	66	1.934	127	2.875	226	3.774	322	4.678	408	5.592	488	6.512
600	20.00	84.4	70	1.930	134	2.866	240	3.760	343	4.657	435	5.565	521	6.479
720	24.00	87.5	71	1.929	138	2.863	248	3.753	353	4.647	448	5.552	537	6.464

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.922	Approximate Time for 100% Consolidation (months)					
2.848	> maximum time above	> 4.00	> 0.50	#N/A	#N/A	#N/A
3.724		> maximum time above	> 4.00	> 2.00	> 1.00	> 0.50
4.605			> maximum time above	> 8.00	> 4.00	> 4.00
5.498				> maximum time above	> 12.00	> 8.00
6.399					> maximum time above	> 16.00
						> maximum time above

TABLE B7

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
**Station 8+500 - EW-N Ramp - CPTUS5**  
**Reduced Pre-Consolidation Pressures - 40 m wide embankment top**

Initial Fill Height (m)		2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)		24 mm	36 mm	48 mm	61 mm	73 mm	85 mm
Primary Consol. Settl. (mm)		344 mm	488 mm	629 mm	770 mm	899 mm	1018 mm
Total Settlement (mm) (*)		368 mm	524 mm	677 mm	831 mm	972 mm	1103 mm
Final Height above O.G.S. (m)		1.632 m	2.476 m	3.323 m	4.169 m	5.028 m	5.897 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	9.3	56	1.944	81	2.919	106	3.894	133	4.887	157	5.843	180	6.820
15	0.50	14.7	75	1.925	108	2.892	140	3.860	174	4.826	205	5.795	235	6.765
30	1.00	18.7	88	1.912	127	2.873	166	3.834	205	4.795	241	5.759	275	6.725
45	1.50	21.3	97	1.903	140	2.860	182	3.818	225	4.775	264	5.736	302	6.698
60	2.00	22.7	102	1.898	147	2.853	191	3.809	236	4.764	277	5.723	316	6.684
120	4.00	29.3	125	1.875	179	2.821	232	3.768	287	4.713	336	5.664	383	6.617
240	8.00	38.7	157	1.843	225	2.775	291	3.709	359	4.641	421	5.579	479	6.521
360	12.00	45.3	180	1.820	257	2.743	333	3.667	410	4.590	480	5.520	546	6.454
480	16.00	52	203	1.797	290	2.710	375	3.625	481	4.539	540	5.460	614	6.386
600	20.00	57.3	221	1.779	316	2.684	408	3.592	502	4.498	588	5.412	668	6.332
720	24.00	62.7	240	1.760	342	2.658	442	3.558	544	4.458	637	5.363	723	6.277

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.632	> maximum time above	> maximum time above	Approximate Time for 100% Consolidation (months)			
2.476		> maximum time above	> 12.00	> 8.00	> 4.00	> 2.00
3.323		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
4.169			> maximum time above	> maximum time above	> maximum time above	> 20.00
5.028				> maximum time above	> maximum time above	> maximum time above
5.897					> maximum time above	> maximum time above
						> maximum time above

TABLE B8

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+600 - S-EW Ramp - BH31FP  
Most Likely Pre-Consolidation Pressures**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	17 mm	25 mm	35 mm	44 mm	54 mm	64 mm
Primary Consol. Settl.(mm)	53 mm	86 mm	173 mm	311 mm	453 mm	585 mm
Total Settlement (mm) (*)	70 mm	111 mm	208 mm	355 mm	507 mm	649 mm
Final Height above O.G.S. (m)	1.93 m	2.889 m	3.792 m	4.645 m	5.493 m	6.351 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	11.8	23	1.977	35	2.965	55	3.945	81	4.919	107	5.893	133	6.867
15	0.50	17.6	26	1.974	40	2.960	65	3.935	99	4.901	134	5.866	167	6.833
30	1.00	23.5	29	1.971	45	2.955	76	3.924	117	4.883	160	5.840	201	6.799
45	1.50	29.4	33	1.967	50	2.950	86	3.914	135	4.865	187	5.813	236	6.764
60	2.00	35.3	36	1.964	55	2.945	96	3.904	154	4.846	214	5.786	271	6.729
120	4.00	41.2	39	1.961	60	2.940	106	3.894	172	4.828	241	5.759	305	6.695
240	8.00	52.9	45	1.955	70	2.930	127	3.873	209	4.791	294	5.706	373	6.627
360	12.00	64.7	51	1.949	81	2.919	147	3.853	245	4.755	347	5.653	442	6.558
480	16.00	70.6	54	1.946	86	2.914	157	3.843	264	4.736	374	5.626	477	6.523
600	20.00	82.4	61	1.939	96	2.904	178	3.822	300	4.700	427	5.573	546	6.454
720	24.00	82.4	61	1.939	96	2.904	178	3.822	300	4.700	427	5.573	546	6.454

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)	Approximate Time for 100% Consolidation (months)					
1.93	> maximum time above	> 4.00	> 0.50	#N/A	#N/A	#N/A
2.889		> maximum time above	> 4.00	> 0.50	> 0.17	#N/A
3.792			> maximum time above	> 4.00	> 1.50	> 1.00
4.645				> maximum time above	> 12.00	> 4.00
5.493					> maximum time above	> 16.00
6.351						> maximum time above

TABLE B9

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+600 - S-EW Ramp - BH31FP  
Reduced Pre-Consolidation Pressures**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	7 m
Immediate Settlement (mm)	17 mm	25 mm	35 mm	44 mm	54 mm	64 mm
Primary Consol. Settl.(mm)	376 mm	557 mm	723 mm	876 mm	1018 mm	1150 mm
Total Settlement (mm) (*)	393 mm	582 mm	758 mm	920 mm	1072 mm	1214 mm
Final Height above O.G.S. (m)	1.607 m	2.418 m	3.242 m	4.08 m	4.928 m	5.786 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	8.2	48	1.952	71	2.929	94	3.906	116	4.884	137	5.863	158	6.842
15	0.50	15.1	74	1.928	109	2.891	144	3.856	176	4.824	208	5.792	238	6.762
30	1.00	21.9	99	1.901	147	2.853	193	3.807	236	4.764	277	5.723	316	6.684
45	1.50	26	115	1.885	170	2.830	223	3.777	272	4.728	319	5.681	363	6.637
60	2.00	27.4	120	1.880	178	2.822	233	3.767	284	4.716	333	5.667	379	6.621
120	4.00	34.2	146	1.854	215	2.785	282	3.718	344	4.656	402	5.598	457	6.543
240	8.00	42.5	177	1.823	262	2.738	342	3.658	416	4.584	487	5.513	553	6.447
360	12.00	47.9	197	1.803	292	2.708	381	3.619	464	4.536	542	5.458	615	6.385
480	16.00	53.4	218	1.782	322	2.678	421	3.579	512	4.488	598	5.402	678	6.322
600	20.00	58.9	238	1.762	353	2.647	461	3.539	560	4.440	654	5.346	741	6.259
720	24.00	63	254	1.746	376	2.624	490	3.510	596	4.404	695	5.305	789	6.212

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	7
Final Height above O.G.S. (m)						
1.607	> maximum time above	> maximum time above	> 12.00	> 4.00	> 2.00	> 2.00
2.418		> maximum time above	> maximum time above	> 20.00	> 12.00	> 8.00
3.242			> maximum time above	> maximum time above	> maximum time above	> 20.00
4.08				> maximum time above	> maximum time above	> maximum time above
4.928					> maximum time above	> maximum time above
5.786						> maximum time above

TABLE B10

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
**Highway 11 - South of Interchange - 60m Wide Embankment Top - BH31FP**  
**Most Likely Pre-Consolidation Pressures**

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	6 m
Immediate Settlement (mm)	22 mm	33 mm	43 mm	54 mm	65 mm	65 mm
Primary Consol. Settl (mm)	91 mm	191 mm	328 mm	490 mm	637 mm	637 mm
Total Settlement (mm) (*)	113 mm	224 mm	371 mm	544 mm	702 mm	702 mm
Final Height above O.G.S. (m)	1.887 m	2.776 m	3.629 m	4.456 m	5.298 m	5.298 m

Time		% Consolidation	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above	Settlement	Height Above
(days)	(months)	U%	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)	(mm)	O.G.S. (m)
5	0.17	11.6	33	1.967	56	2.944	82	3.918	112	4.888	140	5.860	140	5.860
15	0.50	17.6	38	1.962	67	2.933	101	3.899	140	4.860	177	5.823	177	5.823
30	1.00	23.5	43	1.957	78	2.922	120	3.880	169	4.831	215	5.785	215	5.785
45	1.50	29.4	49	1.951	89	2.911	139	3.861	198	4.802	252	5.748	252	5.748
60	2.00	35.3	54	1.946	100	2.900	159	3.841	227	4.773	290	5.710	290	5.710
120	4.00	41.2	59	1.941	112	2.888	178	3.822	256	4.744	327	5.673	327	5.673
240	8.00	52.9	70	1.930	134	2.866	217	3.783	313	4.687	402	5.598	402	5.598
360	12.00	64.7	81	1.919	157	2.843	255	3.745	371	4.629	477	5.523	477	5.523
480	16.00	70.6	86	1.914	168	2.832	275	3.725	400	4.600	515	5.485	515	5.485
600	20.00	82.4	97	1.903	190	2.810	313	3.687	458	4.542	590	5.410	590	5.410
720	24.00	82.4	97	1.903	190	2.810	313	3.687	458	4.542	590	5.410	590	5.410

Note (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	6
Final Height above O.G.S. (m)						
1.887	> maximum time above	> 4.00	> 0.50	> 0.17	#N/A	#N/A
2.776		> maximum time above	> 8.00	> 1.50	> 1.00	> 1.00
3.629			> maximum time above	> 8.00	> 4.00	> 4.00
4.456				> maximum time above	> 16.00	> 16.00
5.298					> maximum time above	> maximum time above
5.298						> maximum time above

TABLE B11

**HIGHWAY 11 - TROUT CREEK BY-PASS**  
**SOUTH INTERCHANGE - SURCHARGE ANALYSIS**  
 Highway 11 - South of Interchange - 60m Wide Embankment Top - BH31FP  
 Reduced Pre-Consolidation Pressures

Initial Fill Height (m)	2 m	3 m	4 m	5 m	6 m	6 m
Immediate Settlement (mm)	22 mm	33 mm	43 mm	54.3 mm	65 mm	65 mm
Primary Consol. Settl. (mm)	501 mm	710 mm	893 mm	1056 mm	1202 mm	1202 mm
Total Settlement (mm) (*)	523 mm	743 mm	936 mm	1110.3 mm	1267 mm	1267 mm
Final Height above O.G.S. (m)	1.477 m	2.257 m	3.064 m	3.8897 m	4.733 m	4.733 m

Time (days)	% Consolidation (months)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	63	1.937	91	2.909	116	3.884	141	4.859	164	5.836	164	5.836
15	0.50	98	1.902	140	2.860	178	3.822	214	4.786	247	5.753	247	5.753
30	1.00	132	1.868	188	2.812	239	3.761	286	4.714	328	5.672	328	5.672
45	1.50	152	1.848	218	2.782	275	3.725	329	4.671	378	5.622	378	5.622
60	2.00	159	1.841	228	2.772	288	3.712	344	4.656	394	5.606	394	5.606
120	4.00	193	1.807	276	2.724	348	3.652	415	4.585	476	5.524	476	5.524
240	8.00	235	1.765	335	2.665	423	3.577	503	4.497	576	5.424	576	5.424
360	12.00	262	1.738	373	2.627	471	3.529	580	4.440	641	5.359	641	5.359
480	16.00	290	1.710	412	2.588	520	3.480	618	4.382	707	5.293	707	5.293
600	20.00	317	1.683	451	2.549	569	3.431	676	4.324	773	5.227	773	5.227
720	24.00	338	1.662	480	2.520	606	3.394	720	4.280	822	5.178	822	5.178

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	2	3	4	5	6	6
Final Height above O.G.S. (m)						
1.477	> maximum time above	> maximum time above	> 16.00	> 8.00	> 4.00	> 4.00
2.257		> maximum time above	> maximum time above	> maximum time above	> 16.00	> 16.00
3.064			> maximum time above	> maximum time above	> maximum time above	> maximum time above
3.8897				> maximum time above	> maximum time above	> maximum time above
4.733					> maximum time above	> maximum time above
4.733						> maximum time above

TABLE B12

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+800 - Hwy 11 - BH23FP - W=60m  
Most Likely Pre-Consolidation Pressures**

Initial Fill Height (m)	3 m	4 m	5 m	6 m	7 m	7 m
Immediate Settlement (mm)	21 mm	27 mm	34 mm	41 mm	48 mm	48 mm
Primary Consol. Settl. (mm)	60 mm	96 mm	116 mm	228 mm	293 mm	293 mm
Total Settlement (mm) (*)	81 mm	123 mm	150 mm	269 mm	341 mm	341 mm
Final Height above O.G.S. (m)	2.919 m	3.877 m	4.85 m	5.731 m	6.659 m	6.659 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	36.4	43	2.957	62	3.938	76	4.924	124	5.876	155	6.845	155	6.845
15	0.50	59.1	56	2.944	84	3.916	103	4.897	176	5.824	221	6.779	221	6.779
30	1.00	72.7	65	2.935	97	3.903	118	4.882	207	5.793	261	6.739	261	6.739
45	1.50	86.4	73	2.927	110	3.890	134	4.866	238	5.762	301	6.699	301	6.699
60	2.00	90.9	76	2.924	114	3.886	139	4.861	248	5.752	314	6.686	314	6.686
120	4.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
240	8.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
360	12.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
480	16.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
600	20.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659
720	24.00	100	81	2.919	123	3.877	150	4.850	269	5.731	341	6.659	341	6.659

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	3	4	5	6	7	7
Final Height above O.G.S. (m)	Approximate Time for 100% Consolidation (months)					
2.919	> 24.00	> 0.17	> 0.17	#N/A	#N/A	#N/A
3.877		> 24.00	> 1.00	#N/A	#N/A	#N/A
4.85			> 24.00	> 0.17	#N/A	#N/A
5.731				> 24.00	> 1.00	> 1.00
6.659					> 24.00	> 24.00
6.659						> 24.00

TABLE B13

**HIGHWAY 11 - TROUT CREEK BY-PASS  
SOUTH INTERCHANGE - SURCHARGE ANALYSIS  
Station 8+800 - Hwy 11 - BH23FP - W=60m  
Reduced Pre-Consolidation Pressures**

Initial Fill Height (m)	3 m	4 m	5 m	6 m	7 m	7 m
Immediate Settlement (mm)	21 mm	27 mm	34 mm	41 mm	48 mm	48 mm
Primary Consol. Settl. (mm)	342 mm	440 mm	537 mm	622 mm	697 mm	697 mm
Total Settlement (mm) (*)	363 mm	467 mm	571 mm	663 mm	745 mm	745 mm
Final Height above O.G.S. (m)	2.637 m	3.533 m	4.429 m	5.337 m	6.255 m	6.255 m

Time (days)	Time (months)	% Consolidation U%	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)	Settlement (mm)	Height Above O.G.S. (m)
5	0.17	58.3	220	2.780	284	3.716	347	4.653	404	5.596	454	6.546	454	6.546
15	0.50	80	295	2.705	379	3.621	464	4.536	539	5.461	606	6.394	606	6.394
30	1.00	90	329	2.671	423	3.577	517	4.483	601	5.399	675	6.325	675	6.325
45	1.50	95	346	2.654	445	3.555	544	4.456	632	5.368	710	6.290	710	6.290
60	2.00	98.3	357	2.643	460	3.540	562	4.438	652	5.348	733	6.267	733	6.267
120	4.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
240	8.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
360	12.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
480	16.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
600	20.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255
720	24.00	100	363	2.637	467	3.533	571	4.429	663	5.337	745	6.255	745	6.255

Note: (\*) Does not include settlements due to secondary consolidation

**Summary of Surcharge Requirements**

Initial Fill Height (m)	3	4	5	6	7	7
Final Height above O.G.S. (m)						
2.637	> 24.00	> 0.17	> 0.17	#N/A	#N/A	#N/A
3.533		> 24.00	> 0.50	> 0.17	> 0.17	> 0.17
4.429			> 24.00	> 0.50	> 0.17	> 0.17
5.337				> 24.00	> 0.50	> 0.50
6.255					> 24.00	> 24.00
6.255						> 24.00



TABLE B14

**HIGHWAY 11 - TROUT CREEK BY PASS - SOUTH INTERCHANGE  
WICK DRAIN DESIGN ASSUMPTIONS**

Site Location	Test Hole	Ch (m <sup>2</sup> /y)	Cv (m <sup>2</sup> /y)	Embankment Load (kPa)	Wick Drain Drainage Length (m)	Disturbance Ratios		Discharge Capacity q <sub>w</sub> (m <sup>3</sup> /s)
						Diameter Ratio (s)	Permeability Ratio (k <sub>c</sub> /k <sub>c</sub> )	
West & East Abutments	CPTUS1	173	35	260	8.5	3	3	1.00E-05
East Approach	CPTUS3	142	28	230	8	3	3	1.00E-05
EW-N Ramp	CPTUS5	137	27	120	12	3	3	1.00E-05

Site Location	Target Percentage Consolidation and Time					
	Schedule 1		Schedule 2		Schedule 3	
	After Stage 1	After Stage 2	After Stage 1	After Stage 2	After Stage 1	After Stage 2
West & East Abutments	50% in 1 month	100% in 12 months	50% before Stage 2	100% in 12 months	50% before Stage 2	100% in 6 months
East Approach	75% in one month	100% in 12 months	75% before Stage 2	100% in 12 months	75% before Stage 2	100% in 6 months
EW-N Ramp	100% in 12 months		100% in 12 months		100% in 6 months	

**Schedule 1:**            2 months: Site preparation (includes installation of wick drains)  
                              3 months: Embankment Construction  
                              12 months: Waiting period for stabilization of settlements

**Schedule 2:**            Embankment construction and stabilization of settlements in 12 months

**Schedule 3:**            Embankment construction and stabilization of settlements in 6 months

TABLE B15

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Most Likely Pc

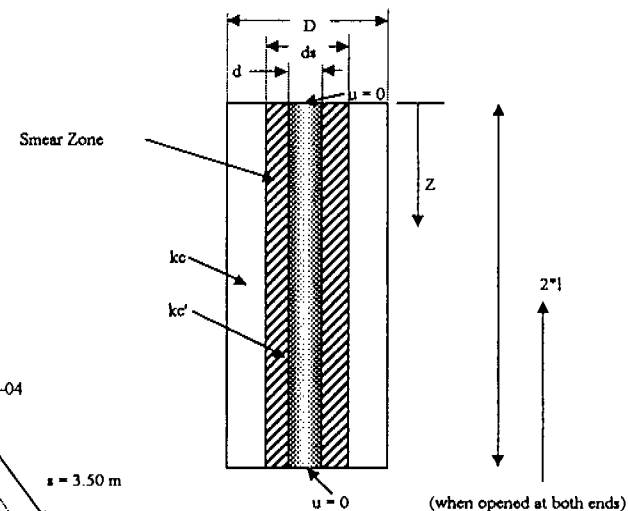
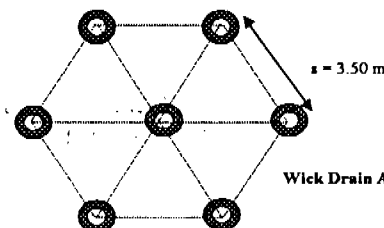
## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	5.49E-06	$m^2/s$	consider reducing $C_H$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	1.10E-06	$m^2/s$	determined by the oedometer test		
$\lambda$	1.10E-06	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_c$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$ 5.00E-03 ;well resistance cannot be ignored if $k_c/q_w > 3.33E-04$		
l	8.50	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL  
 260.00 kPa  
 4.00 m  
 492 mm  
 56 (D/d; should always be >12)  
 0.3759384 f(D/d); regression from Figure 3 of the paper

Uv target: 50 %  
 Target Time (days): 30 days  
 Time for Drainage Path: 30 days



Time Increment for table below =  
 Resultant Maximum Time =

0.17 month  
 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.67	1.17
90	1.17	1.83
98	2.17	3.00

TABLE B16

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS1 - West Abutment - Station 9+760 - Most Likely Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	$s = 3.50$ m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	5.49E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	1.10E-06	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	5.49E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	260.00	kPa		
Drainage Path (m)	4.00	m		
Settlement due to Primary Consolidation	492	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below = 0.17 month  
Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.83	1.33
90	1.50	2.83
98	3.00	8.00

TABLE B17

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Reduced Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	5.49E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	1.10E-06	$m^2/s$	determined by the oedometer test		
$\lambda$	1.10E-06	$m^2/s$	$\approx k_s/(\gamma_w \cdot m_v)$ , or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_u$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_u/k'_s =$	3.00	
$q_w$	1.00E-05	$m^2/s$	drain discharge capacity; $k_u/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_u/q_w > 3.33E-04$
l	8.50	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 n  
 $\alpha$

ML-CL  
 260.00 kPa  
 4.00 m  
 890 mm  
 56 (D/d; should always be >12)  
 0.3759384 f(D/d); regression from Figure 3 of the paper

Uv target: 50 %  
 TargetTime (days): 30 days  
 Time for Drainage Path: 30 days

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.47
75	0.67	1.17
90	1.17	1.83
98	2.17	3.00

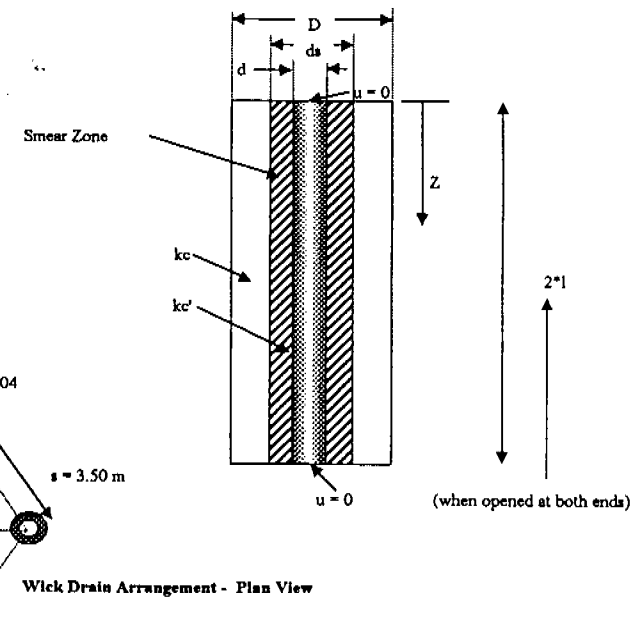


TABLE B18

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS1- West Abutment - Station 9+760 - Reduced Pc

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_h$	5.49E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	1.10E-06	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	5.49E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	260.00	kPa		
Drainage Path (m)	4.00	m		
Settlement due to Primary Consolidation	890	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below = 0.17 month  
Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
50	0.33	0.67
75	0.83	1.33
90	1.50	2.83
98	3.00	8.00

TABLE B19

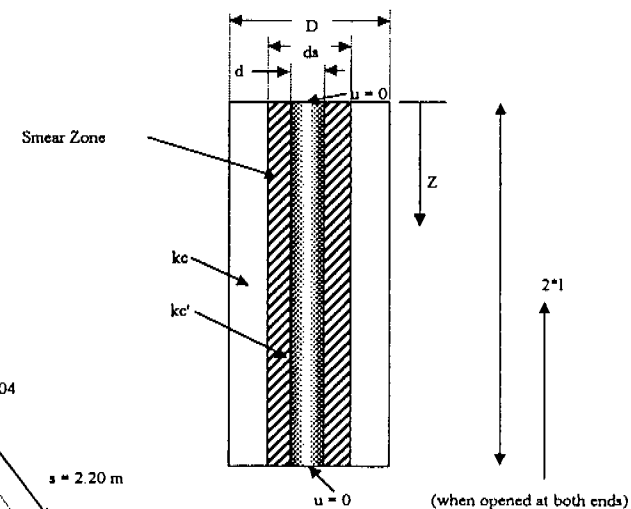
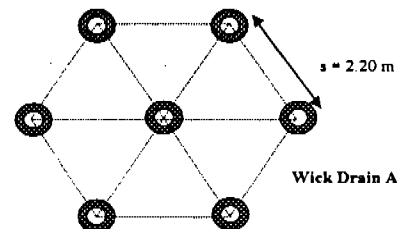
**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Soult Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
 Consolidation Requirement: 40% in 1 month and 100% in 2 months

**INPUT PARAMETERS**

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	2.20	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	35.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ , or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_s$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$ 5.00E-03 ;well resistance cannot be ignored if $k_c/q_w > 3.33e-04$		
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	230.00	kPa	Uv target:	50 %	
Drainage Path (m)	4.50	m	TargetTime (days):	50 days	
Settlement due to Primary Consolidation	480	mm	Time for Drainage Path:	50 days	
n	36	(D/d; should always be >12)			
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper)			

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months



% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.17	0.17
75	0.50	0.50
90	0.67	0.83
98	1.17	1.33

TABLE B20

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: Souht Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 2.20 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_R/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	480	mm		
n	36		(D/d; should always be >12)	
$\alpha$	0.3411297		$f(D/d)$ ; regression from Figure 3 of the paper)	
Time Increment for table below =	0.17	month		
Resultant Maximum Time =	10.17	months		

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.17	0.17
75	0.50	0.50
90	0.83	1.17
98	2.00	3.00

TABLE B21

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

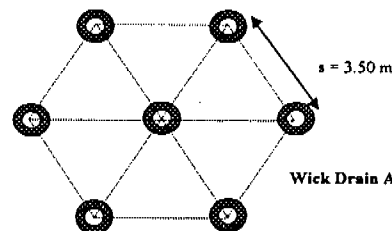
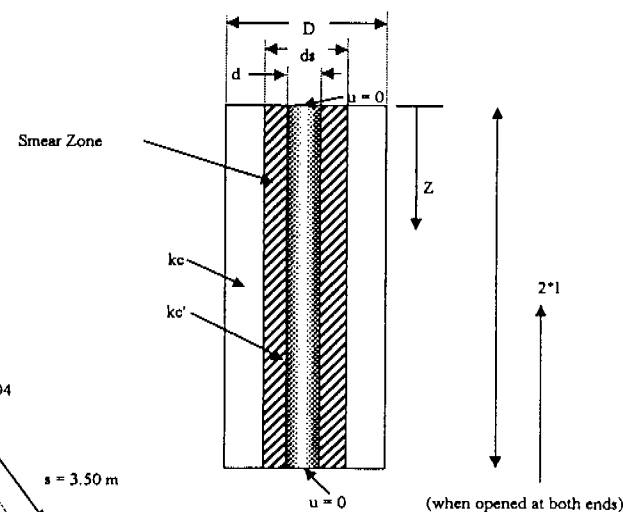
Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely  $P_c$   
 Consolidation Requirement: 75% in 1 month

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear, $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_v/(\gamma_w \cdot m_v)$ , or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_v$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone, $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$ 5.00E-03 ; well resistance cannot be ignored if $k_c/q_w > 3.33e-04$		
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	230.00	kPa	$U_v$ target:	50 %	
Drainage Path (m)	4.50	m	TargetTime (days):	50 days	
Settlement due to Primary Consolidation	480	mm	Time for Drainage Path:	50 days	
n	56	(D/d; should always be $>12$ )			
$\alpha$	0.3759384	$f(D/d)$ , regression from Figure 3 of the paper			

Time Increment for table below =  
 Resultant Maximum Time =

0.17 month  
 10.17 months



Wick Drain Arrangement - Plan View

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
40	0.33	0.50
75	0.83	1.33
90	1.50	2.17
98	2.67	3.50



TABLE B22

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: Souht Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Most Likely Pc  
Consolidation Requirement: 75% in 1 month

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	$s = 3.50$ m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_H$ to account for smear; $C_H/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_H$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	480	mm		
n	56	(D/d; should always be >12)		
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below = 0.17 month  
Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	U <sub>v</sub> and U <sub>h</sub>	U <sub>h</sub> only
40	0.33	0.50
75	1.00	1.83
90	2.00	3.67
98	4.33	more than maximum time entered

TABLE B23

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
 Consolidation Requirement: 40% in 1 month and 100% in 2 months

**INPUT PARAMETERS**

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	2.20	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	35.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_w/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = ds/d =$	3	
$k_s$	5.00E-08	m/s	undisturbed soil permeability		
$k'_s$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	well resistance cannot be ignored if $k_c/q_w > 3.33e-04$
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		
Layer	ML-CL				
Surcharge (kPa)	230.00	kPa	$U_v$ target:	50 %	
Drainage Path (m)	4.50	m	Target Time (days):	50 days	
Settlement due to Primary Consolidation	1030	mm	Time for Drainage Path:	50 days	
n	36				
$\alpha$	0.3411297				

$(D/d, \text{ should always be } > 12)$   
 $0.3411297 \text{ } f(D/d), \text{ regression from Figure 3 of the paper}$

Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	$U_v$ and $U_h$	$U_h$ only
40	0.33	0.17
75	0.50	0.50
90	0.67	0.83
98	1.17	1.33

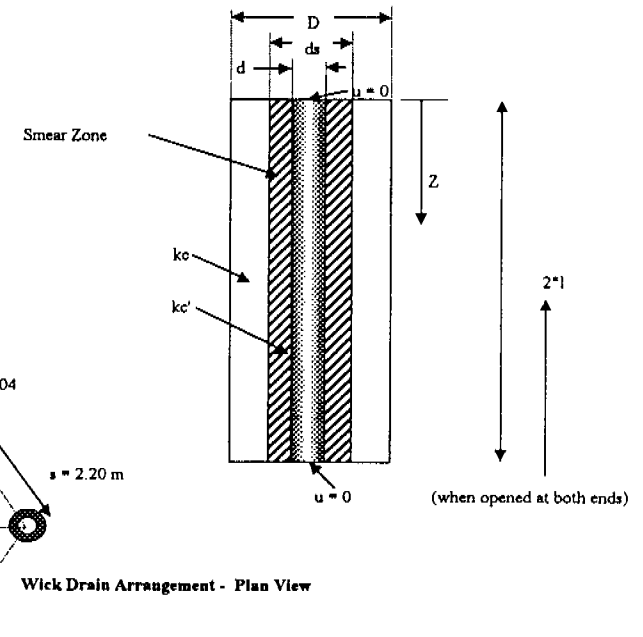


TABLE B24

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
Consolidation Requirement: 40% in 1 month and 100% in 2 months

## INPUT PARAMETERS

D	2.31	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 2.20 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	1030	mm		
n	36	(D/d; should always be >12)		
$\alpha$	0.3411297	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below =

0.17 month

Resultant Maximum Time =

10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.17	0.17
75	0.50	0.50
90	0.83	1.17
98	2.00	3.00

TABLE B25

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
 Consolidation Requirement: 75% in 1 month and 100% in 12 months

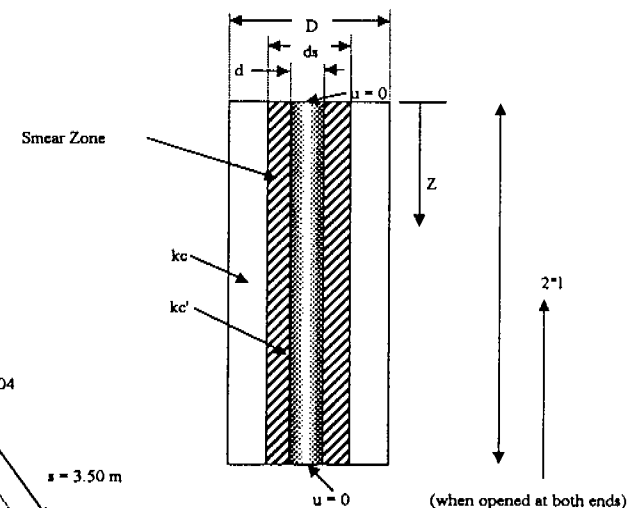
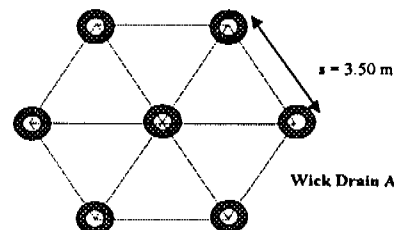
## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.50E-06	$m^2/s$	consider reducing $c_k$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	9.01E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	9.01E-07	$m^2/s$	$=k_s/(y_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_c$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_c/q_w > 3.33e-04$
l	8.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL  
 230.00 kPa  
 4.50 m  
 1030 mm  
 56 (D/d; should always be >12)  
 0.3759384 (D/d); regression from Figure 3 of the paper

Uv target: 50 %  
 TargetTime (days): 50 days  
 Time for Drainage Path: 50 days



Time Increment for table below = 0.17 month  
 Resultant Maximum Time = 10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.33	0.50
75	0.83	1.33
90	1.50	2.17
98	2.67	3.50

TABLE B26

**NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988**  
 (combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"

Ground Engineering, Vol.12 No.5, 1979

Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
 Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS3- Boundary Road - Station 8+310 - Reduced Pc  
 Consolidation Requirement: 75% in 1 month and 100% in 12 months

**INPUT PARAMETERS**

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.50E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	9.01E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.50E-07	m <sup>2</sup> /s	$=k_r/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	230.00	kPa		
Drainage Path (m)	4.50	m		
Settlement due to Primary Consolidation	1030	mm		
n	56	(D/d; should always be >12)		
$\alpha$	0.3759384	f(D/d); regression from Figure 3 of the paper)		

Time Increment for table below =

0.17 month

Resultant Maximum Time =

10.17 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.33	0.50
75	1.00	1.83
90	2.00	3.67
98	4.33	more than maximum time entered

TABLE B27

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

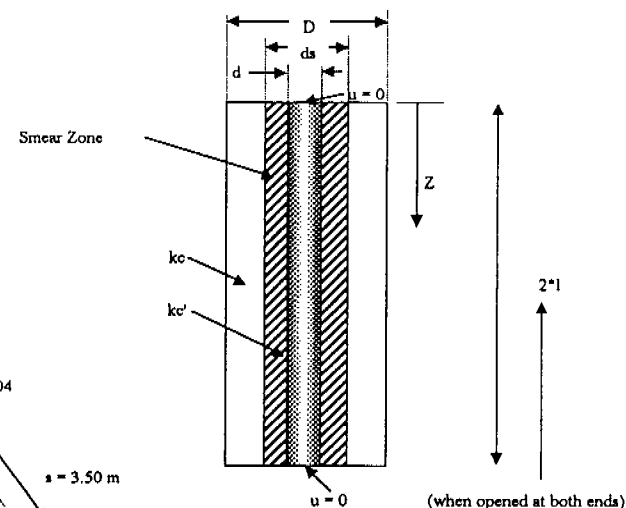
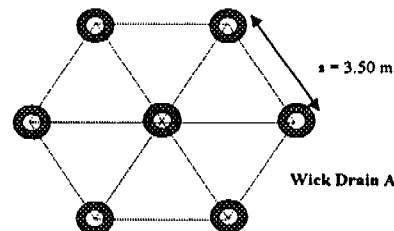
Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: South Interchange  
 Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Most Likely Pc  
 Consolidation Requirement: 100% in one year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.34E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	8.69E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	8.69E-07	$m^2/s$	$=k_s/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s=d_s/d =$	3	
$k_c$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_c/q_w > 3.33e-04$
l	12.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL			Uv target:	50 %
120.00	kPa		TargetTime (days):	220 days
9.30	m		Time for Drainage Path:	220 days
331	mm			
56	(D/d, should always be >12)			
0.3759384	R(D/d); regression from Figure 3 of the paper)			



Time Increment for table below =  
 Resultant Maximum Time =

0.33 month  
 20.33 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.67	0.67
75	1.33	1.67
90	2.33	2.67
98	3.67	4.33

