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Settlement Analyses of Grade Supported Tanks Constructed with the Use of Prefabricated Wick Drains and an Earth Preload

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ABSTRACT

In the design of tank foundations several design techniques are considered. This study focuses on grade supported tanks constructed under an extensive preload and instrumentation program. Settlement estimation methods were performed and compared to field instrumentation data taken at the project sites. Three project sites were selected for this study. The geotechnical investigations were performed by Eustis Engineering Services, L.L.C. and included both undisturbed soil borings and cone penetrometer tests. Conclusions were made about the accuracy of the calculations and how assumptions affect the settlement computation results.

Keywords: Settlement, Consolidation, Geotechnical, Tank Foundations, Wick Drains, Instrumentation

CHAPTER 1
INTRODUCTION

In the design of tank foundations several design techniques may be implemented. This study focuses on grade supported tanks constructed under an extensive preload and instrumentation program. Settlement estimation methods were performed for comparison purposes. Instrumentation data were available to compare the computed settlement values to the actual settlement that occurred at each site. As part of the literature review, consolidation theory, the determination of the coefficient of consolidation, and procedures for laboratory testing were researched and are discussed in this document. These items are essential in determining the soil parameters that represent the native soil conditions that allow the prediction of settlement estimation.

For this study, data were available for three project sites. All three sites are located in Southeastern Louisiana. The geology of the project sites consist of Holocene deposits that overlie Pleistocene Epoch soils. Each site consisted of several tanks of varying tank diameters. The tanks used for this study were constructed after an earthen preload program and extensive instrumentation program. Prefabricated wick drains were also used beneath the tanks to accelerate the rate of consolidation.

Settlement analyses were performed using stress distribution by Westergaard theory and the rate of consolidation by Terzaghi theory via spreadsheets. Settlement analyses were also performed using Settle3D software by RocScience. The results of these methods are compared to the actual occurring settlement. Discussion is included on the reasons for differences in the computed values and the recorded settlement.

CHAPTER 2
LITERATURE REVIEW

2.1 SETTLEMENT

When soil is loaded by a structure, deformations will occur. Vertical deformation at the existing ground surface resulting from the structure load is termed as settlement. In the design of engineered structures, the amount of settlement and the rate at which the structure will settle are two aspects that are of interest. The total settlement of soil area being loaded has three components. These components are immediate settlement, consolidation settlement, and secondary settlement. The immediate settlement also referred to as distortion settlement is estimated using elastic theory. Consolidation settlement is time dependent and is a process that occurs in saturated fine grained soils with a low coefficient of permeability. The settlement rate is dependent on the rate of drainage of the pore water. Secondary compression occurs at a constant effective stress with no subsequent changes in the pore water pressure.

2.2 CONSOLIDATION THEORY

The amount of settlement the clay soil layers experience is directly related to how much pore water is squeezed out of the clay soil voids. This is a simplistic description of the consolidation process. The amount of water that has been moved out of the soil voids and the change in the void ratio of the clayey soils is then directly proportional to the amount of pore water pressure that has dissipated. Therefore, the settlement rate is directly related to the rate of excess pore water pressure. In order to predict the settlement rate, it is necessary to have a theory that can predict the pore pressure and void ratio at a specific time and space in the clay layer. The most commonly used theory of consolidation in soil mechanics is a one dimensional theory that was first developed by Karl Terzaghi in 1925. The Terzaghi theory is a strain theory where the applied load increments result in only small strains in the soils. This translates to both the coefficient of compressibility and the Darcy coefficient of permeability remain essentially constant during consolidation. Terzaghi one-dimensional consolidation equation is written as

$$c_v \frac{d^2u}{dz^2} = \frac{du}{dt} \tag{2-1}$$

where

$$c_v = \frac{k}{\rho_w g} \frac{1+e_o}{a_v} \tag{2-2}$$

The coefficient c_v is termed as the coefficient of consolidation. This coefficient contains the material properties that govern the process of consolidation.

There are a variety of ways to solve the Terzaghi consolidation equation and some are mathematically accurate while others are only approximations. M.E. Harr in 1966 presented an approximate solution by use of the method of finite differences. Following Terzaghi, D.W. Taylor in 1948 gave a rigorous mathematical solution in terms of Fourier series expansions. For the Taylor solution, the initial conditions are the compressible layer has complete drainage at the top and bottom and the initial excess hydrostatic pressure is equal to the applied increment of stress at the boundary. The solution is in terms of the Fourier series expansion as

$$u = (\sigma'_2 - \sigma'_1) \sum_{n=0}^{\infty} f_1(Z) f_2(T) \tag{2-3}$$

where Z is a geometry parameter equal to z/H and T is the time factor. The time factor is related to the coefficient of consolidation by

$$T = c_v \frac{t}{H_{dr}^2} \tag{2-4}$$

where t = time and H_{dr} = the length of the longest drainage path.

The consolidation after some time, t, and at any depth, z, of the consolidating layer is related to the void ratio at that time and final change in void ratio. This is called the consolidation ratio and is expressed as

$$U_Z = \frac{e_1 - e}{e_1 - e_2} \tag{2-5}$$

Putting the solution in terms of the consolidation ratio, the equation becomes

$$U_z = 1 - \sum_{n=0}^{\infty} f_1\,(Z) f_2(T) \tag{2-6}$$

This equation's solution is shown graphically on Figure 1. This figure allows the user to avoid the tedious calculations involved in the equation. The consolidation ratio can be determined from the figure by use of the coefficient of consolidation, the layer thickness, and the drainage conditions. Figure 1 also depicts the progress of consolidation. The lines for the time factors are called isochrones and represent the degree of consolidation for a given time factor within the compressible soil layer.

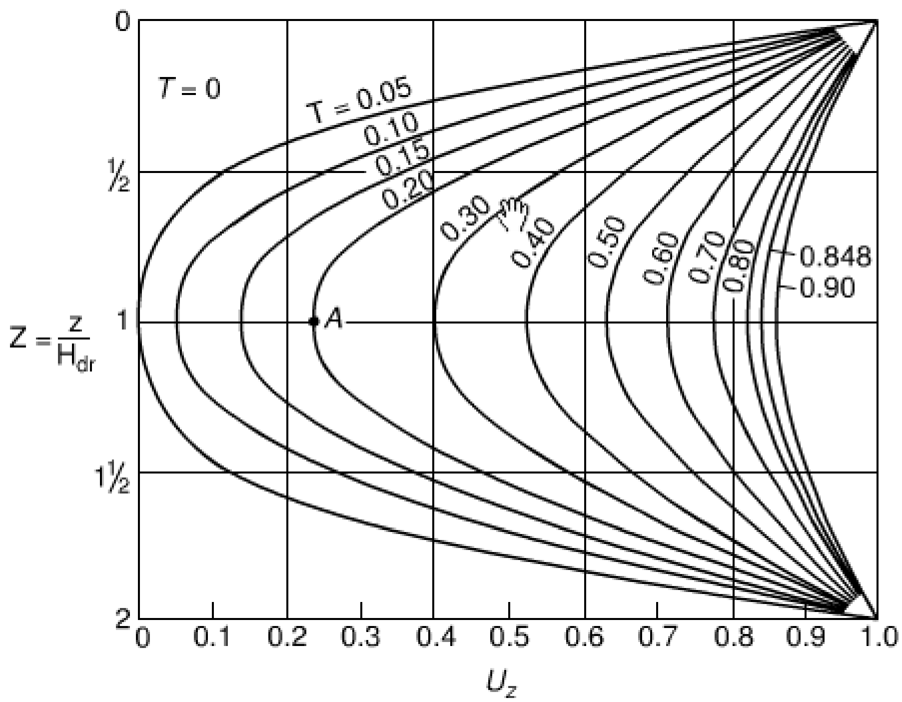

Figure 1: Consolidation Ratio as a function of any location and time factor (Taylor, 1948)

The coefficient of consolidation, the total thickness of the soil layer, and the drainage conditions can be used to calculate the time factor, T. After the time factor has been computed, the consolidation ratio can be determined from Figure 1.

2.3 DETERMINATION OF THE COEFFICIENT OF CONSOLIDATION

The coefficient of consolidation is an important part of the consolidation equation because it takes into account the soil properties that govern the rate of consolidation. This coefficient generally decreases as the liquid limit of the soil increases. The approximate correlations of the coefficient of consolidation with liquid limit are shown on Figure 2.

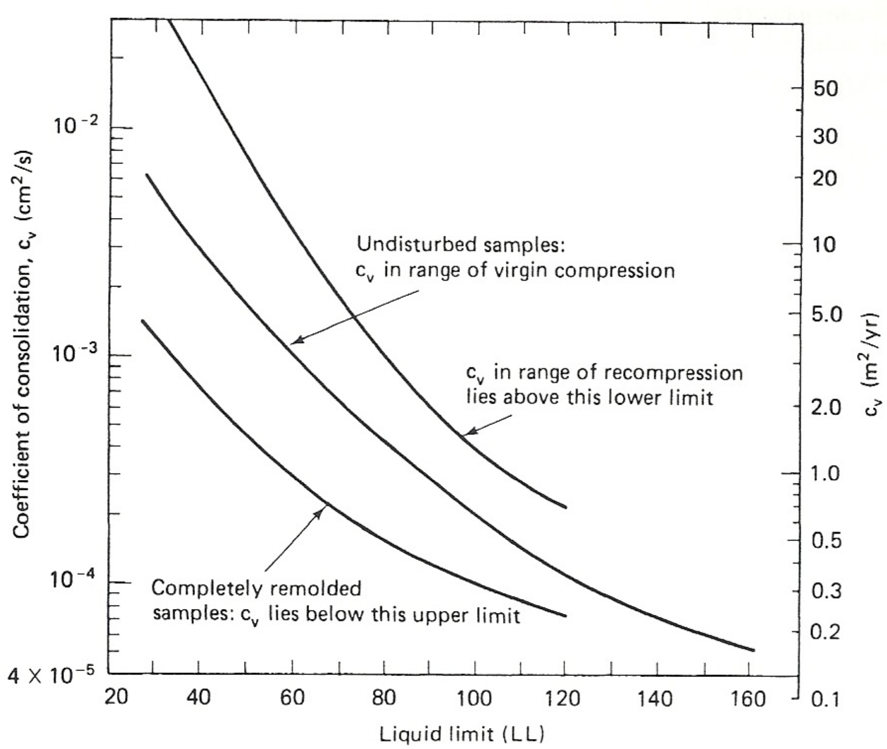

Figure 2: Approximate Correlations of the Coefficient of Consolidation, c_v (Das, 2006)

Casagrande and Taylor developed empirical procedures to approximately fit the observed laboratory data to the Terzaghi theory of consolidation. The curve fitting procedures are used to determine values of the coefficient of consolidation from the laboratory data as well as allow separation the secondary compression from the primary consolidation. These two graphical curve-fitting methods are commonly considered for the determination of the coefficient of consolidation. These methods are Casagrande's Logarithm of Time Fitting Method and Taylor's Square Root of Time Method. The determination of the coefficient of consolidation uses the later part of the consolidation

curve and are typically influenced by secondary compression. Secondary compression is concurrent with primary consolidation and it tends to decrease the value of the coefficient of consolidation. If the early part of the consolidation data is used, the values obtained will be less influenced by secondary compression effects.

In the Casagrande's Logarithm of Time Fitting Method, the deformation dial readings are plotted versus logarithm of time. Several steps may be followed to interpret the laboratory test data to determine the coefficient of consolidation, c_v. The first step is to extend the straight-line portions of primary and secondary consolidation to intersect at a point labeled "A". The ordinate of point "A" is represented by the deformation at the end of 100% primary consolidation, d_{100}. Next, the initial curved portion of the plot is approximated to be a parabola on the natural scale. Select two times, t_1 and t_2, on the curved portion such that $t_2 = 4t_1$. Thirdly, the horizontal line indicated as "DE" is drawn such that the vertical distance shown as "BD" is equal to the distance "x". The ordinate of "BE" then gives the value of "d_o". The ordinate of point 'F" on the consolidation curve represents the deformation at 50% primary consolidation and the abscissa represents the corresponding time. Finally, for 50% average degree of consolidation, the time factor equals 0.197 using the equations presented above. The coefficient of consolidation is then calculated by

$$c_v = \frac{0.197\, H_{dr}^2}{t_{50}} \tag{2-7}$$

where H_{dr} is the average longest drainage path during consolidation. An example of the construction of the Logarithm of Time Method curve is shown in Figure 3.

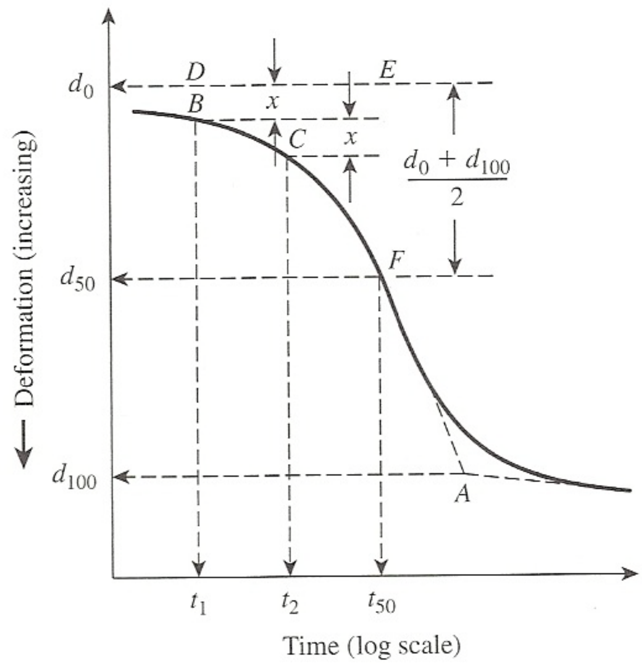

Figure 3: Casagrande's Logarithm of Time Fitting Method (Das, 2006)

In the Taylor's Square Root of Time Fitting Method, a graph of the deformation against the square root of time is made for the incremental loading. As with Casagrande's fitting method, the procedure is based on the similarity between the shapes of the theoretical and experimental curves when plotted versus time. The graph can be interpreted to find the coefficient of consolidation in a few steps. First, the line designated as "AB" is drawn through the early portion of the curve. Next, the line "AC" is drawn such that the segment "OC" equals 1.15 times the segment shown as "OB". The abscissa of point "D" gives the square root of time for 90% of the consolidation. Finally, for 90% consolidation, the time factor equals 0.848. The coefficient of consolidation is then calculated by

$$c_v = \frac{0.848\, H_{dr}^2}{t_{90}} \tag{2-8}$$

where H_{dr} is the average longest drainage path during consolidation. An example of the construction of the Square Root of Time curve is shown in Figure 4.

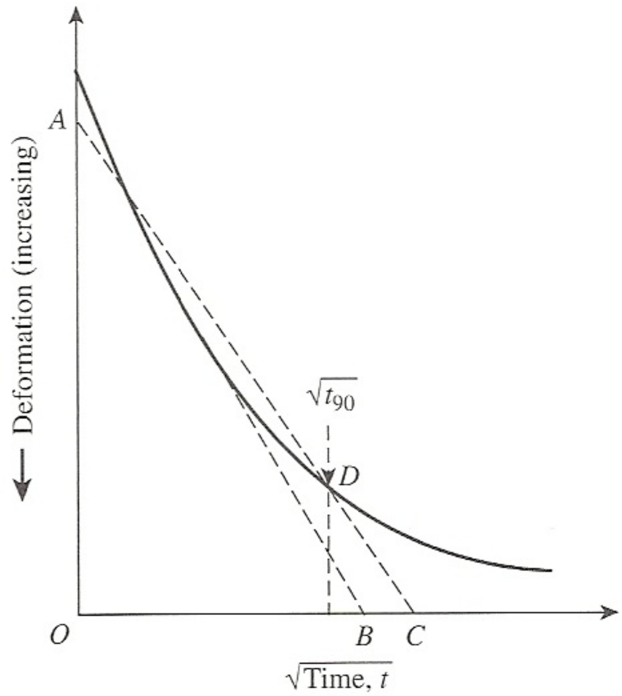

Figure 4: Taylor's Square Root of Time Fitting Method (Das, 2006)

2.4 SECONDARY SETTLEMENT

Secondary consolidation occurs after complete dissipation of excess pore water pressure; therefore at the end of the primary consolidation. When the deformation is plotted with the logarithm of time, the secondary consolidation portion of the graph is practically linear. This indicates the compression is occurring at a slower rate. Secondary consolidation differs from primary consolidation in that it takes place at a constant effective stress. It is often very difficult to separate secondary settlement from the primary settlement in the field. Both primary and secondary consolidation contributes to the total surface settlement and are often not separated for professional practice.

2.5 STRESS DISTRIBUTION

In 1885, J. Boussinesq developed equations for the state of stress within a homogeneous, isotropic, linearly elastic half-space for a point load acting perpendicular

to the surface. Naturally occurring soil deposits do not conform to these ideal material conditions. H.M. Westergaard in 1938 developed a solution for stresses at a point with varied horizontal soil layers. With Westergaard's theory, an elastic soil is interspersed with infinitely thin but rigid layers that allow only vertical movement. Westergaard's solution for vertical stress for a point load with a Poisson's ratio of zero is

$$\sigma_z = \frac{Q}{z^2\pi}\frac{1}{\left[1+2\left(\frac{r}{z}\right)^2\right]^{3/2}} \tag{2-9}$$

where

z = depth from the ground surface to the place of the stress

r = the horizontal distance from the point load to the place where the stress is desired.

This equation may be written as

$$\sigma_z = \frac{Q}{z^2}N_W \tag{2-10}$$

where N_W is an influence factor that is a function of r/z.

The Boussineq and Westergaard theories are compared in Figure 5.

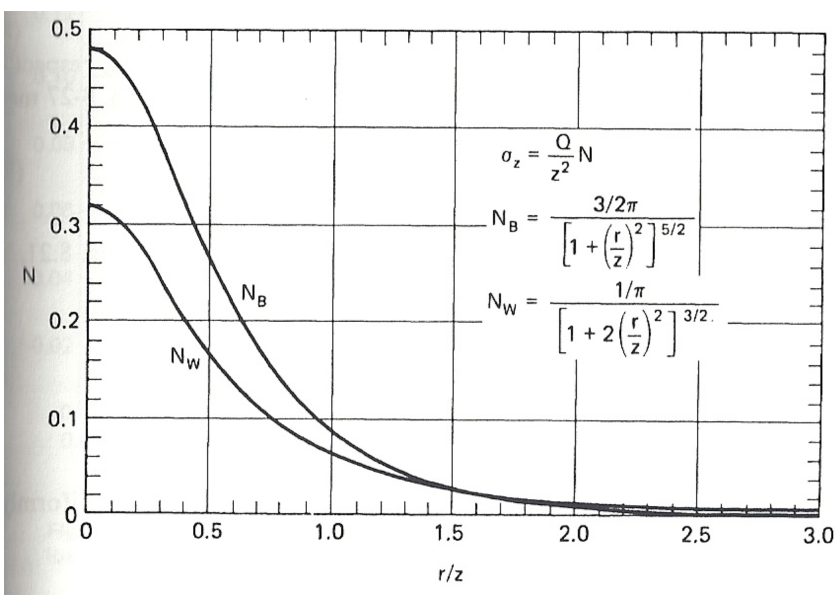

Figure 5: Relationship Between Boussinesq and Westergaard Theories (Holtz, 1981)

2.6 WICK DRAINS

Prefabricated vertical wick drains can be a cost-effective solution for accelerating the consolidation of fine grained soils and limiting long-term settlement. For structures constructed on soft soil, wick drains are used to remove the excess pore water, consolidate the compressible soil layers, and induce the consolidation settlement. Prefabricated vertical wick drains can be installed vertically to depths exceeding 200 feet. The vertical wick drains are usually placed in a triangular configuration of 3 to 12 feet depending on the desired consolidation time. As a result of this method of accelerating the consolidation process, uneven post-construction settlements can be virtually eliminated.

The wick drains function by forcing water to flow through the filter fabric of the wick drain and into the channels of the wick drain core where it can flow vertically out of the soil. This flow may be either up or down to intersecting natural drainage layers consisting of sand or to the surface where a sand drainage blanket or prefabricated horizontal strip drains are available. The water in the soil layers only needs to travel to the nearest prefabricated vertical wick drain to reach a free drainage path. The prefabricated vertical wick drain core is made of high quality flexible polypropylene which exhibits a large water flow capacity in the longitudinal direction of the core. Each vertical wick drain can provide a greater vertical discharge capacity than a 6 inch diameter sand column. The prefabricated vertical wick drain core is tightly wrapped in a geotextile filter made of spun-bonded polypropylene This geotextile jacket has a very high water permeability while retaining the finest of soil particles. Both the core and geotextile jacket have high mechanical strength, a high degree of durability in most environments, and high resistance to chemicals, microorganisms, and bacteria. A wick drain is shown in Figure 6.

Figure 6: Prefabricated Wick Drains with Filter Fabric

2.7 SHEAR STRENGTH TESTING

Several laboratory methods are available to determine the shear strength of soil samples. These laboratory tests include the direct shear test, triaxial test, direct simple shear test, plane strain triaxial test, and the torsional ring shear test. The direct shear test is the oldest and simplest form of shear testing. Although the direct shear test is simple to perform, the reliability of the test results are questionable because the soil is not allowed to fail along the weakest plane. The triaxial shear test is the most reliable form of shear testing. The three standard types of triaxial tests generally conducted are consolidated-drained test (CD), consolidated-undrained test (CU), and the unconsolidated-undrained test (UU and OB).

2.8 CONSOLIDATION TESTING

When a large area is loaded vertically, the compression that will occur can be assumed to be one dimensional. A consolidometer (also referred to as an oedometer) is used to simulate one-dimensional compression in a laboratory. An undisturbed soil sample representing the compressible soil layer is placed into a rigid confining ring to prevent lateral deformation. Porous stones are them placed at the top and bottom of the soil sample. The porous stones allow drainage during the consolidation process.

The soil specimen is usually 2.5 inches in diameter and 1 inch thick. Photographs of a prepared sample for testing are shown in Figure 7 (a and b).

(a)  (b) 

Figure 7: (a) Trimmed sample without porous stones. (b) Sample with porous stones

The load on the specimen is applied through a lever arm and the compression is measured by a micrometer dial gauge. Each load is usually held for 24 hours after which the load is doubled. At the end of the consolidation test, the dry unit weight of the test specimen is determined. Figure 8 is a photograph a consolidometer while a test is in progress and Figure 9 depicts the general shape of the plot of deformation of the specimen against time for a given load increment.

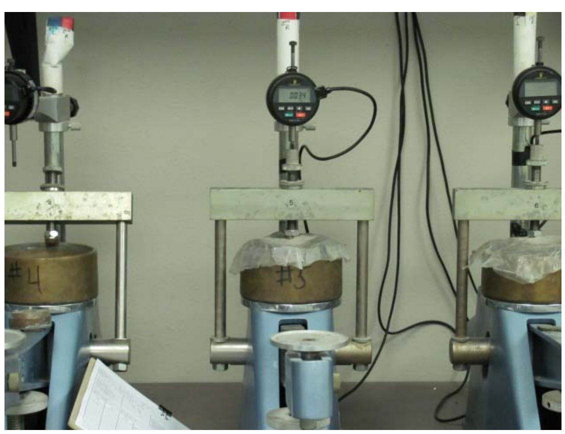

Figure 8: Consolidometer with a consolidation test in progress

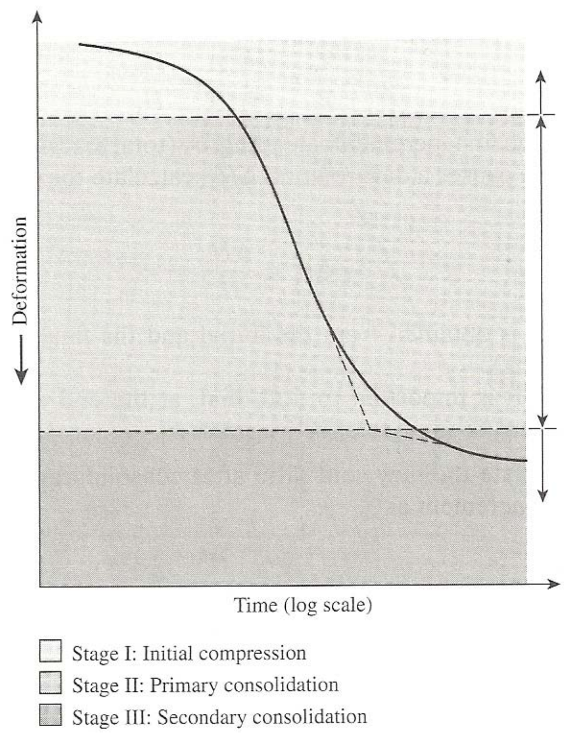

Figure 9: Time-deformation plot during consolidation for a given load increment (Das, 2006)

2.9 ATTERBERG LIMITS

Depending on the moisture content, the behavior of soil can be divided into four basic states: soil, semisolid, plastic, and liquid. The moisture content at the transition from soil to semisolid is the shrinkage limit, the moisture content from semisolid to plastic state is the plastic limit, and the moisture content from plastic to liquid state is the liquid limit. Collectively, these parameters are known as the Atterberg limits.

The plastic limit is the moisture content at which the soil crumbles when rolled by hand into threads approximately 1/8 inch in diameter. The plastic limit is the lower limit of the plastic stage of soil. The plastic limit test is performed by repetitively rolling an ellipsoidal sized soil sample by hand on a ground glass plate. The plastic limit test procedure is given in ASTM, Test Designation D-4318.

The liquid limit is determined by using a liquid limit device consisting of a brass cup and hard rubber base. The brass cup is dropped onto the base by a cam operated by a crank. The soil sample is formed into a paste and placed in the brass cup. A

groove is then cut at the center of the soil paste with a specific grooving tool. By use of the crank, the brass cup is lifted and dropped from a height of 0.394 inches. The moisture content required to close a distance of 0.5 inches along the bottom of the groove after 25 blows or drops is defined as the liquid limit.

Casagrande in 1932 studied the relationship of the plasticity index and the liquid limit of a variety of soils. The plasticity index is the difference between the liquid limit and the plastic limit of a soil. Based on his test results, Casagrande proposed the plasticity chart shown in Figure 10. The key feature of this plasticity chart is the A-line. The A-line separates the inorganic clays from the inorganic silts. The information provided in the chart is the basis for the classification of fine-grained soils in the Unified Soil Classification System. The U-line of the plasticity chart is the upper limit of the relationship of the plasticity index to the liquid limit for any soil. The equation for the A-line is given as PI = 0.73(LL - 20) and the equation for the U-line is given as PI = 0.90(LL - 8).

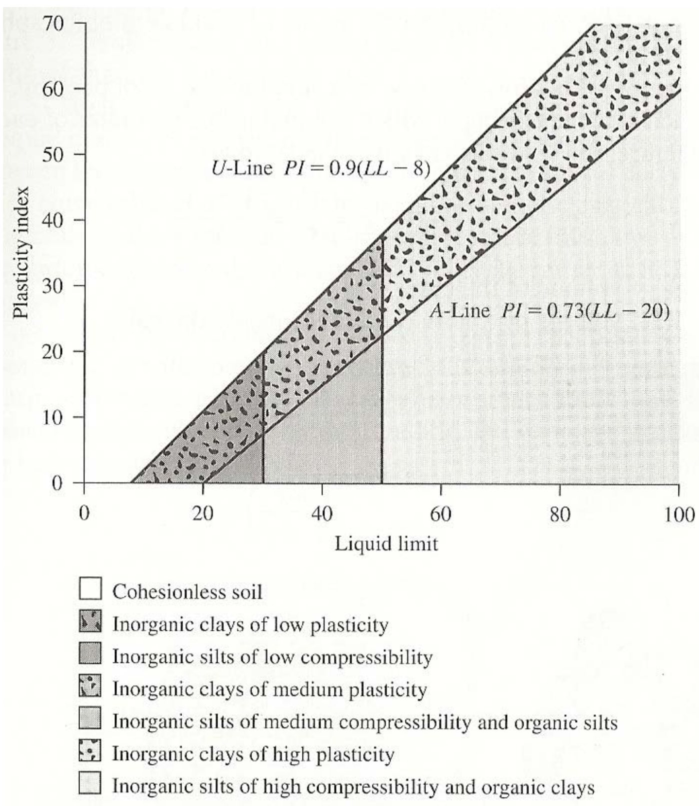

Figure 10: Plasticity Chart (Das, 2006)

CHAPTER 3
GEOTECHNICAL INVESTIGATION

3.1 INTRODUCTION

Three project sites were selected for this study. All three project sites consisted of a subsurface investigation performed with a combination of undisturbed soil borings and cone penetrometer tests (CPT).

3.2 SOIL BORINGS

The soil borings were made using a rotary drill rig mounted on an all-terrain vehicle. Undisturbed samples of cohesive or semi-cohesive subsoils were obtained at close intervals or changes in strata using a 3-in. diameter thin wall Shelby tube sampling barrel. The undisturbed samples were immediately extruded from the sampling barrel in the field while at the project site. Pocket penetrometer tests were also performed on trimmed ends of the extruded samples to provide a general indication of the soil's shear strength or consistency. The results of these tests are typically shown on the boring logs under a column heading "PP." All samples were inspected and visually classified by a soil technician in the field. Representative portions of the samples were then placed in moisture proof containers and returned to the laboratory for additional testing.

Cohesionless soils were obtained during the performance of in situ Standard Penetration Tests. This test consists of driving a 2-in. diameter split spoon sampler 1 foot into the soil after first seating the sampler 6 inches. A 140-lb weight dropped 30 inches is used to advance the sampler. The number of blows required to drive the sampler through the final 1-ft increment is indicative of the relative density or approximate consistency of the subsoils tested. The results of the Standard Penetration Tests are typically recorded on the boring log and shown under a column heading "SPT." Representative samples were also placed in moisture proof containers for preservation of their natural moisture content.

3.3 CONE PENETROMETER TESTS

Cone penetrometer tests (CPT) were performed using a 10-cm^2 cross-sectional area cone with a 60° apex angled tip and 150-cm^2 sleeve area. The penetrometer is hydraulically advanced into the ground at the rate of 2-cm/sec from a track-mounted unit. CPT parameters (tip resistance, friction resistance, and pore pressure) are recorded at 5-cm depth intervals. The results of the CPTs were then plotted graphically with depth. The plots provide corrected cone tip resistance ($q_{t)}$, sleeve friction resistance (f_s), and pore pressure behind cone tip (u_2). Testing is performed in general accordance with methods and procedures outlined in ASTM D 5778-07. Upon completion of the CPTs, the holes were then backfilled in general accordance with current regulatory requirements.

3.4 LABORATORY TESTS

Soil mechanics laboratory tests were performed on the undisturbed samples obtained from the soil borings at the three project sites. Included in these laboratory tests were natural water content, unit weight, and unconfined compression shear (UC), and unconsolidated undrained triaxial compression shear (OB). In addition, Atterberg liquid and plastic limits were performed on selected representative samples. These tests are necessary to confirm the classification of the subsoils and provide the relative strength and compressibility of the subsoils. Consolidation tests were also performed on select samples obtained from the soil borings. The results of these laboratory tests are tabulated on the boring logs for each project site and are included in Appendices A, B, and C. The results of the consolidation tests are shown graphically on separate sheets following the boring logs.