TABLE B28

NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988  
(combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
Ground Engineering, Vol.12 No.5, 1979  
Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
Title: Highway 11 - Trout Creek By-Pass  
Case: South Interchange  
Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Most Likely Pc  
Consolidation Requirement: 100% in one year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.34E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	8.69E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.34E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w \cdot m_v)$ ; for Piezocone $\gamma = 0.1 \cdot C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	120.00	kPa		
Drainage Path (m)	9.30	m		
Settlement due to Primary Consolidation	331	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below =

0.25 month

Resultant Maximum Time =

15.25 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.50	0.75
75	2.00	2.50
90	3.75	5.50
98	9.25	14.75

TABLE B29

**NEW HANSBO METHOD (combined with Lambe & Whitman's book) recommendations**  
**"Consolidation of Clay by Band-Shaped Prefabricated Drains"**  
**Ground Engineering, Vol.12 No.5, 1979**  
**Formulation according to Equation 1 - Including well resistance and smearing**

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Reduced  $P_c$   
 Consolidation Requirement: 100% in 1 year

## INPUT PARAMETERS

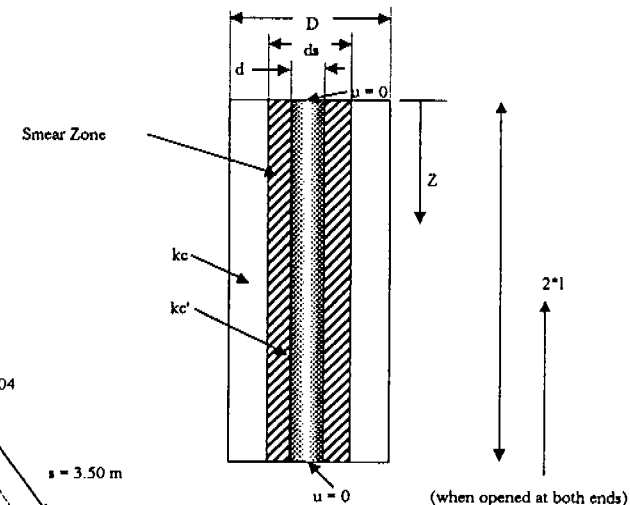
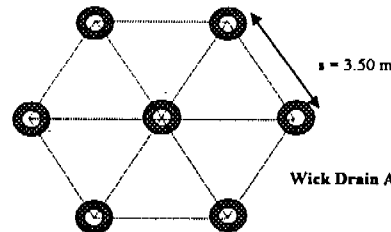
D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing equal to, $s =$	3.50	m)
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$ ; $n =$	56.5	
$C_H$	4.34E-06	$m^2/s$	consider reducing $c_h$ to account for smear; $C_H/C_v$ is often 2 to 5		
$C_v$	8.69E-07	$m^2/s$	determined by the oedometer test		
$\lambda$	8.69E-07	$m^2/s$	$=k_w/(\gamma_w \cdot m_v)$ ; or $\lambda = C_v$ obtained from the oedometer test (Hansbo 1979)		
$d_s$	0.20	m	diameter of the smear zone (typically equal to 1.5 to 3 times d); $s = d_s/d =$	3	
$k_u$	5.00E-08	m/s	undisturbed soil permeability		
$k'_c$	1.67E-08	m/s	soil permeability within the smear zone; $k_c/k'_c =$	3.00	
$q_w$	1.00E-05	$m^3/s$	drain discharge capacity; $k_c/q_w =$	5.00E-03	; well resistance cannot be ignored if $k_c/q_w > 3.33E-04$
l	12.00	m	length of the drain when open at one end only		
			half length of the drain when open at both ends		

Layer  
 Surcharge (kPa)  
 Drainage Path (m)  
 Settlement due to Primary Consolidation  
 $n$   
 $\alpha$

ML-CL

120.00 kPa  
 11.80 m  
 734 mm  
 56 (D/d; should always be >12)  
 0.3759384 f(D/d); regression from Figure 3 of the paper

Uv target: 50 %  
 Target Time (days): 350 days  
 Time for Drainage Path: 352.5 days



Time Increment for table below = 0.25 month  
 Resultant Maximum Time = 15.25 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.50	0.75
75	1.25	1.50
90	2.25	2.50
98	3.75	4.25



TABLE B30

**NEW HANSBO METHOD ACCORDING TO ROBERTSON & CAMPANELLA 1988**  
 (combined with Lambe & Whitman's book recommendations)

Hansbo 1979, "Consolidation of Clay by band-shaped prefabricated drains"  
 Ground Engineering, Vol.12 No.5, 1979  
 Formulation according to Equation 2 - No well resistance

Robertson and Campanella, 1988, "Prediction of wick drain performance using piezometer cone data"  
 Canadian Geotechnical Journal, 25, 56-61 (1988)

Job Number: 19-1104-4  
 Title: Highway 11 - Trout Creek By-Pass  
 Case: Souht Interchange  
 Sub-case: Test Hole CPTUS5-EW-N Ramp - Station 8+500; Reduced Pc  
 Consolidation Requirement: 100% in 1 year

## INPUT PARAMETERS

D	3.67	m	diameter of dewatered soil cylinder (Triangular Spacing)	s = 3.50 m
d	0.065	m	equivalent diameter of band-shaped drain: $2(b+t)/\pi$	
$C_H$	4.34E-06	m <sup>2</sup> /s	consider reducing $C_h$ to account for smear; $C_h/C_v$ is often 2 to 5	
$C_v$	8.69E-07	m <sup>2</sup> /s	determined by the oedometer test	
$\lambda$	4.34E-07	m <sup>2</sup> /s	$=k_h/(\gamma_w * m_v)$ ; for Piezocone $\gamma = 0.1 * C_h$ (Robertson & Campanella, 1988)	
Layer	ML-CL			
Surcharge (kPa)	120.00	kPa		
Drainage Path (m)	11.80	m		
Settlement due to Primary Consolidation	734	mm		
n	56		(D/d; should always be >12)	
$\alpha$	0.3759384		f(D/d); regression from Figure 3 of the paper)	

Time Increment for table below = 0.25 month  
 Resultant Maximum Time = 15.25 months

% Consolidation	Time required (months)	
	Uv and Uh	Uh only
40	0.75	0.75
75	2.00	2.50
90	4.25	5.50
98	10.25	14.75

**TABLE B31**  
**HIGHWAY 11 - TROUT CREEK BY-PASS - SOUTH INTERCHANGE**  
**DESIGN RECOMMENDATIONS FOR DIFFERENT CONSTRUCTION SCHEDULES**

**Schedule 1:** 2 months: Site preparation (includes installation of wick drains)  
 3 months: Embankment Construction  
 12 months: Waiting period for stabilization of settlements

**Schedule 2:** Embankment construction and stabilization of settlements in 12 months

**Schedule 3:** Embankment construction and stabilization of settlements in 6 months

**Location:** H>6 m plus surcharge: Boundary Road: St. 9+800 to 12 m east of West Abutment and 12 m west of East Abutment to 10+140; E-S Ramp: 9+100 to 9+160  
 EW-N Ramp: Station < 8+380; SE-W Ramp: Station > 8+780; High embankments along Hwy 11, north of Sta. 8+960, do not require surcharge or wick drains  
**Surcharge:** 1.5 m  
**Berm Width:** 8 m  
**Berm Height:** 6 m below the pavement final design elevation

Construction Sequence	Height of embankment at this stage (H) for a certain Berm Height (BH)	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = 3.5 m	Wick Spacing = N/A	Wick Spacing = 3.0 m	
Stage 1	H=0 to 9.5 m for BH>4m H=0 to 9.0 for BH=3m H=0 to 8.5 for BH=2m H=0 to 8.0 for BH=1m H=0 to 7.5 for BH=0m	0 to 5 weeks	0 to 5 weeks	0 to 5 weeks	No EPP Requirement
Stage 2	Wait - No construction	5 to 9 weeks	5 to 13 weeks	5 to 7 weeks	-
Stage 3	Complete Embankment to top of surcharge	9 to 10 weeks	13 to 14 weeks	7 to 8 weeks	40 kPa
Stage 4	Wait - No construction	10 to 28 weeks	14 to 52 weeks	8 to 21 weeks	-
Stage 5	Trim to Final Elevation	Start after 28 weeks	Start after 52 weeks	Start after 21 weeks	0 kPa

**Location:** 6m>H>4m plus surcharge: Boundary Road: 10+140 to 10+210; EW-N Ramp: 8+380 to 8+450; SE-W Ramp: 8+780 to 8+720  
 Embankments 4 m to 6 m high in the area north of the bridge along Hwy 11 should include surcharge but no wick drains  
**Surcharge:** 1.2 m  
**Berm Height:** None

Construction Sequence	Description	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = 3.5 m	Wick Spacing = 3.5 m	Wick Spacing = 2.5 m	
Stage 1	Complete Embankment to top of surcharge	0 to 4 weeks	0 to 4 weeks	0 to 4 weeks	No EPP Requirement
Stage 2	Wait - No construction	4 to 45 weeks	4 to 45 weeks	4 to 24 weeks	-
Stage 3	Trim to Final Elevation	Start after 45 weeks	Start after 45 weeks	Start after 24 weeks	0 kPa

**Location:** H<4m plus surcharge: Boundary Road: Stations < 10+210; EW-N Ramp: > 8+450; SE-W Ramp: < 8+720  
**Surcharge:** Refer to table below  
**Berm Height:** None

Construction Sequence	Description	Elapsed Time from Beginning of Construction			Monitoring Requirements: Maximum EPP before this stage
		Schedule 1	Schedule 2	Schedule 3	
		Wick Spacing = N/A	Wick Spacing = N/A	Wick Spacing = N/A	
		Surcharge = 1.2 m	Surcharge = 1.2 m	Surcharge = 2.2 m	
Stage 1	Complete Embankment to top of surcharge	0 to 2 weeks	0 to 2 weeks	0 to 2 weeks	No EPP Requirement
Stage 2	Wait - No construction	2 to 52 weeks	2 to 52 weeks	2 to 10 weeks	-
Stage 3	Trim to Final Elevation	Start after 52 weeks	Start after 52 weeks	Start after 10 weeks	0 kPa

Note: (\*) Trimming to final elevation can only be carried out after both EPP and settlements due to primary consolidation have stabilized within 2% of the value assessed according to the Rectangular Hyperbola Method (refer to text)



**APPENDIX C**

**ConeTec Report**

**(South Interchange Testholes Only)**

**PRESENTATION OF CONE PENETRATION TEST DATA,  
Trout Creek Interchanges**

**Trout Creek, Ontario**

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**Prepared for:**

**Thurber Engineering Ltd.  
Etobicoke, Ontario**

**Prepared by:**

**CONETEC INVESTIGATIONS LTD.**

**March 31, 1999**

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Appendix B CPT Interpretations

Appendix C Summary of Dissipations and Pore Pressure Plots

## 1.0 INTRODUCTION

This report presents the results of a cone penetration testing (CPT) program carried out at the location of the South and North Trout Creek Interchanges, near Trout Creek, Ontario. A total of 10 CPT's with pore pressure dissipation tests were performed for this investigation, with 5 CPTs at each of the south and north interchange sites between the period of March 25<sup>th</sup> and March 26<sup>th</sup>, 1999.

## 2.0 FIELD EQUIPMENT AND PROCEDURES

### 2.1 CPT Procedures

The cone penetration tests (CPT's) were carried out by **ConeTec Investigations Ltd.** of Vancouver, B.C. using an integrated electronic cone system. A 20 ton compression type cone was used for all of the soundings. The 20 ton cone has a tip area of 15 sq cm and friction sleeve area of 225 sq cm. A piezometer element 6 mm thick is located immediately behind the cone tip. The compression cones are designed with an equal end area friction sleeve and a tip end area ratio of 0.85. The cone system used during the program recorded the following parameters at 2.5 cm depth increments:

- Tip Resistance (Qc) in bars
- Sleeve Friction (Fs) in bars
- Dynamic Pore Pressure (Ut) in metres of water

The above parameters were printed simultaneously on a printer and stored on digital media for future analysis and reference.

The porous plastic pore pressure element was located directly behind the cone tip. Each of the elements were saturated in glycerin under vacuum pressure prior to penetration. Pore pressure dissipations were recorded at 5 second intervals during all pauses in the penetration.

A complete set of baseline readings were taken prior to and after each sounding to determine if any zero load offsets had occurred due a temperature change of the probe. Establishing the presence of temperature shifts and load offsets enables the operator to make corrections to the cone data if necessary. These corrections can be important, especially where the load conditions are relatively low, and generally are the single largest source of error with respect to the accuracy of cone data. Since the probes are temperature compensated, load shifts due to changes in probe

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temperature are only a problem when there are extreme temperature changes from before the test is started and while the probe is in situ. For the testing done on this project keeping the cone within an operating temperature range that did not produce load offsets was not a problem. The cone was pushed using track mounted CME 75 provided by All Terrain Drilling. All CPTs were pushed to refusal.

The following is a list of the CPT names, test depths and water tables. The bracketed values in the water table column are from dissipation tests at refusal.

CPT File	CPT Test Name	Depth (m)	Water Table (m)
141cps1	CPT-S1	13.05	0.0 (-0.3)
141cps2	CPT-S2	9.75	0.0 (-0.05)
141cps3	CPT-S3	16.925	0.0 (-0.2)
141cps4	CPT-S4	15.275	0.0
141cps5	CPT-S5	22.075	0.0 (-0.3)
141cpn1	CPT-N1	12.10	0.0 (-0.3)
141cpn2	CPT-N2	17.325	0.0 (0.1)
141cpn3	CPT-N3	15.125	0.0 (0.0)
141cpn4	CPT-N4	19.925 (20.6) *	0.0 (-0.4)
141cpn5	CPT-N5	11.85 (12.55) *	0.0 (-0.45)

\* Pore pressure data at depths below recorded CPT Data (CPT data not recorded)

### 3.0 CONE PENETRATION TEST DATA

#### 3.1 CPT Data

The cone penetration test data is presented in graphical form in Appendix A following the text of this report. For each test there are two sets of plots. The first plot consists of Tip Resistance (Qt) in bars, Sleeve Friction (Fs) in bars, Pore Pressure (U) in metres of water, and Friction Ratio (Rf) plotted versus depth. The second plot consists of Qt, SPT N60, SPT (N1)/60, and Undrained Strength (Su) in kPa. The CPT data is also stored as ASCII text on the accompanying data disk. Penetration data is referenced to existing ground. Stratigraphic interpretations appears on the right side of both plot



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sets. The stratigraphic interpretation is based on a chart relating cone bearing  $Q_c$ , and sleeve friction  $F_s$  developed by Robertson et al, 1986 as shown in Figure 1. Detailed interpretations of the CPT data are included in Appendix B. A description of the interpretation methods is included at the end of Appendix B.

### 3.2 Pore Pressure Dissipation Test Results

Pore pressure dissipations were recorded during selected pauses in penetration for all CPTs tests. The pore pressure data was recorded at 5 second intervals. The pore pressure dissipation data for each CPT is included on the data disk. Pore pressure dissipation data in fine grained soils provides a good indication of the consolidation characteristics. Data from pore pressure dissipation tests in tabular format is presented in Appendix C. The coefficient of consolidation in the horizontal direction,  $c_{hr}$ , was calculated using the equation following equation.

$$c_h = \frac{T^* r^2 \sqrt{I_r}}{t}$$

where:

$T^*$	-	time constant = 0.245 for 50% dissipation
$r$	-	radius of the cone
$I_r$	-	Rigidity Index = $G/S_u$
$t$	-	time for dissipation

For all the dissipations the time for 50 percent dissipation was used to calculate  $c_h$ . A value of 200 for the rigidity index was used in all calculations. The resulting values of  $c_h$  ranged from 1.8 cm<sup>2</sup>/min to 110 cm<sup>2</sup>/min, with most values falling between 2 cm<sup>2</sup>/min to 9 cm<sup>2</sup>/min. Pore pressure dissipation tests in the highly permeable sand layer below the clayey silt reached equilibrium almost instantaneously. The equilibrium values of pore pressure indicate the water table was at the surface to about 0.3 above the surface.

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We trust that the information presented in this report is sufficient for your purposes. If you have any questions regarding the contents of this report, please do not hesitate to contact our office.

Yours truly,

**ConeTec Investigations Ltd.**

Per: 

**Ilmar Weemees, P.Eng.**

ref: 99-141.wpd

**ConeTec Investigations Ltd.**

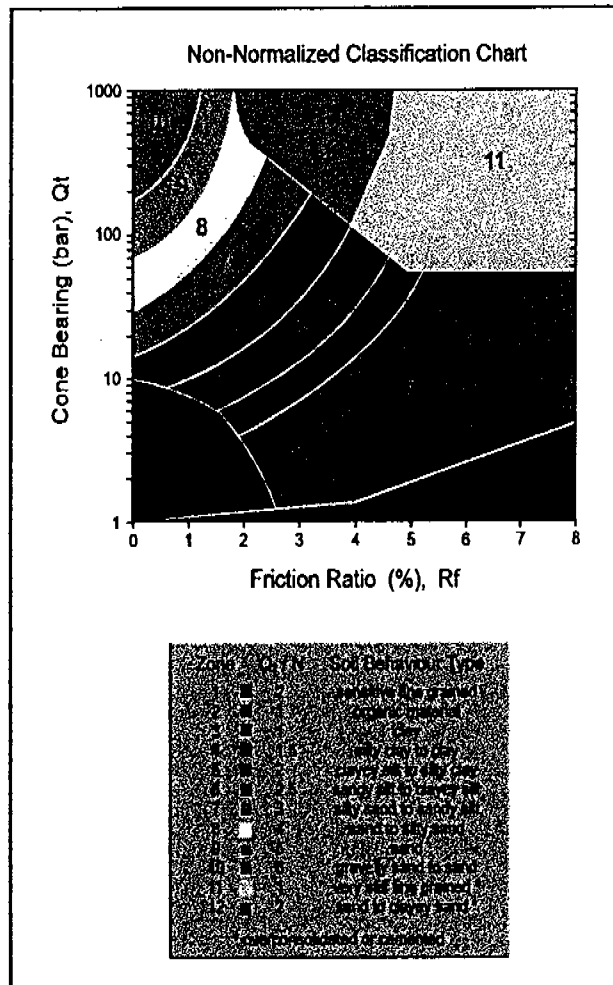


Figure 1. Soil Behaviour Type Classification Chart

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## APPENDIX A

CPT Plots

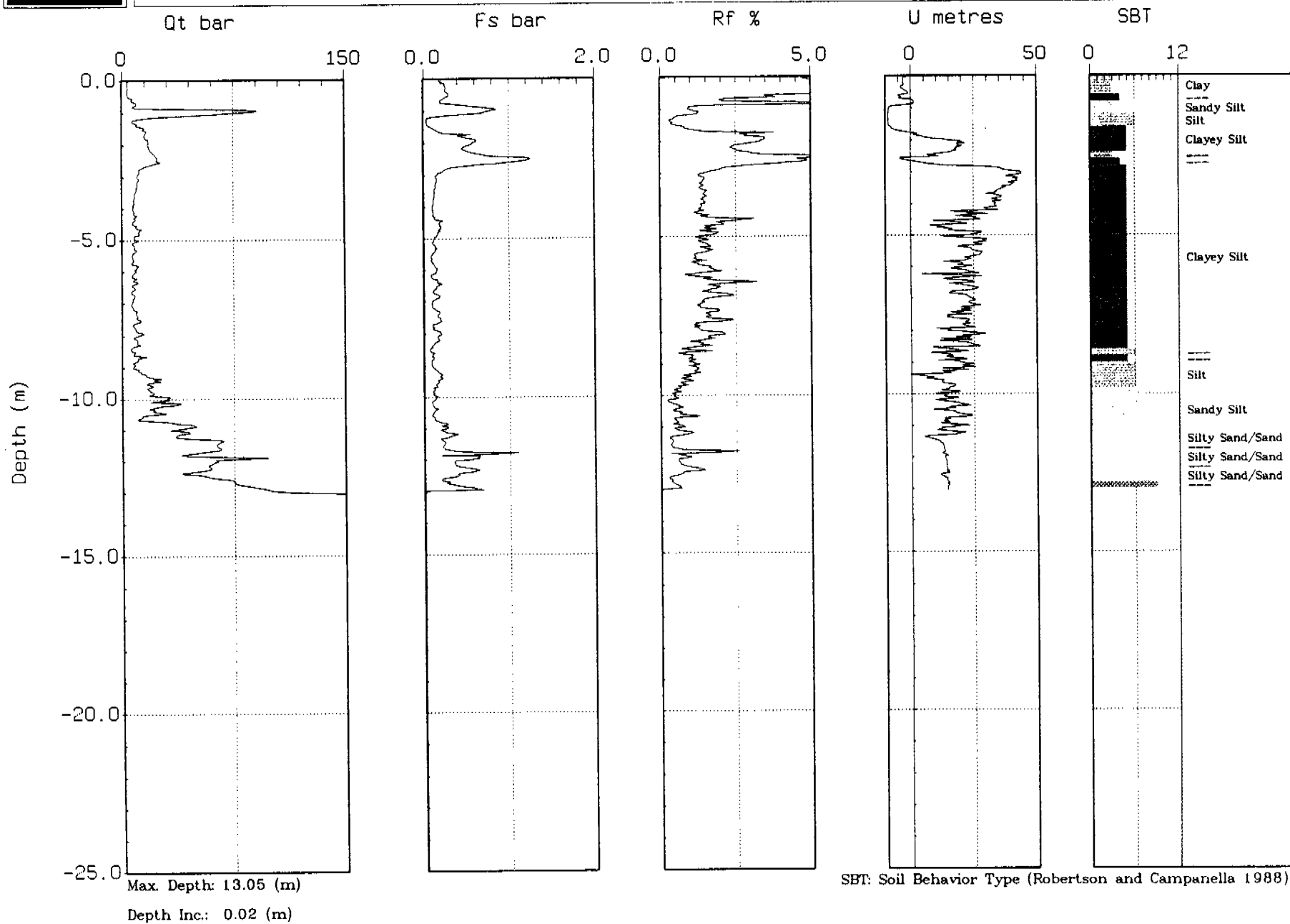
ConeTec Investigations Ltd.



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Site: 99-141 CPT-S1  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 09:11

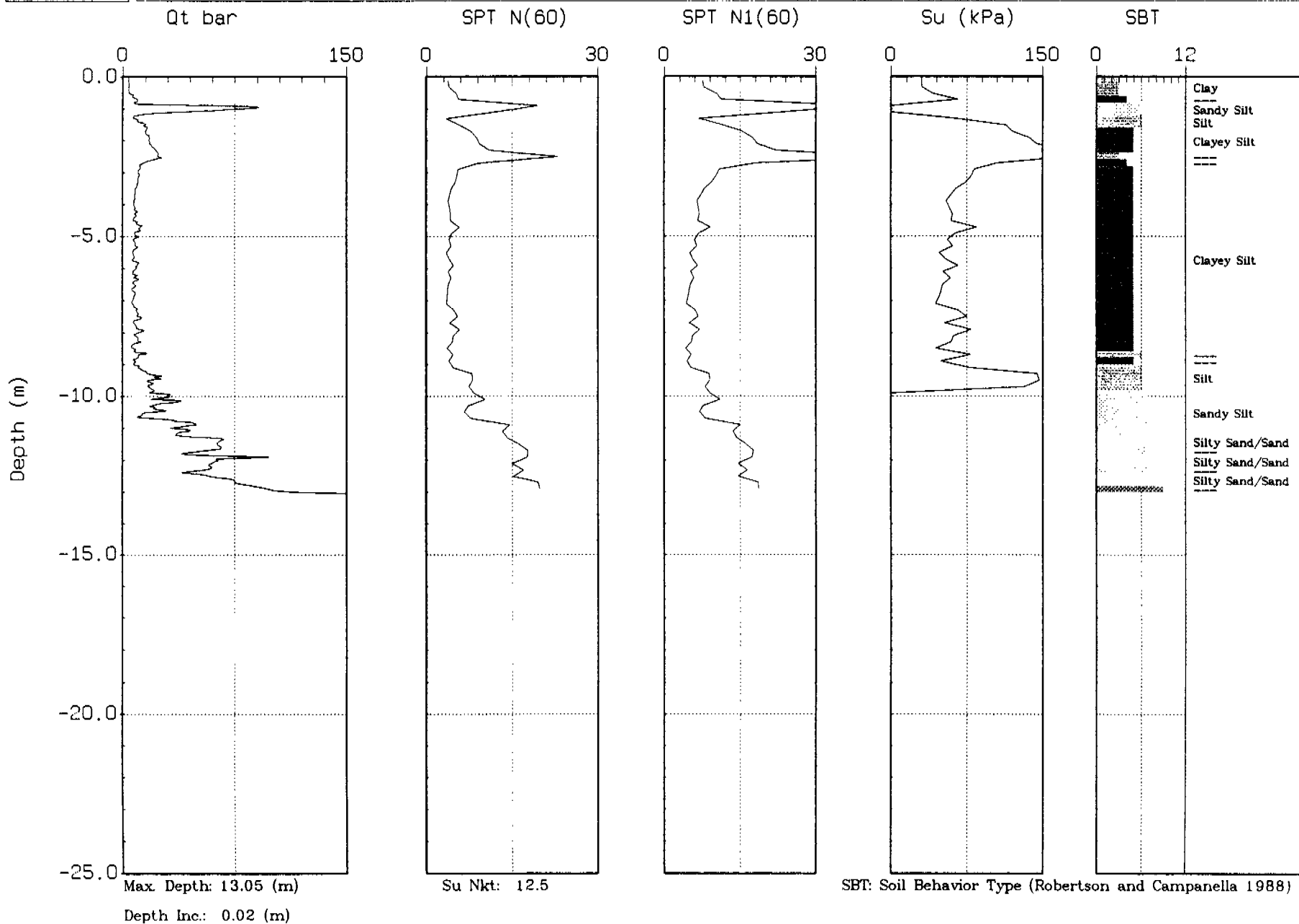




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Site: 99-141 CPT-S1  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

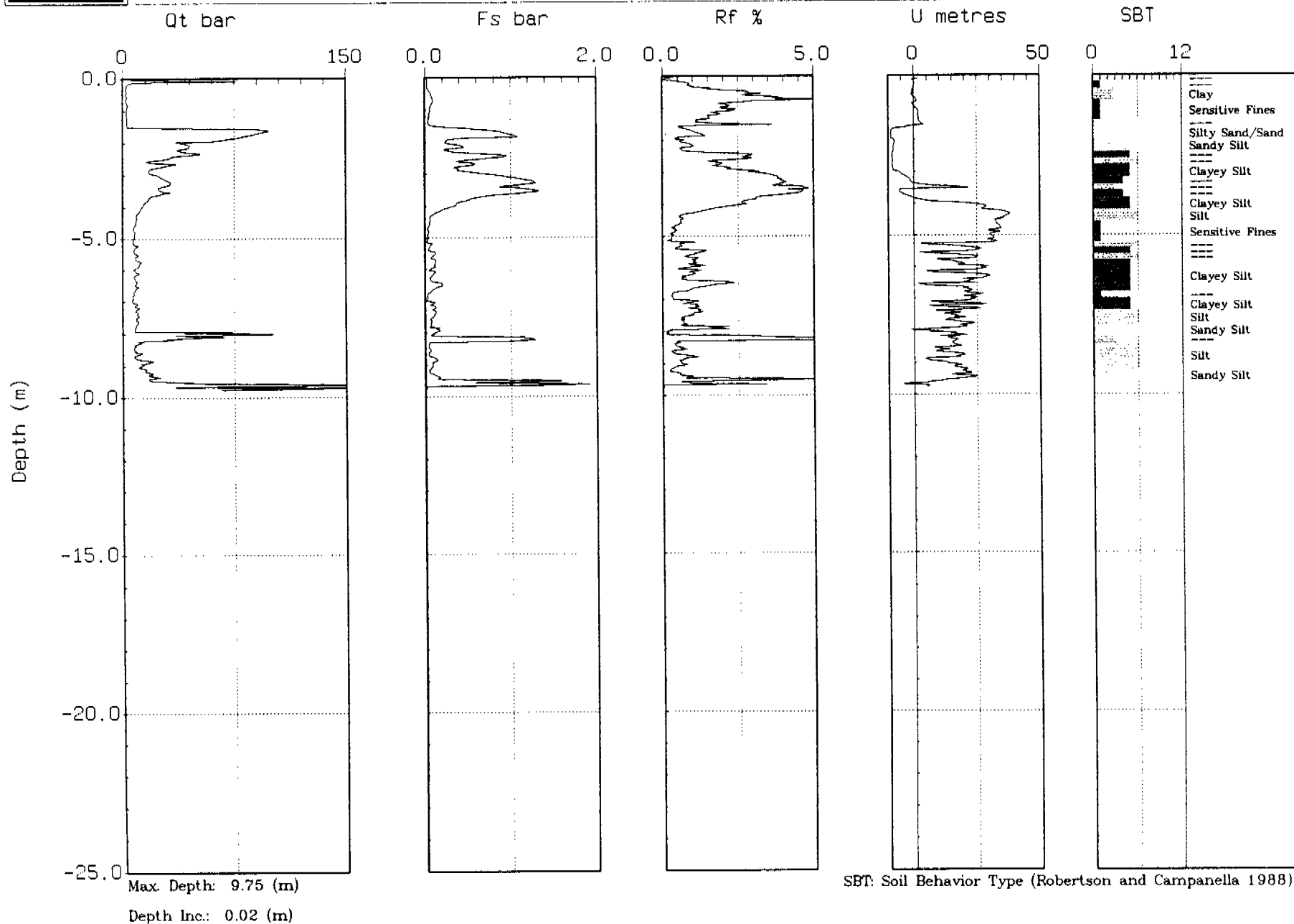




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Site: 99-141 CPT-S2  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

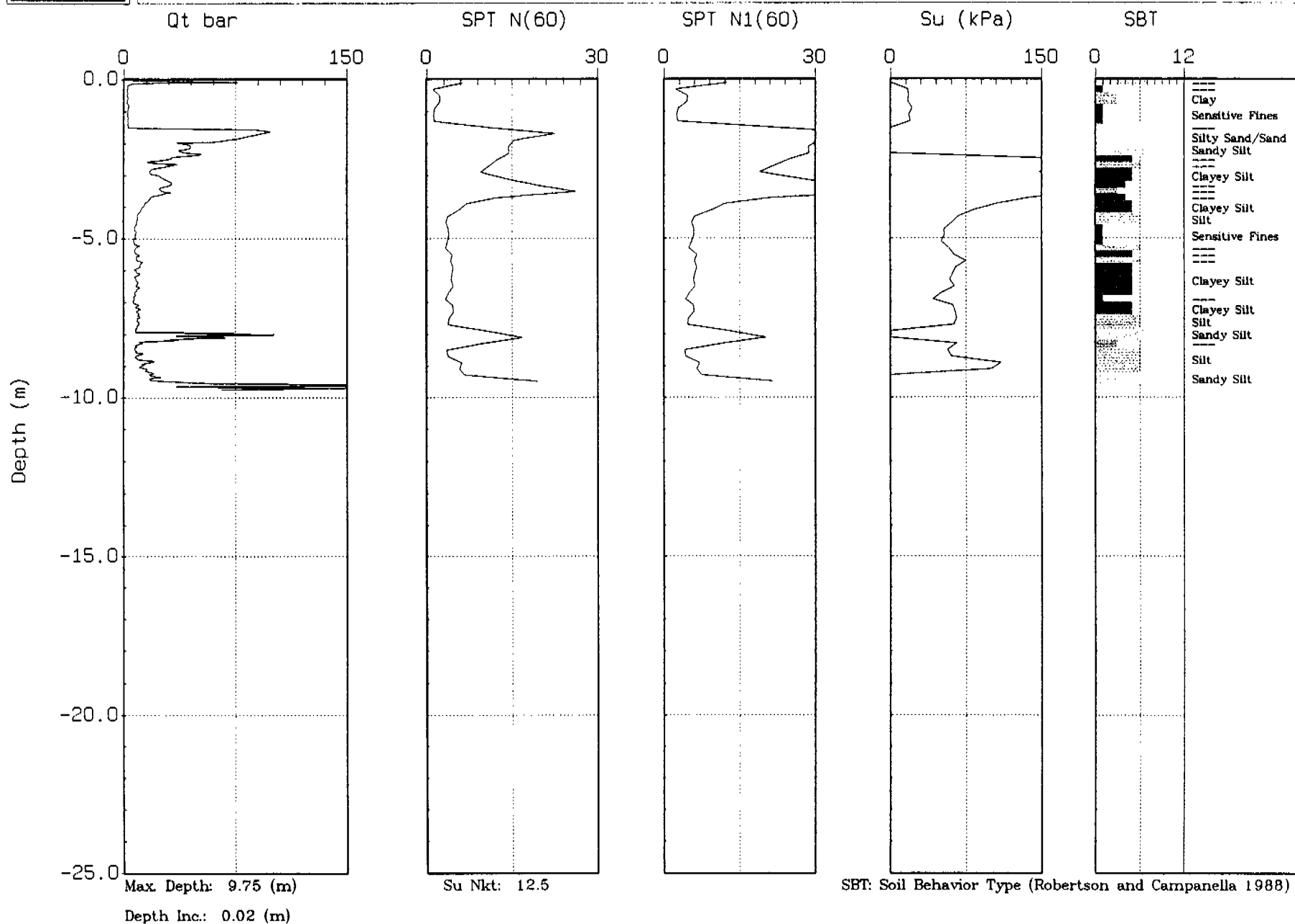




# Thurber Engineering

Site: 99-141 CPT-S2  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 11:29



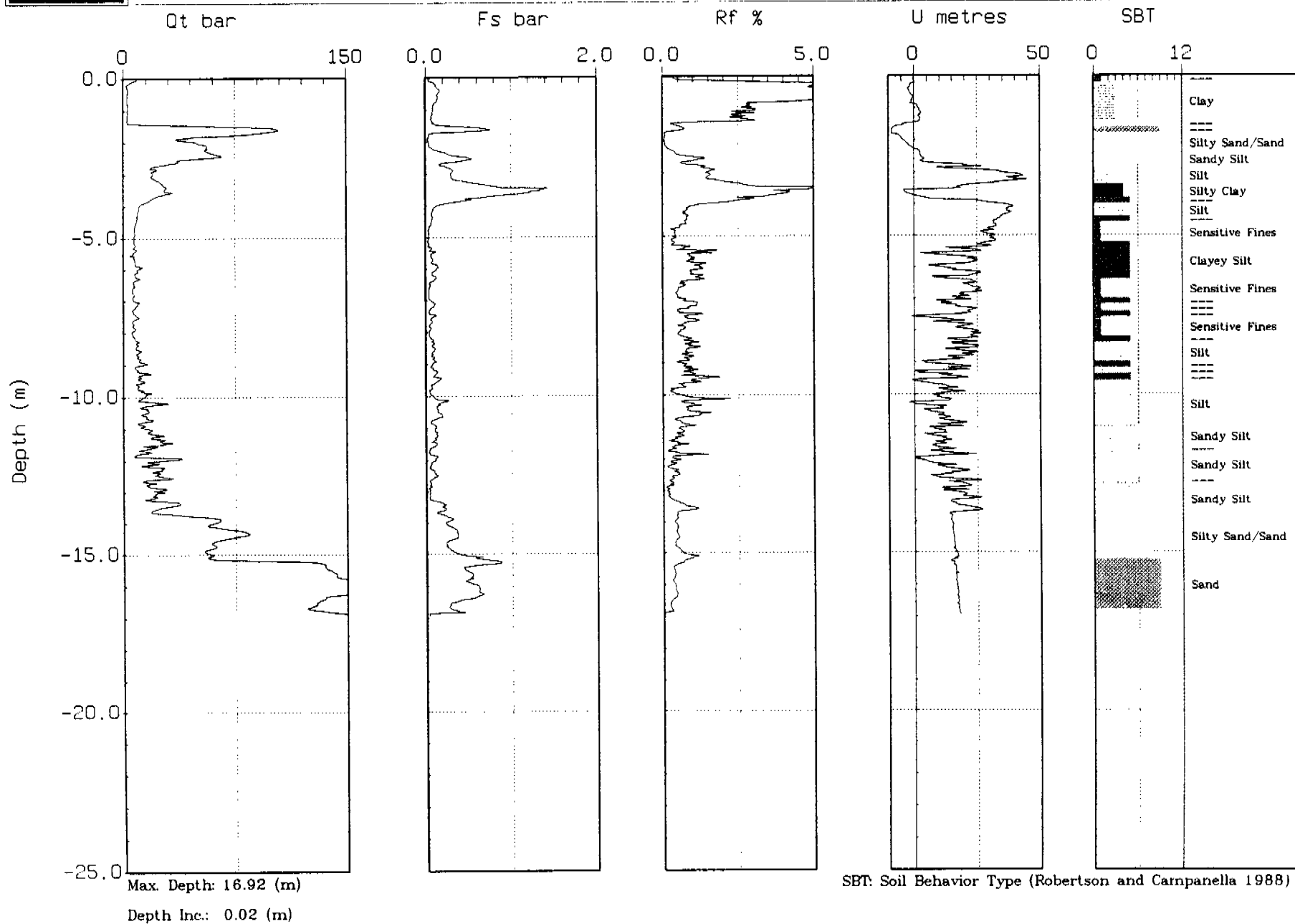




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Site: 99-141 CPT-S3  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03.25.99 13:21