3.5 PROJECT SITE 1

Five undisturbed sample type soil test borings (designated as B-1 through B-5) were drilled between 22 January and 2 February 2010. The borings were made using a

rotary drill rig mounted on an all-terrain vehicle. Borings 1,2, and 3 were each drilled to a depth of 100 feet below the existing ground surface, and Borings 4 and 5 were each drilled to a depth of 150 feet below the existing ground surface. Twenty CPTs (designated as CPT-1 through CPT-20) were performed between 27 January and 3 February 2010. The CPTs were made from a track mounted unit. The boring locations in relation to the proposed tanks and the logs of the borings and CPTs are included in Appendix A.

3.6 PROJECT SITE 2

Seven undisturbed sample type soil borings (designated as B-1 through B-7) were drilled between 24 February and 3 March 2010. The borings were made using a rotary drill rig mounted on an all-terrain vehicle. Borings 1,2,3, and 4 were each drilled to a depth of 100 feet below the existing ground surface, and Borings 5,6, and 7 were each drilled to a depth of 150 feet below the existing ground surface. Twenty-five CPTs were performed between 5 and 15 March 2010. The CPTs were made from a track mounted unit. The boring locations in relation to the proposed tanks and the logs of the borings and CPTs are included in Appendix B.

3.7 PROJECT SITE 3

Seven undisturbed sample type soil test borings (designated as T-19, T-20, T-21, T-23, T-24, T-31, and NT-31) were drilled between 6 April and 10 May 2010. The borings were made using a rotary drill rig mounted on an all-terrain vehicle. Borings T-20, T-21, T-23, and T-24 were each drilled to a depth of 100 feet below the existing ground surface, and Borings T-19, T-31, and NT-31 were each drilled to a depth of 150 feet below the existing ground surface. Thirty-five CPTs (designated as OTK19-1 through OTK19-4, TK19-1 through TK19-4, TK20-1 through TK20-5, TK21-1 through TK21-4, OTK22-1, OTK22-3, OTK22-4, TK22-1 through TK22-3, TK23-1 through TK23-4, TK24-1, TK24-2, TK24-3, and TK24-5, and TK31-1 through TK31-4) were performed

between 12 April and 21 May 2010. The CPTs were made from a track mounted unit. The boring locations in relation to the proposed tanks and the logs of the borings and CPTs are included in Appendix C.

CHAPTER 4
EVALUATION OF DATA AND SETTLEMENT ANALYSES

4.1 INTRODUCTION

For this study, settlement analyses were performed by several methods for comparison purposes. Westergaard theory was executed by the use of spreadsheets and hand computations. By using spreadsheets and hand computations, the analyses were performed assuming a two-dimensional space. The computer software, Settle3D by RocScience, was also used. Westergaard theory was selected within the software to execute the computations. Settle3D is a three-dimensional program for the analysis of vertical consolidation and settlement beneath foundations and surface loads.

4.2 SETTLEMENT ANALYSES USING SPREADSHEET CALCULATIONS

Settlement analyses were performed using stress distribution by Westergaard theory and the rate of consolidation by Terzaghi theory. In order to simplify the calculations, a series of spreadsheets were set up to calculate time rate of settlement based on an applied load over the specified area. Wick drain calculations were also incorporated into the spreadsheets.

4.3 SETTLEMENT ANALYSES USING SETTLE3D SOFTWARE

Settlement analyses were performed utilizing Settle3D software by RocScience. The Settle3D program combines the simplicity of one-dimensional analysis with the visualization capabilities three-dimensional analyses. Modeling can be staged, and time-dependent consolidation analysis can be performed including primary and secondary consolidation (creep) at defined time intervals. A variety of linear and non-linear soil types can be modeled.

4.4 PROJECT SITE 1

Project site 1 consists of three 228-ft diameter and two 310-ft diameter crude oil storage tanks. The storage product has a specific gravity no greater than 0.92. An earth preload was placed atop the tank footprint for at least two months prior to construction of the tanks. In addition, consolidation settlement in the foundation soils was accelerated with the use of prefabricated vertical wick drains. Applicable figures for the earth preload and installation of wick drains are included in Appendix A.

The preload program has two benefits: it mitigates post construction settlement of the tanks, and it allows for storage of more product (i.e., larger bearing intensities). Preliminary analyses indicated the storage tanks at this site may be designed for a 3,100 psf bearing intensity in association with the preload. Considering a 2-ft thick tank pad and a specific gravity of 0.92, this corresponds to a maximum height of 50 feet of product. Prior to tank construction, wick drains were installed to the approximate 80-ft depth in a 5-ft triangular grid pattern, and an earth preload was placed atop the tank footprint for approximately two months. After removal of the earth preload, the tanks were constructed with an instrumentation and staged hydrotest program. The instrumentation included pore pressure transducers, slope inclinometers, and survey settlement points. Instrumentation readings were recorded and will be used to analyze the accuracy of the calculations performed for this study.

4.4.1 EARTH PRELOAD

An earth preload was used prior to construction of the tank foundations to facilitate consolidation of the subsoils and limit post construction settlement of the tanks. The preload also enabled larger bearing intensities (i.e., larger product storage heights) due to a gain in shear strength in the foundation soils. Stability analyses were performed to determine the maximum earth preload height that can be placed with the existing soil conditions. The slope stability analyses were performed using a program developed by the U.S. Army Corps of Engineers, New Orleans District, entitled "Slope

Stability with Uplift Computations" (UPLIFT, Version 2.0, 4 August 1994, FS004) which utilizes the LMVD Method of Planes.

Based on the stability analyses, a maximum earth loading pressure of approximately 2,200 psf (average 20-ft fill height assuming a unit weight of 110 pcf for the fill material) can be placed using side slopes of 1 vertical to 3 horizontal while providing a factor of safety approximately equal to 1.1 against a slope failure. This factor of safety against a slope failure assumed strength gains in the subsoils would not occur as the earth preload was constructed. Based on an average fill height of 20 feet, residual settlement for tank foundations constructed after earth preloading will be reduced. In addition, due to the reduction in total tank settlement, preloading with earth reduces the potential for releveling after construction and performance of hydrotesting.

Assuming a 20-ft high earth preload is constructed and allowed to remain in place for a minimum of two months (with wick drains), settlement estimates of the foundation soils will be significantly reduced. A summary of settlement estimates for a 308 to 390-ft wide preload with an average 20-ft earth surcharge is shown in Table 1. These settlement estimates should be considered ground surface settlement realized at the top of the sand pad.

TABLE 1: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TWO-MONTH EARTH PRELOAD

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	SETTLEMENT AT THE CENTER OF TANK	SETTLEMENT AT THE EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	228	28 TO 43 INCHES	23 TO 35 INCHES
	310	30 TO 45 INCHES	25 TO 38 INCHES
SETTLE3D SOFTWARE	228	30 TO 45 INCHES	25 TO 37 INCHES
	310	32 TO 47 INCHES	27 TO 40 INCHES

4.4.2 WICK DRAINS

The use of wick drains in combination with an earth preload and a staged hydrotest loading program permits the application of bearing pressures up to 3,100 psf

(tank product heights no greater than 50 feet). It is estimated the required soil strengthening may be achieved in approximately two months. Wick drains should be installed in a triangular array with a center to center spacing of 5 feet to an approximate depth of 80 feet, or practical refusal.

4.4.3 WICK DRAIN INSTALLATION

After placement of approximately 1 foot of fill above the prepared subgrade, vertical wick drains were inserted through the fill pad. These vertical wicks were installed in an equilateral triangular pattern as shown in Appendix A. All wick drains were installed to an approximate depth of 80 feet, or practical refusal in the sand deposits using a mandrel that protects the wick drain during installation. These drains were also installed to a plumbness within 1% of vertical and within an area no more than 6 inches from the design location. In some instances vibratory assistance was used to advance the wick. Once each wick had been installed to the required depth and the mandrel has been withdrawn, the wick was cut to provide excess wick length at the ground surface. This excess length was then pinned or stapled to a horizontal wick drain in accordance with the manufacturer’s recommendations. The horizontal strip drains also meet the material requirements shown in Appendix A. The horizontal drains were arranged as shown on the figures in Appendix A, with no more than two rows of vertical wick drains connecting to each horizontal strip drain. Two 6-in. wide horizontal strip drains were also provided between the sand pad and the tank ring walls’ weep holes as shown on the figure in Appendix A.

4.4.4 ESTIMATED TANK SETTLEMENT AFTER EARTH PRELOAD

The estimated two-month duration for an earth preload (approximately 20 feet high comprising clay and a 2-ft thick sand pad) results in settlement of the sand pad and strength gain in the foundation soils. Settlement and strength gain is accelerated by the use of wick drains. These results are summarized in Table 1 for tank diameters of 228 and 310 feet. After the earth preload period elapses and it is determined that adequate consolidation has occurred, the preload material is removed, and the tanks are

constructed. Estimations of the amount of settlement that would be experienced for tank diameters of 228 and 310 feet after the earth preload period were performed by Westergaard theory using spreadsheets and the Settle3D software. These estimates are summarized in Table 2. Estimations of consolidation settlement at the center and edge of each tank are shown. Consolidation settlement will occur over a long period of time and at a diminishing rate. The maximum differential settlement is estimated as 4 to 4½ inches at the center and 1 to 1½ inches at the edge of a 228-ft diameter tank. The maximum differential settlement is estimated as 4½ to 5 inches at the center and 1 to 1½ inches at the edge of a 310-ft diameter tank. Elastic settlement and differential settlement at the center and edge of each tank were also estimated. Elastic settlement occurs instantaneously, and it is estimated no more than 1 inch of differential settlement at the center and at the edge for both tank sizes.

TABLE 2: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TANK CONSTRUCTION

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	MAXIMUM SETTLEMENT IN INCHES		MINIMUM SETTLEMENT IN INCHES	
		CENTER OF TANK	EDGE OF TANK	CENTER OF TANK	EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	228	22.5 TO 23	6 TO 6.5	18.5 TO 19	5 TO 5.5
	310	25 TO 25.5	6.5 TO 7	20.5 TO 21	5.5 TO 6
SETTLE3D SOFTWARE	228	25 TO 26	10 TO 11	21 TO 22	8 TO 9
	310	30 TO 31	11 TO 12	24 TO 25	9 TO 10

4.5 PROJECT SITE 2

Project site 2 consists of four 135-ft diameter asphalt tanks and one 110-ft diameter MDO tanks. The asphalt product has a specific gravity no greater than 1.10 and the MDO product has a specific gravity of no greater than 0.92. An earth preload was placed atop the tank footprint for at least two months prior to construction of the tanks. In addition, consolidation settlement in the foundation soils was accelerated with the use of prefabricated vertical wick drains. Applicable figures for the earth preload and installation of wick drains are included in Appendix B.

As discussed in the previous section for project site 1, the preload program has two benefits: it mitigates post construction settlement of the tanks, and it allows for storage of more product (i.e., larger bearing intensities). Preliminary analyses indicated the storage tanks at this site may be designed for a 3,100 psf bearing intensity in association with the preload. Considering a 2-ft thick tank pad and a specific gravities of 1.10 and 0.92, this corresponds to a maximum heights of 42 and 51 feet of product, respectively. Prior to tank construction, wick drains were installed to the approximate 80-ft depth in a 5-ft triangular grid pattern, and an earth preload was placed atop the tank footprint for approximately two months. After removal of the earth preload, the tanks were constructed with an instrumentation and staged hydrotest program. The instrumentation included pore pressure transducers, slope inclinometers, and survey settlement points. Instrumentation readings were recorded and will be used to analyze the accuracy of the calculations performed for this study.

4.5.1 EARTH PRELOAD

An earth preload was used prior to construction of the tank foundations to facilitate consolidation of the subsoils and limit post construction settlement of the tanks. The preload also enabled larger bearing intensities (i.e., larger product storage heights) due to a gain in shear strength in the foundation soils. Stability analyses were performed to determine the maximum earth preload height that can be placed with the existing soil conditions. The slope stability analyses were performed using a program developed by the U.S. Army Corps of Engineers, New Orleans District, entitled "Slope Stability with Uplift Computations" (UPLIFT, Version 2.0, 4 August 1994, FS004) which utilizes the LMVD Method of Planes.

Based on the stability analyses, a maximum earth loading pressure of approximately 2,200 psf (average 20-ft fill height assuming a unit weight of 110 pcf for the fill material) can be placed using side slopes of 1 vertical to 3 horizontal while providing a factor of safety approximately equal to 1.1 against a slope failure. This factor of safety against a slope failure assumed strength gains in the subsoils would not occur as the earth preload was constructed. Based on an average fill height of 20 feet,

residual settlement for tank foundations constructed after earth preloading will be reduced. In addition, due to the reduction in total tank settlement, preloading with earth reduces the potential for releveling after construction and performance of hydrotesting.

Assuming a 20-ft high earth preload is constructed and allowed to remain in place for a minimum of two months (with wick drains), settlement estimates of the foundation soils will be significantly reduced. A summary of settlement estimates for a 190 to 215-ft wide preload with an average 20-ft earth surcharge is shown in Table 3. These settlement estimates should be considered ground surface settlement realized at the top of the sand pad.

TABLE 3: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TWO-MONTH EARTH PRELOAD

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	SETTLEMENT AT THE CENTER OF TANK	SETTLEMENT AT THE EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	110	26 TO 39 INCHES	15 TO 23 INCHES
	135	28 TO 42 INCHES	22 TO 34 INCHES
SETTLE3D SOFTWARE	110	28 TO 42 INCHES	17 TO 25 INCHES
	135	30 TO 44 INCHES	25 TO 38 INCHES

4.5.2 WICK DRAINS

The use of wick drains in combination with an earth preload and a staged hydrotest loading program permits the application of bearing pressures up to 3,100 psf (tank product heights no greater than 51 feet for the MDO product and 42 feet for the asphalt product). It is estimated the required soil strengthening may be achieved in approximately two months. Wick drains should be installed in a triangular array with a center to center spacing of 5 feet to an approximate depth of 80 feet, or practical refusal.

4.5.3 WICK DRAIN INSTALLATION

After placement of approximately 1 foot of fill above the prepared subgrade, vertical wick drains were inserted through the fill pad. These vertical wicks were

installed in an equilateral triangular pattern as shown in Appendix B. All wick drains were installed to an approximate depth of 80 feet, or practical refusal in the sand deposits using a mandrel that protects the wick drain during installation. These drains were also installed to a plumbness within 1% of vertical and within an area no more than 6 inches from the design location. In some instances vibratory assistance was used to advance the wick. Once each wick had been installed to the required depth and the mandrel has been withdrawn, the wick was cut to provide excess wick length at the ground surface. This excess length was then pinned or stapled to a horizontal wick drain in accordance with the manufacturer's recommendations. The horizontal strip drains also meet the material requirements shown in Appendix B. The horizontal drains were arranged as shown on the figures in Appendix B, with no more than two rows of vertical wick drains connecting to each horizontal strip drain. Two 6-in. wide horizontal strip drains were also provided between the sand pad and the tank ring walls' weep holes as shown on the figure in Appendix B.