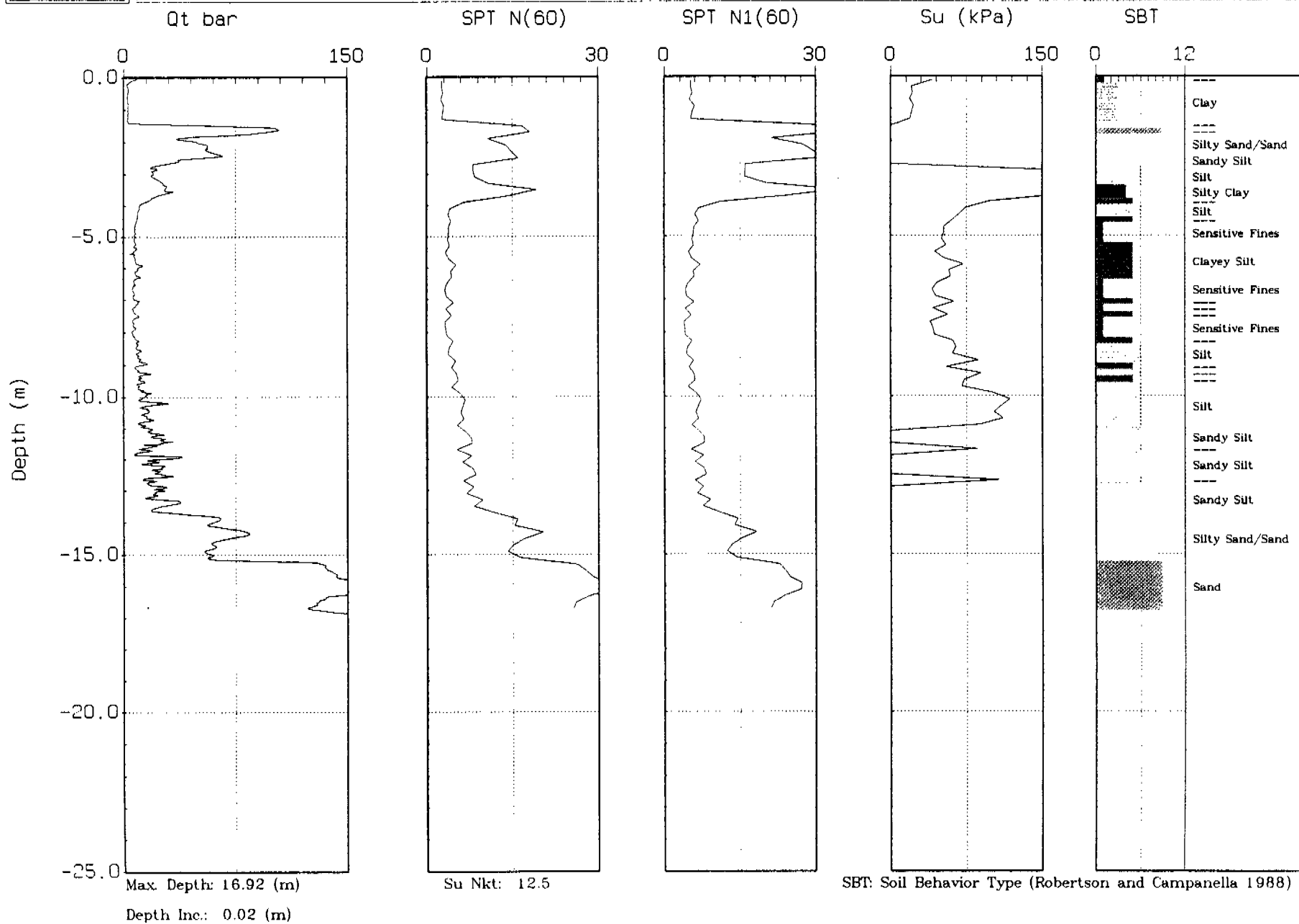
SBT: Soil Behavior Type (Robertson and Campanella 1988)



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Site: 99-141 CPT-S3  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 13:21

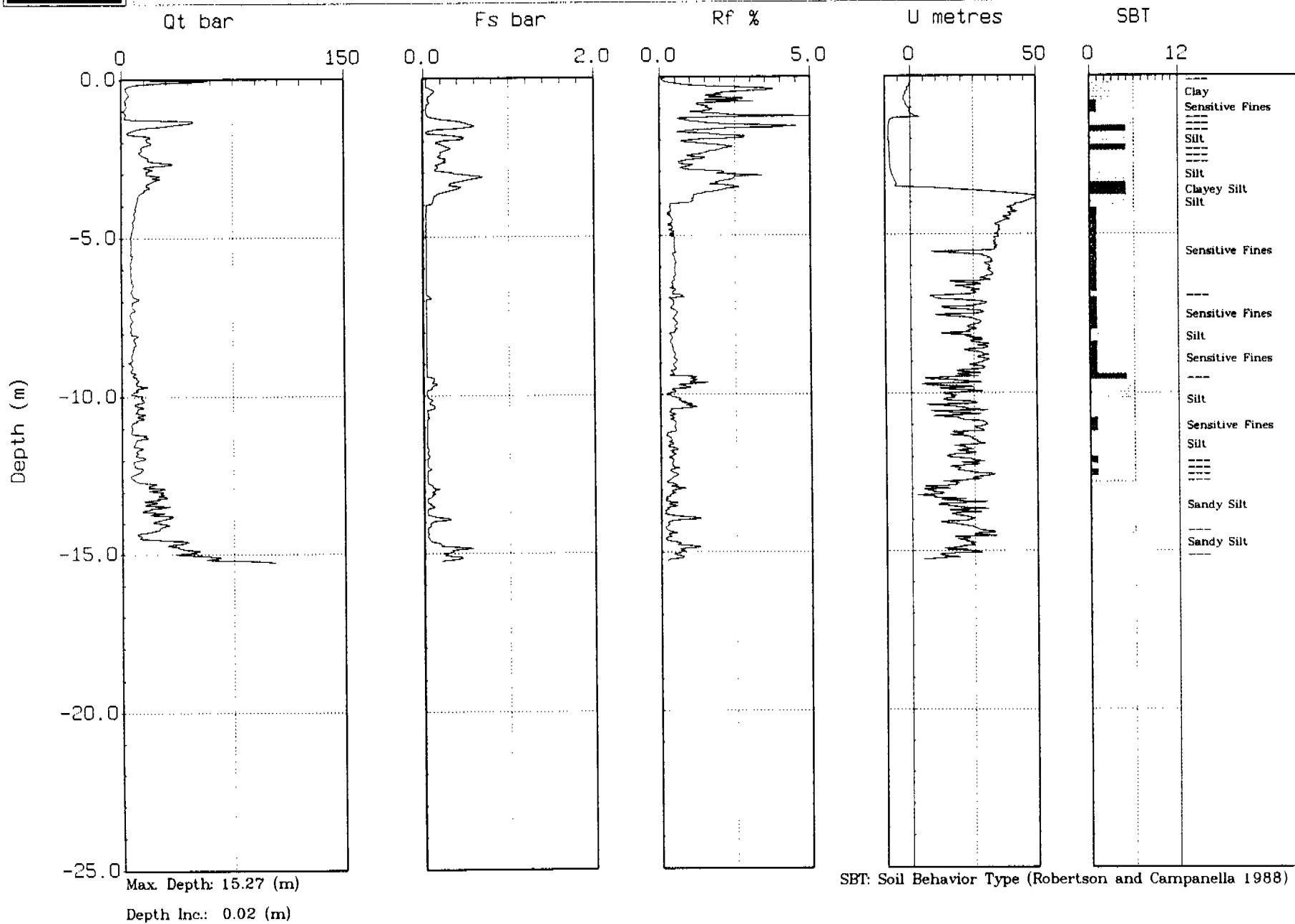




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Site: 99-141 CPT-S4  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 15:35



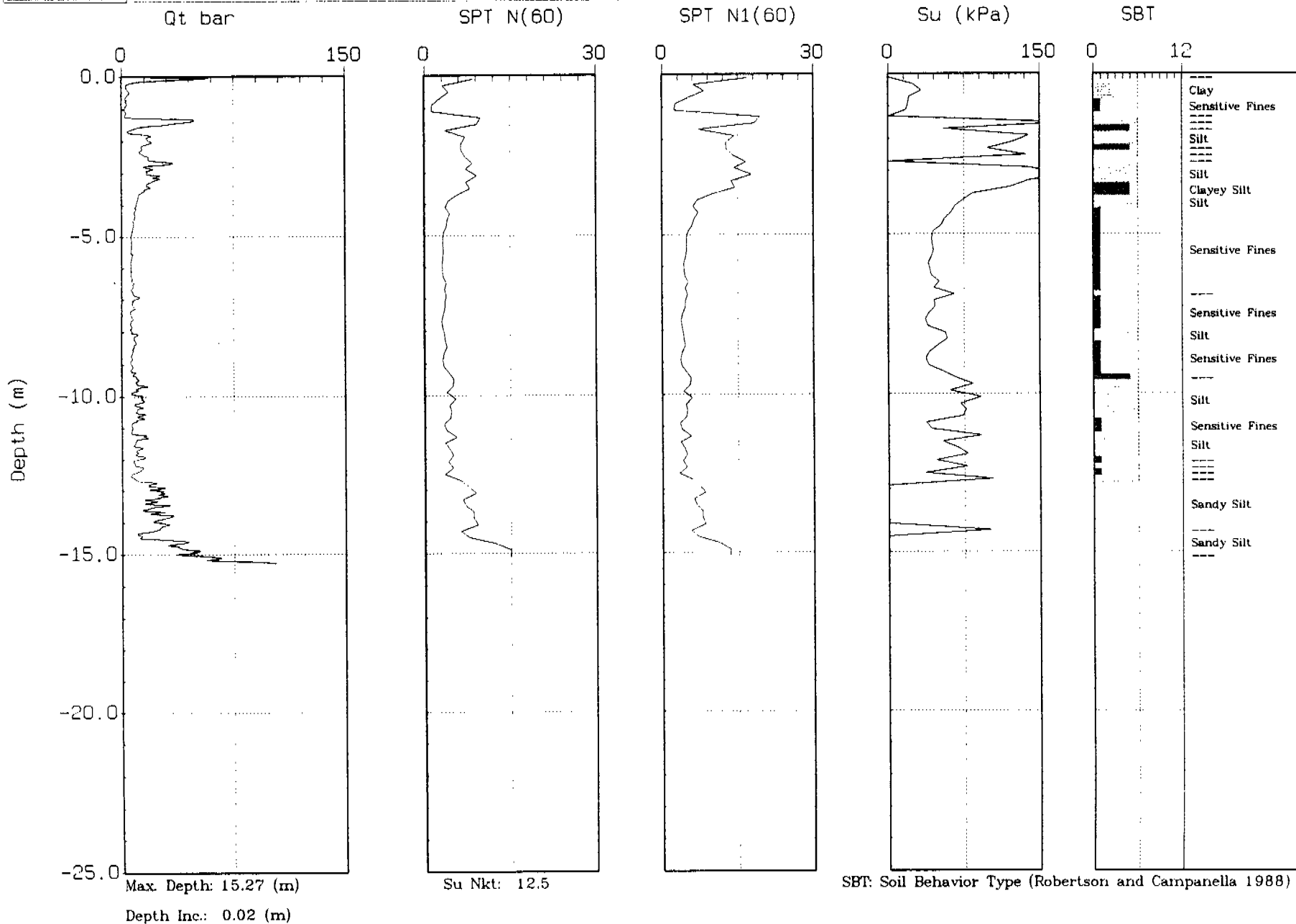
SBT: Soil Behavior Type (Robertson and Campanella 1988)



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Site: 99-141 CPT-S4  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 15:35

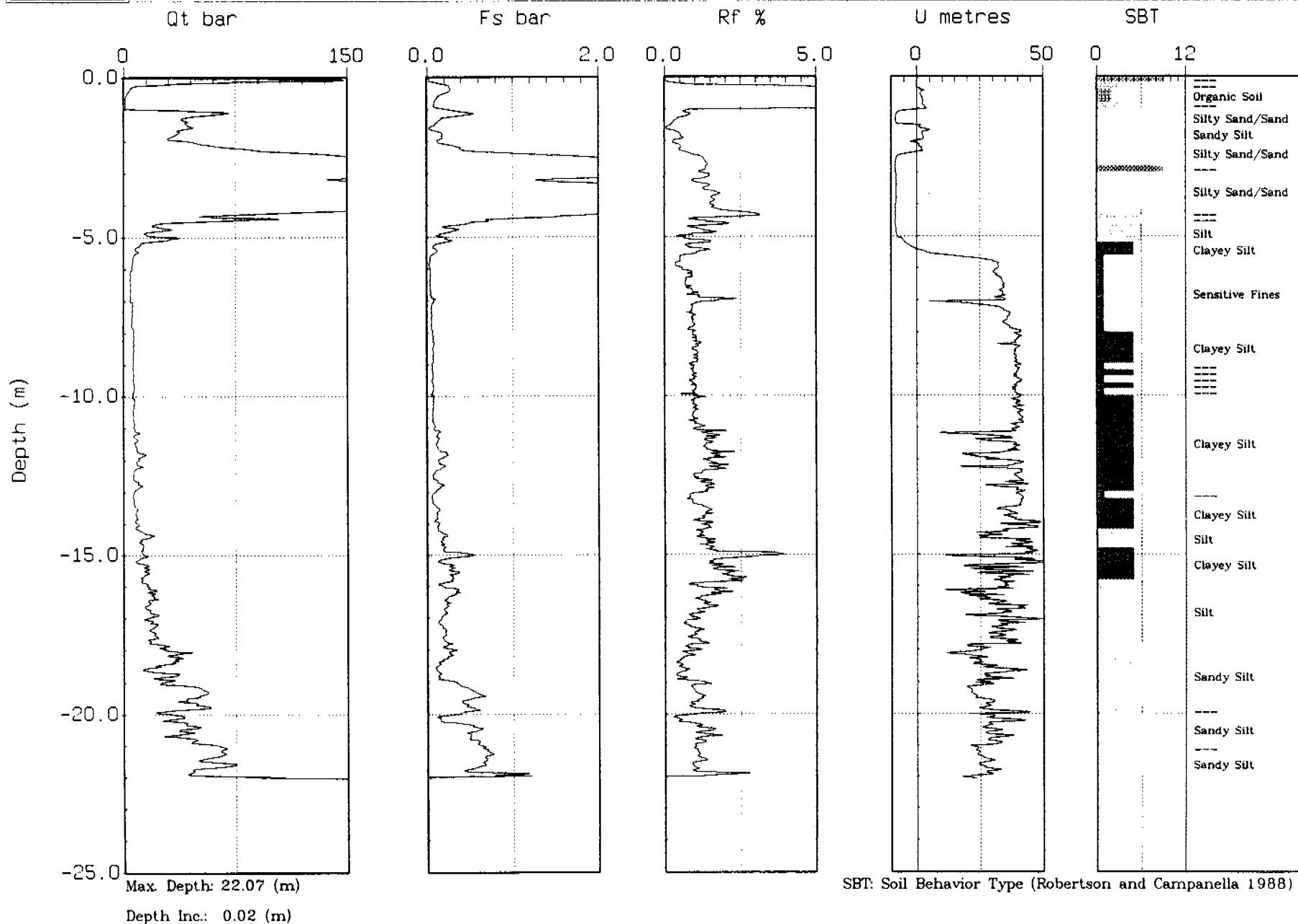




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Site: 99-141 CPT-S5  
Location: SINTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 17:56

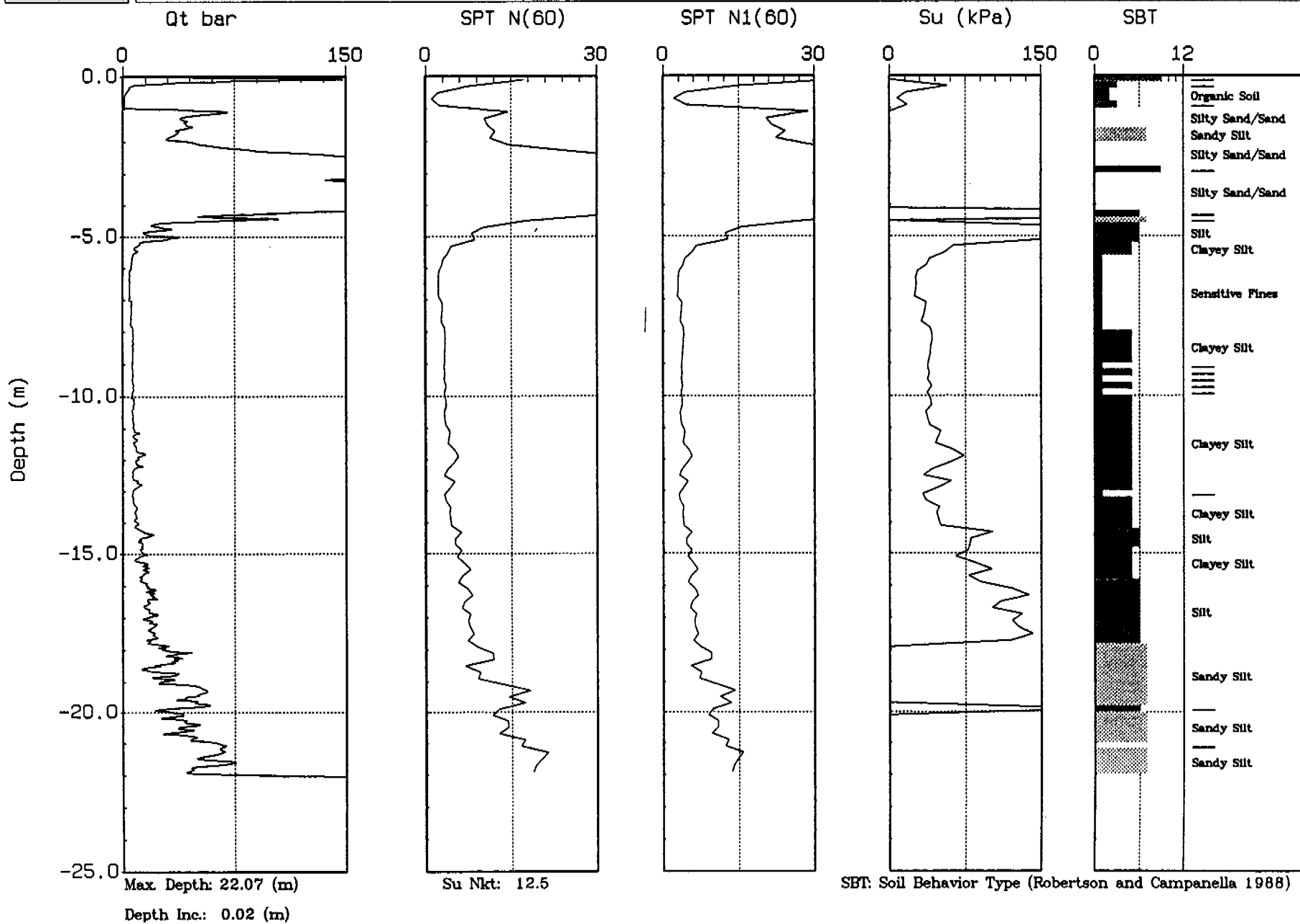




# Thurber Engineering

Site: 99-141 CPT-S5  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03/25/99 17:56



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**APPENDIX B**  
**CPT Interpretations**

**ConeTec Investigations Ltd.**



# ConeTec

Geotechnical and Environmental Site Investigation Contractors

## ConeTec CPT Interpretations as of January 7, 1999 (Release 1.00.19)

ConeTec's interpretation routine should be considered a calculator of current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (typically 0.25m). Note that  $Q_t$  is the recorded tip value,  $Q_c$ , corrected for pore pressure effects. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction,  $F_s$ , are not required.

The tip correction is:  $Q_t = Q_c + (1-a) \cdot U_d$

where:  $Q_t$  is the corrected tip load

$Q_c$  is the recorded tip load

$U_d$  is the recorded dynamic pore pressure

$a$  is the Net Area Ratio for the cone (typically 0.85 for ConeTec cones)

Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). The stress calculations use unit weights assigned to the Soil Behaviour Type zones or from a user defined unit weight profile.

Details regarding the interpretation methods for all of the interpreted parameters is given in table 1. The appropriate references referred to in table 1 are listed in table 2.

The estimated Soil Behaviour Type is based on the charts developed by Robertson and Campanella shown in figure 1.

**Table 1 CPT Interpretation Methods**

Interpreted Parameter	Description	Equation	Ref
Depth	mid layer depth		
AvgQt	Averaged corrected tip ( $Q_t$ )	$AvgQt = \frac{1}{n} \sum_{i=1}^n Q_{t_i}$	
AvgFs	Averaged sleeve friction ( $F_s$ )	$AvgFs = \frac{1}{n} \sum_{i=1}^n F_{s_i}$	
AvgRf	Averaged friction ratio (Rf)	$AvgRf = 100\% \cdot \frac{AvgFs}{AvgQt}$	
AvgUd	Averaged dynamic pore pressure ( $U_d$ )	$AvgUd = \frac{1}{n} \sum_{i=1}^n U_{d_i}$	
SBT	Soil Behavior Type as defined by Robertson and Campanella		1



# CPT Interpretations

U.Wt.	Unit Weight of soil determined from: 1) uniform value or 2) value assigned to each SBT zone 3) user supplied unit weight profile		
TStress	Total vertical overburden stress at mid layer depth	$TStress = \sum_{i=1}^n \gamma_i h_i$ where $\gamma_i$ is layer unit weight $h_i$ is layer thickness	
EStress	Effective vertical overburden stress at mid layer depth	$EStress = TStress - Ueq$	
Ueq	Equilibrium pore pressure determined from: 1) hydrostatic from water table depth 2) user supplied profile		
Cn	SPT $N_{60}$ overburden correction factor	$Cn = (\sigma_v')^{0.5}$ where $\sigma_v'$ is in tsf $0.5 < Cn < 2.0$	
$N_{60}$	SPT N value at 60% energy calculated from Qt/N ratios assigned to each SBT zone		3
$(N1)_{60}$	SPT $N_{60}$ value corrected for overburden pressure	$N1_{60} = Cn \cdot N_{60}$	3
$\Delta(N1)_{60}$	Equivalent Clean Sand Correction to $(N1)_{60}$	$\Delta(N1)_{60} = \frac{K_{SPT}}{1 - K_{SPT}} \cdot (N1)_{60}$  Where: $K_{SPT}$ is defined as:  0.0 for FC < 5% 0.0167 • (FC - 5) for 5% < FC < 35% 0.5 for FC > 35%  FC - Fines Content in %	7
$(N1)_{60cs}$	Equivalent Clean Sand $(N1)_{60}$	$(N1)_{60cs} = (N1)_{60} + \Delta(N1)_{60}$	7
Su	Undrained shear strength - Nkt is use selectable	$Su = \frac{Qt - \sigma_v}{Nkt}$	2
k	Coefficient of permeability (assigned to each SBT zone)		6
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{Qt - \sigma_v}$	2
Qtn	Normalized Qt for Soil Behavior Type classification as defined by Robertson, 1990	$Qtn = \frac{Qt - \sigma_v}{\sigma_v}$	4
Rfn	Normalized Rf for Soil Behavior Type classification as defined by Robertson, 1990	$Rfn = 100\% \cdot \frac{f_s}{Qt - \sigma_v}$	4
SBTn	Normalized Soil Behavior Type (slightly modified from that published by Robertson, 1990. This version includes all the soil zones of the original non-normalized SBT chart - see figure 1)		4
Qc1	Normalized Qt for seismic analysis	$qc1 = qc \cdot (Pa/\sigma_v')^{0.5}$ where: Pa = atm. pressure	5
Qc1N	Dimensionless Normalized Qt1	$qc1N = qc1 / Pa$ where: Pa = atm. pressure	

# CPT Interpretations

$\Delta Q_{c1N1}$	Equivalent clean sand correction	$\Delta q_{c1N} = \frac{K_{cPT}}{1 - K_{cPT}} \cdot q_{c1N}$ <p>Where: <math>K_{cPT}</math> is defined as:</p> <p>0.0 for <math>FC &lt; 5\%</math>  <math>0.0267 \cdot (FC - 5)</math> for <math>5\% &lt; FC &lt; 35\%</math>  0.5 for <math>FC &gt; 35\%</math></p> <p>FC - Fines Content in %</p>	5
$Q_{c1Ncs}$	Clean Sand equivalent $Q_{c1N}$	$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$	5
$I_c$	Soil index for estimating grain characteristics	$I_c = [(3.47 - \log Q)^2 + (\log F + 1.22)^2]^{0.5}$	5
FC	Fines content (%)	$FC = 1.75(I_c^{3.25}) - 3.7$ $FC = 100$ for $I_c > 3.5$ $FC = 0$ for $I_c < 1.26$ $FC = 5\%$ if $1.64 < I_c < 2.6$ AND $R_{fn} < 0.5$	8
PHI	Friction Angle	Campanella and Robertson Durunoglu and Mitchel Janbu	1
Dr	Relative Density	Ticino Sand Hokksund Sand Schmertmann 1976 Jamiolkowski - All Sands	1
OCR	Over Consolidation Ratio		1
State Parameter			9
CRR	Cyclic Resistance Ratio		7

# CPT Interpretations

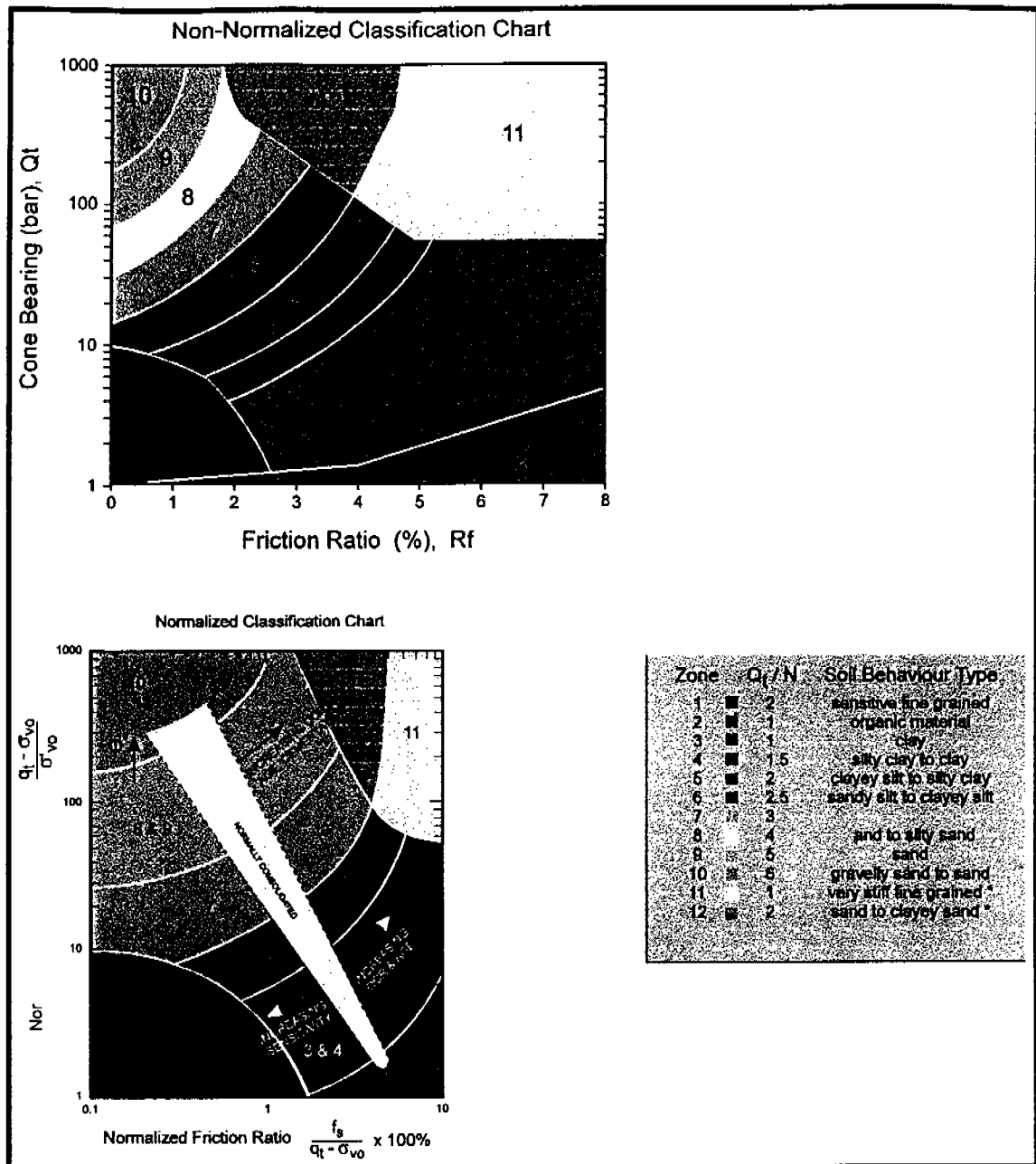


Figure 1 Non-Normalized and Normalized Soil Behaviour Type Classification Charts

## CPT Interpretations

**Table 2    References**

No.	Reference
1	Robertson, P.K. and Campanella, R.G., 1986, "Guidelines for Use, Interpretation and Application of the CPT and CPTU", UBC, Soil Mechanics Series No. 105, Civil Eng. Dept., Vancouver, B.C., Canada
2	Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.
3	Robertson, P.K. and Campanella, R.G., 1989, "Guidelines for Geotechnical Design Using CPT and CPTU", UBC, Soil Mechanics Series No. 120, Civil Eng. Dept., Vancouver, B.C., Canada
4	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
5	Robertson, P.K. and Fear, C.E., 1995, "Liquefaction of Sands and its Evaluation", Keynote Lecture, First International Conference on Earthquake Geotechnical Engineering, Tokyo, Japan.
6	ConeTec Internal Report
7	Robertson, P.K. and Wride, C.E., 1997, "Cyclic Liquefaction and its Evaluation Based on SPT and CPT", NCEER Workshop Paper, January 22, 1997
8	Wride, C.E. and Robertson, P.K., 1997, "Phase II Data Review Report (Massey and Kidd Sites, Fraser River Delta)", Volume 1 - Data Report (June 1997), University of Alberta.
9	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-4079

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S1

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 09:11

CPT File: 141CPS1.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	3.8	0.22	5.81	-2.91	3	17.5	2.2	1.0	1.23	2.00	3.8	7.6	30.2	0.00
0.38	3.8	0.27	7.08	-2.94	2	12.5	5.9	2.3	3.68	2.00	3.8	7.6	29.8	0.00
0.62	7.6	0.22	2.92	-2.78	4	18.0	9.8	3.6	6.13	2.00	5.1	10.2	60.4	0.00
0.88	48.4	0.64	1.31	-3.14	7	18.5	14.3	5.7	8.58	2.00	16.1	32.3	UnDef	0.16
1.12	29.6	0.33	1.10	-9.00	7	18.5	18.9	7.9	11.04	2.00	9.9	19.7	UnDef	0.10
1.38	10.8	0.04	0.41	-8.99	6	18.0	23.5	10.0	13.49	2.00	4.3	8.6	84.4	0.00
1.62	15.3	0.23	1.47	-6.28	6	18.0	28.0	12.1	15.94	2.00	6.1	12.2	119.9	0.08
1.88	16.9	0.54	3.22	5.88	5	18.0	32.5	14.1	18.39	2.00	8.5	16.9	132.7	0.10
2.12	18.8	0.49	2.60	19.39	5	18.0	37.0	16.2	20.85	2.00	9.4	18.8	147.4	0.10
2.38	22.8	0.88	3.86	13.32	4	18.0	41.5	18.2	23.30	2.00	15.2	30.4	179.2	0.00
2.62	17.7	0.75	4.28	1.19	3	17.5	45.9	20.2	25.75	2.00	17.7	35.3	137.6	0.00
2.88	10.9	0.20	1.87	32.38	5	18.0	50.4	22.2	28.20	2.00	5.5	10.9	83.5	0.09
3.12	10.4	0.14	1.37	41.58	5	18.0	54.9	24.2	30.66	1.99	5.2	10.4	78.9	0.09
3.38	9.5	0.13	1.35	39.21	5	18.0	59.4	26.3	33.11	1.91	4.7	9.1	71.2	0.09
3.62	8.1	0.12	1.47	34.06	5	18.0	63.9	28.3	35.56	1.84	4.0	7.4	59.6	0.09
3.88	7.6	0.11	1.41	33.95	5	18.0	68.4	30.4	38.01	1.78	3.8	6.7	55.1	0.09
4.12	8.2	0.11	1.29	29.24	5	18.0	72.9	32.4	40.47	1.72	4.1	7.0	59.5	0.09
4.38	7.7	0.15	1.98	25.14	5	18.0	77.4	34.5	42.92	1.67	3.9	6.5	55.7	0.11
4.62	10.6	0.18	1.75	14.05	5	18.0	81.9	36.5	45.37	1.62	5.3	8.6	78.2	0.10
4.88	9.3	0.14	1.56	21.67	5	18.0	86.4	38.6	47.82	1.58	4.7	7.3	67.5	0.11
5.12	7.9	0.11	1.42	24.69	5	18.0	90.9	40.6	50.28	1.54	4.0	6.1	56.2	0.10
5.38	7.9	0.12	1.55	24.01	5	18.0	95.4	42.6	52.73	1.50	3.9	5.9	55.5	0.10
5.62	7.0	0.08	1.20	25.66	5	18.0	99.9	44.7	55.18	1.46	3.5	5.1	48.0	0.09
5.88	9.4	0.13	1.37	20.46	5	18.0	104.4	46.7	57.63	1.43	4.7	6.7	66.9	0.11
6.12	7.6	0.10	1.38	18.95	5	18.0	108.9	48.8	60.09	1.40	3.8	5.3	52.3	0.10
6.38	8.0	0.16	1.95	20.87	5	18.0	113.4	50.8	62.54	1.37	4.0	5.5	55.2	0.10
6.62	7.3	0.12	1.67	22.86	5	18.0	117.9	52.9	64.99	1.35	3.7	4.9	49.0	0.09
6.88	7.4	0.14	1.93	19.94	5	18.0	122.4	54.9	67.44	1.32	3.7	4.9	49.0	0.09
7.12	7.3	0.10	1.32	24.78	5	18.0	126.9	57.0	69.90	1.30	3.7	4.8	48.5	0.09
7.38	9.8	0.16	1.69	21.07	5	18.0	131.4	59.0	72.35	1.27	4.9	6.2	67.5	0.10
7.62	9.0	0.15	1.69	18.76	5	18.0	135.9	61.1	74.80	1.25	4.5	5.6	61.3	0.10
7.88	10.9	0.15	1.35	18.87	5	18.0	140.4	63.1	77.25	1.23	5.4	6.7	75.8	0.11
8.12	9.3	0.16	1.73	22.34	5	18.0	144.9	65.2	79.71	1.21	4.6	5.6	62.6	0.10
8.38	7.6	0.09	1.20	22.03	5	18.0	149.4	67.2	82.16	1.19	3.8	4.5	48.8	0.09
8.62	10.3	0.09	0.90	14.19	6	18.0	153.9	69.3	84.61	1.18	4.1	4.8	69.9	0.10
8.88	8.1	0.08	1.04	17.15	5	18.0	158.4	71.3	87.06	1.16	4.1	4.7	52.4	0.09
9.12	12.3	0.14	1.15	20.44	6	18.0	162.9	73.4	89.52	1.14	4.9	5.6	85.3	0.11
9.38	21.2	0.19	0.88	8.46	6	18.0	167.4	75.4	91.97	1.13	8.5	9.6	156.1	0.09
9.62	17.9	0.14	0.75	13.80	6	18.0	171.9	77.5	94.42	1.11	7.2	8.0	129.5	0.09

Run No: 99-0331-0827-4079

CPT File: 141CPS1.COR

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	23.7	0.11	0.48	14.77	7	18.5	176.4	79.6	96.87	1.10	7.9	8.7	UnDef	0.09
10.12	29.6	0.10	0.34	14.00	7	18.5	181.1	81.7	99.33	1.08	9.9	10.7	UnDef	0.08
10.38	22.6	0.12	0.51	17.20	7	18.5	185.7	83.9	101.78	1.07	7.5	8.0	UnDef	0.09
10.62	16.7	0.11	0.65	18.98	6	18.0	190.2	86.0	104.23	1.06	6.7	7.1	118.5	0.09
10.88	41.7	0.23	0.55	15.35	7	18.5	194.8	88.1	106.68	1.04	13.9	14.5	UnDef	0.10
11.12	39.1	0.28	0.71	15.35	7	18.5	199.4	90.3	109.14	1.03	13.0	13.4	UnDef	0.10
11.38	63.0	0.22	0.36	9.56	8	19.0	204.1	92.5	111.59	1.02	15.8	16.0	UnDef	0.11
11.62	60.2	0.29	0.48	12.27	8	19.0	208.9	94.8	114.04	1.01	15.1	15.1	UnDef	0.10
11.88	64.4	0.65	1.01	12.97	8	19.0	213.6	97.1	116.49	0.99	16.1	16.0	UnDef	0.15
12.12	59.5	0.37	0.63	13.55	8	19.0	218.4	99.4	118.95	0.98	14.9	14.6	UnDef	0.12
12.38	50.5	0.50	0.99	14.04	7	18.5	223.1	101.7	121.40	0.97	16.8	16.3	UnDef	0.12
12.62	72.4	0.25	0.35	12.91	8	19.0	227.8	103.9	123.85	0.96	18.1	17.4	UnDef	0.11
12.88	96.0	0.40	0.42	14.27	9	19.5	232.6	106.3	126.30	0.95	19.2	18.2	UnDef	0.16

Run No: 99-0331-0827-4079  
 Job No: 99-141  
 Client: Thurber Engineering  
 Project: Trout Lake By-Pass  
 Site: 99-141 CPT-S1  
 Location: S.INTERCHANGE  
 Cone: 20 TON A 058  
 CPT Date: 99/25/03  
 CPT Time: 09:11  
 CPT File: 141CPS1.COR  
 Northing (m): 0.000  
 Easting (m): 0.000  
 Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Mkt used: 12.50

Averaging Increment (m): 0.25

Phi Method : Robertson and Campanella, 1983

Dr Method : Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param
0.12	5.0E-08	-0.08	393.2	5.85	11	7.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.38	1.0E-15	-0.09	164.9	7.19	11	7.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.62	5.0E-07	-0.04	208.6	2.95	12	15.3	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
0.88	5.0E-04	-0.01	842.7	1.32	9	96.8	0.0	96.8	2.1	50	87.5	1.0	-0.43
1.12	5.0E-04	-0.03	372.4	1.11	9	59.2	0.0	59.2	3.6	48	68.8	1.0	-0.33
1.38	5.0E-05	-0.10	105.4	0.42	9	21.6	0.0	21.6	5.0	42	36.4	10.0	-0.12
1.62	5.0E-05	-0.05	124.3	1.50	9	30.5	6.9	37.4	11.9	44	43.7	10.0	-0.26
1.88	5.0E-06	0.02	117.6	3.28	7	33.8	22.6	56.4	20.0	UnDef	UnDef	10.0	UnDef
2.12	5.0E-06	0.09	114.1	2.65	7	37.6	19.8	57.4	17.9	UnDef	UnDef	10.0	UnDef
2.38	5.0E-07	0.05	123.1	3.93	12	45.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
2.62	5.0E-08	-0.01	85.2	4.39	11	35.3	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef
2.88	5.0E-06	0.28	47.1	1.97	7	21.9	23.5	45.4	24.4	UnDef	UnDef	6.0	UnDef
3.12	5.0E-06	0.38	40.7	1.45	7	20.8	19.6	40.4	23.1	UnDef	UnDef	6.0	UnDef
3.38	5.0E-06	0.40	33.9	1.44	7	18.5	22.6	41.1	25.6	UnDef	UnDef	6.0	UnDef
3.62	5.0E-06	0.40	26.3	1.60	7	15.2	32.3	47.5	30.5	UnDef	UnDef	6.0	UnDef
3.88	5.0E-06	0.43	22.7	1.55	7	13.8	38.4	52.1	32.6	UnDef	UnDef	6.0	UnDef
4.12	5.0E-06	0.33	23.0	1.41	7	14.3	34.0	48.4	31.3	UnDef	UnDef	6.0	UnDef
4.38	5.0E-06	0.29	20.2	2.20	6	13.2	52.8	65.9	38.8	UnDef	UnDef	6.0	UnDef
4.62	5.0E-06	0.09	26.8	1.89	7	17.5	46.1	63.6	32.1	UnDef	UnDef	6.0	UnDef
4.88	5.0E-06	0.20	21.9	1.72	6	15.0	54.3	69.3	34.4	UnDef	UnDef	6.0	UnDef
5.12	5.0E-06	0.27	17.3	1.61	6	12.4	49.8	62.2	37.8	UnDef	UnDef	6.0	UnDef
5.38	5.0E-06	0.26	16.3	1.76	6	12.1	48.4	60.5	40.0	UnDef	UnDef	6.0	UnDef
5.62	5.0E-06	0.33	13.4	1.40	6	10.5	41.9	52.4	44.0	UnDef	UnDef	6.0	UnDef
5.88	5.0E-06	0.17	17.9	1.54	6	13.8	55.0	68.8	36.7	UnDef	UnDef	6.0	UnDef
6.12	5.0E-06	0.19	13.4	1.60	6	10.9	43.7	54.6	42.7	UnDef	UnDef	6.0	UnDef
6.38	5.0E-06	0.21	13.6	2.27	6	11.3	45.1	56.3	47.1	UnDef	UnDef	6.0	UnDef
6.62	5.0E-06	0.26	11.6	1.99	6	10.0	40.2	50.2	48.7	UnDef	UnDef	3.0	UnDef
6.88	5.0E-06	0.21	11.2	2.32	6	9.9	39.7	49.6	51.7	UnDef	UnDef	3.0	UnDef
7.12	5.0E-06	0.29	10.6	1.60	6	9.7	38.8	48.5	47.6	UnDef	UnDef	3.0	UnDef
7.38	5.0E-06	0.16	14.3	1.96	6	12.7	50.8	63.5	44.0	UnDef	UnDef	6.0	UnDef
7.62	5.0E-06	0.14	12.5	1.98	6	11.5	46.2	57.7	46.9	UnDef	UnDef	6.0	UnDef
7.88	5.0E-06	0.11	15.0	1.55	6	13.7	54.8	68.5	40.1	UnDef	UnDef	6.0	UnDef
8.12	5.0E-06	0.18	12.0	2.04	6	11.5	45.9	57.4	48.3	UnDef	UnDef	3.0	UnDef
8.38	5.0E-06	0.22	9.1	1.49	6	9.3	37.0	46.3	50.3	UnDef	UnDef	3.0	UnDef
8.62	5.0E-05	0.06	12.6	1.06	6	12.4	49.4	61.8	39.2	32	30.0	6.0	0.01
8.88	5.0E-06	0.12	9.2	1.30	6	9.6	38.5	48.2	48.3	UnDef	UnDef	3.0	UnDef
9.12	5.0E-05	0.10	14.5	1.32	6	14.4	57.4	71.8	38.8	32	30.0	6.0	-0.01
9.38	5.0E-05	0.00	25.9	0.95	7	24.4	30.0	54.4	25.6	36	30.0	6.0	-0.06
9.62	5.0E-05	0.03	20.9	0.83	7	20.3	31.7	52.1	27.8	34	30.0	6.0	-0.02

Run No: 99-0331-0827-4079

CPT File: 141CPS1.COR

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param	
9.88	5.0E-04	0.02	27.5	0.52	7	26.5	18.0	44.6	20.2	36	30.0	1.0	-0.01	2.9
10.12	5.0E-04	0.01	34.0	0.36	9	32.7	0.0	32.7	5.0	38	35.3	1.0	0.00	0.0
10.38	5.0E-04	0.03	24.7	0.56	7	24.6	21.0	45.6	22.2	34	30.0	1.0	-0.01	3.2
10.62	5.0E-05	0.06	17.2	0.73	7	18.0	35.8	53.8	29.9	32	30.0	6.0	0.01	5.0
10.88	5.0E-04	0.01	45.1	0.58	9	44.4	15.6	60.1	14.8	38	44.0	1.0	-0.07	2.8
11.12	5.0E-04	0.01	41.1	0.74	7	41.1	20.5	61.7	17.5	38	41.8	1.0	-0.08	3.5
11.38	5.0E-03	0.00	65.9	0.37	9	65.5	0.0	65.5	5.0	40	55.2	1.0	-0.07	0.0
11.62	5.0E-03	0.00	61.3	0.49	9	61.8	0.0	61.8	5.0	40	53.5	1.0	-0.08	0.0
11.88	5.0E-03	0.00	64.1	1.05	7	65.4	24.0	89.4	15.1	40	55.1	1.0	-0.15	3.2
12.12	5.0E-03	0.00	57.7	0.65	9	59.7	15.9	75.6	12.9	40	52.5	1.0	-0.10	2.2
12.38	5.0E-04	0.00	47.5	1.04	7	50.1	27.5	77.6	18.3	38	47.5	1.0	-0.12	4.7
12.62	5.0E-03	0.00	67.5	0.36	9	71.0	0.0	71.0	5.0	40	57.5	1.0	-0.07	0.0
12.88	5.0E-02	0.00	88.1	0.43	9	93.1	0.0	93.1	5.0	42	65.2	1.0	-0.10	0.0



Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-4700

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S2

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 11:29

CPT File: 141CPS2.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	15.4	0.02	0.13	0.17	6	18.0	2.2	1.0	1.23	2.00	6.2	12.3	123.0	0.08
0.38	2.2	0.04	1.78	-0.25	1	17.5	6.7	3.0	3.68	2.00	1.1	2.2	17.0	0.00
0.62	2.2	0.08	3.51	-0.25	3	17.5	11.1	4.9	6.13	2.00	2.2	4.4	16.9	0.00
0.88	2.8	0.06	2.22	0.12	3	17.5	15.4	6.9	8.58	2.00	2.8	5.6	21.1	0.00
1.12	2.5	0.05	1.88	1.58	1	17.5	19.8	8.8	11.04	2.00	1.2	2.5	18.4	0.00
1.38	2.7	0.04	1.65	2.08	1	17.5	24.2	10.7	13.49	2.00	1.3	2.7	19.4	0.00
1.62	81.4	0.67	0.82	-5.32	8	19.0	28.8	12.8	15.94	2.00	20.4	40.7	UnDef	0.00
1.88	65.5	0.61	0.93	-8.90	8	19.0	33.5	15.1	18.39	2.00	16.4	32.7	UnDef	0.29
2.12	41.7	0.33	0.80	-7.93	7	18.5	38.2	17.3	20.85	2.00	13.9	27.8	UnDef	0.13
2.38	39.3	0.65	1.65	-8.39	7	18.5	42.8	19.5	23.30	2.00	13.1	26.2	UnDef	0.15
2.62	25.2	0.51	2.02	-8.54	6	18.0	47.4	21.6	25.75	2.00	10.1	20.1	197.6	0.11
2.88	19.1	0.47	2.44	-7.87	5	18.0	51.9	23.7	28.20	2.00	9.5	19.1	148.5	0.11
3.12	28.6	1.08	3.77	-3.31	5	18.0	56.4	25.7	30.66	1.93	14.3	27.6	224.3	0.00
3.38	26.6	1.12	4.22	6.19	4	18.0	60.9	27.8	33.11	1.86	17.8	33.0	208.2	0.00
3.62	22.0	0.93	4.20	-4.58	3	17.5	65.3	29.8	35.56	1.79	22.0	39.5	170.8	0.21
3.88	14.4	0.41	2.83	7.85	5	18.0	69.8	31.7	38.01	1.74	7.2	12.5	109.4	0.13
4.12	10.7	0.18	1.66	29.74	5	18.0	74.2	33.8	40.47	1.68	5.4	9.0	79.9	0.10
4.38	9.0	0.06	0.62	36.09	6	18.0	78.8	35.8	42.92	1.64	3.6	5.9	65.4	0.08
4.62	7.6	0.04	0.48	33.26	1	17.5	83.2	37.8	45.37	1.59	3.8	6.0	53.9	0.00
4.88	7.7	0.03	0.35	31.58	1	17.5	87.6	39.7	47.82	1.55	3.8	6.0	54.5	0.00
5.12	7.7	0.04	0.48	28.28	1	17.5	91.9	41.7	50.28	1.52	3.9	5.9	54.5	0.08
5.38	7.9	0.07	0.83	20.01	5	18.0	96.4	43.6	52.73	1.48	4.0	5.9	55.7	0.09
5.62	9.7	0.09	0.97	15.84	6	18.0	100.9	45.7	55.18	1.45	3.9	5.6	69.7	0.09
5.88	9.5	0.10	1.03	19.28	5	18.0	105.4	47.7	57.63	1.42	4.7	6.7	67.5	0.10
6.12	8.6	0.08	0.96	20.07	5	18.0	109.9	49.8	60.09	1.39	4.3	5.9	59.8	0.10
6.38	8.7	0.11	1.30	24.59	5	18.0	114.4	51.8	62.54	1.36	4.3	5.9	60.3	0.10
6.62	8.3	0.10	1.18	14.72	5	18.0	118.9	53.9	64.99	1.33	4.2	5.5	57.0	0.10
6.88	6.6	0.02	0.32	22.93	1	17.5	123.3	55.9	67.44	1.31	3.3	4.3	43.1	0.09
7.12	9.1	0.10	1.07	17.39	5	18.0	127.8	57.9	69.90	1.29	4.5	5.8	62.3	0.10
7.38	9.5	0.10	1.08	16.44	5	18.0	132.2	59.9	72.35	1.26	4.8	6.0	65.5	0.10
7.62	9.4	0.06	0.67	16.48	6	18.0	136.8	61.9	74.80	1.24	3.7	4.7	64.0	0.10
7.88	27.3	0.12	0.42	14.88	7	18.5	141.3	64.1	77.25	1.22	9.1	11.1	UnDef	0.08
8.12	42.4	0.75	1.76	14.45	7	18.5	145.9	66.2	79.71	1.20	14.1	17.0	UnDef	0.14
8.38	8.5	0.13	1.50	16.63	5	18.0	150.5	68.3	82.16	1.18	4.2	5.0	55.9	0.09
8.62	9.2	0.04	0.48	13.14	6	18.0	155.0	70.4	84.61	1.17	3.7	4.3	60.9	0.10
8.88	14.3	0.10	0.70	11.24	6	18.0	159.5	72.4	87.06	1.15	5.7	6.6	101.6	0.09
9.12	15.2	0.05	0.35	18.00	6	18.0	164.0	74.5	89.52	1.13	6.1	6.9	108.7	0.00
9.38	20.5	0.34	1.64	20.45	6	18.0	168.5	76.5	91.97	1.12	8.2	9.2	150.5	0.15

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-4700

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S2

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 11:29

CPT File: 141CPS2.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1) Param	
0.12	5.0E-05	0.00	1000.0	0.13	10	30.8	0.0	30.8	0.0	50	79.3	10.0	-0.21	0.0
0.38	1.0E-07	-0.03	70.5	1.84	7	4.4	2.6	7.0	19.0	UnDef	UnDef	10.0	UnDef	0.7
0.62	5.0E-08	-0.04	42.8	3.69	6	4.4	14.4	18.8	33.6	UnDef	UnDef	6.0	UnDef	4.1
0.88	5.0E-08	-0.03	38.5	2.35	7	5.6	10.2	15.8	29.2	UnDef	UnDef	6.0	UnDef	3.8
1.12	1.0E-07	0.02	26.2	2.05	6	5.0	15.7	20.7	33.4	UnDef	UnDef	6.0	UnDef	2.3
1.38	1.0E-07	0.03	22.7	1.81	6	5.3	19.5	24.8	34.4	UnDef	UnDef	6.0	UnDef	2.6
1.62	5.0E-03	-0.01	633.3	0.82	10	162.8	0.0	162.8	0.6	50	90.8	1.0	-0.34	0.0
1.88	5.0E-03	-0.02	431.3	0.93	9	131.0	0.0	131.0	2.2	48	82.2	1.0	-0.32	0.0
2.12	5.0E-04	-0.02	238.2	0.81	9	83.4	0.0	83.4	3.9	46	67.3	1.0	-0.25	0.0
2.38	5.0E-04	-0.03	199.5	1.66	9	78.7	10.4	89.1	9.4	46	64.0	1.0	-0.31	2.1
2.62	5.0E-05	-0.04	114.2	2.06	7	50.4	19.2	69.6	15.3	42	49.7	10.0	-0.29	4.2
2.88	5.0E-06	-0.06	78.4	2.51	7	38.2	28.6	66.8	21.1	UnDef	UnDef	10.0	UnDef	7.0
3.12	5.0E-06	-0.02	109.0	3.84	12	56.4	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef	UnDef
3.38	5.0E-07	0.01	93.7	4.32	11	50.5	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef	UnDef
3.62	5.0E-08	-0.04	71.7	4.33	6	40.3	71.5	111.8	28.9	UnDef	UnDef	10.0	UnDef	26.3
3.88	5.0E-06	0.03	43.1	2.98	6	25.5	55.0	80.5	30.6	UnDef	UnDef	6.0	UnDef	9.3
4.12	5.0E-06	0.25	29.6	1.78	7	18.5	36.5	55.0	29.9	UnDef	UnDef	6.0	UnDef	6.4
4.38	5.0E-05	0.38	22.8	0.68	7	15.0	16.9	31.8	24.8	34	30.0	6.0	0.02	2.9
4.62	1.0E-07	0.42	17.8	0.53	7	12.3	17.4	29.7	26.9	UnDef	UnDef	6.0	UnDef	3.5
4.88	1.0E-07	0.38	17.1	0.40	7	12.2	0.0	12.2	5.0	UnDef	UnDef	6.0	UnDef	0.0
5.12	1.0E-07	0.33	16.3	0.54	7	12.0	20.2	32.2	28.5	UnDef	UnDef	6.0	UnDef	3.8
5.38	5.0E-06	0.21	16.0	0.95	7	12.0	38.8	50.8	33.6	UnDef	UnDef	6.0	UnDef	5.4
5.62	5.0E-05	0.12	19.1	1.08	7	14.4	35.8	50.2	31.7	34	30.0	6.0	-0.02	4.5
5.88	5.0E-06	0.16	17.7	1.16	7	13.7	45.5	59.3	33.8	UnDef	UnDef	6.0	UnDef	6.2
6.12	5.0E-06	0.18	15.0	1.10	6	12.2	48.6	60.8	36.2	UnDef	UnDef	6.0	UnDef	5.9
6.38	5.0E-06	0.24	14.5	1.50	6	12.1	48.2	60.3	40.3	UnDef	UnDef	6.0	UnDef	5.9
6.62	5.0E-06	0.11	13.2	1.38	6	11.3	45.3	56.6	41.2	UnDef	UnDef	6.0	UnDef	5.5
6.88	1.0E-07	0.29	9.6	0.39	7	8.8	35.4	44.2	36.1	UnDef	UnDef	3.0	UnDef	4.3
7.12	5.0E-06	0.13	13.5	1.25	6	11.9	47.6	59.5	39.7	UnDef	UnDef	6.0	UnDef	5.8
7.38	5.0E-06	0.11	13.7	1.26	6	12.3	49.1	61.4	39.5	UnDef	UnDef	6.0	UnDef	6.0
7.62	5.0E-05	0.11	12.9	0.79	6	11.9	47.6	59.5	35.8	32	30.0	6.0	0.03	4.7
7.88	5.0E-04	0.03	40.4	0.45	9	34.1	0.0	34.1	5.0	38	36.4	1.0	-0.04	0.0
8.12	5.0E-04	0.02	61.9	1.82	7	52.1	36.0	88.2	20.3	40	48.6	1.0	-0.20	5.8
8.38	5.0E-06	0.12	10.2	1.82	6	10.3	41.1	51.4	50.2	UnDef	UnDef	3.0	UnDef	5.0
8.62	5.0E-05	0.06	10.8	0.58	6	10.9	43.7	54.6	36.7	30	30.0	3.0	0.07	4.3
8.88	5.0E-05	0.02	17.5	0.79	7	16.8	34.8	51.5	30.2	32	30.0	6.0	0.00	4.8
9.12	5.0E-05	0.06	18.2	0.40	7	17.6	0.0	17.6	5.0	32	30.0	6.0	0.05	0.0
9.38	5.0E-05	0.06	24.6	1.79	6	23.4	68.4	91.8	32.9	34	30.0	6.0	-0.10	8.0

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5304

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S3

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 13:21

CPT File: 141CPS3.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method : Robertson and Campanella, 1983

Dr Method : Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	4.5	0.07	1.59	-0.42	1	17.5	2.2	1.0	1.23	2.00	2.3	4.5	36.1	0.00
0.38	2.8	0.14	5.18	-2.00	3	17.5	6.6	2.9	3.68	2.00	2.8	5.6	21.9	0.00
0.62	2.5	0.13	5.30	-0.89	3	17.5	10.9	4.8	6.13	2.00	2.5	5.0	19.2	0.00
0.88	2.8	0.09	3.07	0.17	3	17.5	15.3	6.7	8.58	2.00	2.8	5.7	21.5	0.00
1.12	2.7	0.07	2.67	2.16	3	17.5	19.7	8.7	11.04	2.00	2.7	5.4	20.0	0.00
1.38	16.3	0.09	0.58	0.73	6	18.0	24.1	10.6	13.49	2.00	6.5	13.0	128.1	0.08
1.62	95.8	0.48	0.50	-7.81	9	19.5	28.8	12.9	15.94	2.00	19.2	38.3	UnDef	0.00
1.88	48.5	0.03	0.05	-6.01	8	19.0	33.6	15.2	18.39	2.00	12.1	24.3	UnDef	0.16
2.12	54.9	0.05	0.09	-2.31	8	19.0	38.4	17.5	20.85	2.00	13.7	27.4	UnDef	0.20
2.38	59.6	0.30	0.50	2.09	8	19.0	43.1	19.8	23.30	2.00	14.9	29.8	UnDef	0.24
2.62	30.5	0.31	1.02	6.00	7	18.5	47.8	22.1	25.75	2.00	10.2	20.3	UnDef	0.11
2.88	19.7	0.29	1.46	23.30	6	18.0	52.4	24.2	28.20	1.99	7.9	15.7	153.4	0.10
3.12	21.6	0.35	1.60	40.73	6	18.0	56.9	26.2	30.66	1.91	8.7	16.5	168.5	0.10
3.38	27.4	0.92	3.35	24.82	5	18.0	61.4	28.3	33.11	1.84	13.7	25.3	214.6	0.17
3.62	25.0	0.99	3.94	-1.30	4	18.0	65.9	30.3	35.56	1.78	16.7	29.6	194.6	0.20
3.88	13.9	0.32	2.31	19.45	5	18.0	70.4	32.4	38.01	1.72	6.9	11.9	105.3	0.11
4.12	9.9	0.08	0.81	37.83	6	18.0	74.9	34.4	40.47	1.67	3.9	6.6	72.9	0.08
4.38	9.0	0.07	0.77	35.10	6	18.0	79.4	36.5	42.92	1.62	3.6	5.8	65.6	0.08
4.62	7.6	0.05	0.60	31.75	5	18.0	83.9	38.5	45.37	1.58	3.8	6.0	54.3	0.08
4.88	7.4	0.03	0.38	29.61	1	17.5	88.3	40.5	47.82	1.54	3.7	5.7	52.3	0.00
5.12	7.3	0.02	0.34	30.39	1	17.5	92.7	42.4	50.28	1.50	3.7	5.5	51.2	0.00
5.38	7.3	0.06	0.84	23.67	5	18.0	97.1	44.4	52.73	1.47	3.6	5.4	50.6	0.10
5.62	7.0	0.07	0.96	15.24	5	18.0	101.6	46.4	55.18	1.44	3.5	5.0	47.6	0.09
5.88	9.6	0.11	1.16	16.49	5	18.0	106.1	48.5	57.63	1.41	4.8	6.7	68.2	0.11
6.12	8.4	0.09	1.05	20.97	5	18.0	110.6	50.5	60.09	1.38	4.2	5.8	58.3	0.10
6.38	7.8	0.07	0.95	18.20	5	18.0	115.1	52.6	62.54	1.35	3.9	5.3	53.1	0.09
6.62	6.2	0.04	0.58	23.22	1	17.5	119.6	54.6	64.99	1.32	3.1	4.1	40.4	0.09
6.88	6.8	0.04	0.52	20.10	1	17.5	123.9	56.5	67.44	1.30	3.4	4.4	44.2	0.09
7.12	8.6	0.08	0.97	14.15	5	18.0	128.4	58.5	69.90	1.28	4.3	5.5	58.5	0.10
7.38	7.4	0.06	0.78	21.31	5	18.0	132.9	60.5	72.35	1.26	3.7	4.7	48.6	0.09
7.62	6.9	0.06	0.85	8.97	5	18.0	137.4	62.6	74.80	1.24	3.5	4.3	44.2	0.09
7.88	6.5	0.04	0.65	19.99	1	17.5	141.8	64.6	77.25	1.22	3.2	3.9	40.3	0.09
8.12	7.2	0.05	0.64	24.08	1	17.5	146.2	66.5	79.71	1.20	3.6	4.3	45.9	0.09
8.38	8.9	0.08	0.89	19.15	5	18.0	150.6	68.5	82.16	1.18	4.4	5.2	58.8	0.09
8.62	9.8	0.08	0.78	20.19	6	18.0	155.1	70.5	84.61	1.17	3.9	4.6	66.1	0.10
8.88	11.9	0.09	0.73	14.34	6	18.0	159.6	72.6	87.06	1.15	4.8	5.5	82.2	0.11
9.12	9.5	0.08	0.87	15.79	6	18.0	164.1	74.6	89.52	1.13	3.8	4.3	62.5	0.10
9.38	11.7	0.12	1.06	10.80	6	18.0	168.6	76.7	91.97	1.12	4.7	5.2	80.0	0.11
9.62	10.3	0.08	0.82	5.71	6	18.0	173.1	78.7	94.42	1.10	4.1	4.5	68.5	0.10

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	ESTress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60	Su (kPa)	CRR
9.88	14.1	0.05	0.36	13.39	6	18.0	177.6	80.8	96.87	1.09	5.7	6.2	99.0	0.00
10.12	17.4	0.16	0.90	8.93	6	18.0	182.1	82.8	99.33	1.08	7.0	7.5	124.6	0.10
10.38	14.7	0.13	0.88	6.54	6	18.0	186.6	84.8	101.78	1.06	5.9	6.3	103.0	0.13
10.62	15.3	0.14	0.94	10.49	6	18.0	191.1	86.9	104.23	1.05	6.1	6.4	107.5	0.13
10.88	12.8	0.08	0.65	15.24	6	18.0	195.6	88.9	106.68	1.04	5.1	5.3	87.0	0.11
11.12	19.9	0.11	0.56	8.90	7	18.5	200.2	91.1	109.14	1.03	6.6	6.8	UnDef	0.09
11.38	25.5	0.10	0.40	10.83	7	18.5	204.8	93.2	111.59	1.01	8.5	8.6	UnDef	0.00
11.62	15.9	0.06	0.36	10.11	6	18.0	209.4	95.3	114.04	1.00	6.4	6.4	110.8	0.00
11.88	20.4	0.09	0.43	10.46	7	18.5	213.9	97.4	116.49	0.99	6.8	6.7	UnDef	0.00
12.12	20.0	0.05	0.26	7.32	7	18.5	218.6	99.6	118.95	0.98	6.7	6.5	UnDef	0.00
12.38	23.0	0.09	0.40	16.14	7	18.5	223.2	101.8	121.40	0.97	7.7	7.4	UnDef	0.00
12.62	20.2	0.06	0.28	14.57	7	18.5	227.8	104.0	123.85	0.96	6.7	6.5	UnDef	0.00
12.88	22.6	0.04	0.16	18.43	7	18.5	232.4	106.1	126.30	0.95	7.5	7.1	UnDef	0.00
13.12	19.2	0.03	0.17	19.02	7	18.5	237.1	108.3	128.76	0.94	6.4	6.0	UnDef	0.00
13.38	31.8	0.16	0.51	17.09	7	18.5	241.7	110.5	131.21	0.93	10.6	9.9	UnDef	0.09
13.62	25.5	0.18	0.70	21.70	7	18.5	246.3	112.7	133.66	0.92	8.5	7.8	UnDef	0.10
13.88	61.0	0.25	0.42	14.50	8	19.0	251.0	114.9	136.11	0.91	15.3	13.9	UnDef	0.10
14.12	64.4	0.28	0.44	15.04	8	19.0	255.8	117.2	138.57	0.90	16.1	14.5	UnDef	0.10
14.38	78.9	0.36	0.45	15.14	8	19.0	260.5	119.5	141.02	0.90	19.7	17.7	UnDef	0.11
14.62	61.2	0.25	0.40	15.58	8	19.0	265.2	121.8	143.47	0.89	15.3	13.6	UnDef	0.10
14.88	57.0	0.29	0.51	15.91	8	19.0	270.0	124.1	145.92	0.88	14.3	12.5	UnDef	0.11
15.12	76.4	0.63	0.83	16.47	8	19.0	274.8	126.4	148.38	0.87	19.1	16.6	UnDef	0.15
15.38	135.3	0.58	0.43	15.64	9	19.5	279.6	128.7	150.83	0.86	27.1	23.3	UnDef	0.24
15.62	142.6	0.51	0.36	16.34	9	19.5	284.4	131.2	153.28	0.85	28.5	24.4	UnDef	0.26
15.88	158.4	0.51	0.32	16.36	9	19.5	289.3	133.6	155.73	0.85	31.7	26.8	UnDef	0.32
16.12	159.8	0.61	0.38	16.78	9	19.5	294.2	136.0	158.19	0.84	32.0	26.8	UnDef	0.32
16.38	135.4	0.50	0.37	16.98	9	19.5	299.1	138.4	160.64	0.83	27.1	22.5	UnDef	0.22
16.62	126.9	0.27	0.21	17.13	9	19.5	303.9	140.8	163.09	0.82	25.4	20.9	UnDef	0.19

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5304

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S3

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 13:21

CPT File: 141CPS3.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1) Param
0.12	1.0E-07	-0.01	470.0	1.59	9	9.1	0.0	9.1	4.9	UnDef	UnDef	10.0	UnDef 0.0
0.38	5.0E-08	-0.09	94.8	5.31	11	5.6	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef UnDef
0.62	5.0E-08	-0.06	49.9	5.54	1	5.0	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef UnDef
0.88	5.0E-08	-0.03	39.9	3.24	6	5.7	16.5	22.1	32.9	UnDef	UnDef	6.0	UnDef 4.9
1.12	5.0E-08	0.04	28.9	2.88	6	5.4	21.6	27.0	36.2	UnDef	UnDef	6.0	UnDef 5.4
1.38	5.0E-05	0.00	150.5	0.59	9	32.5	0.0	32.5	4.8	44	47.3	10.0	-0.18 0.0
1.62	5.0E-02	-0.01	742.0	0.50	10	191.6	0.0	191.6	0.0	50	95.0	1.0	-0.31 0.0
1.88	5.0E-03	-0.02	316.3	0.05	10	97.0	0.0	97.0	0.0	46	73.5	1.0	-0.04 0.0
2.12	5.0E-03	-0.01	310.7	0.09	10	109.7	0.0	109.7	0.0	46	75.0	1.0	-0.09 0.0
2.38	5.0E-03	0.00	298.5	0.50	10	119.2	0.0	119.2	1.0	46	75.6	1.0	-0.23 0.0
2.62	5.0E-04	0.01	136.0	1.04	9	61.0	6.4	67.4	8.6	44	54.9	1.0	-0.22 1.3
2.88	5.0E-05	0.10	79.4	1.50	7	39.4	16.1	55.5	15.9	42	41.1	10.0	-0.19 3.5
3.12	5.0E-05	0.18	80.3	1.65	7	42.2	18.9	61.1	16.6	42	42.6	10.0	-0.20 4.0
3.38	5.0E-06	0.08	94.9	3.43	7	51.6	46.1	97.7	22.7	UnDef	UnDef	10.0	UnDef 10.6
3.62	5.0E-07	-0.02	80.2	4.05	6	45.4	62.3	107.7	26.7	UnDef	UnDef	10.0	UnDef 16.8
3.88	5.0E-06	0.12	40.7	2.44	7	24.4	42.8	67.2	28.9	UnDef	UnDef	6.0	UnDef 7.9
4.12	5.0E-05	0.36	26.5	0.88	7	16.8	18.4	35.3	24.6	36	30.0	6.0	-0.01 3.2
4.38	5.0E-05	0.37	22.5	0.84	7	14.9	20.6	35.5	26.7	34	30.0	6.0	0.01 3.3
4.62	5.0E-06	0.39	17.6	0.68	7	12.3	21.7	34.0	28.9	UnDef	UnDef	6.0	UnDef 4.0
4.88	1.0E-07	0.37	16.1	0.43	7	11.7	0.0	11.7	5.0	UnDef	UnDef	6.0	UnDef 0.0
5.12	1.0E-07	0.39	15.1	0.39	7	11.3	0.0	11.3	5.0	UnDef	UnDef	6.0	UnDef 0.0
5.38	5.0E-06	0.28	14.2	0.96	6	10.9	43.8	54.7	35.9	UnDef	UnDef	6.0	UnDef 5.4
5.62	5.0E-06	0.16	12.8	1.12	6	10.2	40.9	51.2	39.5	UnDef	UnDef	6.0	UnDef 5.0
5.88	5.0E-06	0.12	17.6	1.30	6	13.8	55.1	68.9	35.1	UnDef	UnDef	6.0	UnDef 6.7
6.12	5.0E-06	0.20	14.4	1.21	6	11.8	47.2	59.0	38.0	UnDef	UnDef	6.0	UnDef 5.8
6.38	5.0E-06	0.17	12.6	1.11	6	10.7	43.0	53.7	39.7	UnDef	UnDef	6.0	UnDef 5.3
6.62	1.0E-07	0.32	9.2	0.71	6	8.4	33.8	42.2	41.8	UnDef	UnDef	3.0	UnDef 4.1
6.88	1.0E-07	0.23	9.8	0.63	6	9.0	36.0	45.0	39.5	UnDef	UnDef	3.0	UnDef 4.4
7.12	5.0E-06	0.09	12.5	1.14	6	11.2	45.0	56.2	40.1	UnDef	UnDef	6.0	UnDef 5.5
7.38	5.0E-06	0.22	10.0	0.95	6	9.5	38.1	47.6	42.8	UnDef	UnDef	3.0	UnDef 4.7
7.62	5.0E-06	0.02	8.8	1.07	6	8.7	34.9	43.6	46.9	UnDef	UnDef	3.0	UnDef 4.3
7.88	1.0E-07	0.24	7.8	0.83	6	8.0	32.1	40.2	47.1	UnDef	UnDef	3.0	UnDef 3.9
8.12	1.0E-07	0.27	8.6	0.80	6	8.8	35.3	44.2	44.4	UnDef	UnDef	3.0	UnDef 4.3
8.38	5.0E-06	0.14	10.7	1.07	6	10.7	42.8	53.5	42.7	UnDef	UnDef	3.0	UnDef 5.2
8.62	5.0E-05	0.14	11.7	0.93	6	11.7	46.7	58.4	39.4	30	30.0	3.0	0.03 4.6
8.88	5.0E-05	0.05	14.2	0.85	6	13.9	53.7	67.6	34.7	32	30.0	6.0	0.01 5.4
9.12	5.0E-05	0.08	10.5	1.05	6	10.9	43.8	54.7	43.0	30	30.0	3.0	0.03 4.3
9.38	5.0E-05	0.01	13.1	1.24	6	13.4	53.4	66.8	40.2	32	30.0	6.0	-0.01 5.2
9.62	5.0E-05	-0.04	10.9	0.98	6	11.6	46.4	58.0	41.4	30	30.0	3.0	0.02 4.5