4.5.4 ESTIMATED TANK SETTLEMENT AFTER EARTH PRELOAD

The estimated two-month duration for an earth preload (approximately 20 feet high comprising clay and a 2-ft thick sand pad) results in settlement of the sand pad and strength gain in the foundation soils. Settlement and strength gain is accelerated by the use of wick drains. These results are summarized in Table 3 for tank diameters of 110 and 135 feet. After the earth preload period elapses and it is determined that adequate consolidation has occurred, the preload material is removed, and the tanks are constructed. Estimations of the amount of settlement that would be experienced for tank diameters of 110 and 135 feet after the earth preload period were performed by Westergaard theory using spreadsheets and the Settle3D software. These estimates are summarized in Table 4. Estimations of consolidation settlement and differential settlement at the center and edge of each tank are shown. Consolidation settlement will occur over a long period of time and at a diminishing rate. The maximum differential settlement is estimated as 3½ to 4 inches at the center and 1 to 1½ inches at the edge of a 135-ft diameter tank. The maximum differential settlement is estimated as 3 to 3½

inches at the center and ½ to 1 inch at the edge of a 110-ft diameter tank. Elastic settlement and differential settlement at the center and edge of each tank were also estimated. Elastic settlement occurs instantaneously, and it is estimated no more than 1 inch of differential settlement at the center and at the edge for both tank sizes.

TABLE 4: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TANK CONSTRUCTION

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	MAXIMUM SETTLEMENT IN INCHES		MINIMUM SETTLEMENT IN INCHES	
		CENTER OF TANK	EDGE OF TANK	CENTER OF TANK	EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	110	17 TO 17.5	3 TO 3.5	14 TO 14.5	2.5 TO 3
	135	19.5 TO 20	5.5 TO 6	16 TO 16.5	4.5 TO 5
SETTLE3D SOFTWARE	228	20 TO 21	4 TO 5	17 TO 18	5 TO 6
	310	22 TO 23	7 TO 8	19 TO 20	6 TO 7

4.6 PROJECT SITE 3

Project site 3 consists of five 228-ft diameter and two 150-ft diameter crude oil tanks. The storage product has a specific gravity no greater than 0.92. An earth preload was placed atop the tank footprint for at least two months prior to construction of the tanks. In addition, consolidation settlement in the foundation soils was accelerated with the use of prefabricated vertical wick drains. Applicable figures for the earth preload and installation of wick drains are included in Appendix C.

As discussed in the previous section for project sites 1 and 2, the preload program has two benefits: it mitigates post construction settlement of the tanks, and it allows for storage of more product (i.e., larger bearing intensities). Preliminary analyses indicated the storage tanks at this site may be designed for a 2,900 psf bearing intensity in association with the preload. Considering a 2-ft thick tank pad and a specific gravity of 0.92, this corresponds to a maximum heights of 46 feet of product. Prior to tank construction, wick drains were installed to the approximate 80-ft depth in a 5-ft triangular grid pattern, and an earth preload was placed atop the tank footprint for approximately two months. After removal of the earth preload, the tanks were constructed with an instrumentation and staged hydrotest program. The instrumentation included pore

pressure transducers, slope inclinometers, and survey settlement points. Instrumentation readings were recorded and will be used to analyze the accuracy of the calculations performed for this study.

4.6.1 EARTH PRELOAD

An earth preload was used prior to construction of the tank foundations to facilitate consolidation of the subsoils and limit post construction settlement of the tanks. The preload also enabled larger bearing intensities (i.e., larger product storage heights) due to a gain in shear strength in the foundation soils. Stability analyses were performed to determine the maximum earth preload height that can be placed with the existing soil conditions. The slope stability analyses were performed using a program developed by the U.S. Army Corps of Engineers, New Orleans District, entitled "Slope Stability with Uplift Computations" (UPLIFT, Version 2.0, 4 August 1994, FS004) which utilizes the LMVD Method of Planes.

Based on the stability analyses, a maximum earth loading pressure of approximately 2,915 psf (average 26.5-ft fill height assuming a unit weight of 110 pcf for the fill material) can be placed using side slopes of 1 vertical to 3 horizontal while providing a factor of safety approximately equal to 1.1 against a slope failure. This factor of safety against a slope failure assumed strength gains in the subsoils would not occur as the earth preload was constructed. Based on an average fill height of 26.5 feet, residual settlement for tank foundations constructed after earth preloading will be reduced. In addition, due to the reduction in total tank settlement, preloading with earth reduces the potential for releveling after construction and performance of hydrotesting.

Assuming a 26.5-ft high earth preload is constructed and allowed to remain in place for a minimum of two months (with wick drains), settlement estimates of the foundation soils will be significantly reduced. A summary of settlement estimates for a 306 to384-ft wide preload with an average 26.5-ft earth surcharge is shown in Table 5. These settlement estimates should be considered ground surface settlement realized at the top of the sand pad.

TABLE 5: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TWO-MONTH EARTH PRELOAD

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	SETTLEMENT AT THE CENTER OF TANK	SETTLEMENT AT THE EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	110	55 TO 82 INCHES	46 TO 69 INCHES
	135	59 TO 88 INCHES	50 TO 76 INCHES
SETTLE3D SOFTWARE	110	57 TO 84 INCHES	48 TO 71 INCHES
	135	62 TO 89 INCHES	52 TO 78 INCHES

4.6.2 WICK DRAINS

The use of wick drains in combination with an earth preload and a staged hydrotest loading program permits the application of bearing pressures up to 2,900 psf (tank product heights no greater than 46 feet). It is estimated the required soil strengthening may be achieved in approximately two months. Wick drains should be installed in a triangular array with a center to center spacing of 5 feet to an approximate depth of 80 feet, or practical refusal.

4.6.3 WICK DRAIN INSTALLATION

After placement of approximately 1 foot of fill above the prepared subgrade, vertical wick drains were inserted through the fill pad. These vertical wicks were installed in an equilateral triangular pattern as shown in Appendix C. All wick drains were installed to an approximate depth of 80 feet, or practical refusal in the sand deposits using a mandrel that protects the wick drain during installation. These drains were also installed to a plumbness within 1% of vertical and within an area no more than 6 inches from the design location. In some instances vibratory assistance was used to advance the wick. Once each wick had been installed to the required depth and the mandrel has been withdrawn, the wick was cut to provide excess wick length at the ground surface. This excess length was then pinned or stapled to a horizontal wick drain in accordance with the manufacturer’s recommendations. The horizontal strip drains also meet the material requirements shown in Appendix C. The horizontal drains were arranged as shown on the figures in Appendix C, with no more than two rows of

vertical wick drains connecting to each horizontal strip drain. Two 6-in. wide horizontal strip drains were also provided between the sand pad and the tank ring walls' weep holes as shown on the figure in Appendix C.

4.6.4 ESTIMATED TANK SETTLEMENT AFTER EARTH PRELOAD

The estimated two-month duration for an earth preload (approximately 26.5 feet high comprising clay and a 2-ft thick sand pad) results in settlement of the sand pad and strength gain in the foundation soils. Settlement and strength gain is accelerated by the use of wick drains. These results are summarized in Table 5 for tank diameters of 228 and 150 feet. After the earth preload period elapses and it is determined that adequate consolidation has occurred, the preload material is removed, and the tanks are constructed. Estimations of the amount of settlement that would be experienced for tank diameters of 228 and 150 feet after the earth preload period were performed by Westergaard theory using spreadsheets and the Settle3D software. These estimates are summarized in Table 6. Estimations of consolidation settlement and differential settlement at the center and edge of each tank are shown. Consolidation settlement will occur over a long period of time and at a diminishing rate. The maximum differential settlement is estimated as 4 to 5 inches at the center and 2 to 3 inches at the edge of a 228-ft diameter tank. The maximum differential settlement is estimated as 1½ to 2½ inches at the center and 1 to 2 inch at the edge of a 150-ft diameter tank. Elastic settlement and differential settlement at the center and edge of each tank were also estimated. Elastic settlement occurs instantaneously, and it is estimated no more than 1 inch of differential settlement at the center and at the edge for both tank sizes.

TABLE 6: ESTIMATED CONSOLIDATION SETTLEMENT AFTER TANK CONSTRUCTION

TYPE OF ANALYSIS	TANK DIAMETER IN FEET	MAXIMUM SETTLEMENT IN INCHES		MINIMUM SETTLEMENT IN INCHES	
		CENTER OF TANK	EDGE OF TANK	CENTER OF TANK	EDGE OF TANK
WESTERGAARD THEORY BY SPREADSHEET	150	14.5 TO 15	3 TO 3.5	13 TO 13.5	2.5 TO 3
	228	20.5 TO 21	11 TO 11.5	16.5 TO 17	9 TO 9.5
SETTLE3D SOFTWARE	150	18 TO 19	5 TO 8	15 TO 16	3 TO 4
	228	22 TO 24	13 TO 14	18 TO 19	11 TO 12

4.7 INSTRUMENTATION

The use of instrumentation is recommended to monitor the effectiveness of the earth preload prior to tank construction and to monitor the tanks during hydrotesting. These instruments are monitored and data retrieved and evaluated on a periodic basis during the earth preload and hydrotest. The readings obtained during the instrumentation program are presented in Appendices A, B, and C for each project site.

Once the subgrade is prepared and the tank pad is installed, settlement plates are installed prior to the placement of the earth preload materials. Settlement plates are an instrumentation tool used to evaluate settlement of the ground surface due to placement of earth preload clay fill soils. The settlement plates are located at the center and edge of the crown of each preload configuration. The elevation of the settlement plate and riser is determined prior to any fill placement using a benchmark sufficiently removed from the surcharge area so as not to be influenced by the fill. Once this initial elevation is determined, the plate should not be disturbed during fill placement and compaction.

Vibrating wire type pore pressure transducers are also installed beneath each tank pad. These transducers are read during the earth preload and hydrotest. The leads are buried and threaded through the tank ringwall to a remote reading station. A minimum of three nests of pore pressure transducers are installed. One nest is installed at the centers of the proposed tanks, and the second is installed at a point approximately one-half to two-thirds of the tank radius from each tank's center. A third

nest is installed outside the tank footprint. Each transducer nest should consist of three vibrating wire pore pressure transducers. The transducers at each nest are installed at depths of approximately 15, 30, and 45 feet below the existing ground surface. Transducers are monitored weekly (at a minimum) during the earth preload program, at the end of filling to a given stage loading of the hydrotest, and approximately twice weekly during all holding periods of the hydrotest.

Lateral flow may produce large deformations of the tank without strength gains of the foundation soils. Therefore, a minimum of four inclinometers are spaced at 90 degree intervals along the outside of each tank. The inclinometers are set to a depth of approximately 100 feet. All inclinometers are monitored once at the end of filling for each stage of the hydrotest and approximately twice weekly thereafter.

Level surveys of the tank ringwall are performed in conjunction with the subsurface instrumentation. A minimum of 16 survey points are equally spaced around the perimeter of each tank. These survey points will be used in conjunction with the subsurface instrumentation to evaluate the performance of the stage loading process. These settlements are then referenced to an established benchmark prior to the stage loading. The benchmark should be located a minimum of 500 feet from the nearest tank so the benchmark elevation is not affected by tank loading. The settlement points are monitored at the end of filling to a given stage loading, and approximately twice weekly during all holding periods of the hydrotest.

CHAPTER 5
SUMMARY AND CONCLUSIONS

Tanks foundations may be constructed utilizing different computational techniques. This study focused on grade supported tanks constructed under an earthen preload and instrumentation program. Settlement estimation methods were performed to compare the results to the actual settlement that has occurred to date. Instrumentation data were available to compare the computed settlement values to the actual settlement that has occurred at each site. Settlement analyses were performed using stress distribution by Westergaard theory and the rate of consolidation by Terzaghi theory via spreadsheets. Settlement analyses were also performed using Settle3D software by RocScience. Based on the results, the two methods are within reasonable margins of each other for the tank structures. Because the tank structure construction is not complete, the settlement values reported in this document cannot be directly compared to the settlement readings available to date. The settlement values shown in Chapter 4 are ultimate settlements that will occur approximately 50 to 60 years from the date of initial construction. However, calculations were performed with the appropriate time lapses and the Settle3D model was within ten percent of the actual readings taken from the field instrumentation.

The Settle3D model tends to predict slightly larger amounts of settlement. The variation in results is due to the many assumptions that are made for both methods. The variation in assumptions can lead to great variance in settlement predictions. When predicting settlement, it is important to identify the state of soil and determine if each soil strata is experiencing virgin compression or has reached the zone of recompression. When estimating time rate of settlement, it is essential to have adequate consolidation test results for compressible soil zones. The rate of consolidation and consolidation coefficients determined from the test results will drastically help with the predictions of consolidation settlement. Another factor to consider is the amount of soil disturbance experienced during construction. For example, the installation of prefabricated wick drains can have a large impact on the rate of consolidation.