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 Param	(N1)
9.88	5.0E-05	0.03	15.3	0.41	7	15.7	0.0	15.7	5.0	32	30.0	6.0	0.06	0.0
10.12	5.0E-05	-0.01	18.8	1.01	7	19.1	45.0	64.1	31.3	34	30.0	6.0	-0.03	5.9
10.38	5.0E-05	-0.03	15.2	1.01	6	16.0	64.0	80.0	35.2	32	30.0	6.0	-0.01	6.3
10.62	5.0E-05	0.00	15.5	1.07	6	16.5	65.8	82.3	35.4	32	30.0	6.0	-0.02	6.4
10.88	5.0E-05	0.04	12.2	0.77	6	13.6	54.4	68.0	36.7	32	30.0	3.0	0.03	5.3
11.12	5.0E-04	-0.01	19.7	0.63	7	20.9	28.1	48.9	26.5	34	30.0	1.0	0.00	3.8
11.38	5.0E-04	0.00	25.2	0.43	7	26.4	0.0	26.4	5.0	34	30.0	1.0	0.01	0.0
11.62	5.0E-05	-0.01	14.5	0.42	7	16.3	0.0	16.3	5.0	32	30.0	6.0	0.06	0.0
11.88	5.0E-04	-0.01	18.7	0.48	7	20.6	0.0	20.6	5.0	34	30.0	1.0	0.02	0.0
12.12	5.0E-04	-0.03	17.9	0.30	7	20.1	0.0	20.1	5.0	32	30.0	1.0	0.06	0.0
12.38	5.0E-04	0.02	20.4	0.45	7	22.8	0.0	22.8	5.0	34	30.0	1.0	0.02	0.0
12.62	5.0E-04	0.01	17.3	0.31	7	19.8	0.0	19.8	5.0	32	30.0	1.0	0.07	0.0
12.88	5.0E-04	0.03	19.1	0.18	7	21.9	0.0	21.9	5.0	34	30.0	1.0	0.10	0.0
13.12	5.0E-04	0.03	15.6	0.20	7	18.5	0.0	18.5	5.0	32	30.0	1.0	0.11	0.0
13.38	5.0E-04	0.01	26.6	0.55	7	30.3	22.7	53.0	21.1	36	33.0	1.0	-0.02	3.6
13.62	5.0E-04	0.03	20.4	0.77	7	24.0	36.2	60.2	27.5	34	30.0	1.0	-0.01	4.7
13.88	5.0E-03	0.00	50.9	0.43	9	56.9	0.0	56.9	5.0	38	51.1	1.0	-0.06	0.0
14.12	5.0E-03	0.00	52.7	0.46	9	59.5	0.0	59.5	5.0	40	52.4	1.0	-0.06	0.0
14.38	5.0E-03	0.00	63.8	0.47	9	72.2	0.0	72.2	5.0	40	57.9	1.0	-0.08	0.0
14.62	5.0E-03	0.00	48.0	0.42	9	55.4	0.0	55.4	5.0	38	50.4	1.0	-0.05	0.0
14.88	5.0E-03	0.00	43.8	0.53	9	51.2	17.7	68.9	14.6	38	48.1	1.0	-0.06	2.4
15.12	5.0E-03	0.00	58.3	0.86	9	67.9	23.3	91.3	14.6	40	56.2	1.0	-0.12	3.2
15.38	5.0E-02	0.00	102.9	0.44	9	119.3	0.0	119.3	5.0	42	72.3	1.0	-0.12	0.0
15.62	5.0E-02	0.00	106.5	0.36	9	124.5	0.0	124.5	5.0	42	73.6	1.0	-0.11	0.0
15.88	5.0E-02	0.00	116.5	0.33	9	137.1	0.0	137.1	4.1	42	76.3	1.0	-0.11	0.0
16.12	5.0E-02	0.00	115.3	0.39	9	137.0	0.0	137.0	4.8	42	76.3	1.0	-0.12	0.0
16.38	5.0E-02	0.00	95.6	0.38	9	115.1	0.0	115.1	5.0	42	71.3	1.0	-0.10	0.0
16.62	5.0E-02	0.00	87.9	0.22	9	106.9	0.0	106.9	4.8	42	69.2	1.0	-0.05	0.0

Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5760

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S4

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 15:35

CPT File: 141CPS4.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
0.12	20.9	0.03	0.14	-0.07	7	18.5	2.3	1.1	1.23	2.00	7.0	13.9	UnDef	0.09
0.38	3.6	0.10	2.70	-1.23	3	17.5	6.8	3.1	3.68	2.00	3.6	7.1	27.9	0.00
0.62	3.2	0.06	1.90	-2.45	1	17.5	11.2	5.1	6.13	2.00	1.6	3.2	24.3	0.00
0.88	2.6	0.04	1.62	-1.80	1	17.5	15.6	7.0	8.58	2.00	1.3	2.6	19.4	0.00
1.12	2.3	0.05	2.00	-0.08	1	17.5	19.9	8.9	11.04	2.00	1.2	2.3	16.8	0.00
1.38	35.9	0.40	1.12	-5.74	7	18.5	24.4	10.9	13.49	2.00	12.0	23.9	UnDef	0.11
1.62	8.2	0.24	2.92	-8.75	4	18.0	29.0	13.1	15.94	2.00	5.5	10.9	63.2	0.09
1.88	16.9	0.34	1.98	-8.77	6	18.0	33.5	15.1	18.39	2.00	6.8	13.6	132.8	0.09
2.12	15.3	0.23	1.53	-8.59	6	18.0	38.0	17.2	20.85	2.00	6.1	12.3	119.6	0.09
2.38	14.1	0.20	1.44	-8.40	6	18.0	42.5	19.2	23.30	2.00	5.6	11.3	109.1	0.09
2.62	24.3	0.22	0.89	-8.29	7	18.5	47.1	21.3	25.75	2.00	8.1	16.2	UnDef	0.10
2.88	17.2	0.19	1.13	-8.05	6	18.0	51.6	23.4	28.20	2.00	6.9	13.8	133.4	0.09
3.12	22.2	0.55	2.47	-7.29	6	18.0	56.1	25.5	30.66	1.94	8.9	17.3	173.4	0.12
3.38	17.3	0.37	2.12	-6.04	5	18.0	60.6	27.5	33.11	1.87	8.6	16.1	133.2	0.10
3.62	12.4	0.21	1.69	25.20	5	18.0	65.1	29.6	35.56	1.80	6.2	11.2	94.0	0.09
3.88	10.2	0.10	1.00	48.41	6	18.0	69.6	31.6	38.01	1.74	4.1	7.1	76.1	0.09
4.12	8.9	0.03	0.34	40.88	6	18.0	74.1	33.7	40.47	1.69	3.6	6.0	65.3	0.00
4.38	8.3	0.03	0.32	39.42	1	17.5	78.6	35.6	42.92	1.64	4.2	6.8	60.2	0.00
4.62	7.6	0.03	0.37	35.90	1	17.5	82.9	37.6	45.37	1.60	3.8	6.1	54.1	0.00
4.88	6.6	0.03	0.39	34.87	1	17.5	87.3	39.5	47.82	1.56	3.3	5.1	45.8	0.00
5.12	6.3	0.03	0.46	33.84	1	17.5	91.7	41.4	50.28	1.52	3.2	4.8	43.3	0.08
5.38	6.3	0.03	0.48	33.64	1	17.5	96.1	43.3	52.73	1.49	3.1	4.7	42.5	0.09
5.62	6.6	0.03	0.45	23.14	1	17.5	100.4	45.3	55.18	1.45	3.3	4.8	44.9	0.09
5.88	6.0	0.03	0.50	31.32	1	17.5	104.8	47.2	57.63	1.42	3.0	4.3	39.7	0.09
6.12	6.1	0.03	0.49	31.54	1	17.5	109.2	49.1	60.09	1.40	3.1	4.3	40.2	0.09
6.38	7.0	0.03	0.43	27.51	1	17.5	113.6	51.0	62.54	1.37	3.5	4.8	46.7	0.09
6.62	6.9	0.03	0.42	23.86	1	17.5	117.9	52.9	64.99	1.35	3.4	4.6	45.5	0.09
6.88	9.0	0.05	0.52	17.57	6	18.0	122.4	54.9	67.44	1.32	3.6	4.7	61.9	0.09
7.12	7.2	0.03	0.42	25.06	1	17.5	126.8	56.9	69.90	1.30	3.6	4.7	47.6	0.09
7.38	6.3	0.03	0.48	21.94	1	17.5	131.2	58.8	72.35	1.28	3.1	4.0	39.5	0.09
7.62	6.3	0.03	0.47	21.48	1	17.5	135.6	60.8	74.80	1.26	3.2	4.0	39.8	0.09
7.88	6.1	0.03	0.49	24.88	1	17.5	139.9	62.7	77.25	1.24	3.1	3.8	37.7	0.09
8.12	8.4	0.03	0.36	20.78	6	18.0	144.4	64.7	79.71	1.22	3.4	4.1	55.9	0.00
8.38	8.4	0.03	0.36	26.79	6	18.0	148.9	66.7	82.16	1.20	3.4	4.0	55.6	0.00
8.62	6.9	0.03	0.44	26.75	1	17.5	153.3	68.7	84.61	1.18	3.4	4.1	42.8	0.09
8.88	6.2	0.03	0.48	29.01	1	17.5	157.7	70.6	87.06	1.16	3.1	3.6	37.1	0.08
9.12	6.9	0.03	0.44	26.96	1	17.5	162.1	72.5	89.52	1.15	3.4	4.0	42.2	0.09
9.38	9.2	0.06	0.69	21.19	6	18.0	166.5	74.5	91.97	1.13	3.7	4.2	60.1	0.09
9.62	11.7	0.11	0.95	14.35	6	18.0	171.0	76.6	94.42	1.12	4.7	5.2	79.6	0.11

Run No: 99-0331-0827-5760

CPT File: 141CPS4.COR

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60	Su (kPa)	CRR
9.88	9.4	0.04	0.46	19.87	6	18.0	175.5	78.6	96.87	1.10	3.7	4.1	60.9	0.09
10.12	12.3	0.07	0.54	15.13	6	18.0	180.0	80.7	99.33	1.09	4.9	5.4	84.0	0.10
10.38	10.7	0.09	0.81	19.24	6	18.0	184.5	82.7	101.78	1.08	4.3	4.6	70.9	0.10
10.62	12.2	0.04	0.35	18.92	6	18.0	189.0	84.8	104.23	1.06	4.9	5.2	82.6	0.00
10.88	7.1	0.03	0.42	25.25	1	17.5	193.4	86.8	106.68	1.05	3.5	3.7	41.2	0.09
11.12	8.9	0.03	0.34	25.20	6	18.0	197.9	88.7	109.14	1.04	3.5	3.7	55.2	0.09
11.38	11.2	0.03	0.26	22.11	6	18.0	202.4	90.8	111.59	1.03	4.5	4.6	73.2	0.00
11.62	9.9	0.04	0.36	23.57	6	18.0	206.9	92.8	114.04	1.02	4.0	4.0	62.8	0.09
11.88	11.6	0.04	0.36	19.70	6	18.0	211.4	94.9	116.49	1.00	4.6	4.7	75.9	0.10
12.12	8.8	0.03	0.38	23.66	6	18.0	215.9	96.9	118.95	0.99	3.5	3.5	52.8	0.09
12.38	9.9	0.04	0.42	19.92	6	18.0	220.4	99.0	121.40	0.98	4.0	3.9	61.8	0.09
12.62	11.1	0.03	0.29	27.06	6	18.0	224.9	101.0	123.85	0.97	4.4	4.3	70.5	0.10
12.88	21.8	0.10	0.47	13.99	7	18.5	229.4	103.1	126.30	0.96	7.3	7.0	UnDef	0.09
13.12	26.0	0.08	0.32	7.97	7	18.5	234.1	105.3	128.76	0.95	8.7	8.3	UnDef	0.00
13.38	20.7	0.06	0.28	16.88	7	18.5	238.7	107.5	131.21	0.94	6.9	6.5	UnDef	0.00
13.62	20.2	0.04	0.19	19.84	7	18.5	243.3	109.7	133.66	0.93	6.7	6.3	UnDef	0.00
13.88	27.0	0.16	0.60	20.84	7	18.5	247.9	111.8	136.11	0.93	9.0	8.3	UnDef	0.10
14.12	26.4	0.05	0.19	18.31	7	18.5	252.6	114.0	138.57	0.92	8.8	8.1	UnDef	0.00
14.38	12.6	0.03	0.27	28.40	6	18.0	257.1	116.1	141.02	0.91	5.0	4.6	80.0	0.10
14.62	35.6	0.11	0.31	22.61	7	18.5	261.7	118.2	143.47	0.90	11.9	10.7	UnDef	0.08
14.88	43.4	0.36	0.83	19.93	7	18.5	266.3	120.4	145.92	0.89	14.5	12.9	UnDef	0.11
15.12	65.8	0.32	0.49	16.69	8	19.0	271.0	122.6	148.38	0.88	16.4	14.5	UnDef	0.12



Interpretation Output - Release 1.00.17

Run No: 99-0331-0827-5760

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S4

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 15:35

CPT File: 141CPS4.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 Param	(N1)
0.12	5.0E-04	0.00	1000.0	0.14	10	41.8	0.0	41.8	0.0	50	87.2	1.0	-0.22	0.0
0.38	5.0E-08	-0.05	111.2	2.76	7	7.1	4.0	11.1	18.6	UnDef	UnDef	10.0	UnDef	2.1
0.62	1.0E-07	-0.10	60.1	1.97	7	6.3	4.9	11.2	21.5	UnDef	UnDef	10.0	UnDef	1.2
0.88	1.0E-07	-0.11	34.8	1.73	7	5.2	7.5	12.6	27.1	UnDef	UnDef	6.0	UnDef	1.5
1.12	1.0E-07	-0.06	23.6	2.19	6	4.6	18.4	23.0	36.0	UnDef	UnDef	6.0	UnDef	2.3
1.38	5.0E-04	-0.02	325.8	1.13	9	71.8	0.0	71.8	4.3	48	69.6	1.0	-0.31	0.0
1.62	5.0E-07	-0.13	60.5	3.02	7	16.4	21.5	37.9	26.3	UnDef	UnDef	10.0	UnDef	6.0
1.88	5.0E-05	-0.06	109.9	2.02	7	33.9	13.2	47.1	15.5	42	43.5	10.0	-0.28	2.9
2.12	5.0E-05	-0.07	87.1	1.57	7	30.7	11.7	42.3	15.3	42	38.8	10.0	-0.23	2.6
2.38	5.0E-05	-0.08	71.0	1.49	7	28.1	13.1	41.2	16.9	40	34.7	10.0	-0.20	2.8
2.62	5.0E-04	-0.04	112.0	0.91	9	48.7	6.0	54.7	9.1	42	48.9	1.0	-0.19	1.2
2.88	5.0E-05	-0.06	71.2	1.16	7	34.4	12.2	46.6	14.8	40	37.6	10.0	-0.18	2.7
3.12	5.0E-05	-0.05	85.1	2.53	7	44.1	30.4	74.4	20.3	42	43.8	10.0	-0.29	5.9
3.38	5.0E-06	-0.06	60.5	2.20	7	32.9	28.9	61.8	22.5	UnDef	UnDef	10.0	UnDef	6.7
3.62	5.0E-06	0.18	39.7	1.79	7	22.8	28.0	50.8	25.6	UnDef	UnDef	6.0	UnDef	5.9
3.88	5.0E-05	0.46	30.1	1.07	7	18.2	19.7	37.8	24.5	36	30.0	6.0	-0.02	3.4
4.12	5.0E-05	0.44	24.3	0.37	7	15.4	0.0	15.4	5.0	34	30.0	6.0	0.07	0.0
4.38	1.0E-07	0.46	21.1	0.36	7	13.9	0.0	13.9	5.0	UnDef	UnDef	6.0	UnDef	0.0
4.62	1.0E-07	0.45	18.0	0.41	7	12.4	0.0	12.4	5.0	UnDef	UnDef	6.0	UnDef	0.0
4.88	1.0E-07	0.51	14.5	0.45	7	10.5	0.0	10.5	5.0	UnDef	UnDef	6.0	UnDef	0.0
5.12	1.0E-07	0.52	13.1	0.54	7	9.8	26.8	36.6	32.4	UnDef	UnDef	6.0	UnDef	4.1
5.38	1.0E-07	0.52	12.3	0.56	7	9.5	32.7	42.3	34.0	UnDef	UnDef	3.0	UnDef	4.4
5.62	1.0E-07	0.31	12.4	0.53	7	9.8	30.7	40.5	33.4	UnDef	UnDef	3.0	UnDef	4.3
5.88	1.0E-07	0.50	10.5	0.60	6	8.8	35.0	43.8	37.6	UnDef	UnDef	3.0	UnDef	4.3
6.12	1.0E-07	0.50	10.2	0.60	6	8.7	34.9	43.7	38.0	UnDef	UnDef	3.0	UnDef	4.3
6.38	1.0E-07	0.36	11.4	0.51	7	9.8	37.0	46.7	34.6	UnDef	UnDef	3.0	UnDef	4.7
6.62	1.0E-07	0.30	10.8	0.51	7	9.4	37.8	47.2	35.8	UnDef	UnDef	3.0	UnDef	4.6
6.88	5.0E-05	0.14	14.1	0.61	7	12.1	31.1	43.2	32.0	32	30.0	6.0	0.05	3.9
7.12	1.0E-07	0.30	10.5	0.50	6	9.6	38.3	47.9	36.3	UnDef	UnDef	3.0	UnDef	4.7
7.38	1.0E-07	0.29	8.4	0.61	6	8.1	32.6	40.7	42.4	UnDef	UnDef	3.0	UnDef	4.0
7.62	1.0E-07	0.27	8.2	0.60	6	8.1	32.5	40.6	42.9	UnDef	UnDef	3.0	UnDef	4.0
7.88	1.0E-07	0.35	7.5	0.64	6	7.7	30.9	38.6	45.3	UnDef	UnDef	3.0	UnDef	3.8
8.12	5.0E-05	0.18	10.8	0.43	7	10.5	0.0	10.5	5.0	30	30.0	3.0	0.10	0.0
8.38	5.0E-05	0.26	10.4	0.43	7	10.3	0.0	10.3	5.0	30	30.0	3.0	0.11	0.0
8.62	1.0E-07	0.33	7.8	0.56	6	8.3	33.2	41.5	43.4	UnDef	UnDef	3.0	UnDef	4.1
8.88	1.0E-07	0.43	6.6	0.65	6	7.4	29.6	37.0	48.7	UnDef	UnDef	3.0	UnDef	3.6
9.12	1.0E-07	0.33	7.3	0.57	6	8.1	32.4	40.5	45.1	UnDef	UnDef	3.0	UnDef	4.0
9.38	5.0E-05	0.15	10.1	0.84	6	10.6	42.5	53.1	41.5	30	30.0	3.0	0.06	4.2
9.62	5.0E-05	0.05	13.0	1.12	6	13.3	53.3	66.6	39.2	32	30.0	6.0	0.00	5.2

Run No: 99-0331-0827-5760

CPT File: 141CPS4.COR

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param	
9.88	5.0E-05	0.13	9.7	0.57	6	10.6	42.2	52.8	38.8	30	30.0	3.0	0.08	4.1
10.12	5.0E-05	0.05	13.0	0.63	7	13.7	45.1	58.8	33.7	32	30.0	6.0	0.04	4.9
10.38	5.0E-05	0.10	10.7	0.98	6	11.8	47.1	58.8	41.8	30	30.0	3.0	0.03	4.6
10.62	5.0E-05	0.08	12.2	0.42	7	13.3	0.0	13.3	5.0	32	30.0	3.0	0.08	0.0
10.88	1.0E-07	0.27	5.9	0.58	6	7.6	30.4	38.1	50.2	UnDef	UnDef	1.5	UnDef	3.7
11.12	5.0E-05	0.20	7.8	0.44	6	9.4	37.7	47.1	41.5	30	30.0	3.0	0.13	3.7
11.38	5.0E-05	0.11	10.1	0.32	7	11.7	0.0	11.7	5.0	30	30.0	3.0	0.12	0.0
11.62	5.0E-05	0.15	8.5	0.46	6	10.3	41.2	51.5	40.0	30	30.0	3.0	0.11	4.0
11.88	5.0E-05	0.08	10.0	0.44	6	11.9	47.6	59.5	36.2	30	30.0	3.0	0.09	4.7
12.12	5.0E-05	0.17	6.8	0.50	6	8.9	35.6	44.5	45.6	30	30.0	3.0	0.13	3.5
12.38	5.0E-05	0.10	7.8	0.54	6	10.0	39.9	49.9	43.1	30	30.0	3.0	0.10	3.9
12.62	5.0E-05	0.16	8.7	0.36	6	11.0	44.0	55.0	37.7	30	30.0	3.0	0.13	4.3
12.88	5.0E-04	0.01	18.9	0.52	7	21.5	26.9	48.3	25.8	34	30.0	1.0	0.02	3.7
13.12	5.0E-04	-0.02	22.4	0.35	7	25.3	0.0	25.3	5.0	34	30.0	1.0	0.03	0.0
13.38	5.0E-04	0.02	17.0	0.32	7	19.9	0.0	19.9	5.0	32	30.0	1.0	0.07	0.0
13.62	5.0E-04	0.03	16.2	0.21	7	19.3	0.0	19.3	5.0	32	30.0	1.0	0.10	0.0
13.88	5.0E-04	0.03	21.9	0.66	7	25.5	29.9	55.4	25.2	34	30.0	1.0	-0.01	4.2
14.12	5.0E-04	0.02	20.9	0.21	7	24.7	0.0	24.7	5.0	34	30.0	1.0	0.08	0.0
14.38	5.0E-05	0.14	8.6	0.34	6	11.7	46.7	58.3	37.6	30	30.0	3.0	0.13	4.6
14.62	5.0E-04	0.02	27.9	0.34	7	32.7	0.0	32.7	5.0	36	35.3	1.0	0.02	0.0
14.88	5.0E-04	0.01	33.8	0.88	7	39.5	30.1	69.6	21.2	38	40.7	1.0	-0.07	4.8
15.12	5.0E-03	0.00	51.4	0.51	9	59.4	15.1	74.5	12.6	38	52.3	1.0	-0.07	2.1

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0828-0150

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S5

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 17:56

CPT File: 141CPS5.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60	Su (kPa)	CRR
0.12	71.8	0.09	0.13	-0.06	8	19.0	2.4	1.1	1.23	2.00	17.9	35.9	UnDef	0.36
0.38	3.8	0.25	6.58	1.13	3	17.5	6.9	3.3	3.68	2.00	3.8	7.5	29.6	0.00
0.62	1.2	0.12	9.58	1.80	2	12.5	10.7	4.6	6.13	2.00	1.2	2.5	9.1	0.00
0.88	2.0	0.10	5.09	2.69	2	12.5	13.8	5.2	8.58	2.00	2.0	4.0	15.1	0.00
1.12	54.8	0.39	0.71	-6.73	8	19.0	17.8	6.7	11.04	2.00	13.7	27.4	UnDef	0.20
1.38	40.9	0.12	0.29	-7.45	8	19.0	22.5	9.0	13.49	2.00	10.2	20.4	UnDef	0.13
1.62	39.8	0.08	0.19	2.46	8	19.0	27.2	11.3	15.94	2.00	10.0	19.9	UnDef	0.13
1.88	33.9	0.16	0.46	2.04	7	18.5	31.9	13.5	18.39	2.00	11.3	22.6	UnDef	0.11
2.12	62.4	0.28	0.45	0.41	8	19.0	36.6	15.8	20.85	2.00	15.6	31.2	UnDef	0.26
2.38	126.9	1.15	0.91	-3.03	9	19.5	41.4	18.1	23.30	2.00	25.4	50.8	UnDef	0.00
2.62	185.1	2.49	1.34	-8.38	8	19.0	46.2	20.5	25.75	2.00	46.3	92.5	UnDef	0.00
2.88	238.0	3.02	1.27	-8.55	8	19.0	51.0	22.8	28.20	2.00	59.5	119.0	UnDef	0.00
3.12	166.4	2.12	1.27	-8.24	8	19.0	55.8	25.1	30.66	1.95	41.6	81.3	UnDef	0.00
3.38	193.9	2.50	1.29	-8.16	8	19.0	60.5	27.4	33.11	1.87	48.5	90.6	UnDef	0.00
3.62	224.8	3.61	1.60	-8.10	8	19.0	65.2	29.7	35.56	1.80	56.2	100.9	UnDef	0.00
3.88	226.8	3.55	1.56	-8.16	8	19.0	70.0	32.0	38.01	1.73	56.7	98.1	UnDef	0.00
4.12	161.3	3.00	1.86	-8.44	8	19.0	74.8	34.3	40.47	1.67	40.3	67.4	UnDef	0.00
4.38	74.4	1.38	1.85	-8.46	7	18.5	79.4	36.5	42.92	1.62	24.8	40.2	UnDef	0.35
4.62	26.0	0.36	1.37	-8.42	6	18.0	84.0	38.6	45.37	1.57	10.4	16.4	201.1	0.10
4.88	21.0	0.21	0.99	-8.02	6	18.0	88.5	40.7	47.82	1.53	8.4	12.9	161.0	0.09
5.12	19.3	0.18	0.94	-5.14	6	18.0	93.0	42.7	50.28	1.50	7.7	11.5	146.7	0.09
5.38	8.4	0.09	1.09	0.39	5	18.0	97.5	44.8	52.73	1.46	4.2	6.2	59.8	0.10
5.62	6.3	0.04	0.59	18.16	1	17.5	101.9	46.8	55.18	1.43	3.2	4.5	42.4	0.09
5.88	5.6	0.02	0.43	31.96	1	17.5	106.3	48.7	57.63	1.40	2.8	4.0	36.6	0.09
6.12	4.5	0.04	0.82	31.09	1	17.5	110.7	50.6	60.09	1.38	2.3	3.1	27.2	0.08
6.38	4.4	0.03	0.68	33.80	1	17.5	115.1	52.5	62.54	1.35	2.2	3.0	26.2	0.08
6.62	4.4	0.04	0.85	33.88	1	17.5	119.4	54.4	64.99	1.33	2.2	2.9	26.0	0.08
6.88	4.3	0.06	1.41	34.00	1	17.5	123.8	56.4	67.44	1.30	2.2	2.8	24.7	0.00
7.12	5.7	0.06	0.98	22.53	1	17.5	128.2	58.3	69.90	1.28	2.9	3.7	35.7	0.08
7.38	5.6	0.05	0.89	35.91	1	17.5	132.6	60.2	72.35	1.26	2.8	3.6	34.5	0.08
7.62	5.4	0.05	0.92	35.14	1	17.5	136.9	62.1	74.80	1.24	2.7	3.4	32.6	0.08
7.88	6.2	0.05	0.89	38.49	1	17.5	141.3	64.1	77.25	1.22	3.1	3.8	38.1	0.09
8.12	6.7	0.07	0.98	39.92	5	18.0	145.8	66.0	79.71	1.20	3.4	4.0	42.1	0.09
8.38	6.6	0.07	1.04	38.27	5	18.0	150.2	68.1	82.16	1.19	3.3	3.9	40.9	0.09
8.62	6.6	0.07	1.02	38.86	5	18.0	154.8	70.1	84.61	1.17	3.3	3.9	40.4	0.09
8.88	6.5	0.06	0.99	39.27	5	18.0	159.2	72.2	87.06	1.15	3.2	3.7	39.0	0.09
9.12	6.3	0.06	0.92	39.95	1	17.5	163.7	74.2	89.52	1.14	3.2	3.6	37.5	0.08
9.38	6.4	0.06	0.95	39.58	5	18.0	168.1	76.2	91.97	1.12	3.2	3.6	38.1	0.08
9.62	6.7	0.06	0.95	39.69	5	18.0	172.6	78.2	94.42	1.11	3.4	3.7	40.2	0.09

Depth (m)	AvgQt (bar)	AvgFs (bar)	AvgRf (%)	AvgUd (m)	SBT	U.Wt. (kN/m <sup>3</sup> )	TStress (kPa)	EStress (kPa)	Ueq (kPa)	Cn	N60 (blows/ft)	(N1)60 (blows/ft)	Su (kPa)	CRR
9.88	6.5	0.06	0.94	39.25	5	18.0	177.1	80.3	96.87	1.09	3.3	3.6	38.0	0.08
10.12	7.0	0.07	0.98	39.71	5	18.0	181.6	82.3	99.33	1.08	3.5	3.8	41.1	0.09
10.38	6.5	0.06	0.99	40.33	5	18.0	186.1	84.3	101.78	1.07	3.3	3.5	37.4	0.08
10.62	6.5	0.06	0.94	41.00	5	18.0	190.6	86.4	104.23	1.05	3.3	3.4	36.8	0.08
10.88	6.8	0.07	1.05	40.03	5	18.0	195.1	88.4	106.68	1.04	3.4	3.6	39.1	0.08
11.12	8.0	0.11	1.41	29.83	5	18.0	199.6	90.5	109.14	1.03	4.0	4.1	47.6	0.09
11.38	7.9	0.12	1.46	32.70	5	18.0	204.1	92.5	111.59	1.02	4.0	4.0	47.1	0.09
11.62	8.6	0.13	1.48	38.46	5	18.0	208.6	94.6	114.04	1.01	4.3	4.3	52.0	0.09
11.88	11.6	0.19	1.63	26.29	5	18.0	213.1	96.6	116.49	1.00	5.8	5.8	75.4	0.10
12.12	9.5	0.16	1.64	35.11	5	18.0	217.6	98.7	118.95	0.99	4.8	4.7	58.8	0.09
12.38	6.7	0.08	1.27	39.64	5	18.0	222.1	100.7	121.40	0.98	3.3	3.3	35.7	0.08
12.62	8.0	0.10	1.27	40.21	5	18.0	226.6	102.8	123.85	0.97	4.0	3.9	45.9	0.09
12.88	9.0	0.13	1.43	37.83	5	18.0	231.1	104.8	126.30	0.96	4.5	4.3	53.7	0.09
13.12	6.4	0.05	0.84	41.00	1	17.5	235.6	106.8	128.76	0.95	3.2	3.0	32.6	0.08
13.38	7.4	0.08	1.13	39.57	5	18.0	240.0	108.8	131.21	0.94	3.7	3.5	40.3	0.08
13.62	8.4	0.12	1.41	35.87	5	18.0	244.5	110.8	133.66	0.93	4.2	3.9	47.4	0.09
13.88	8.5	0.11	1.26	42.01	5	18.0	249.0	112.9	136.11	0.92	4.2	3.9	47.8	0.09
14.12	9.3	0.12	1.29	39.82	5	18.0	253.5	114.9	138.57	0.91	4.6	4.2	54.0	0.09
14.38	15.6	0.19	1.21	29.38	6	18.0	258.0	117.0	141.02	0.90	6.2	5.7	104.2	0.11
14.62	12.0	0.17	1.44	42.24	5	18.0	262.5	119.0	143.47	0.90	6.0	5.4	75.1	0.10
14.88	12.3	0.31	2.48	43.41	5	18.0	267.0	121.1	145.92	0.89	6.2	5.5	77.3	0.10
15.12	10.4	0.23	2.24	35.15	5	18.0	271.5	123.1	148.38	0.88	5.2	4.6	61.5	0.00
15.38	14.9	0.27	1.78	31.70	6	18.0	276.0	125.2	150.83	0.87	6.0	5.2	97.4	0.11
15.62	13.7	0.30	2.21	35.03	5	18.0	280.5	127.2	153.28	0.87	6.8	5.9	87.1	0.10
15.88	13.7	0.20	1.49	34.36	6	18.0	285.0	129.3	155.73	0.86	5.5	4.7	87.0	0.10
16.12	18.3	0.31	1.72	25.03	6	18.0	289.5	131.3	158.19	0.85	7.3	6.3	123.4	0.13
16.38	18.8	0.23	1.22	28.10	6	18.0	294.0	133.4	160.64	0.85	7.5	6.4	126.9	0.13
16.62	15.8	0.22	1.36	36.43	6	18.0	298.5	135.4	163.09	0.84	6.3	5.3	102.8	0.11
16.88	18.9	0.19	0.99	31.77	6	18.0	303.0	137.5	165.54	0.83	7.6	6.3	127.3	0.13
17.12	18.8	0.14	0.75	38.73	6	18.0	307.5	139.5	168.00	0.83	7.5	6.2	125.6	0.13
17.38	19.0	0.19	1.01	32.96	6	18.0	312.0	141.6	170.45	0.82	7.6	6.3	127.2	0.13
17.62	19.6	0.19	0.96	33.77	6	18.0	316.5	143.6	172.90	0.82	7.8	6.4	131.3	0.13
17.88	25.0	0.23	0.94	28.52	7	18.5	321.1	145.7	175.35	0.81	8.3	6.8	UnDef	0.18
18.12	35.7	0.26	0.72	20.76	7	18.5	325.7	147.9	177.81	0.80	11.9	9.6	UnDef	0.11
18.38	30.4	0.14	0.47	24.74	7	18.5	330.3	150.1	180.26	0.80	10.1	8.1	UnDef	0.10
18.62	22.0	0.11	0.52	33.83	7	18.5	334.9	152.2	182.71	0.79	7.3	5.8	UnDef	0.14
18.88	28.4	0.19	0.65	28.72	7	18.5	339.6	154.4	185.16	0.79	9.5	7.5	UnDef	0.12
19.12	43.4	0.42	0.97	23.45	7	18.5	344.2	156.6	187.62	0.78	14.5	11.3	UnDef	0.13
19.38	51.8	0.58	1.12	22.41	7	18.5	348.8	158.7	190.07	0.78	17.3	13.4	UnDef	0.15
19.62	45.8	0.43	0.95	28.76	7	18.5	353.4	160.9	192.52	0.77	15.3	11.8	UnDef	0.13
19.88	37.0	0.47	1.28	31.17	7	18.5	358.1	163.1	194.97	0.77	12.3	9.4	UnDef	0.24
20.12	35.3	0.16	0.45	33.45	7	18.5	362.7	165.3	197.43	0.76	11.8	9.0	UnDef	0.10
20.38	43.7	0.52	1.18	28.47	7	18.5	367.3	167.4	199.88	0.76	14.6	11.0	UnDef	0.17
20.62	37.9	0.50	1.33	31.82	7	18.5	371.9	169.6	202.33	0.75	12.6	9.5	UnDef	0.28
20.88	51.3	0.56	1.10	30.19	7	18.5	376.6	171.8	204.78	0.75	17.1	12.8	UnDef	0.15
21.12	66.5	0.69	1.03	23.50	8	19.0	381.2	174.0	207.24	0.74	16.6	12.3	UnDef	0.16
21.38	58.1	0.69	1.19	26.46	7	18.5	385.9	176.2	209.69	0.74	19.4	14.3	UnDef	0.17
21.62	64.8	0.61	0.95	26.20	8	19.0	390.6	178.5	212.14	0.73	16.2	11.9	UnDef	0.15
21.88	54.2	0.69	1.28	28.23	7	18.5	395.3	180.7	214.59	0.73	18.1	13.2	UnDef	0.19

## Interpretation Output - Release 1.00.17

Run No: 99-0331-0828-0150

Job No: 99-141

Client: Thurber Engineering

Project: Trout Lake By-Pass

Site: 99-141 CPT-S5

Location: S.INTERCHANGE

Cone: 20 TON A 058

CPT Date: 99/25/03

CPT Time: 17:56

CPT File: 141CPS5.COR

Northing (m): 0.000

Easting (m): 0.000

Elevation (m): 0.000

Water Table (m): 0.00 (ft): 0.0

Su Nkt used: 12.50

Averaging Increment (m): 0.25

Phi Method: Robertson and Campanella, 1983

Dr Method: Jamiolkowski - All Sands

State Parameter M: 1.20

Used Unit Weights Assigned to Soil Zones

Values of 1.0E9 or UnDef are printed for parameters that are not valid for the material type (SBT)

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1 Param
0.12	5.0E-03	0.00	1000.0	0.13	10	143.5	0.0	143.5	0.0	50	95.0	1.0	-0.21 0.0
0.38	5.0E-08	0.02	113.5	6.71	11	7.5	UnDef	UnDef	0.0	UnDef	UnDef	10.0	UnDef UnDef
0.62	1.0E-15	0.10	24.9	10.00	1	2.5	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef UnDef
0.88	1.0E-15	0.09	36.0	5.47	1	4.0	UnDef	UnDef	100.0	UnDef	UnDef	6.0	UnDef UnDef
1.12	5.0E-03	-0.01	813.8	0.71	10	109.6	0.0	109.6	0.0	50	88.8	1.0	-0.35 0.0
1.38	5.0E-03	-0.02	451.3	0.30	10	81.8	0.0	81.8	0.0	48	76.1	1.0	-0.22 0.0
1.62	5.0E-03	0.00	349.5	0.19	10	79.6	0.0	79.6	0.0	48	72.1	1.0	-0.16 0.0
1.88	5.0E-04	0.00	247.6	0.47	9	67.7	0.0	67.7	1.5	46	64.9	1.0	-0.20 0.0
2.12	5.0E-03	0.00	393.2	0.45	10	124.8	0.0	124.8	0.0	48	80.2	1.0	-0.24 0.0
2.38	5.0E-02	0.00	697.5	0.91	9	253.9	0.0	253.9	0.8	50	95.0	1.0	-0.36 0.0
2.62	5.0E-03	-0.01	900.5	1.35	9	370.1	0.0	370.1	2.1	50	95.0	1.0	-0.43 0.0
2.88	5.0E-03	0.00	1000.0	1.27	9	476.1	0.0	476.1	1.6	50	95.0	1.0	-0.44 0.0
3.12	5.0E-03	-0.01	660.8	1.28	9	332.1	0.0	332.1	2.5	50	95.0	1.0	-0.40 0.0
3.38	5.0E-03	-0.01	705.6	1.29	9	370.5	0.0	370.5	2.4	50	95.0	1.0	-0.40 0.0
3.62	5.0E-03	-0.01	754.8	1.61	12	412.5	UnDef	UnDef	0.0	50	95.0	1.0	-0.44 UnDef
3.88	5.0E-03	-0.01	706.9	1.57	9	401.0	0.0	401.0	3.5	50	95.0	1.0	-0.43 0.0
4.12	5.0E-03	-0.01	468.3	1.87	9	275.5	7.4	282.8	6.0	48	95.0	1.0	-0.42 1.1
4.38	5.0E-04	-0.02	201.6	1.87	9	123.1	20.0	143.1	10.2	46	73.2	1.0	-0.33 3.8
4.62	5.0E-05	-0.05	65.1	1.42	7	41.8	20.7	62.5	17.4	40	42.3	10.0	-0.18 4.3
4.88	5.0E-05	-0.06	49.5	1.03	7	32.9	16.9	49.9	17.7	38	35.4	6.0	-0.13 3.5
5.12	5.0E-05	-0.05	42.9	0.99	7	29.5	17.8	47.3	19.1	38	32.3	6.0	-0.11 3.6
5.38	5.0E-06	-0.07	16.7	1.23	6	12.6	50.5	63.1	35.4	UnDef	UnDef	6.0	UnDef 6.2
5.62	1.0E-07	0.23	11.3	0.70	6	9.2	37.0	46.2	37.3	UnDef	UnDef	3.0	UnDef 4.5
5.88	1.0E-07	0.56	9.4	0.53	6	8.1	32.3	40.4	38.8	UnDef	UnDef	3.0	UnDef 4.0
6.12	1.0E-07	0.72	6.7	1.09	6	6.3	25.4	31.7	53.6	UnDef	UnDef	3.0	UnDef 3.1
6.38	1.0E-07	0.82	6.2	0.92	6	6.1	24.4	30.5	53.6	UnDef	UnDef	1.5	UnDef 3.0
6.62	1.0E-07	0.82	6.0	1.17	4	6.0	24.1	30.1	57.6	UnDef	UnDef	1.5	UnDef 2.9
6.88	1.0E-07	0.86	5.5	1.98	4	5.8	23.0	28.8	67.3	UnDef	UnDef	1.5	UnDef 2.8
7.12	1.0E-07	0.34	7.6	1.26	6	7.5	30.1	37.6	52.2	UnDef	UnDef	3.0	UnDef 3.7
7.38	1.0E-07	0.65	7.2	1.16	6	7.3	29.1	36.4	52.8	UnDef	UnDef	3.0	UnDef 3.6
7.62	1.0E-07	0.66	6.5	1.23	6	6.9	27.6	34.5	55.8	UnDef	UnDef	3.0	UnDef 3.4
7.88	1.0E-07	0.63	7.4	1.16	6	7.7	30.8	38.6	51.9	UnDef	UnDef	3.0	UnDef 3.8
8.12	5.0E-06	0.59	8.0	1.25	6	8.3	33.1	41.3	51.2	UnDef	UnDef	3.0	UnDef 4.0
8.38	5.0E-06	0.57	7.5	1.35	6	8.0	32.1	40.1	53.5	UnDef	UnDef	3.0	UnDef 3.9
8.62	5.0E-06	0.59	7.2	1.33	6	7.9	31.5	39.4	54.4	UnDef	UnDef	3.0	UnDef 3.9
8.88	5.0E-06	0.61	6.7	1.31	6	7.6	30.4	38.0	55.9	UnDef	UnDef	3.0	UnDef 3.7
9.12	1.0E-07	0.64	6.3	1.24	4	7.3	29.4	36.7	56.7	UnDef	UnDef	3.0	UnDef 3.6
9.38	5.0E-06	0.62	6.3	1.28	4	7.4	29.5	36.9	57.5	UnDef	UnDef	3.0	UnDef 3.6
9.62	5.0E-06	0.59	6.4	1.27	4	7.6	30.5	38.1	56.8	UnDef	UnDef	3.0	UnDef 3.7

Depth (m)	k (cm/s)	Bq	Qtn	Rfn (%)	SBTn	Qc1N	DeltaQc1N	Qc1Ncs	Fc (%)	Phi (Deg)	Dr (%)	OCR	State Del(n1)60 (N1) Param
9.88	5.0E-06	0.61	5.9	1.29	4	7.3	29.1	36.4	59.0	UnDef	UnDef	1.5	UnDef 3.6
10.12	5.0E-06	0.56	6.2	1.32	4	7.7	30.7	38.4	57.9	UnDef	UnDef	1.5	UnDef 3.8
10.38	5.0E-06	0.63	5.5	1.39	4	7.1	28.5	35.6	61.8	UnDef	UnDef	1.5	UnDef 3.5
10.62	5.0E-06	0.65	5.3	1.33	4	7.0	28.0	35.0	62.3	UnDef	UnDef	1.5	UnDef 3.4
10.88	5.0E-06	0.59	5.5	1.47	4	7.3	29.1	36.3	62.7	UnDef	UnDef	1.5	UnDef 3.6
11.12	5.0E-06	0.31	6.6	1.88	4	8.4	33.4	41.8	61.5	UnDef	UnDef	3.0	UnDef 4.1
11.38	5.0E-06	0.36	6.4	1.97	4	8.2	33.0	41.2	63.1	UnDef	UnDef	3.0	UnDef 4.0
11.62	5.0E-06	0.40	6.9	1.95	4	8.8	35.3	44.1	60.9	UnDef	UnDef	3.0	UnDef 4.3
11.88	5.0E-06	0.15	9.7	2.00	6	11.8	47.0	58.8	52.6	UnDef	UnDef	3.0	UnDef 5.8
12.12	5.0E-06	0.31	7.4	2.12	4	9.6	38.4	48.0	60.1	UnDef	UnDef	3.0	UnDef 4.7
12.38	5.0E-06	0.60	4.4	1.90	4	6.7	26.6	33.3	72.8	UnDef	UnDef	1.5	UnDef 3.3
12.62	5.0E-06	0.47	5.6	1.78	4	7.9	31.6	39.5	65.1	UnDef	UnDef	1.5	UnDef 3.9
12.88	5.0E-06	0.36	6.4	1.92	4	8.8	35.3	44.1	62.5	UnDef	UnDef	3.0	UnDef 4.3
13.12	1.0E-07	0.67	3.8	1.33	4	6.2	24.9	31.1	71.9	UnDef	UnDef	1.5	UnDef 3.0
13.38	5.0E-06	0.51	4.6	1.67	4	7.1	28.5	35.7	69.4	UnDef	UnDef	1.5	UnDef 3.5
13.62	5.0E-06	0.37	5.3	1.99	4	7.9	31.8	39.7	68.1	UnDef	UnDef	1.5	UnDef 3.9
13.88	5.0E-06	0.46	5.3	1.79	4	8.0	31.9	39.8	66.7	UnDef	UnDef	1.5	UnDef 3.9
14.12	5.0E-06	0.37	5.9	1.78	4	8.7	34.6	43.3	63.7	UnDef	UnDef	1.5	UnDef 4.2
14.38	5.0E-05	0.11	11.1	1.45	6	14.4	57.7	72.2	45.4	30	30.0	3.0	0.01 5.7
14.62	5.0E-06	0.29	7.9	1.84	4	11.0	44.0	55.0	56.6	UnDef	UnDef	3.0	UnDef 5.4
14.88	5.0E-06	0.29	8.0	3.17	4	11.2	44.8	56.0	64.8	UnDef	UnDef	3.0	UnDef 5.5
15.12	5.0E-06	0.26	6.2	3.03	1	9.4	UnDef	UnDef	100.0	UnDef	UnDef	1.5	UnDef UnDef
15.38	5.0E-05	0.13	9.7	2.18	4	13.3	53.4	66.7	54.0	30	30.0	3.0	0.00 5.2
15.62	5.0E-06	0.17	8.6	2.78	4	12.1	48.5	60.7	60.9	UnDef	UnDef	3.0	UnDef 5.9
15.88	5.0E-05	0.17	8.4	1.89	4	12.1	48.3	60.3	55.3	30	30.0	3.0	0.03 4.7
16.12	5.0E-05	0.06	11.7	2.04	6	16.0	64.0	80.0	48.7	30	30.0	3.0	-0.03 6.3
16.38	5.0E-05	0.07	11.9	1.44	6	16.3	65.1	81.4	43.9	30	30.0	3.0	0.00 6.4
16.62	5.0E-05	0.15	9.5	1.67	6	13.6	54.4	68.0	50.8	30	30.0	3.0	0.02 5.3
16.88	5.0E-05	0.09	11.6	1.17	6	16.2	64.6	80.8	42.1	30	30.0	3.0	0.02 6.3
17.12	5.0E-05	0.13	11.3	0.89	6	15.9	63.6	79.5	39.8	30	30.0	3.0	0.04 6.2
17.38	5.0E-05	0.10	11.2	1.21	6	16.0	64.0	79.9	43.1	30	30.0	3.0	0.02 6.3
17.62	5.0E-05	0.10	11.4	1.15	6	16.3	65.3	81.7	42.1	30	30.0	3.0	0.02 6.4
17.88	5.0E-04	0.05	15.0	1.07	6	20.7	82.8	103.6	36.0	32	30.0	1.0	-0.01 6.8
18.12	5.0E-04	0.01	22.0	0.79	7	29.4	40.1	69.5	26.6	34	32.2	1.0	-0.03 5.4
18.38	5.0E-04	0.02	18.0	0.53	7	24.8	34.2	59.0	26.7	32	30.0	1.0	0.02 4.6
18.62	5.0E-04	0.08	12.3	0.61	7	17.8	67.6	85.4	34.6	32	30.0	1.0	0.05 5.7
18.88	5.0E-04	0.04	16.2	0.74	7	22.9	52.5	75.3	31.1	32	30.0	1.0	0.01 5.8
19.12	5.0E-04	0.01	25.5	1.05	7	34.6	48.2	82.8	26.8	36	36.9	1.0	-0.06 6.5
19.38	5.0E-04	0.01	30.4	1.20	7	41.1	48.9	90.0	25.3	36	41.8	1.0	-0.09 6.9
19.62	5.0E-04	0.02	26.2	1.03	7	36.1	46.6	82.7	26.1	36	38.0	1.0	-0.06 6.4
19.88	5.0E-04	0.03	20.5	1.42	7	28.9	89.8	118.8	33.3	34	31.7	1.0	-0.06 8.5
20.12	5.0E-04	0.04	19.2	0.50	7	27.5	32.7	60.2	25.3	34	30.3	1.0	0.02 4.6
20.38	5.0E-04	0.02	23.9	1.29	7	33.8	66.0	99.8	29.8	34	36.2	1.0	-0.07 7.8
20.62	5.0E-04	0.03	20.2	1.47	6	29.1	100.2	129.3	34.0	34	31.9	1.0	-0.06 8.9
20.88	5.0E-04	0.02	27.6	1.19	7	39.1	53.7	92.8	26.7	36	40.4	1.0	-0.08 7.2
21.12	5.0E-03	0.00	36.0	1.09	7	50.4	42.7	93.1	22.2	38	47.6	1.0	-0.10 5.0
21.38	5.0E-04	0.01	30.7	1.28	7	43.7	54.5	98.3	25.8	36	43.6	1.0	-0.09 7.6
21.62	5.0E-03	0.01	34.1	1.01	7	48.5	41.1	89.7	22.2	38	46.5	1.0	-0.09 4.8
21.88	5.0E-04	0.01	27.8	1.38	7	40.3	64.6	104.9	28.1	36	41.2	1.0	-0.09 8.2

**Thurber Engineering**

## **APPENDIX C**

### **Summary of Dissipations and Pore Pressure Plots**

**ConeTec Investigations Ltd.**

### Summary of Pore Pressure Dissipation Plots

Test CPT - S1

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo (m)
2.5	8.8	115	---
4.5	5.2	196	---
6.5	3.4	295	---
8.5	7.6	134	---
10.5	25.0	41	---
13.0	---	---	13.3

Test CPT - S2

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	8.3	121	---
5.5	2.4	415	---
6.5	4.5	225	---
8.5	4.8	213	---
9.75	---	---	9.8

Test CPT - S3

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	13.2	77	---
5.5	3.5	290	---
7.7	2.7	860	---
9.5	5.1	200	---
11.5	17.6	58	---
16.93	---	---	17.1



Test CPT - S4

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
3.5	3.5	290	---
5.5	2.5	398	---
7.5	2.6	383	---
9.5	2.4	423	---
11.3	11.3	90	---

Test CPT - S5

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
7.0	11.2	91	---
15.0	6.4	159	---
22.08	---	---	22.4

Test CPT - N1

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
5.0	3.2	316	---
7.0	4.9	205	---
9.0	27.0	38	---
12.1	---	---	12.4

Test CPT - N2

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
8.0	1.8	560	---
10.0	4.0	253	---
12.0	12.7	80	---
16.0	110	9	---
17.3	---	---	17.2

Test CPT - N3

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
5.0	1.4	703	---
7.0	1.7	603	---
12.0	68.0	15	---
15.12	---	---	15.1

Test CPT - N4

Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
7.5	4.4	230	---
10.0	1.9	534	---
13.0	2.5	403	---
20.6	---	---	21.0

Test CPT - N5

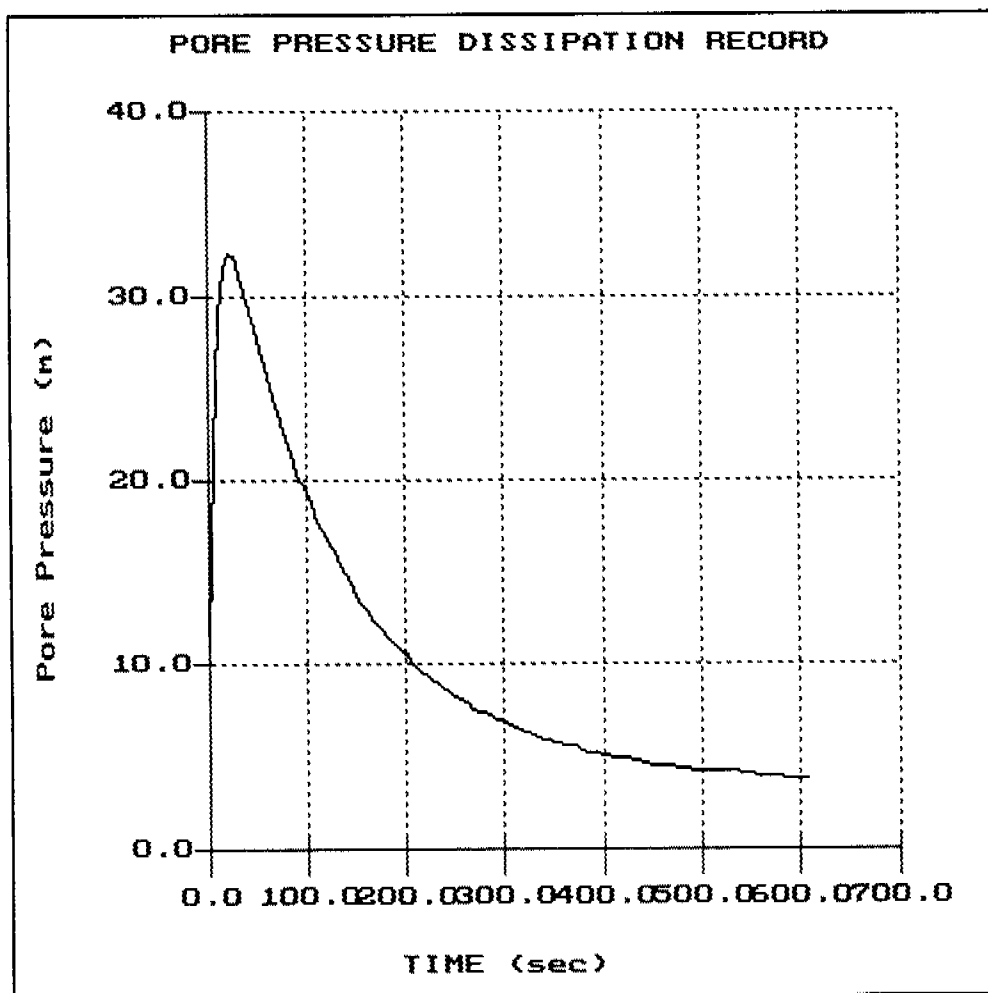
Depth (m)	$c_h(\text{cm}^2/\text{min})$	t-50 (sec)	Uo(m)
4.0	2.7	373	---
9.0	60.3	17	---
12.55	---	---	13.0

Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 2.50  
(ft): 8.20  
Duration: 605.0s

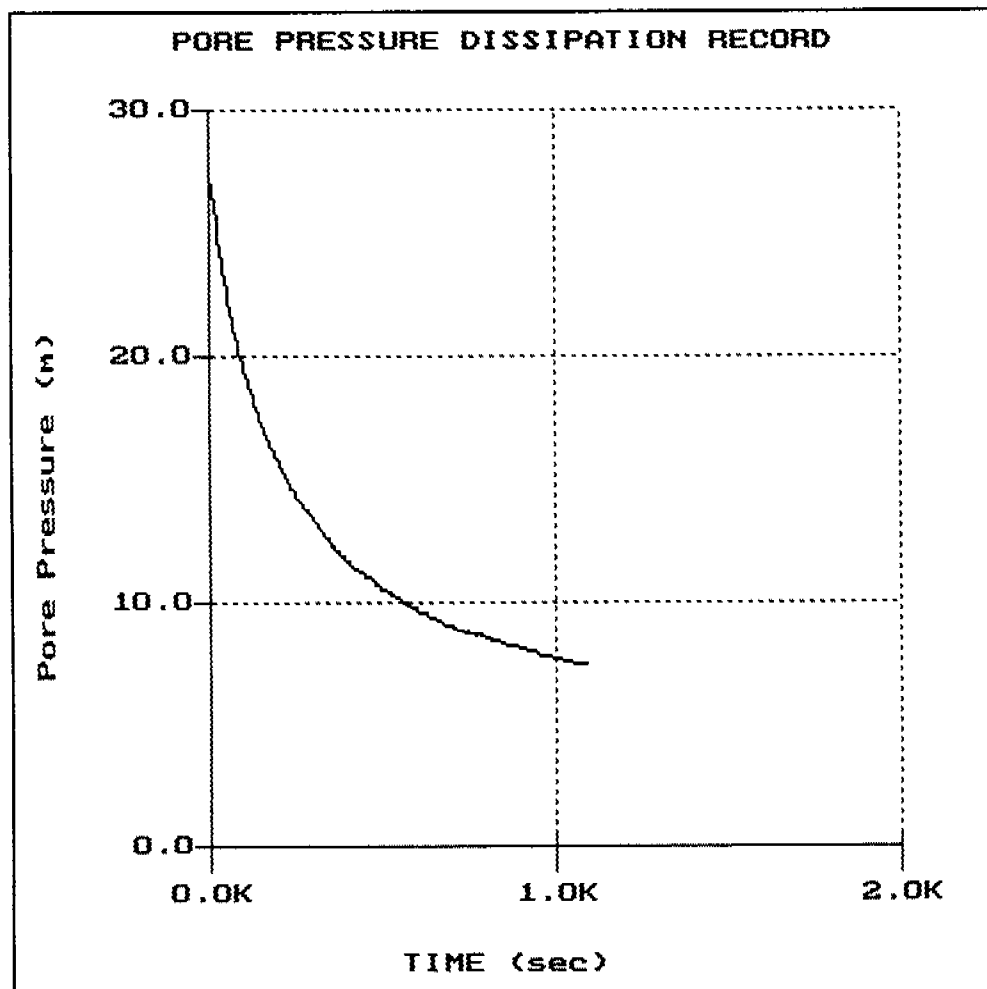


Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 4.50  
(ft): 14.76  
Duration: 1090.0s

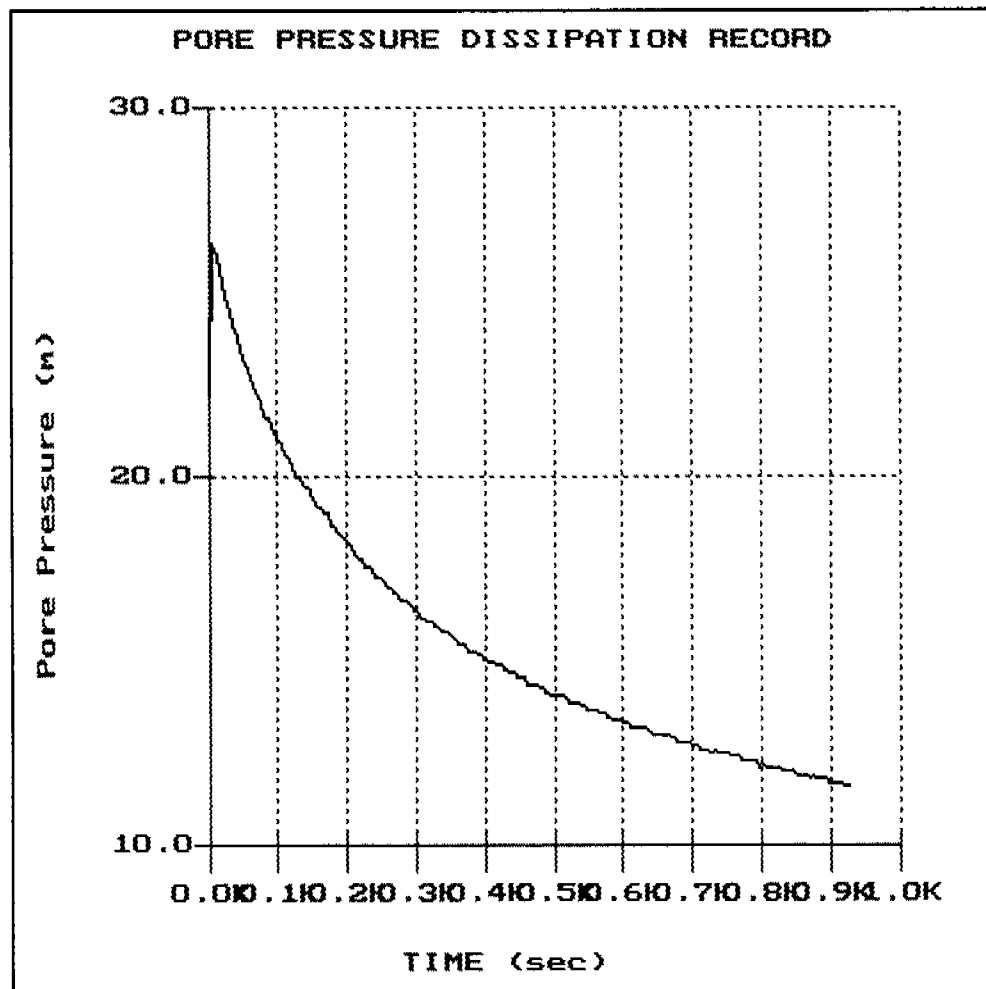


Thurber Engineering

Hole: CPTUS1  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 6.50  
(ft): 21.33  
Duration : 925.0s

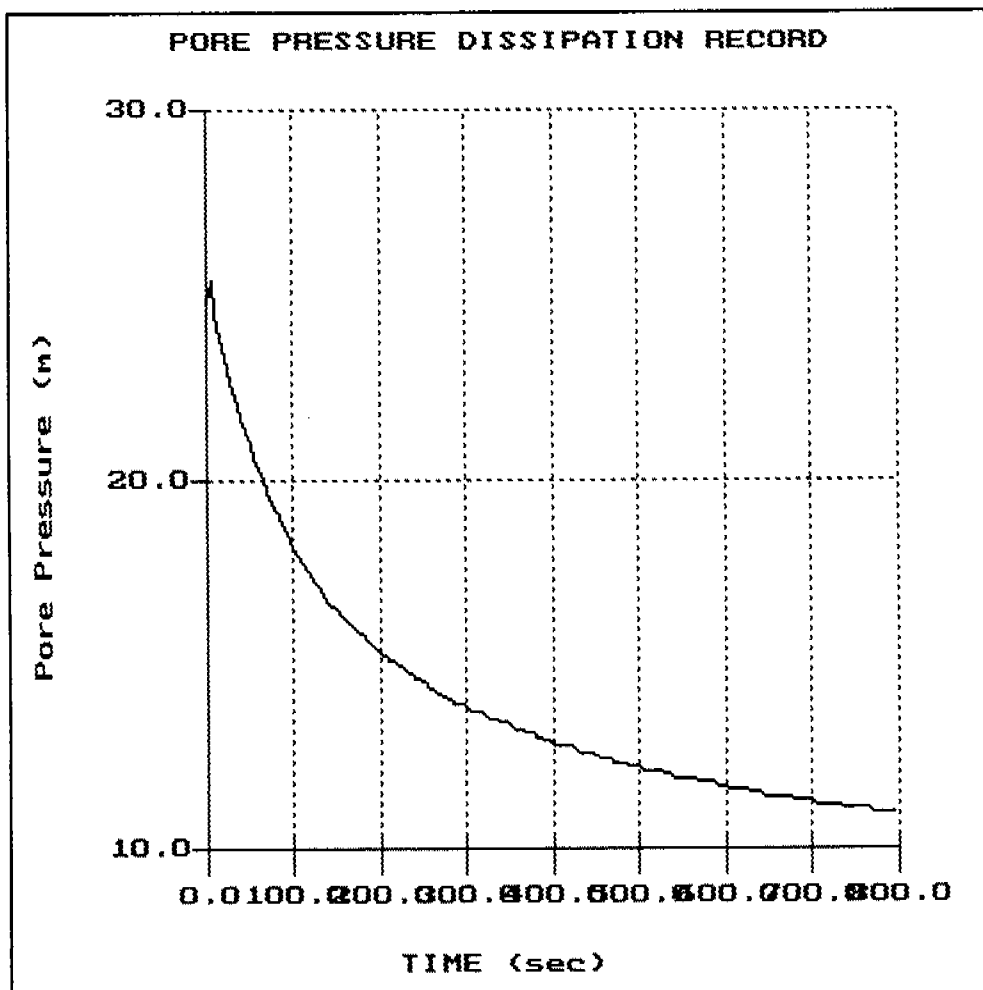


Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 8.50  
(ft): 27.89  
Duration: 795.0s



Thurber Engineering

Hole: CPTUS1

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 09:11

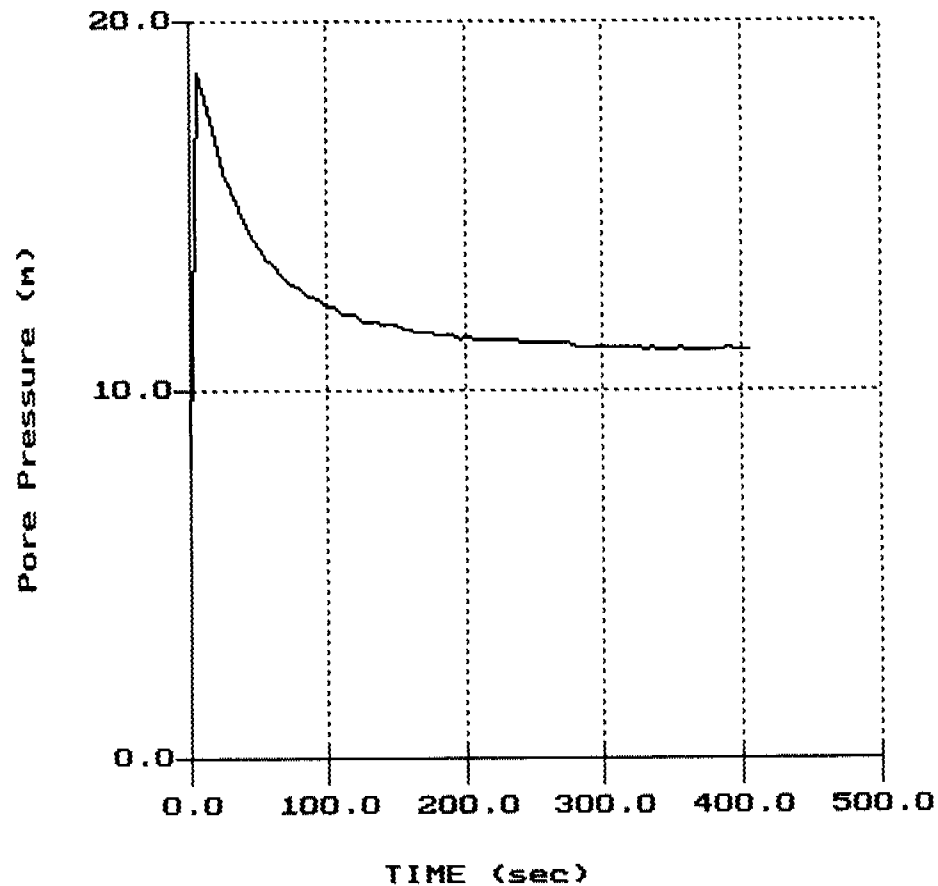
File: 141CPS1.PPD

Depth (m): 10.50

(ft): 34.45

Duration : 405.0s

PORE PRESSURE DISSIPATION RECORD

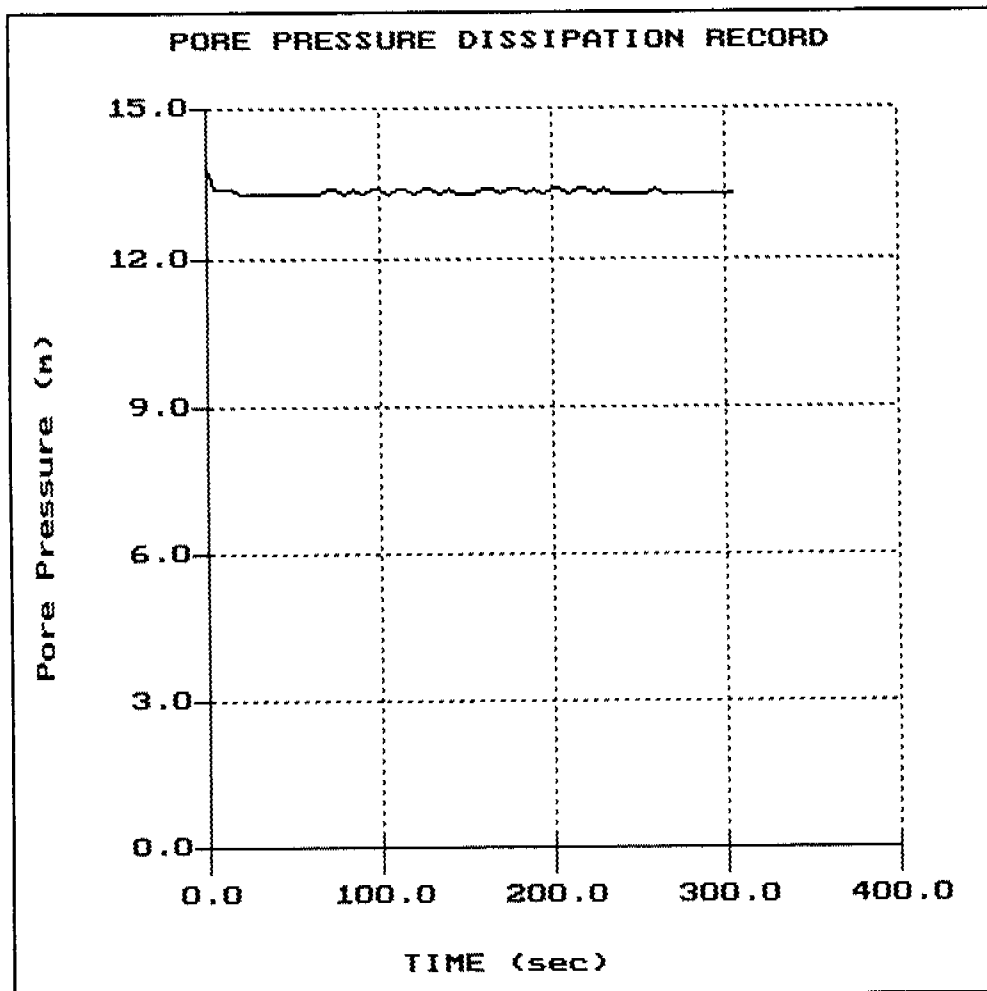


Thurber Engineering

Hole: CPTUS1  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 09:11

File: 141CPS1.PPD  
Depth (m): 13.00  
      (ft): 42.65  
Duration : 305.0s



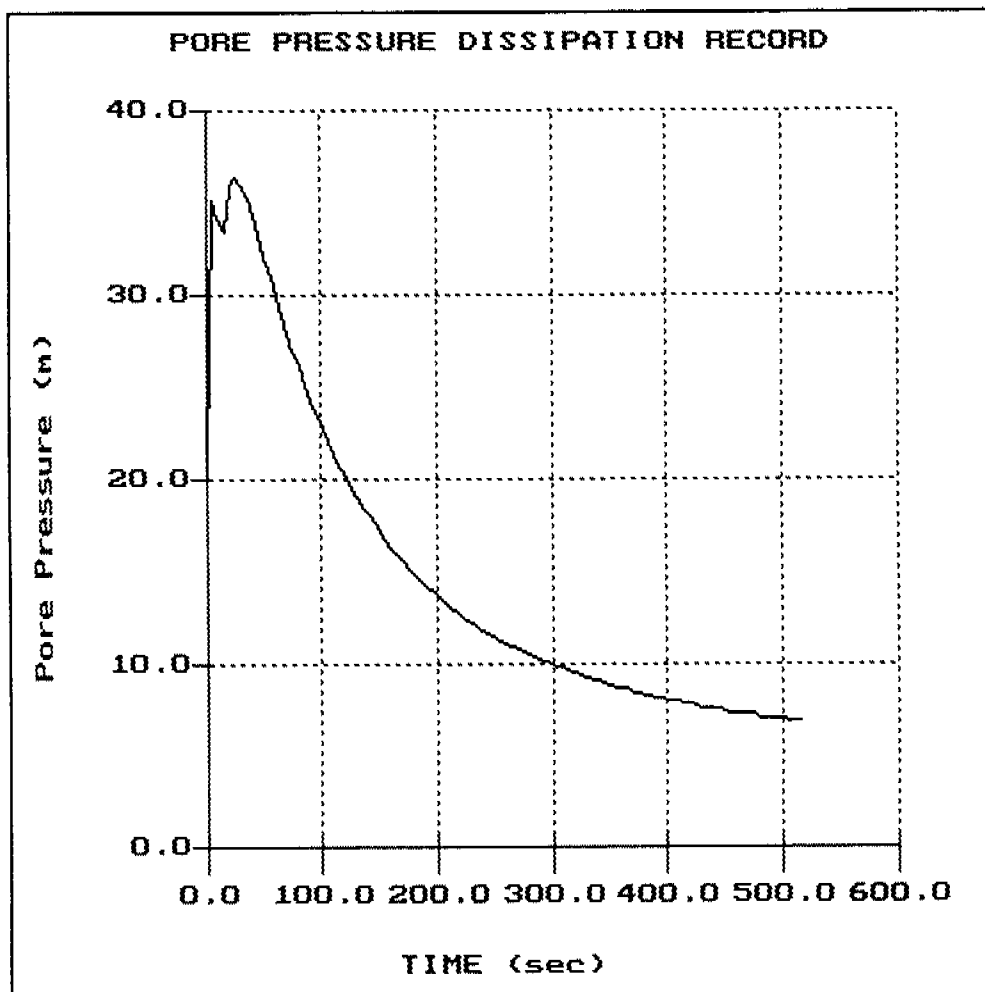


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 3.50  
(ft): 11.48  
Duration : 515.0s