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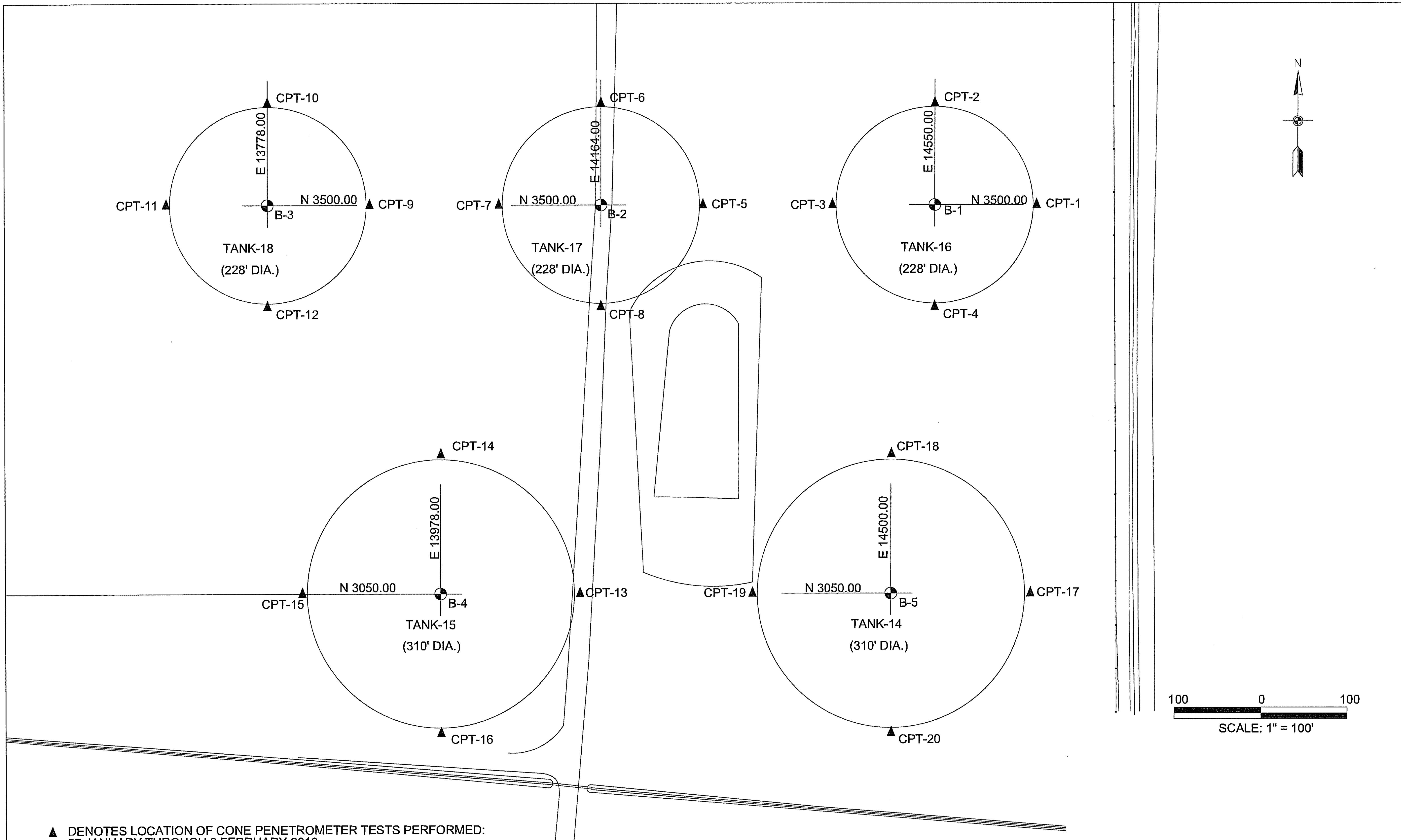
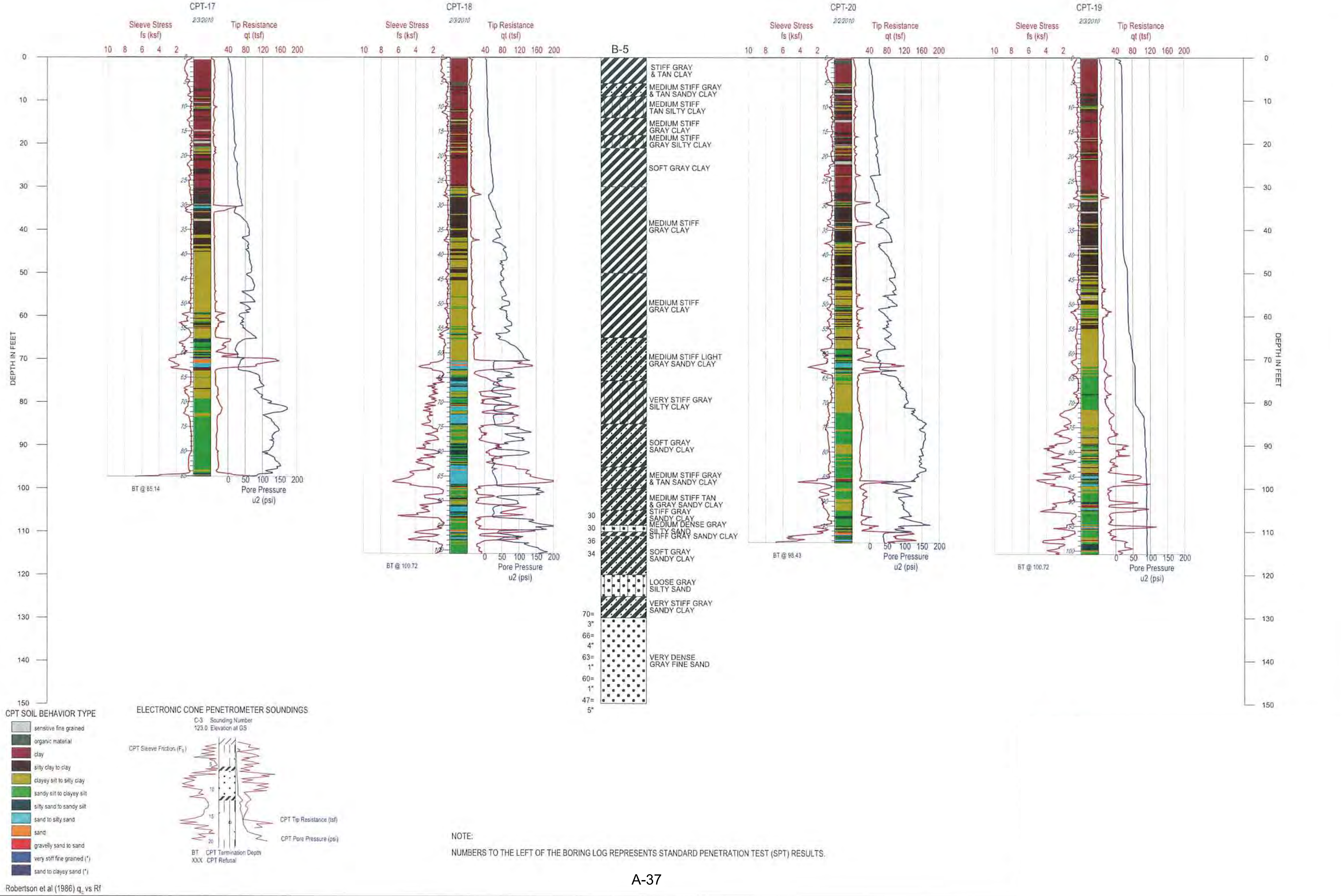
APPENDIX A



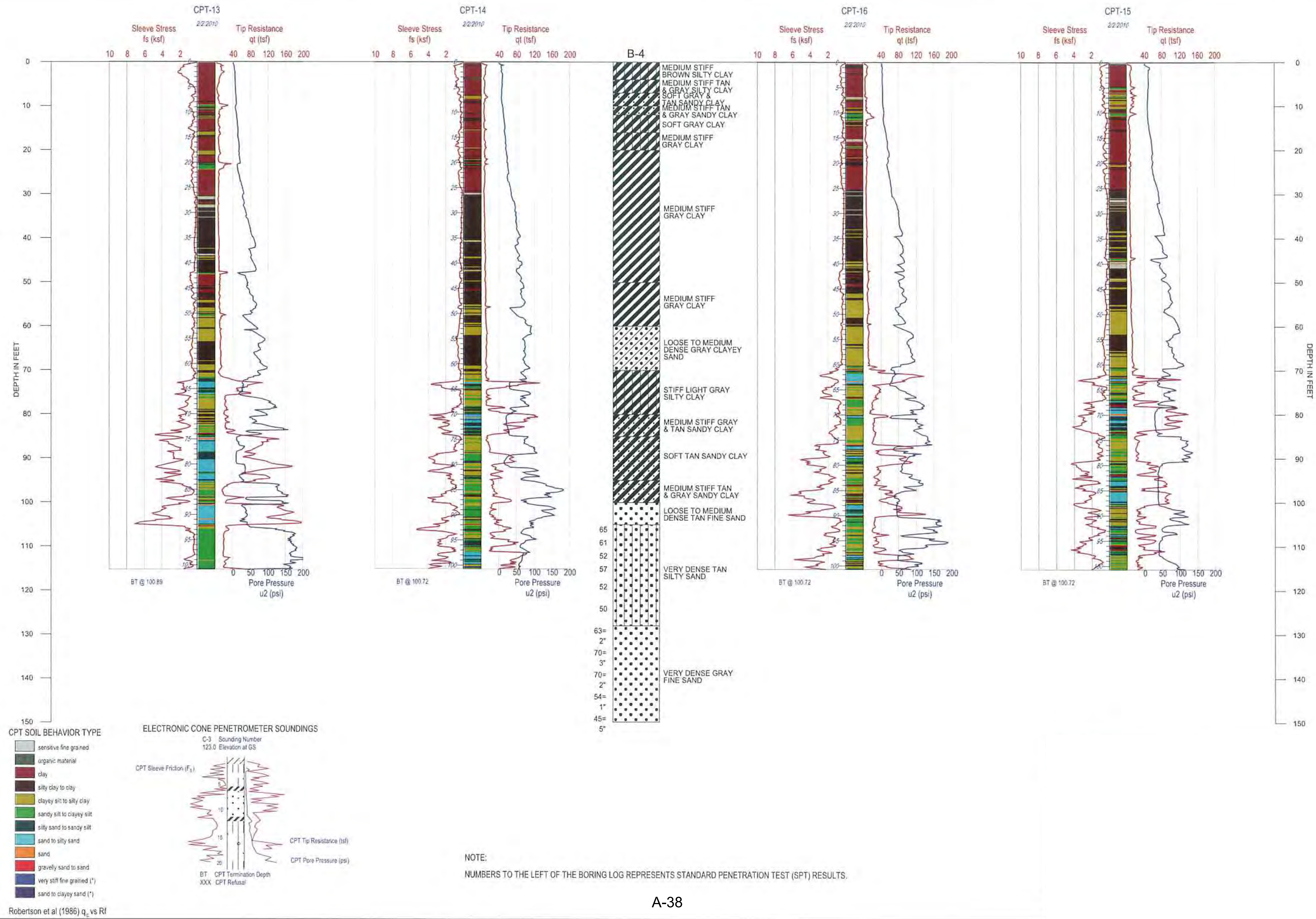
▲ DENOTES LOCATION OF CONE PENETROMETER TESTS PERFORMED:
27 JANUARY THROUGH 3 FEBRUARY 2010

⊕ DENOTES LOCATION OF UNDISTURBED SOIL BORINGS DRILLED:
22 JANUARY THROUGH 2 FEBRUARY 2010



NOTE:

NUMBERS TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULTS.



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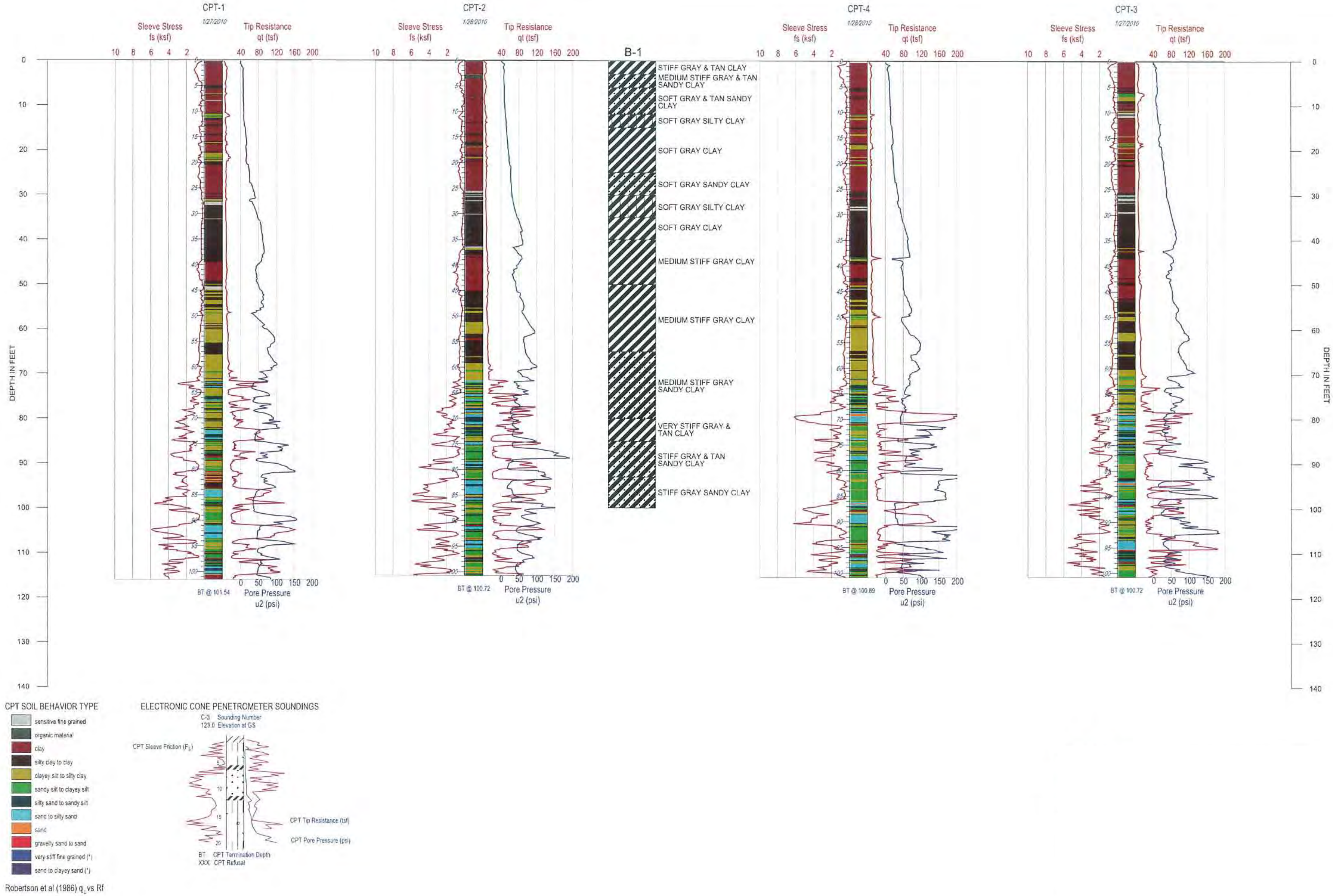
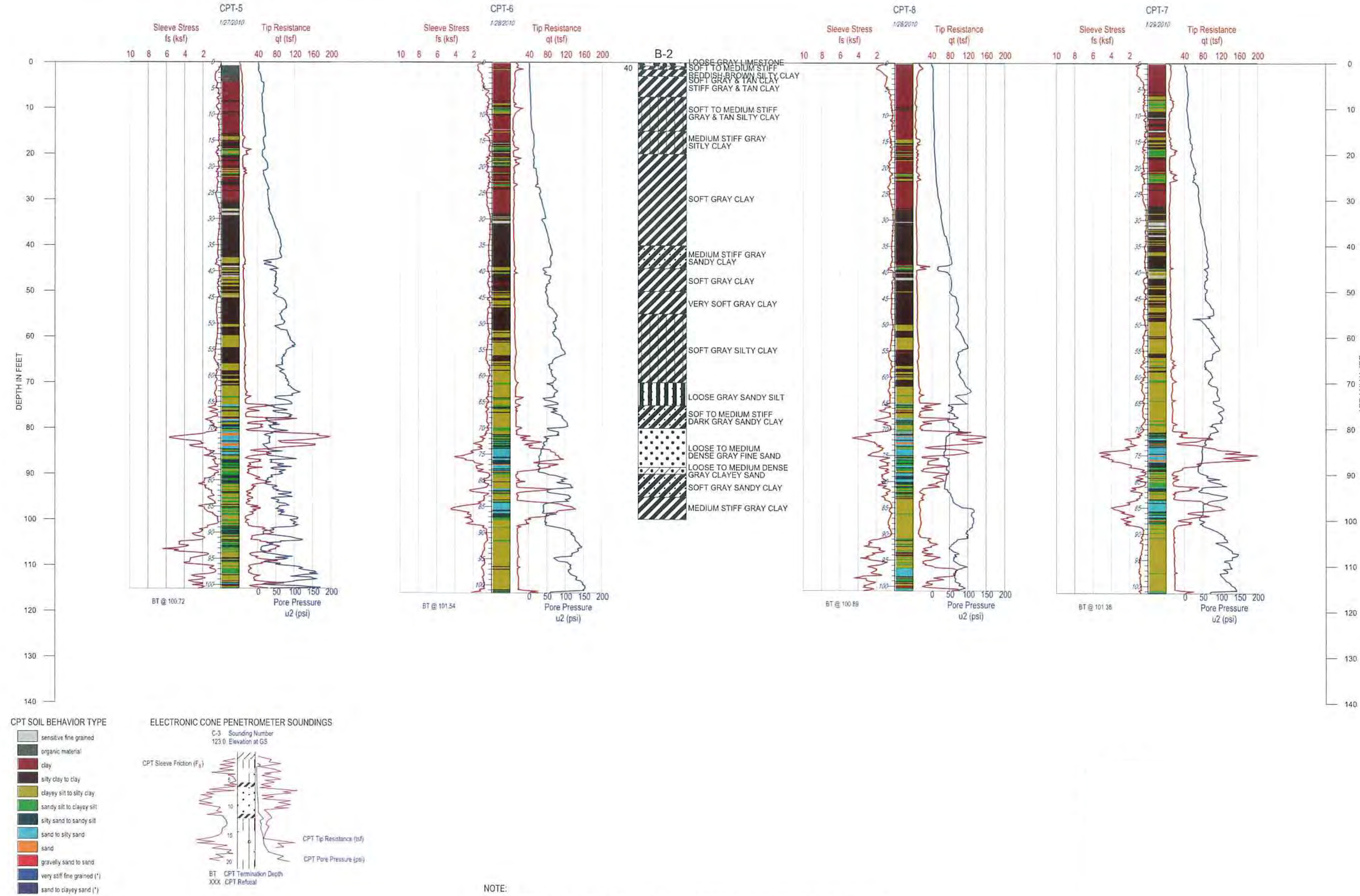
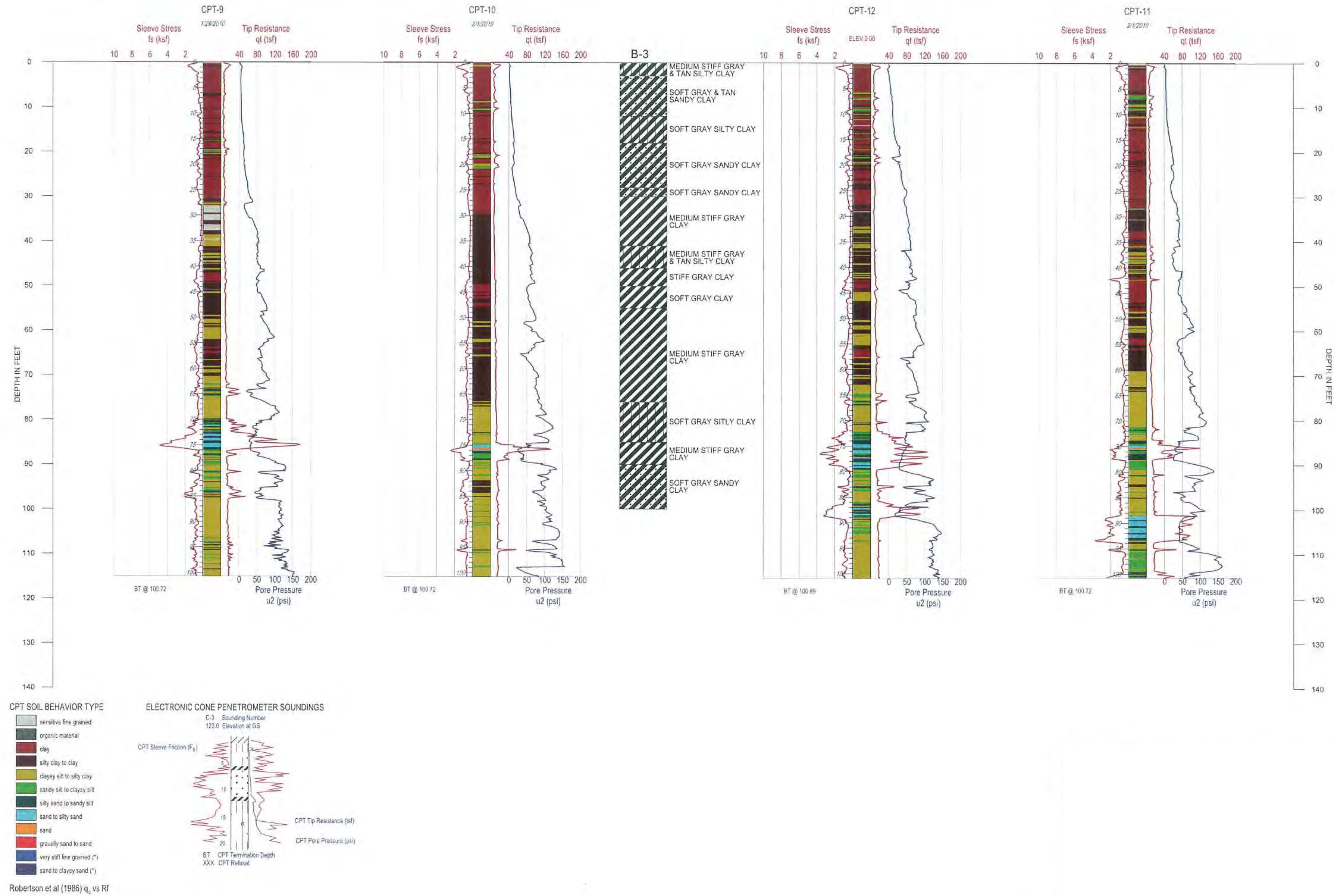