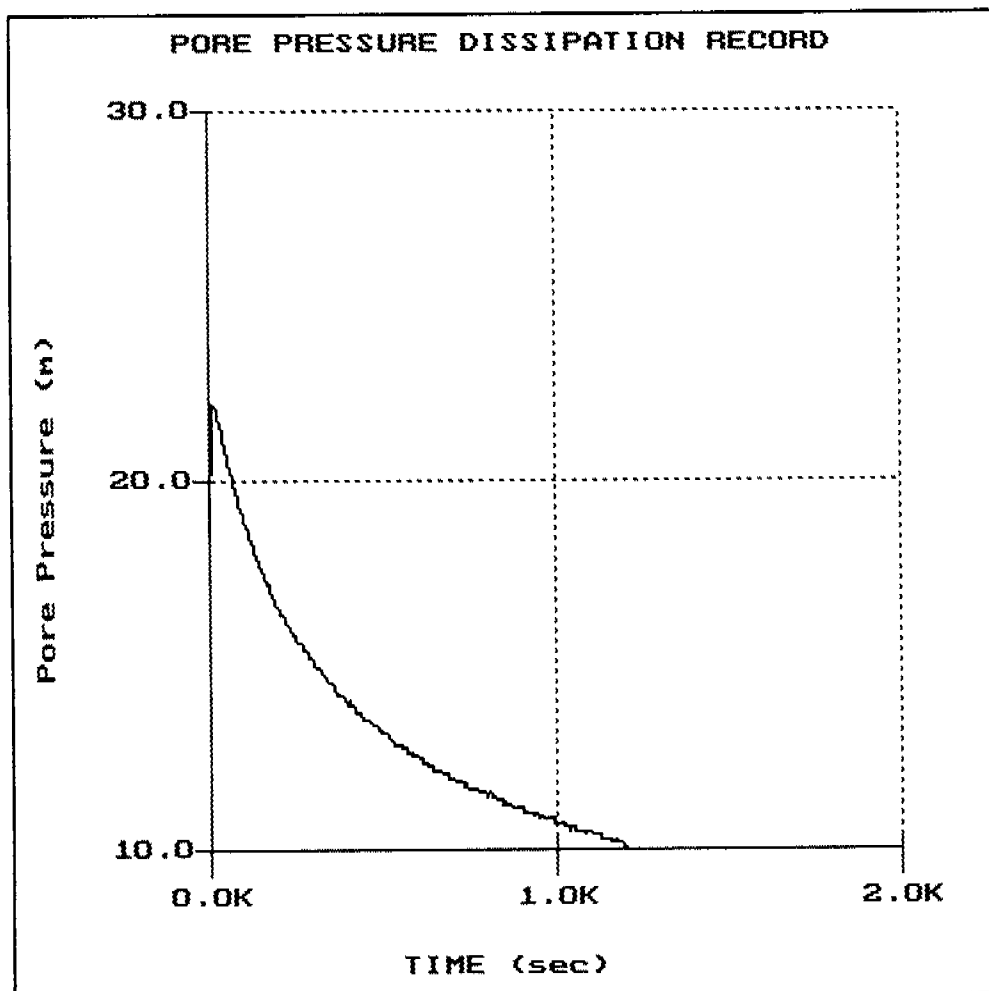


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 5.50  
(ft): 18.04  
Duration : 1205.0s

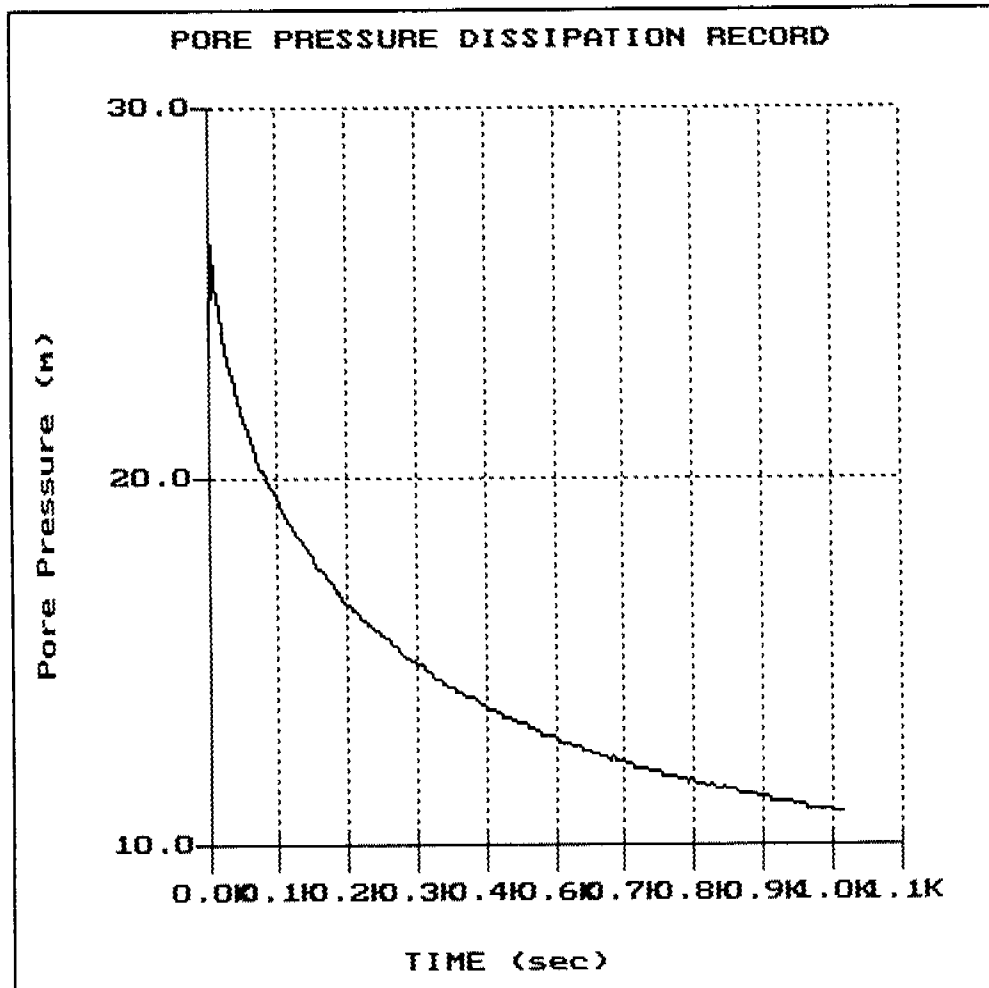


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 6.50  
(ft): 21.33  
Duration: 1005.0s

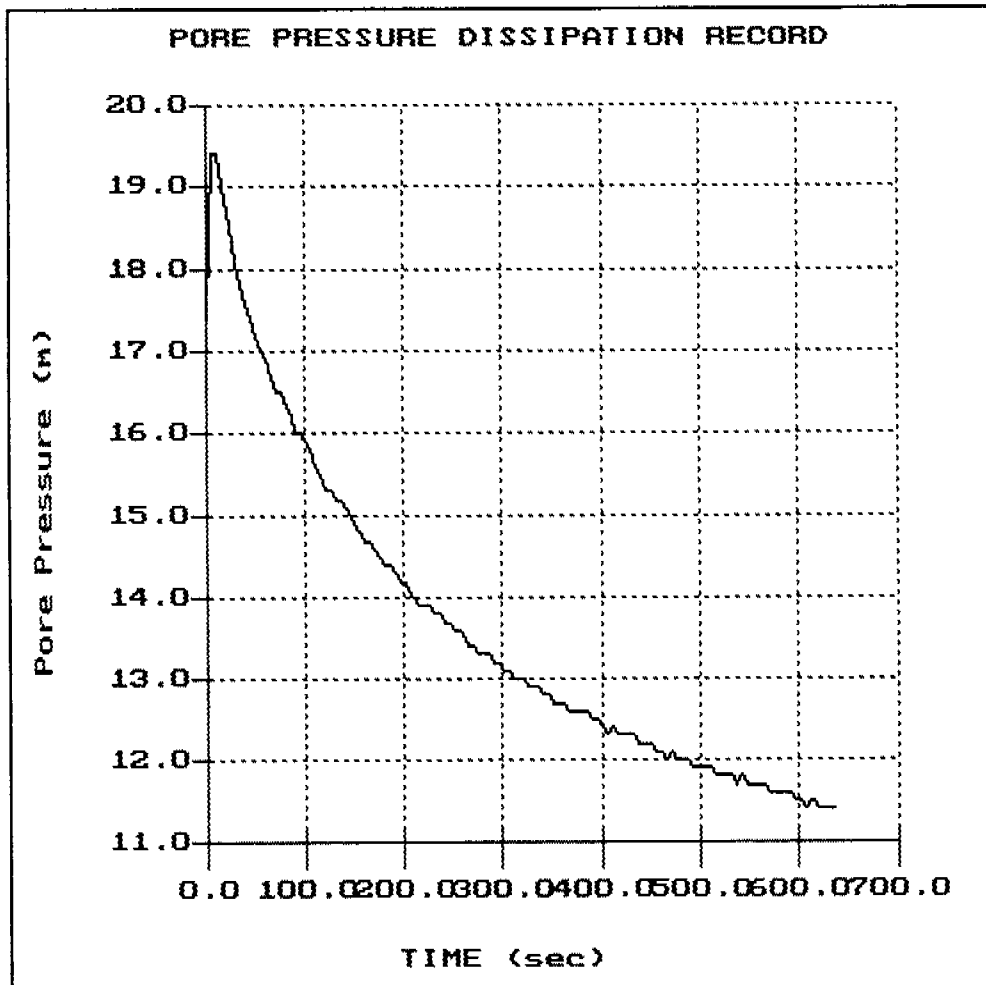


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 8.50  
(ft): 27.89  
Duration : 635.0s

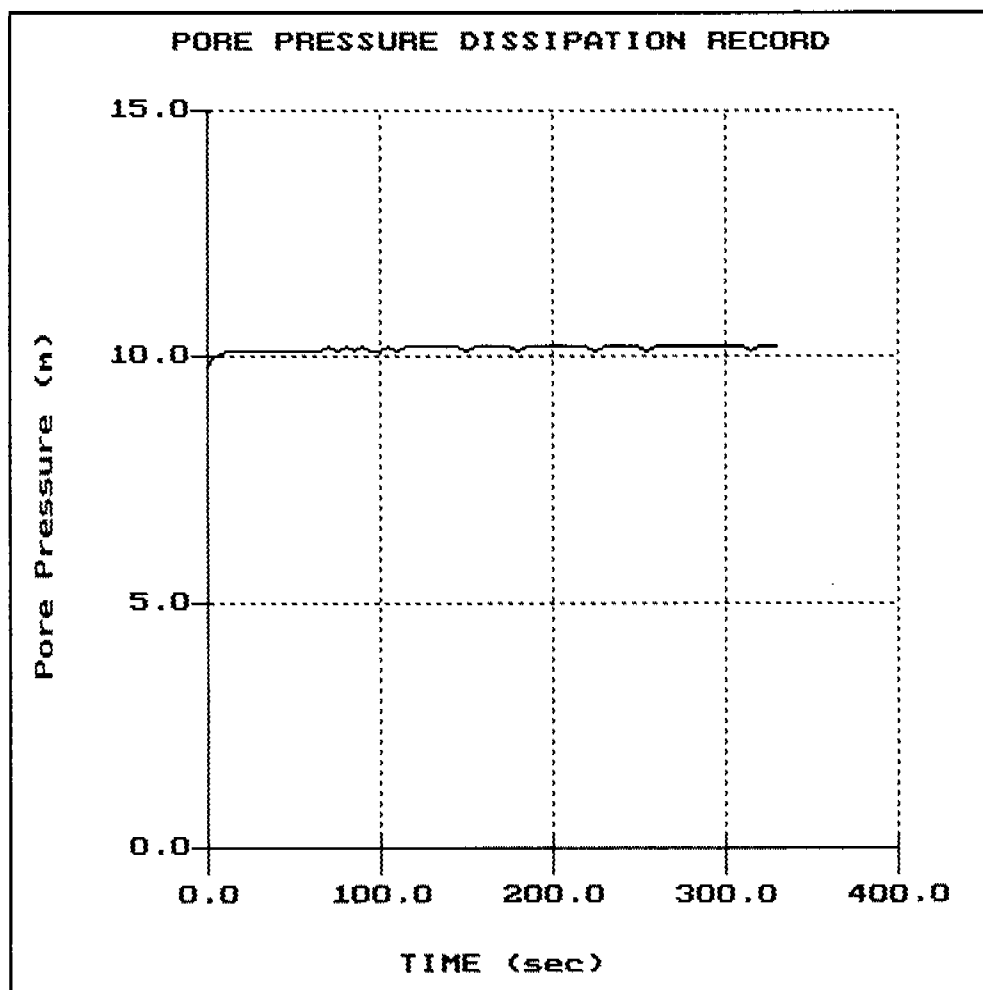


Thurber Engineering

Hole: CPTUS2  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 11:29

File: 141CPS2.PPD  
Depth (m): 9.75  
(ft): 31.99  
Duration: 330.0s

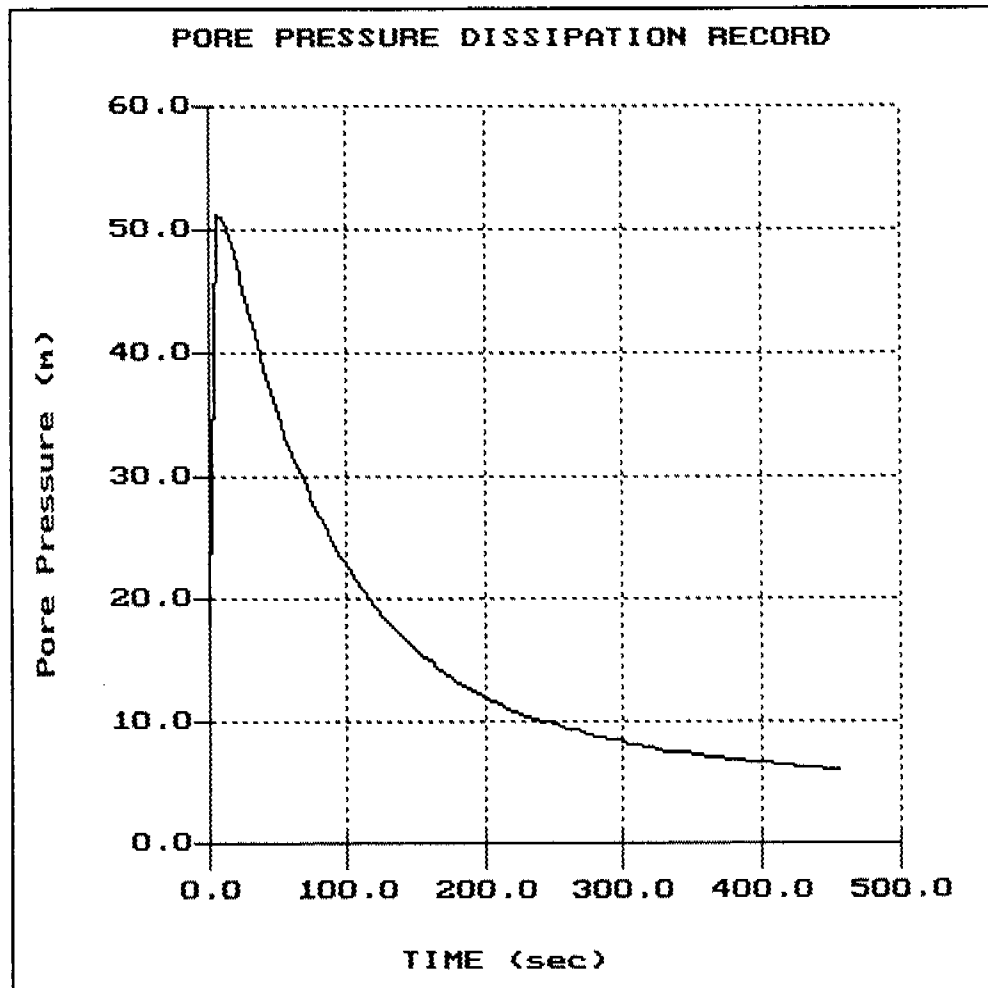


Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 3.50  
(ft): 11.48  
Duration: 455.0s

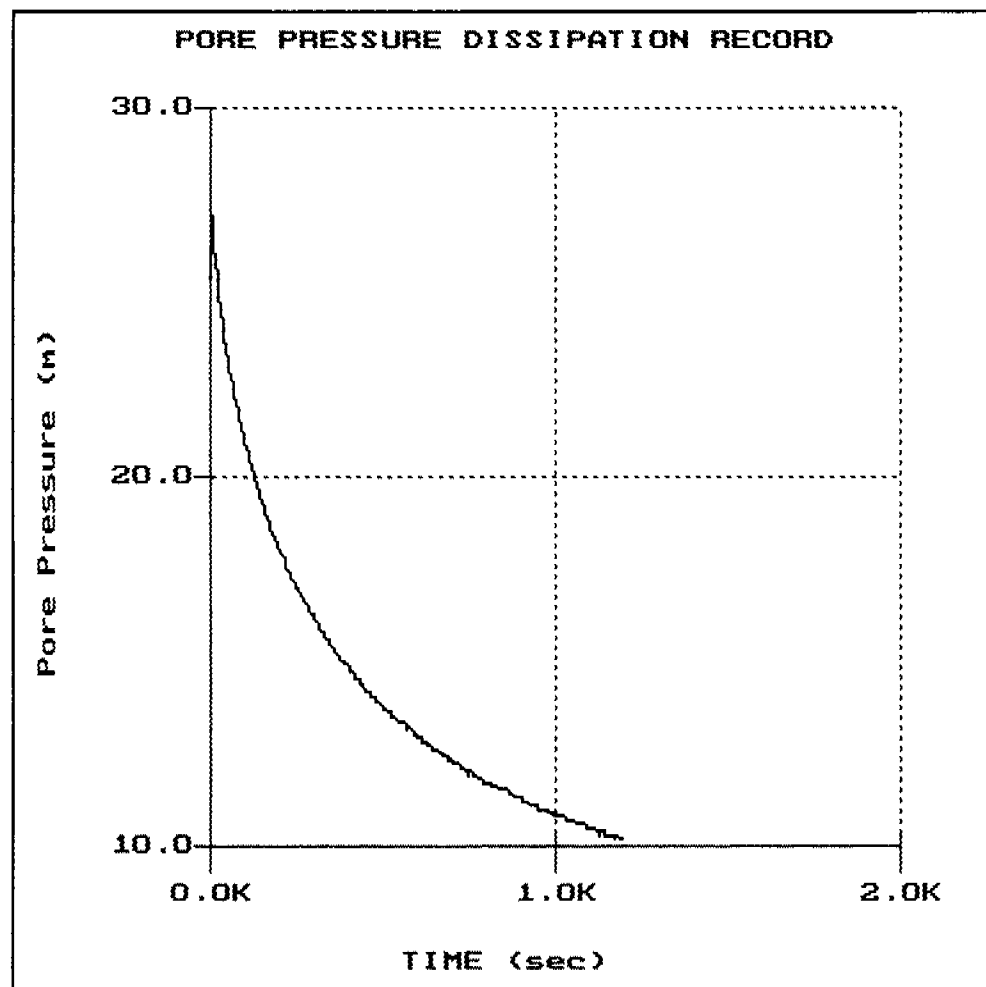


Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 5.50  
(ft): 18.04  
Duration: 1195.0s

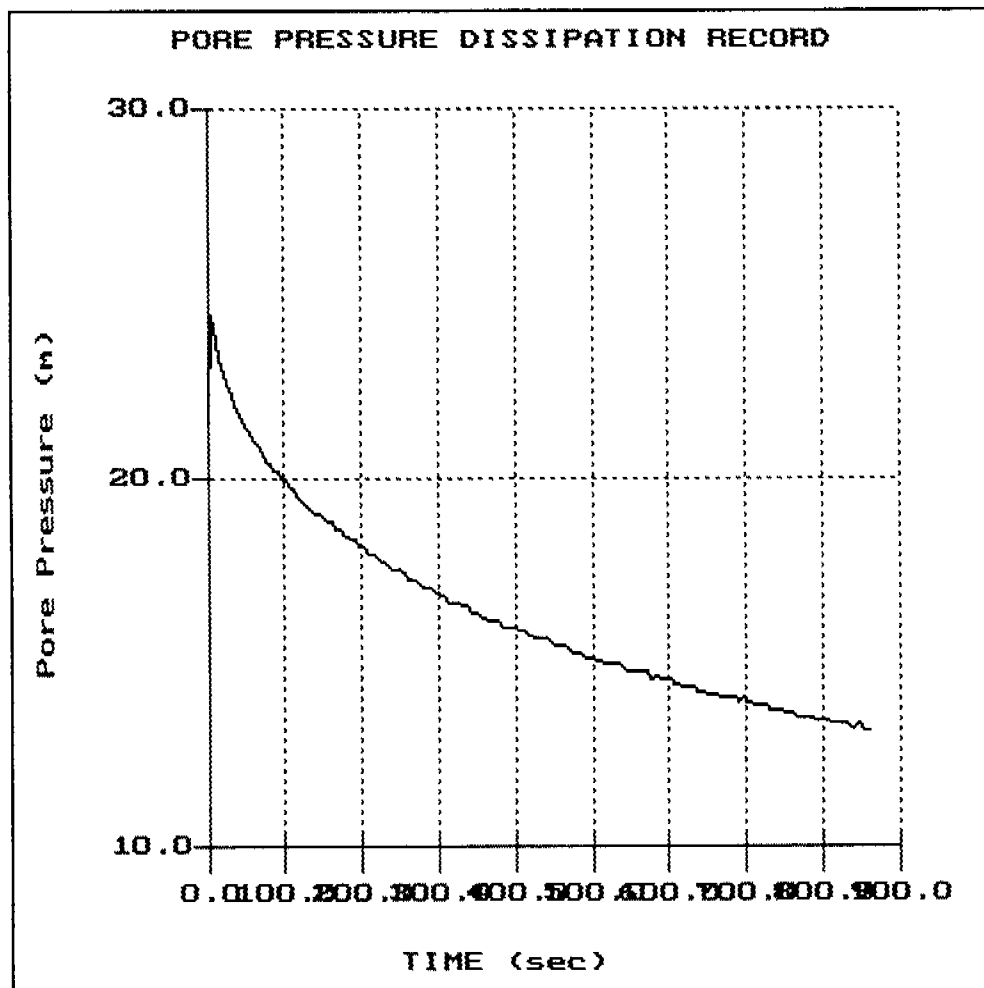


Thurber Engineering

Hole: CPTUS3  
Location: S. INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 7.70  
(ft): 25.26  
Duration: 860.0s





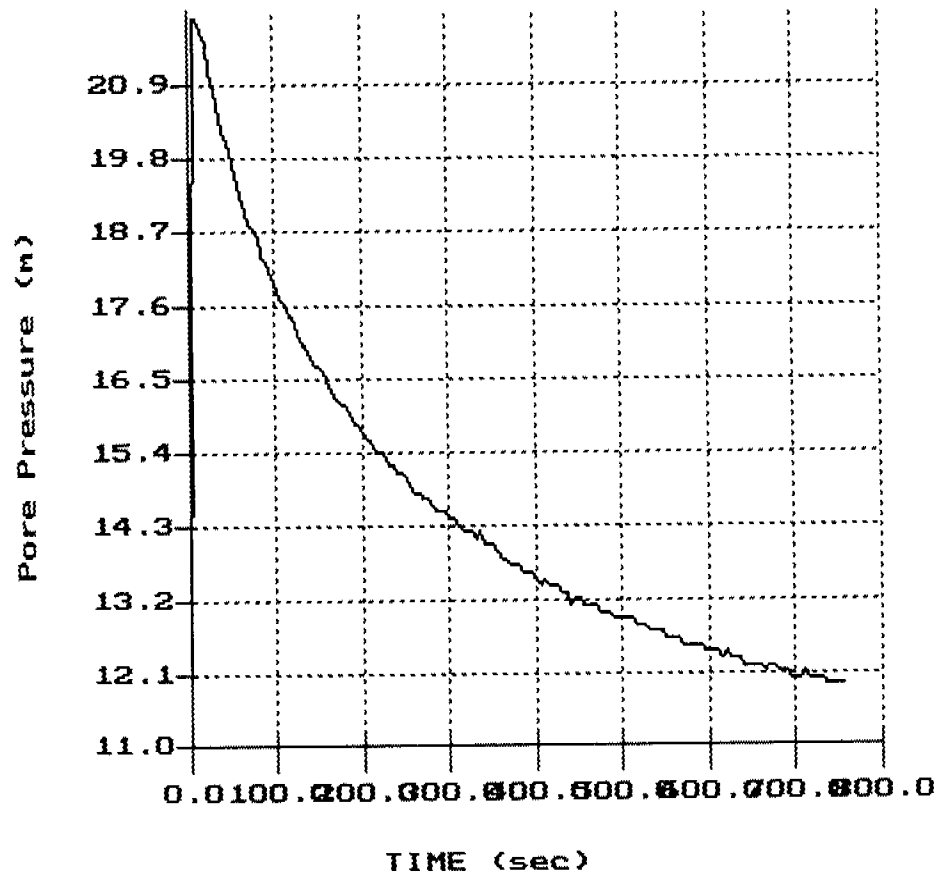
Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 9.50  
(ft): 31.17  
Duration : 755.0s

PORE PRESSURE DISSIPATION RECORD

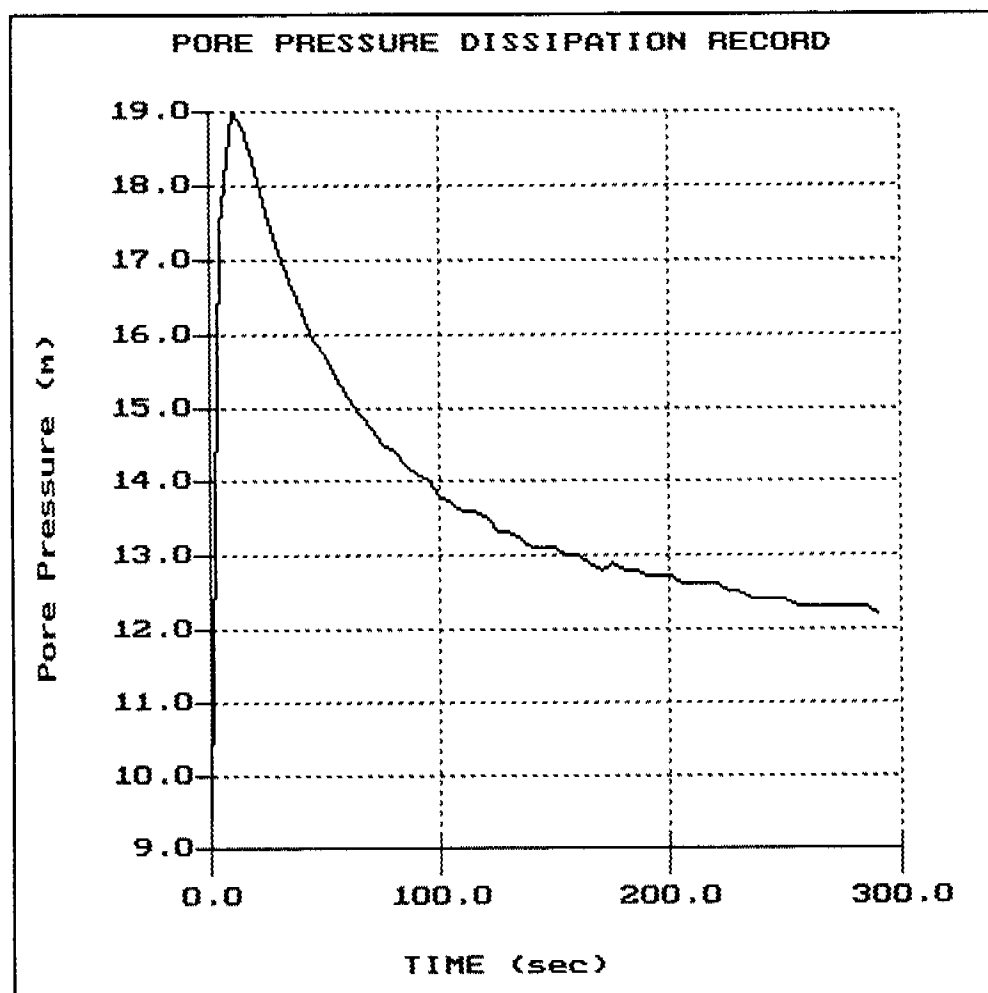


Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 11.50  
(ft): 37.73  
Duration : 290.0s