CPT-1
1/27/2010
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
CPT-2
1/28/2010
B-1
STIFF GRAY & TAN CLAY
MEDIUM STIFF GRAY & TAN SANDY CLAY
SOFT GRAY & TAN SANDY CLAY
SOFT GRAY SILTY CLAY
SOFT GRAY CLAY
SOFT GRAY SANDY CLAY
SOFT GRAY SILTY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY SANDY CLAY
VERY STIFF GRAY & TAN CLAY
STIFF GRAY & TAN SANDY CLAY
STIFF GRAY SANDY CLAY
CPT-4
1/28/2010
CPT-3
1/27/2010
DEPTH IN FEET
BT @ 101.54
BT @ 100.72
BT @ 100.89
BT @ 100.72
Pore Pressure u2 (psi)
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
123.0 Elevation at GS
CPT Sleeve Friction (F_s)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal



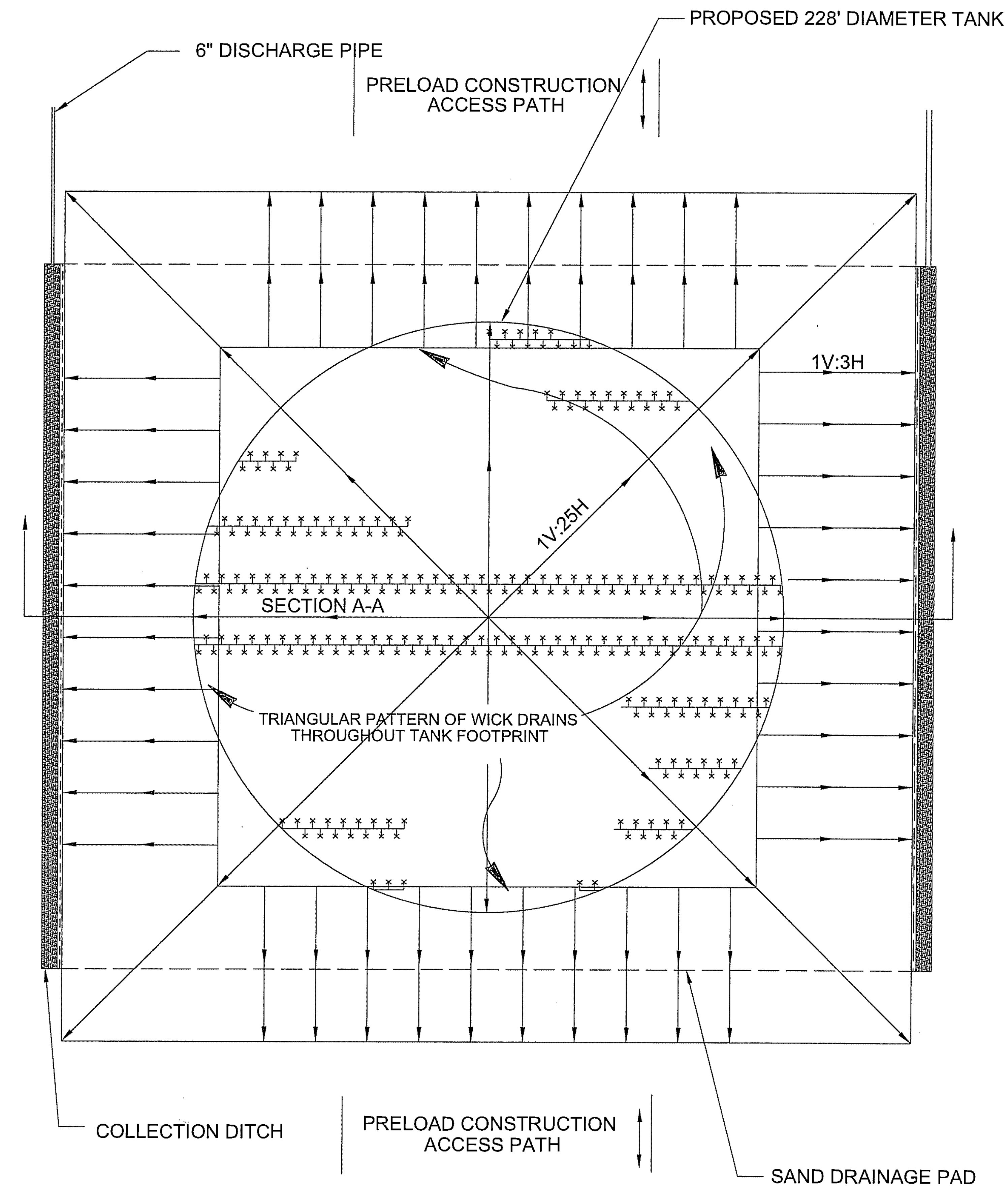
Robertson et al (1986) q_c vs Rf

NOTE:

THE NUMBER TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULT.

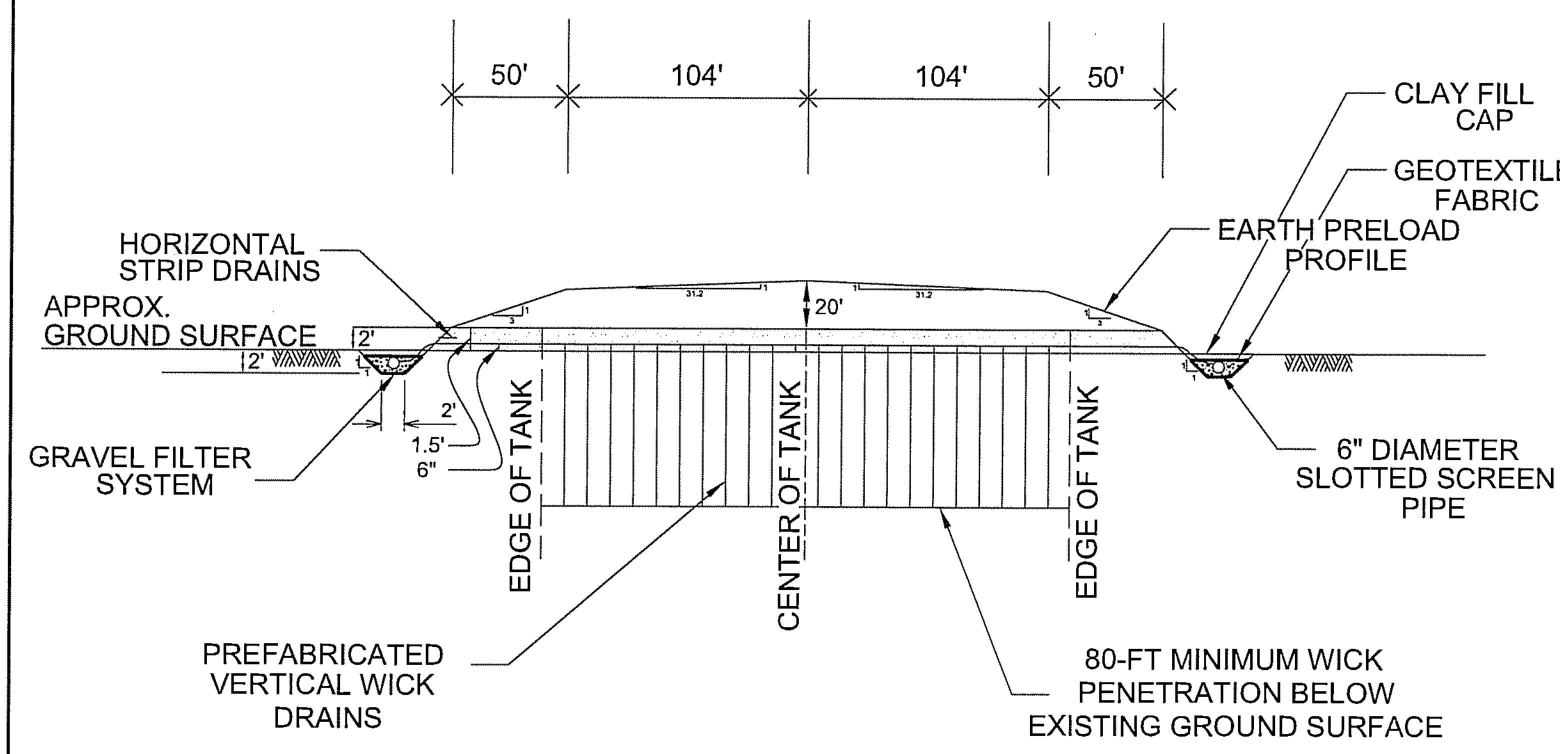


CPT-9
CPT-10
CPT-12
CPT-11
B-3
Sleeve Stress
fs (ksf)
Tip Resistance
qt (tsf)
Pore Pressure
u2 (psi)
DEPTH IN FEET
MEDIUM STIFF GRAY & TAN SILTY CLAY
SOFT GRAY & TAN SANDY CLAY
SOFT GRAY SILTY CLAY
SOFT GRAY SANDY CLAY
SOFT GRAY SANDY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY & TAN SILTY CLAY
STIFF GRAY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY SITLY CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY SANDY CLAY
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
123.0 Elevation at GS
CPT Sleeve Friction (F_s)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal