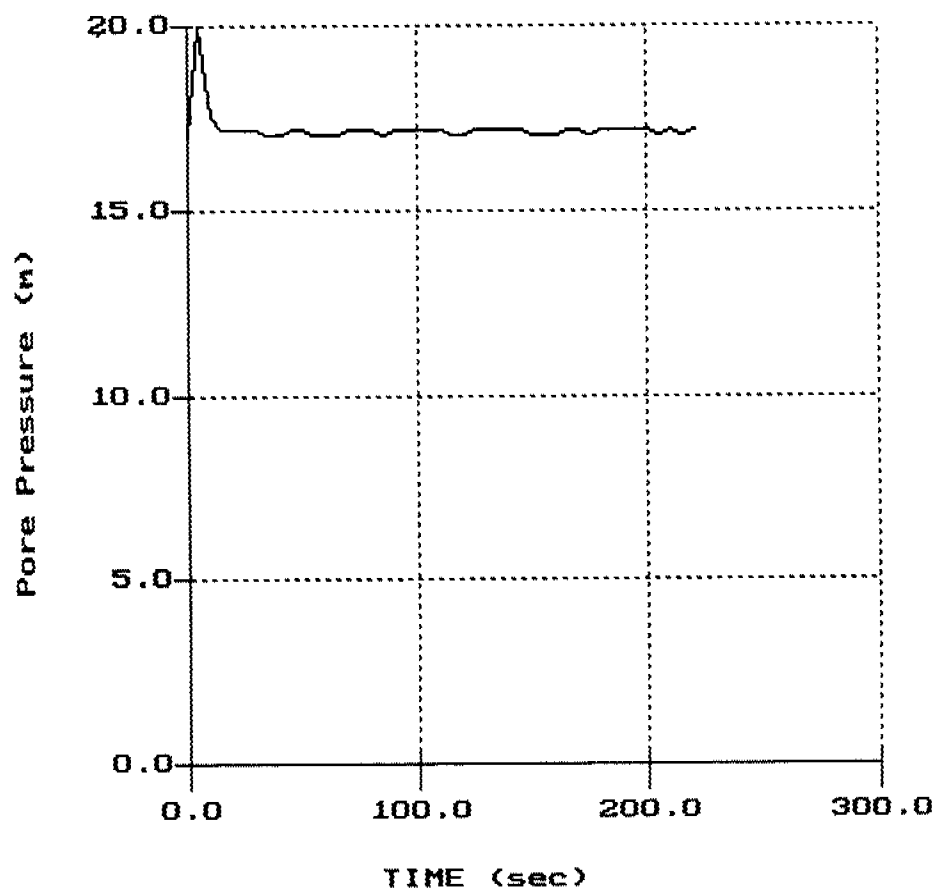
Thurber Engineering

Hole: CPTUS3  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 13:21

File: 141CPS3.PPD  
Depth (m): 16.93  
(ft): 55.54  
Duration : 220.0s

PORE PRESSURE DISSIPATION RECORD

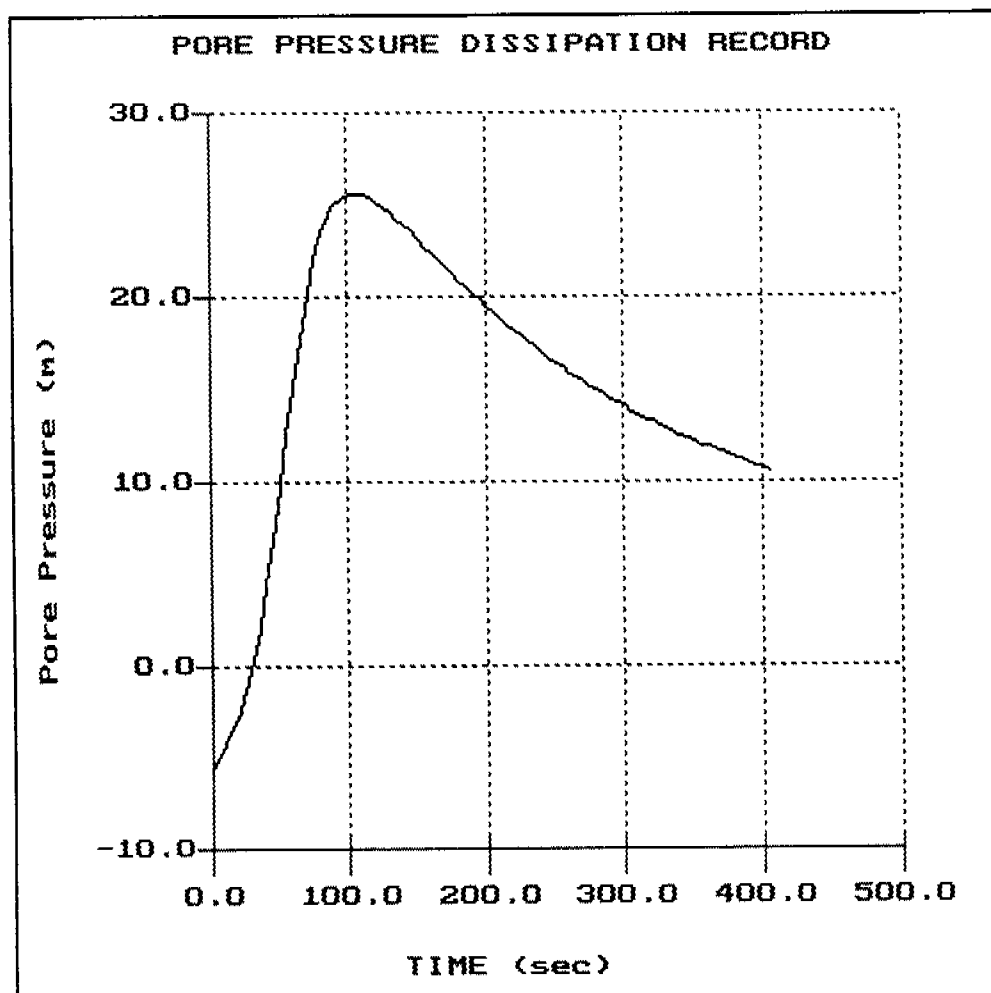


Thurber Engineering

Hole: CPTUS4  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 15:35

File: 141CP\$4.PPD  
Depth (m): 3.50  
(ft): 11.48  
Duration : 405.0s



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

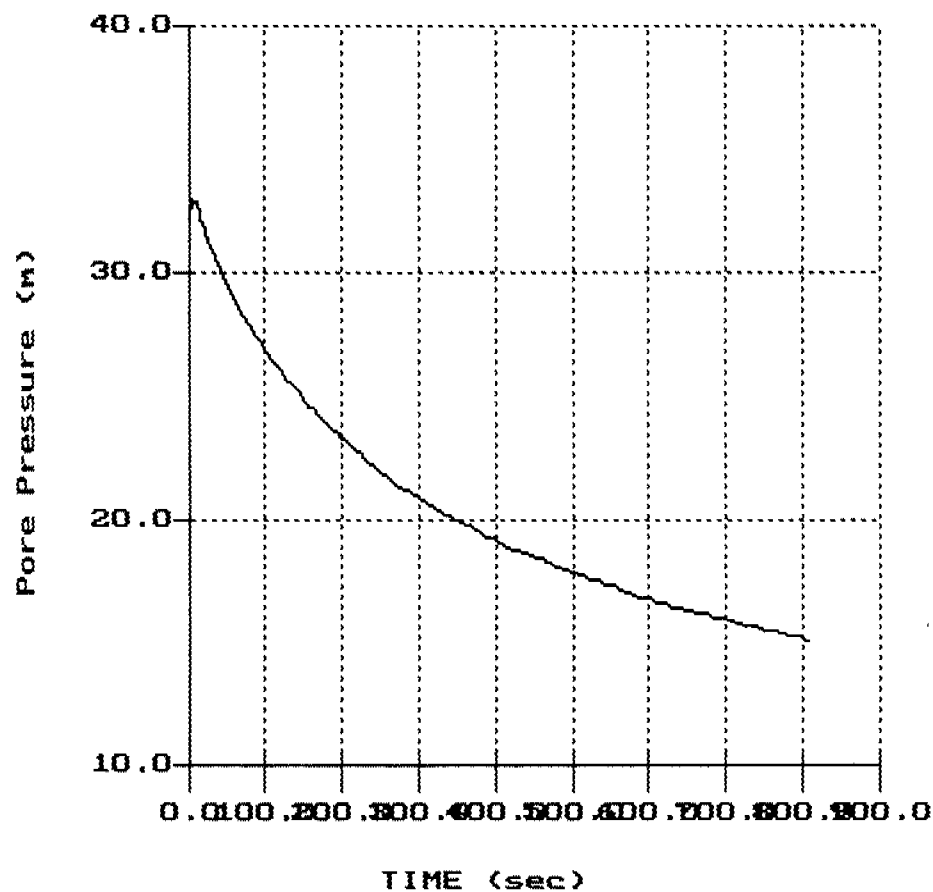
File: 141CPS4.PPD

Depth (m): 5.50

(ft): 18.04

Duration: 805.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

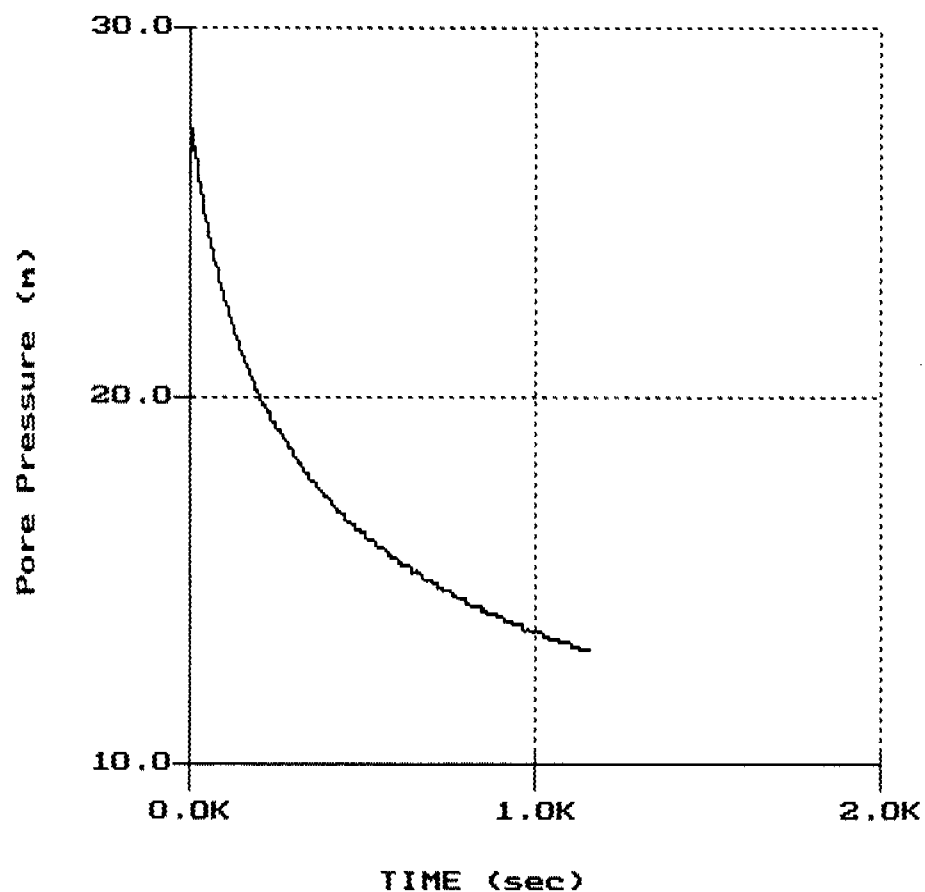
File: 141CPS4.PPD

Depth (m): 7.50

(ft): 24.61

Duration: 1160.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

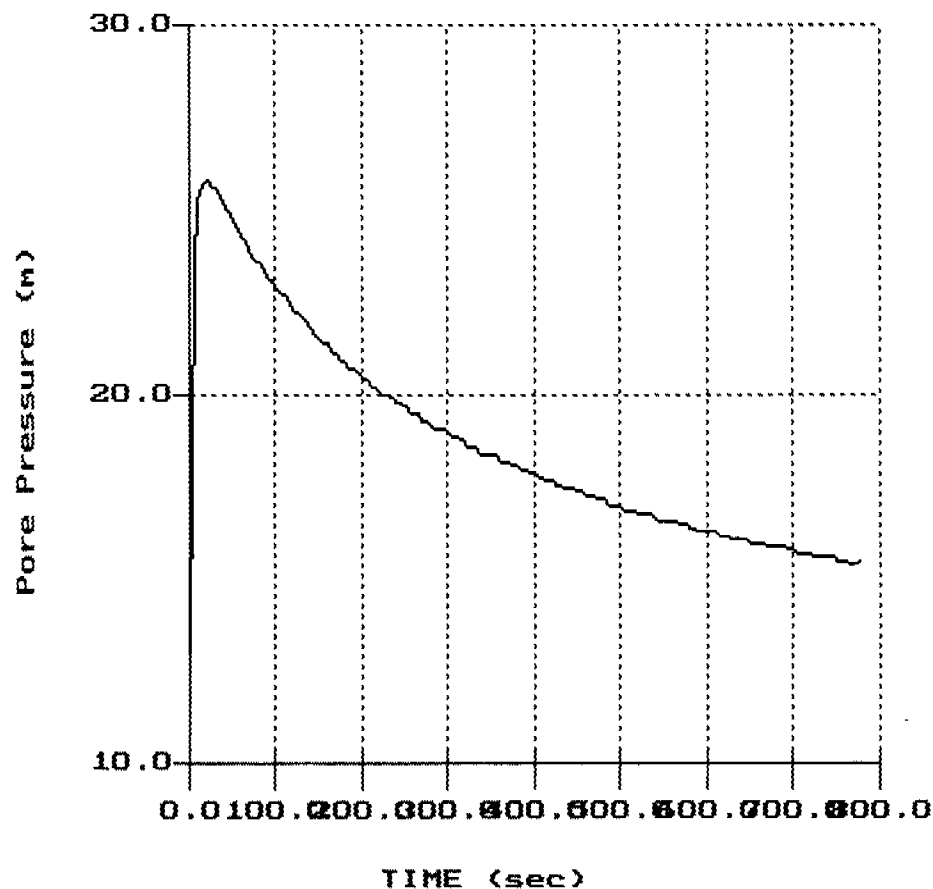
File: 141CPS4.PPD

Depth (m): 9.50

(ft): 31.17

Duration: 775.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS4

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 15:35

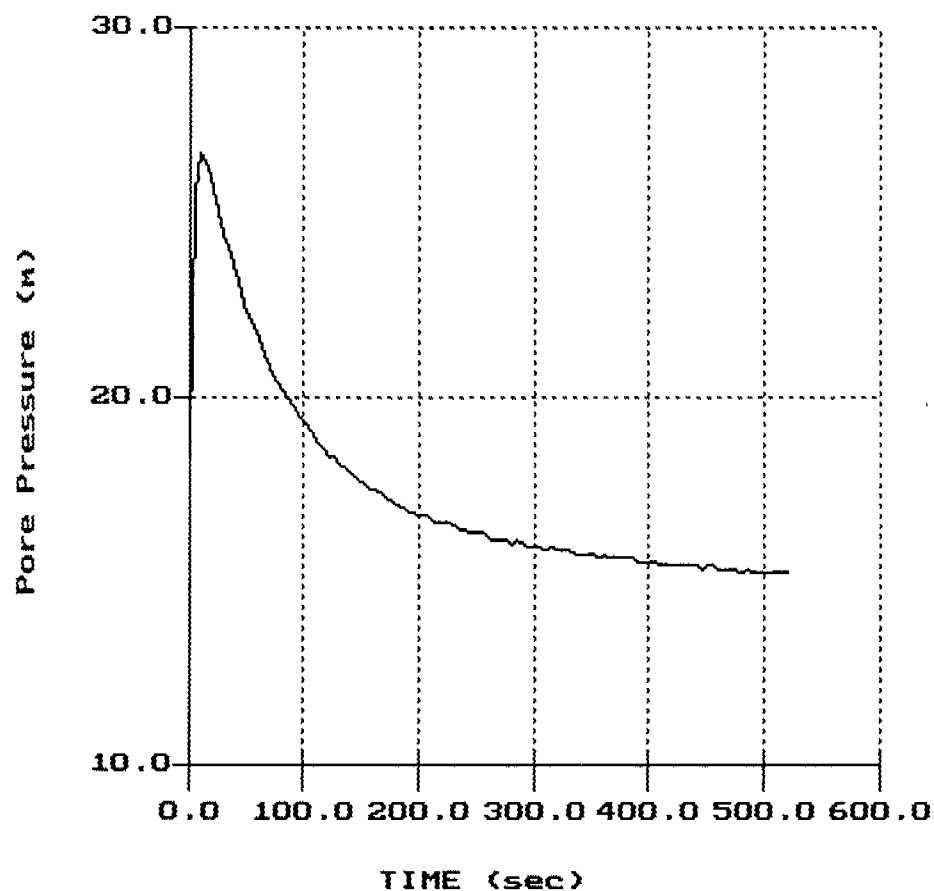
File: 141CPS4.PPD

Depth (m): 13.00

(ft): 42.65

Duration : 520.0s

PORE PRESSURE DISSIPATION RECORD



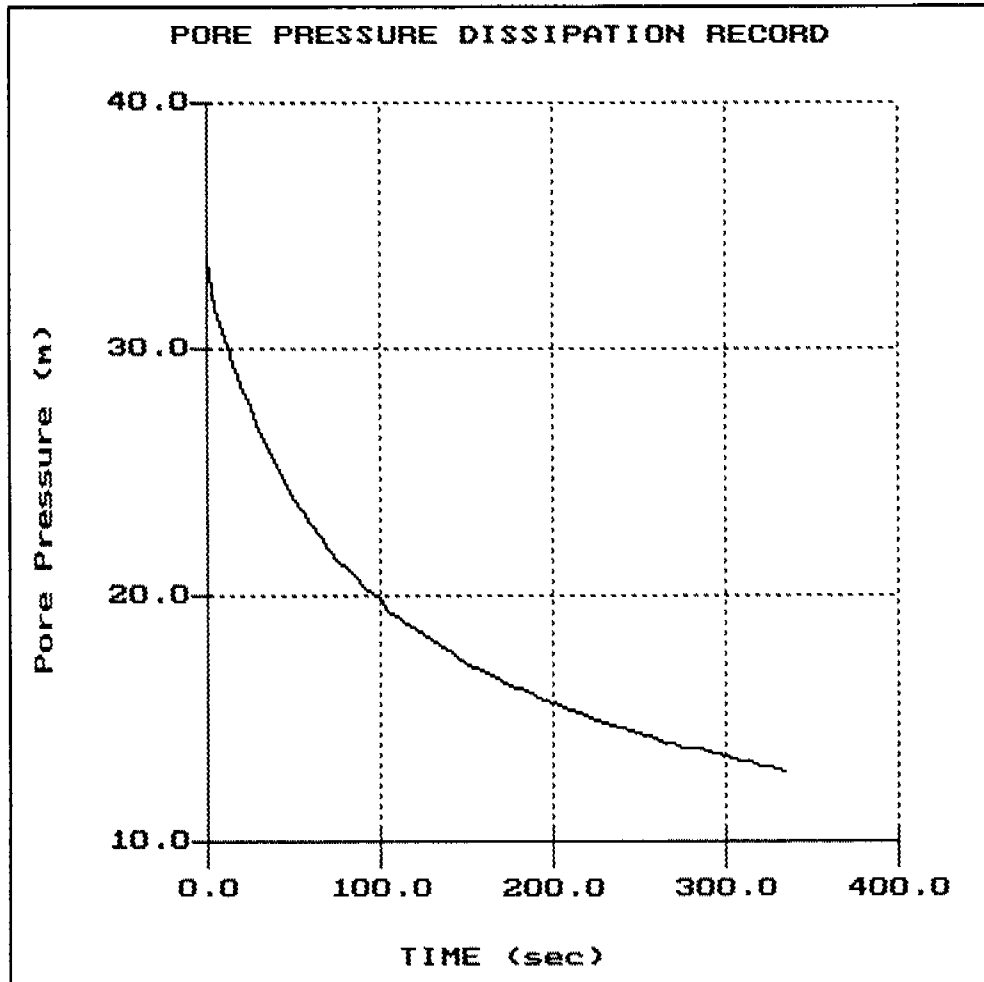


Thurber Engineering

Hole: CPTUS5  
Location: S.INTERCHANGE

Cone: 20 TON A 058  
Date: 03:25:99 17:56

File: 141CPS5.PPD  
Depth (m): 7.00  
(ft): 22.97  
Duration : 335.0s



Thurber Engineering

Hole: CPTUS5

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 17:56

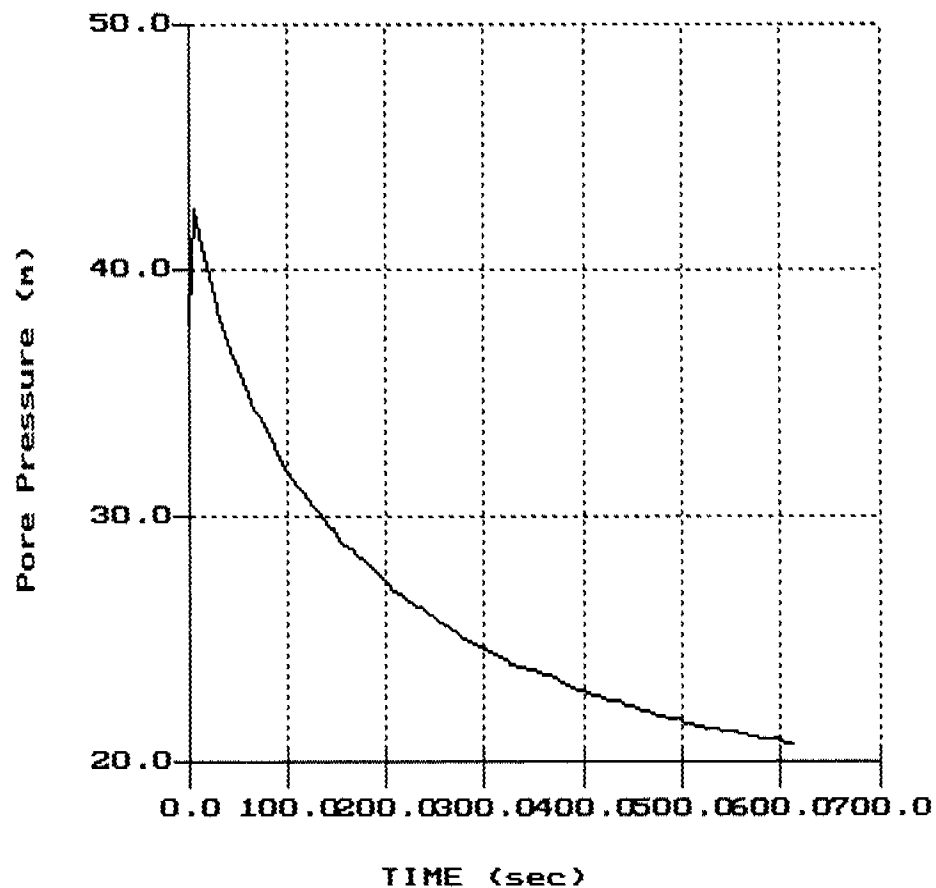
File: 141CPS5.PPD

Depth (m): 15.00

(ft): 49.21

Duration: 610.0s

PORE PRESSURE DISSIPATION RECORD



Thurber Engineering

Hole: CPTUS5

Location: S.INTERCHANGE

Cone: 20 TON A 058

Date: 03:25:99 17:56

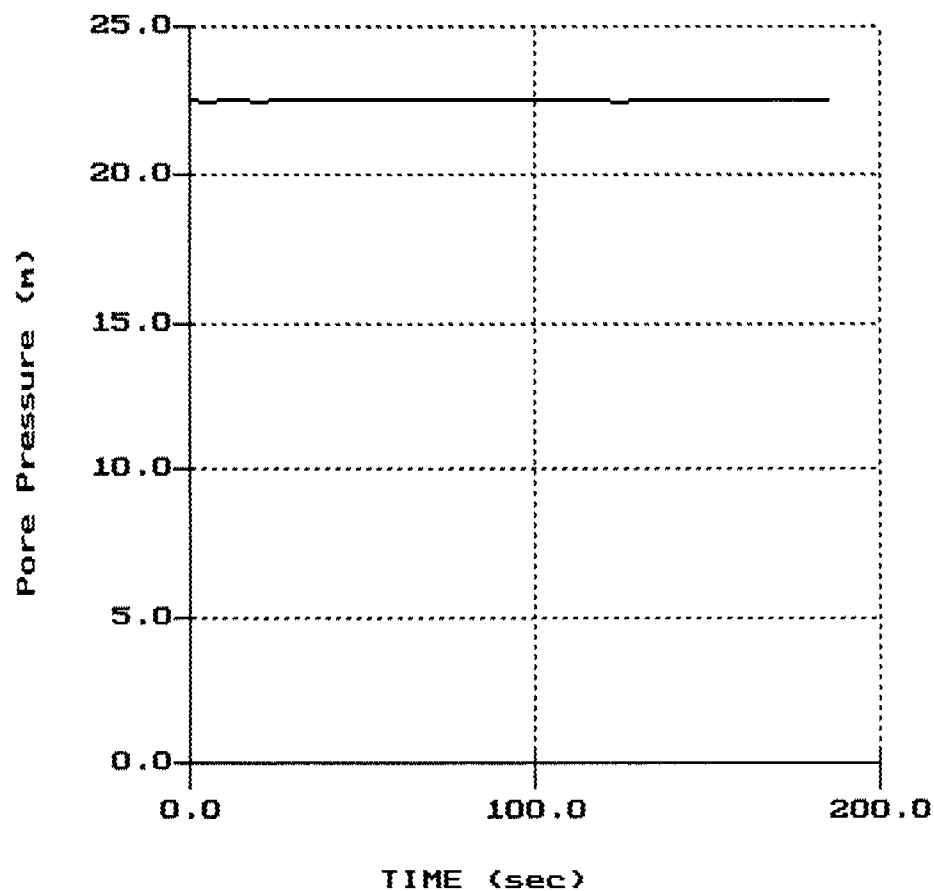
File: 141CPS5.PPD

Depth (m): 22.08

(ft): 72.44

Duration : 185.0s

PORE PRESSURE DISSIPATION RECORD





**APPENDIX D**

**NON STANDARD SPECIAL PROVISIONS**

**Granular Blanket**

**Wick Drains**

Special Provision

**1.0 SCOPE**

This non-standard special provision specifies the requirements for the surface preparation, supply, placement and compaction of the Granular Filter blanket in connection with the installation of the prefabricated vertical drains.

**2.0 MATERIALS**

The Granular Filter Blanket shall be Granular'A' material and shall satisfy the physical and gradation requirements as specified in OPSS 1010.

**3.0 CONSTRUCTION**

3.1 The Granular 'A' blanket shall be placed and compacted to the limits and, grades shown on the plans or as directed by the Contract Administrator.

3.2 The Granular 'A' blanket shall be placed subsequent to the required subexcavation.

3.3 The Granular 'A' blanket shall be end-dumped in areas of land reclamation.

3.4 The Granular 'A' blanket shall be placed and compacted in lift thicknesses not exceeding 250 mm except in land reclamation areas.

3.5 The Granular 'A' blanket shall be compacted to 90%  $\pm$  2% of its standard proctor density.

**4.0 PAYMENT**

4.1 Measurement of Payment

Measurement of payment shall be by the tonne. The method of determining

the mass of materials for payment shall conform to OPSS 102.

#### 4.2 Basis of Payment

Granular 'A' Blanket - Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment and material required to do the, work.

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**WICK DRAINS**

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**ITEM NO. \_\_\_\_****Special Provision****1.0 GENERAL****1.1 Scope**

This non-standard special provision specifies the requirements for the supply and installation of wick drains in accordance with the details shown on the plans and with the requirements of these specifications.

**1.2 Qualifications**

This work shall be undertaken by a recognized specialist subcontractor with at least 5 years of proven satisfactory experience in work of this type and magnitude.

**2.0 SITE CONDITIONS**

The Contractor shall refer to the Foundation Investigation Report in the Contract Documents for a description of subsurface conditions at this site. The Record of Borehole sheets are not represented as a complete description of the subsurface conditions, but only present what was found in borings at the indicated locations on the date boreholes were drilled. The subsurface conditions may be variable between the borehole locations. The Contractor should verify existing surface conditions.

**3.0 MATERIALS****3.1** The prefabricated drain shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile material. The core configuration should be 'Studded' or 'Groved' ('Filament' or 'Cuspated' are not acceptable).

The Contractor shall submit samples of the prefabricated drain for evaluation and approval to the Contract Administrator at least one month



which shall be advanced through the underlying soil and the granular blanket. The mandrel shall protect the prefabricated drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation on the drain. The mandrel shall be provided with an "anchor" rod or plate at the bottom to prevent the soil from entering the bottom of the mandrel during installation of the drain and to anchor the bottom of the drain at the required depth at the time of mandrel removal. The projected cross-sectional area of the mandrel and anchor combination shall not exceed 7700 mm<sup>2</sup>.

## **5.0 INSTALLATION**

### **5.1 Installation Method Proposal Submission**

At least three weeks prior to the installation of the drainage strips, the Contractor shall submit to the Contract Administrator, for review and approval, details of the sequence and method of installation. The submittals shall satisfy the specifications and at a minimum contain the following specific information:

- Size, type, weight, maximum pushing force, and configuration of the installation rig.
- Dimensions and length of mandrel.
- Details of drain anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for overcoming obstructions.
- Proposed methods for splicing drains.

Approval by the Engineer will not relieve the Contractor of his responsibilities to install vertical drain strips in accordance with the plans and specifications.

### **5.2 Construction Sequence**

Vertical drains shall be installed subsequent to the construction of the

granular 'A' blanket and prior to installation of monitoring instruments and placement of the embankment material.

### 5.3 Trial Drains

Prior to the installation of prefabricated drains within the areas designated on the plans, the Contractor shall demonstrate that the proposed materials, equipment and installation method produces a satisfactory drain installation in accordance with these specifications. The Contractor will be required to install a total of ten trial drains at locations within the work area as designated by the Contractor Administrator.

Should the ten trial drains be installed to the satisfaction of the Contract Administrator, the trial drains can be incorporated as part of the permanent installation. The Contractor will be compensated for each trial drain if the installation satisfies the requirements of this specification, at the same unit price as the production drains. The Contractor shall not be compensated for unsatisfactory trial drains.

Approval by the Contract Administrator of the method and equipment used to install the trial drains shall not constitute, necessarily, acceptance of the method for the remainder of the project. If, at any time, the Contractor Administrator installation considers that the method of installation does not produce a drain which satisfies the project requirements, the Contractor shall alter his method and/or equipment as necessary to comply with these specifications.

### 5.4 Layout

Prefabricated drains shall be located and staked out by the Contractor. The location of the drains shall not vary by more than 150 mm from the locations indicated on the drawings.

### 5.5 Plumbness

Drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The equipment shall be carefully checked for plumbness, and the Contractor shall provide the Contract Administrator with a suitable means of verifying the plumbness of the mandrel and of determining the

specifications described above shall be rejected. Rejected drains may be removed at the Contractor's own expense and time. The Contractor shall not be compensated for the materials and work associated with rejected drains.

Replacement drains shall be installed within a 50 cm radius from the location of the rejected drain as directed by the Contract Administrator.

#### 5.11 Geotechnical Instrumentation

Installation of the drains should be coordinated with the placement of geotechnical instrumentation as shown on the drawings. Special care should be taken to install drains in such a manner so as not to disturb instrumentation already in place. The replacement of instrumentation damaged as a result of the Contractor's activities will be the responsibility of the Contractor.

### 6.0 **PAYMENT**

#### 6.1 Measurement of Payment

Measurement of the item "WICK DRAINS" is by Plan Quantity, as may be revised by Adjusted Plan Quantity shall be by the linear metre for all accepted drains installed including the protruding portion. Properly completed obstructed wick drains and properly installed replacement wick drains and trial drains will be measured for payment.

#### 6.2 Basis for Payment

Item - Wick Drains

Payment at the contract unit price per linear metre for the above item shall be full compensation for all labour, materials and equipment to complete the work in accordance with the Plans and Specifications.

No payment shall be made for unacceptable drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.

PRODUCT SPECIFICATIONS			
	TEST METHOD	UNITS	VALUE
PHYSICAL PROPERTIES			
Drain Body Material		Studded or Groved	Polypropylene
Filter Material		Non-Woven	Polypropylene
Weight	ASTM-D-1777	g/m	75
Width		mm	not less than 100
Thickness	ASTM-D-5199	mm	not less than 3
Mass of Filter	ASTM-D-1777	g/m <sup>2</sup>	154
MECHANICAL PROPERTIES			
Drain composite Tensile Strength	ASTM D-4595	kN	0.375 @ 10%
Filter Puncture Strength	ASTM-D-751-68	kN	0.335
Filter Grab Strength	ASTM-D-1682	kN	0.800
Filter Trapezoidal Tear	ASTM-D-1117	kN	0.220
Filter Burst Strength	ASTM-D-751-68	kPa	2000
Discharge Capacity @ 70 kPa	ASTM-D4716	m <sup>3</sup> /s	100x10 <sup>-6</sup>
FOS	CAN/CGSB-148.1 No. 10.2	μm	15 to 100
Minimum elongation at break (%)	CAN/CGSB-148.1 No. 7.3	%	15
Water Permeability	ASTM D-4491	m/s	5.0E-06

## **MEMORANDUM**

TO: Robert Kivi, P.Eng., MMM

DATE: June 2, 1999

FROM: Paulo Branco, P.Eng., Thurber

FILE: 19-1104-4

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### **TROUT CREEK BYPASS - KING'S HIGHWAY 11 SOUTH INTERCHANGE WICK DRAIN DESIGN AND MONITORING PROGRAM**

This memorandum summarizes the changes included in our Final Report dated June 2, 1999, for the above noted project, following discussions with Mr. Tony Sangiuliano, P.Eng. of MTO - Pavements and Foundations Section. Mr. Sangiuliano's review comments on our Draft Report dated April 22, 1999, were included in a memorandum to the MTO - Northern Region, dated May 5, 1999.

#### **1. Introduction**

Reference to the Terms of Reference has been included in the report

#### **8 Engineering Analysis**

##### **8.1 General**

##### *Areas and Geometry:*

- Figure A1 has been modified to clearly include the stations referred to in the text.

##### *Soil Properties:*

- Reference to Trow's oedometer test results has been included in the text (Page 10). The text also explain that, in view of the CPTU and Trow's tests, and the sensitivity of our analysis to the  $P_c$  values, a parametric analysis was carried out assuming two sets of  $P_c$  values: Most Likely and Reduced (50% of M.L.; not necessarily reflecting normally consolidated conditions)

## 8.2 Stability Analysis

### *Geometry*

- Figures A7 to A12 present typical embankment cross-sections. MMM has prepared embankment cross-sections, which will be included in the contract documents. The text has been modified to explain why the upper portion of the embankments will be temporarily slightly steeper.

### *Surcharge*

- The height of surcharge varies up to 1.5 m depending on the magnitude and rate of settlements due to primary consolidation.

### *Results*

- Requirements for EPP dissipation during construction stages have been included in Table B31
- The reason for carrying out an analysis of an embankment with a berm width of 8m has been included in the end of Page 12.
- EPP versus time for most likely values of  $P_c$  have also been included in Appendix A (Figures A13B, A15B to A18B)

## 8.3 Settlement Analysis

### 8.3.2 One-Dimensional Consolidation - No Wick Drains

- Reference to wick drains requirements for different construction schedules have been included in the text

### 8.3.3 Settlements due to Primary Consolidation - With Wick Drains

- EPP dissipation and EPP values have been included in the text (Page 20)

### 8.3.4 Settlements due to Secondary Consolidation

- No action from Thurber required

## **9 Embankment Design Recommendations**

### **9.1 Embankment Geometry and Construction Schedule**

- Illustrations of the general layout of the wick drains for different construction schedules have been prepared by MMM.
- The reason for selecting an 8 m wide berm has been explained at the end of Page 12

### **9.2 Site Preparation**

- NSSP for the sand blanket has been included in Appendix D. As discussed, there should be no need for dewatering at this site as far as the wick drain installation is concerned.

### **9.3 Wick Drain Specification**

- NSSP for the wick drain has been included in Appendix D.

### **9.4 Monitoring Program**

- A layout of instruments and specifications will included in the detailed design of the monitoring program. As discussed with Mr. Sangiuliano, preparation of monitoring drawings and specifications was beyond the scope of this work.
- Settlement pins are valuable if anchored below the surcharge. They provide information about the settlement of the embankment top, which, when analysed in conjunction with the settlement rod data, indicate the embankment compressibility.
- Prediction of lateral displacements at depth have been included in Section 8.4

### **9.5 Trial Embankment**

No action from Thurber required.

## **MEMORANDUM**

**TO:** Robert Kivi, P.Eng., MMM

**DATE:** September 16, 1999

**FROM:** Paulo Branco, P.Eng., Thurber

**FILE:** 19-1104-4

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### **TROUT CREEK BYPASS - KING'S HIGHWAY 11 NORTH INTERCHANGE WICK DRAIN DESIGN AND MONITORING PROGRAM**

This memorandum summarizes the changes included in our Final Report for the above noted project, dated September 17, 1999, and a response to a review of our report carried out by Mr. Sangiuliano, P.Eng. Mr. Sangiuliano's review comments on our Draft Report dated June 1, 1999, were included in a memorandum to the MTO - Northern Region, dated June 7, 1999.

#### **7. Subsurface Conditions**

Page 6 - The comparison of the results from oedometer tests and the piezocone are not directly comparable. The comparison of the results requires the use of empirical conversion factors which we thought would better be left out of this factual portion of the report.

Page 6 - The use of the term "Clayey Silt " was included in the report as a result of the analysis of the piezocone data. Some of the test results indicate that the silt content is actually high in the lower portion of the Silty Clay. In any event, for the sake of consistency with Trow's report we have included the term Silty Clay where it read Clayey Silt.

Page 6 - Undrained shear strength results are provided automatically by the piezocone when it detects the presence of clayey material. For the sake of consistency with our description of that soil layer we have removed the Cu values from the text. Pore pressure dissipation tests were carried out in the Lower Silt in order to provide us with Ch values for the consolidation analysis. The Lower Silt impedes vertical drainage of water from the Silty Clay and it should be included in the consolidation analysis. Therefore Ch values in the Lower Silt layer are required.



## **8. Engineering Analysis**

### **8.1 General**

The base drawing used to prepare Figure A1 is already very crowded and difficult to read. Therefore we decided to show the limits of the "study areas" by highlighting the Stations at the boundaries between regions.

The ramp designations have been corrected.

### **8.2 Stability Analysis**

Reference to Figures A3 to A7 was made in the last column of Table B3. Reference to these figures has been included in the report text as well.

Reference to pore pressure dissipation plots and reference to the use of excess pore pressure in the analysis have been included in Section 8.3.

Pore pressure dissipation plots for the cases with wick drains have been included in Appendix A.

### **8.3 Settlement Analysis**

8.3.2 Modifications have been made to the text to explain the meaning of "minimum time"

8.3.3 The text has been modified to clarify the selection of wick drain spacing

8.3.4 No action required

## **9 Embankment Design Recommendations**

9.2 and 9.3 These section have been modified accordingly

9.4.1 Thurber has submitted a proposal for preparation of specifications for the supply and installation of instruments

9.5 No action required