PLAN VIEW

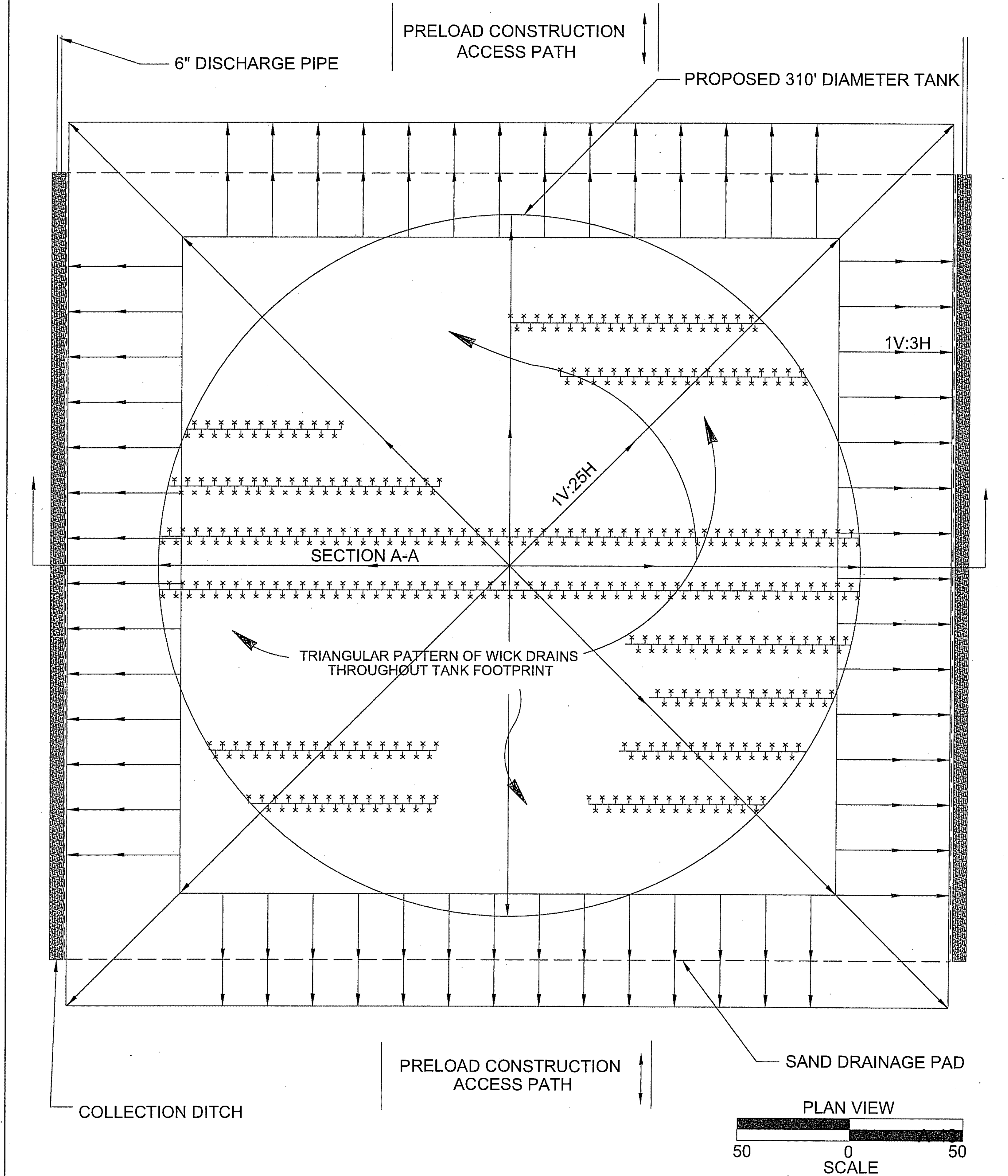
50 0 50
SCALE

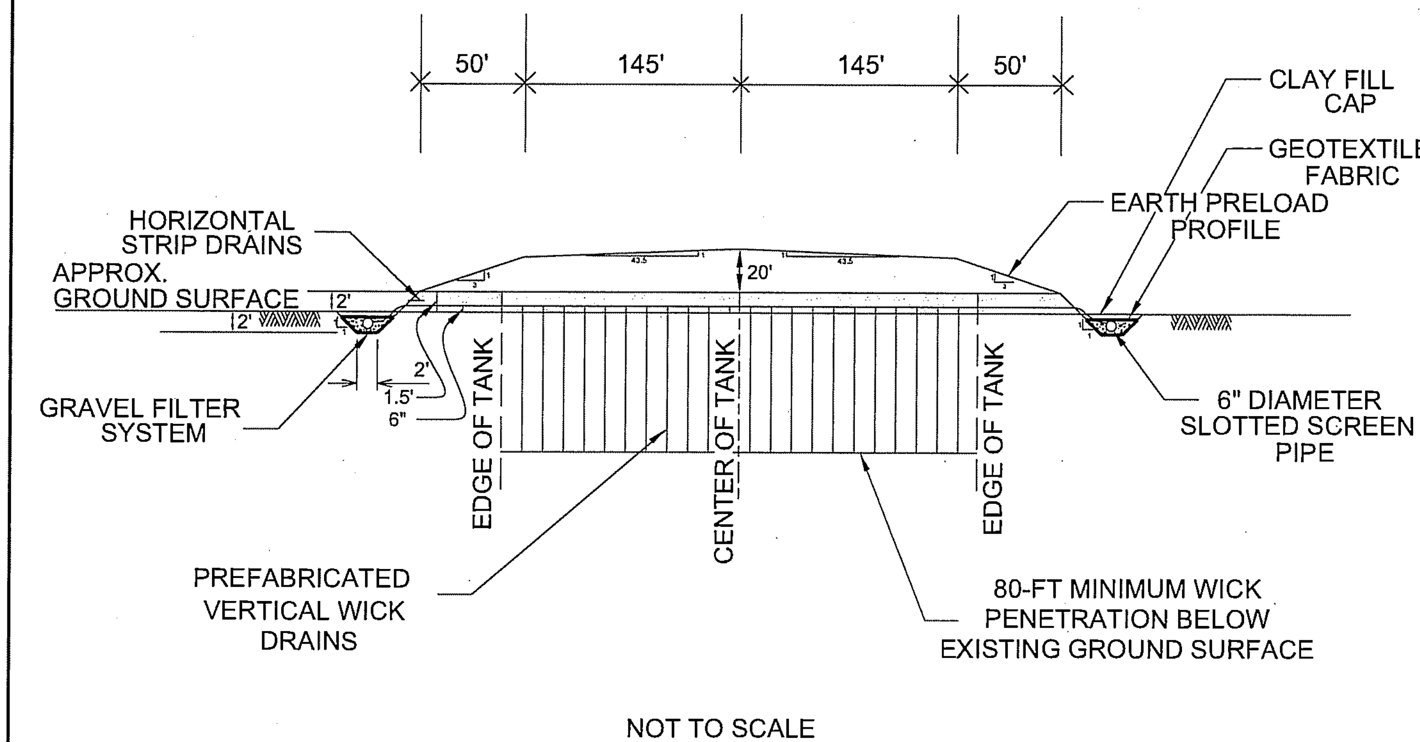


NOT TO SCALE

SECTION A-A

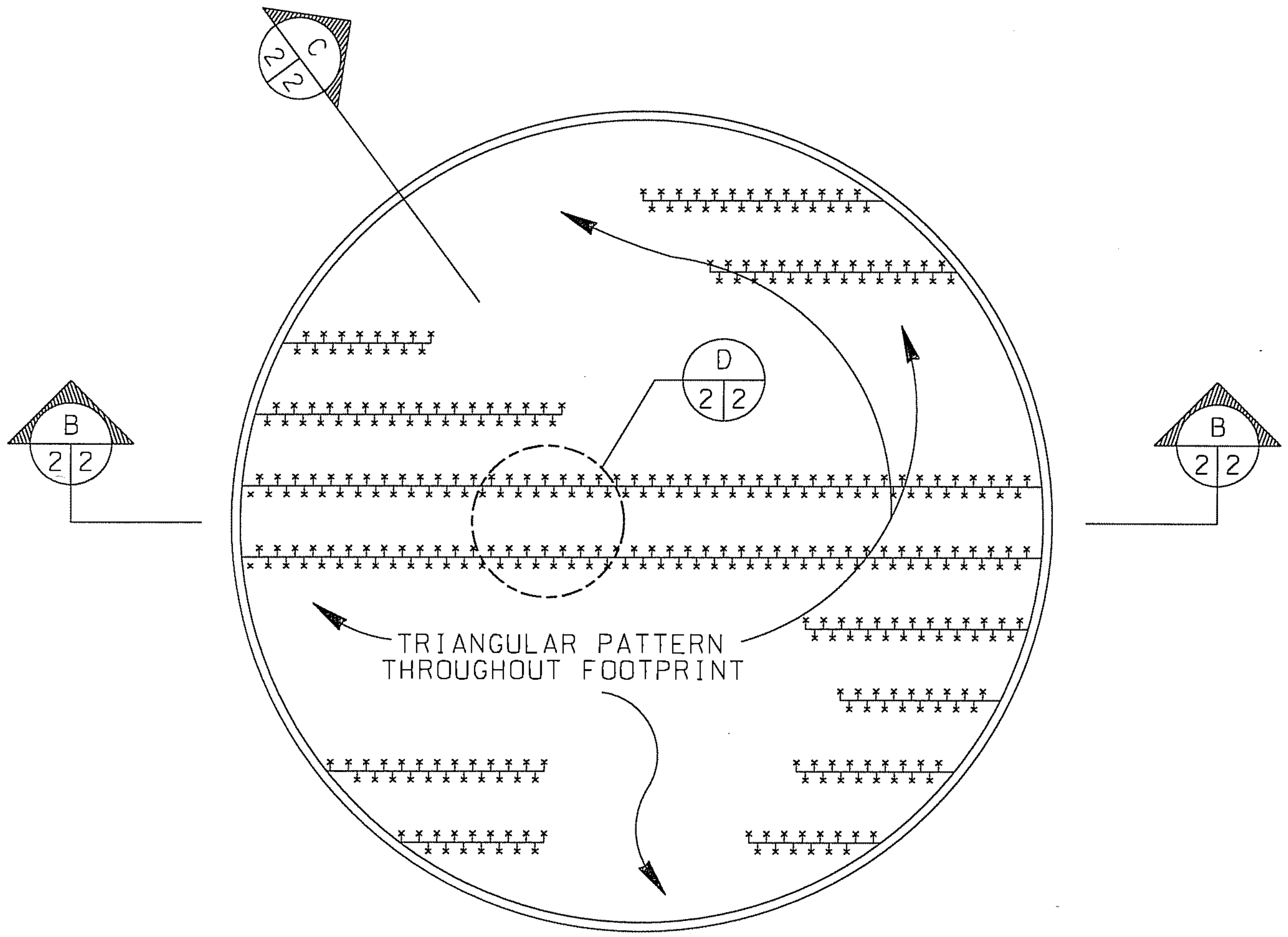
NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY BE PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS



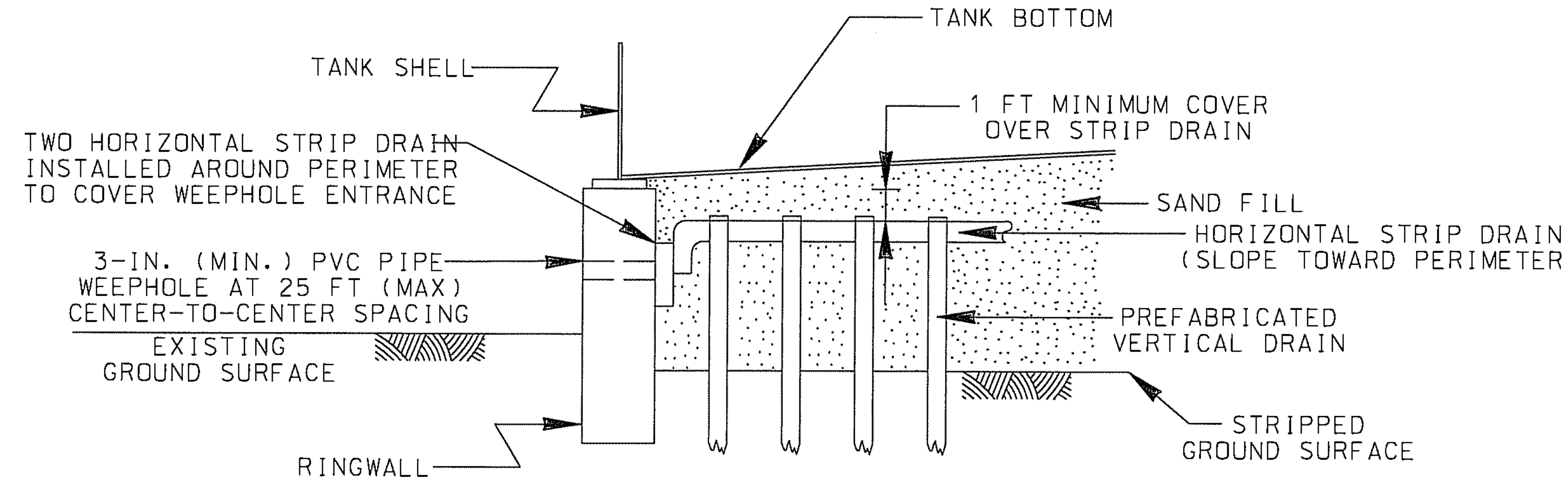


SECTION A-A

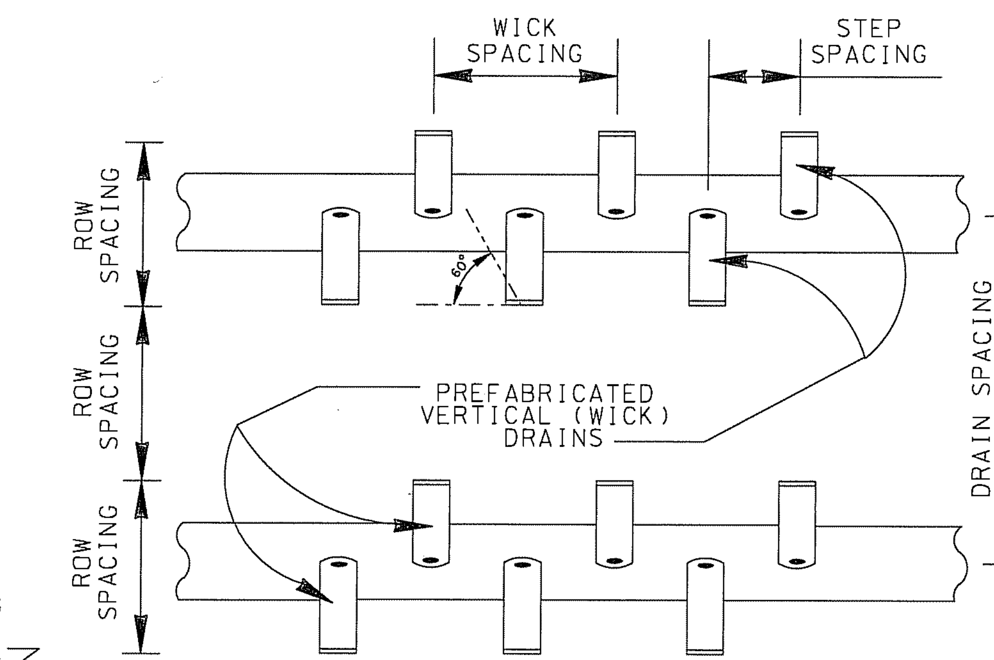
NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY BE PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS



A 2|2 **PLAN**
NOT TO SCALE

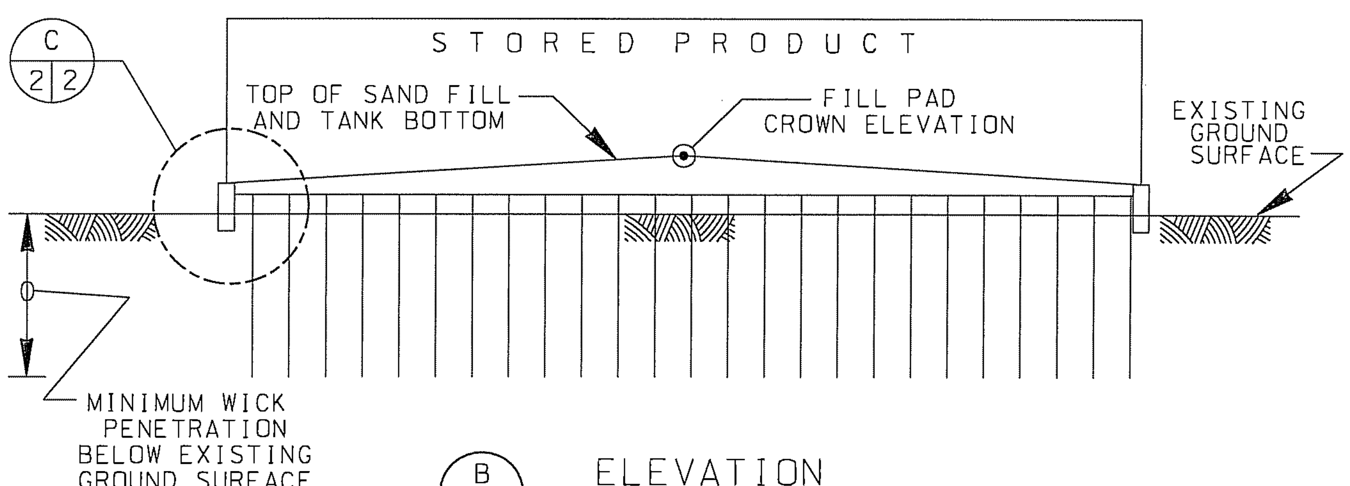


C 2|2 **DETAIL AT RINGWALL**
NOT TO SCALE

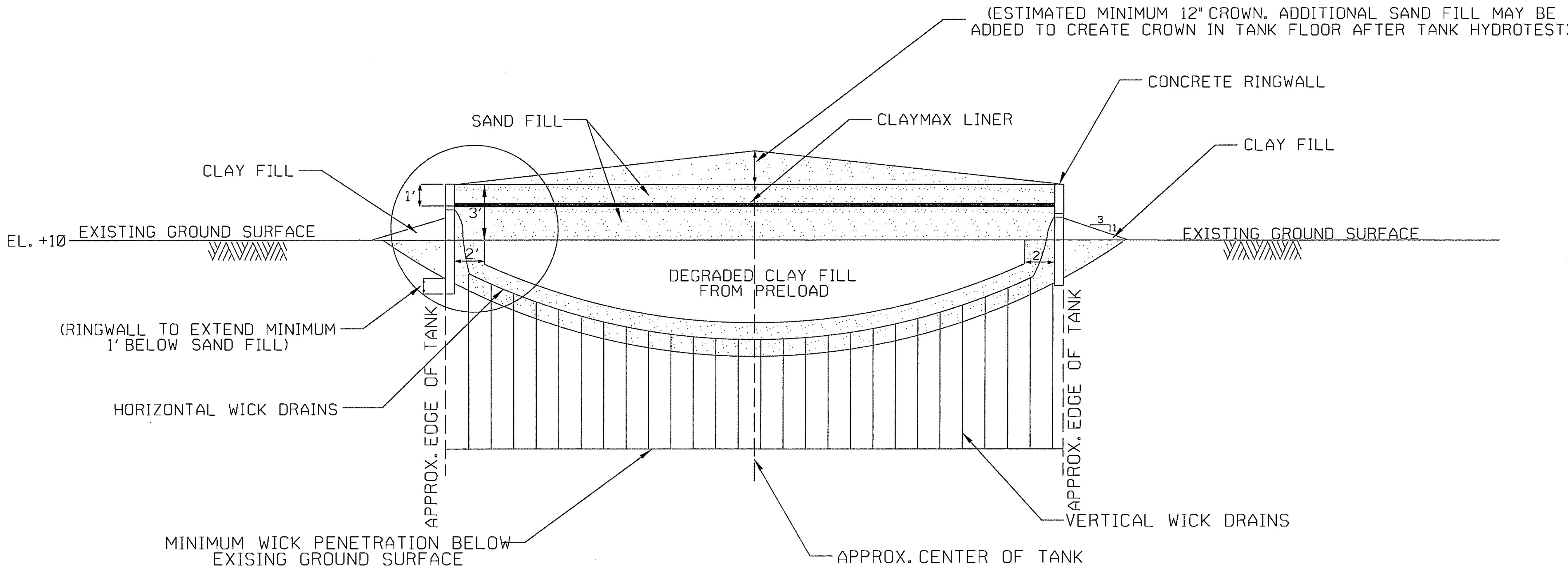


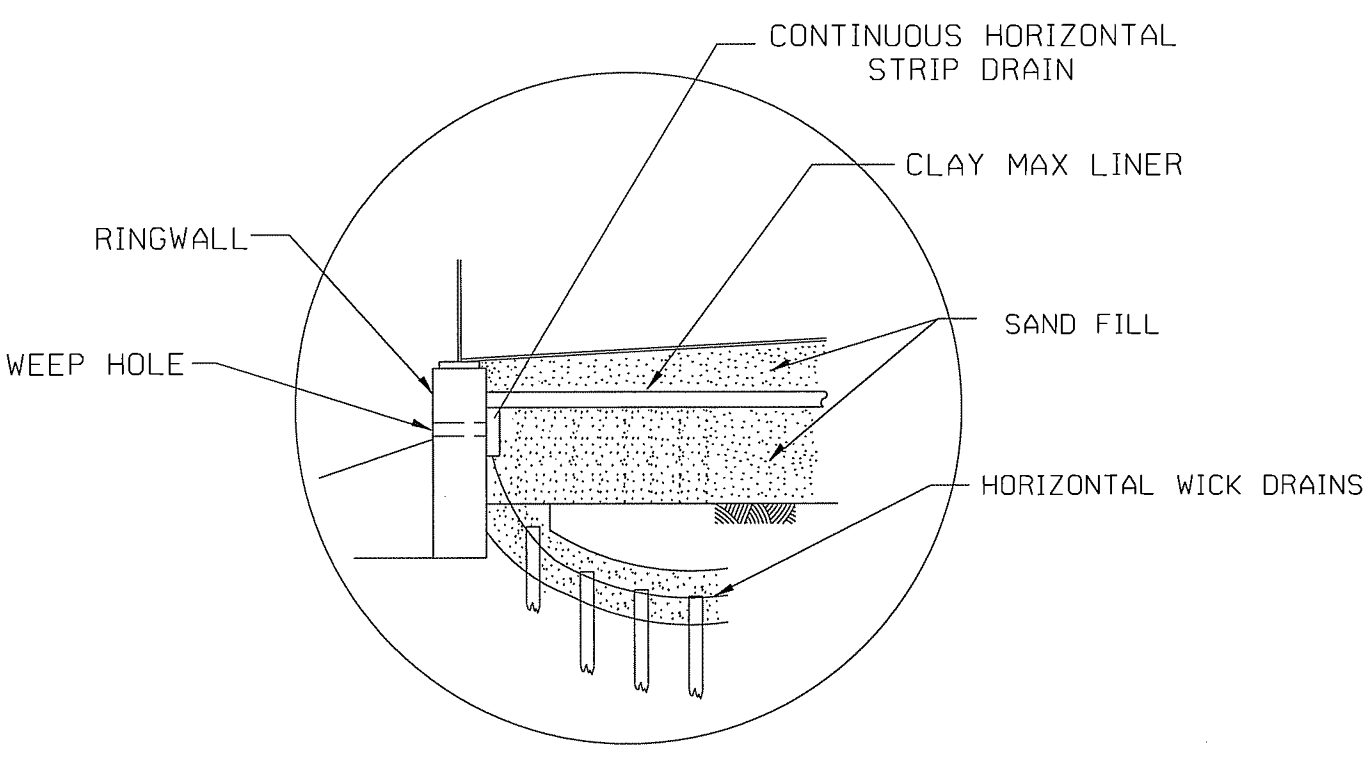
WICK SPACING (FT)	ROW SPACING (FT)	STEP SPACING (FT)	DRAIN SPACING (FT)
3	2.5	1.5	5.0
4	3.5	2	7.0
5	4.25	2.5	8.5
6	5.25	3	10.5

D 2|2 **DETAIL OF WICK DRAIN PATTERN**
NOT TO SCALE



B 2|2 **ELEVATION**
NOT TO SCALE





NOT TO SCALE
SCHEMATIC ONLY

LEGEND AND NOTES FOR LOG OF BORING AND TEST RESULTS

PP — Pocket penetrometer: Resistance in tons per square foot

SPT — Standard Penetration Test: Number of blows of a 140-lb hammer dropped 30 inches required to drive 2-in. O.D., 1.4-in. I.D. sampler a distance of 1 foot into the soil after first seating it 6 inches

SPLR — Type of Sampling: Shelby, SPT, Auger, No sample

SYMBOL — Clay, Silt, Sand, Peat/Humus, Shells, Stone/Gravel

Predominant type shown heavy; Modifying type shown light

USC — Unified Soil Classification

DENSITY — Unit weight in pounds per cubic foot

SHEAR TESTS

TYPE

- UC — Unconfined compression shear
- OB — Unconsolidated undrained triaxial compression shear on one specimen confined at the approximate overburden pressure
- UU — Unconsolidated undrained triaxial compression shear
- CU — Consolidated undrained triaxial compression shear
- DS — Direct shear

Ø — Angle of internal friction in degrees

c — Cohesion in pounds per square foot

ATTERBERG LIMITS

- LL — Liquid Limit
- PL — Plastic Limit
- PI — Plasticity Index

OTHER TESTS

- CON — Consolidation
- PD — Particle size distribution (sieve and/or hydrometer)
- k — Coefficient of permeability in centimeters per second
- SP — Swelling pressure in pounds per square foot

Other laboratory test results reported on separate figures

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 2/01/10 **Boring:** T-16 B-1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.25				Stiff gray & tan clay w/wood, silty sand pockets, & trace of roots	CH	1	0-2.67	33	88	117	UC	--	1158					
					Medium stiff gray & tan sandy clay w/trace of decayed wood	CL													
	0.50						2	5-6	31	89	117	UC	--	655					
					Soft gray & tan sandy clay	CL													
							3	8-9											
10																			
							4	11-12	29	92	119	UC	--	374					
					Soft gray silty clay	CL													
							5	14-15	40	79	111	UC	--	251					
					Soft gray clay	CH													
	0.75						6	18-19	50	70	106	UC	--	338					
20																			
	0.25				w/silty sand pockets & lenses		7	23-24	38	81	111	UC	--	330					
					Soft gray sandy clay w/silty sand pockets & lenses	CL													
	0.50						8	28-29	36	85	115	UC	--	372	45	18	27		CONS
30																			
					Soft gray silty clay w/shell fragments	CL													
	0.25						9	33-34	39	82	114	UC	--	397					
					Soft gray clay w/wood & trace of silt	CH													
	0.50						10	38-39	56	68	105	UC	--	473					
40																			
					Medium stiff gray clay	CH													
	1.50						11	43-44											
	1.50				w/silty sand pockets		12	48-49	50	72	18	UC	--	336					
50																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 2/01/10 **Boring:** T-16 B-1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/silty clay layers	CH													
	0.50						13	53-54											
	0.50				w/silty sand lenses		14	58-59	47	75	110	UC	--	774	64	18	46		CONS
60																			
	0.50				w/organic matter		15	63-64											
					Medium stiff gray sandy clay w/trace of wood	CL													
	0.50						16	68-69	31	87	113	UC	--	370					
70																			
	0.50				Medium stiff gray sandy clay		17	73-74											
	0.50						18	78-79	29										
80					Very stiff gray & tan clay w/silty sand pockets	CH													
	2.00						19	83-84	33	90	119	UC	--	1652					
					Siff gray & tan sandy clay w/silty sand pockets	CL													
	1.00						20	88-89	32						43	16	27		
90																			
	1.50				Stiff gray sandy clay	CL	21	93-94											
	1.50						22	98-99	29	94	122	UC	--	772					
100																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/22/10 **Boring:** ~~2~~ T-17 B-2

Refer to "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0		40			Loose gray limestone	GP	1A	0-0.75	4										
					Soft to medium stiff reddish-brown silty clay w/roots, gravel, wood, & clay	CL	1B	0.75-1.5	19										
						CH	2	2-3	28										
	0.50				Soft gray & tan clay w/silty sand pockets, gravel, & limestone	CH	3	5-6	33	90	119	UC	--	1168					
	0.25				Stiff gray & tan clay w/silt pockets & trace of roots	CL	4	8-9	31	91	120	UC	--	452	42	18	24		
10					Soft to medium stiff gray & tan silty clay w/concretions														
	0.25				Soft to medium stiff gray & tan silty clay		5	11-12	36	86	117	UC	--	390					
							6	14-15	36	86	117	UC	--	545					
					Medium stiff gray silty clay	CL													
20	0.25						7	19-20	29	94	122	UC	--	590	33	17	16		CONS
					Soft gray clay	CH													
	0.25						8	24-25											
30	0.25				w/decayed wood & roots		9	29-30	65	61	101	UC	--	449					
	0.25				Soft gray clay		10	34-35											
40	0.25				w/silty sand pockets		11	39-40	58	66	104	UC	--	424					
					Medium stiff gray sandy clay w/shell fragments	CL													
	0.25						12	44-45	31	92	121	UC	--	519	39	13	26		CONS
					Soft gray clay w/decayed wood	CH													
50	0.50						13	49-50	59	65	104	UC	--	269					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 2 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/22/10 **Boring:** 2 Refer to "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	ø	C	Atterberg Limits LL	PL	PI		Other Tests
50					Very soft gray clay w/trace of silt	CH													
							14	54-55											
					Soft gray silty clay	CL													
60	0.25						15	59-60	37	85	116	UC	--	419	41	17	24		
					w/organic matter		16	64-65											
70	0.25				w/shell fragments & decayed wood		17	69-70	33	89	118	UC	--	480					
					Loose gray sandy silt w/clay layers	ML													
	0.25						18	74-75											
					Soft to medium stiff dark gray sandy clay w/trace of wood	CL													
80	0.50						19	79-80	30	91	119	UC	--	431					
					Loose to medium dense gray fine sand w/clay pockets	SP													
	0.50						20	84-85	26										
90					Loose to medium dense gray clayey sand w/shell fragments & trace of organic matter	SC	21	89-90	31	90	117	UC	--	224					
					Soft gray sandy clay w/trace of wood	CL													
							22	94-95	30	92	119	UC	--	267					
					Medium stiff gray clay w/silt pockets, shell fragments, & roots	CH													
100							23	99-100	37	82	112	UC	--	660					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 1 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 2/22/10 02 **Boring:** T-18 B-3 **Refer to "Legends & Notes"**

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Medium stiff gray & tan silty clay w/wood & roots	CL													
	0.50						1	2-3	26	96	122	UC	--	584					
					Soft gray & tan sandy clay	CL													
	0.25						2	5-6	32	88	116	UC	--	333					
	0.25				w/concretions		3	8-9											
10																			
	0.25						4	11-12	37	84	115	UC	--	418					
					Soft gray silty clay	CL													
	0.25						5	14-15											
	0.25				Soft gray sandy clay	CL	6	18-19	38	83	115	UC	--	267					
20																			
	0.50				w/trace of decayed wood		7	23-24	38	82	113	UC	--	444					
	0.50				Soft gray sandy clay	CL	8	28-29											
30					Medium stiff gray clay w/decayed wood & roots	CH													
	1.00						9	33-34	52	70	106	UC	--	781	79	21	58		
	1.25				w/silty sand pockets & shell fragments		10	38-39	38	83	114	UC	--	679					
40																			
					Medium stiff gray & tan silty clay w/silty sand pockets & shell fragments	CL													
	1.00						11	43-44	42	78	110	UC	--	520					
					Stiff gray clay	CH													
	1.00						12	48-49	43	79	113	UC	--	1089					
50																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 2 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 2/22/10 (handwritten "02" over "22") **Boring:** T-18 B-3 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Soft gray clay w/decayed wood	CH													
	0.50						13	53-54	59	65	104	UC	--	387					
					Medium stiff gray clay	CH													
	0.50						14	58-59											
60																			
	0.75				w/wood		15	63-64	53										
	1.00				Medium stiff gray clay		16	68-69											
70																			
	0.75				w/shell fragments		17	73-74	38	82	114	UC	--	867					
					Soft gray silty clay w/shell fragments	CL													
	0.75						18	78-79	36	83	113	UC	--	339					
80																			
	0.75				Soft gray silty clay		19	83-84											
					Medium stiff gray clay w/silty sand pockets & lenses, & concretions	CH													
	0.75						20	88-89	35	86	116	UC	--	520					
90																			
					Soft gray sandy clay	CL													
	0.75						21	93-94											
	0.50						22	98-99	34	84	113	UC	--	390	36	19	17		
100																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/25 & 27/10 **Boring:** T-15 B-4 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	0.50				Medium stiff brown silty clay w/roots	CL	1	2-3	23	101	124	UC	--	786					
	0.50				Medium stiff tan & gray silty clay	CL	2	5-6	31	92	120	UC	--	712	47	18	29		CONS
	0.25				Soft gray & tan sandy clay	CL	3	8-9	31	91	120	UC	--	357					
10	0.50				Medium stiff tan & gray sandy clay	CL	4	11-12	36	86	117	UC	--	548					
	0.50				Soft gray silty clay	CL	5	14-15	40	81	114	UC	--	496	60	16	44		
	0.50				Medium stiff gray silty clay	CL	6	18-19	32	91	120	UC	--	724					
20					Medium stiff gray clay w/silty sand pockets, roots, & concretions	CH													
	0.75						7	23-24	41										
30	0.75				w/silty sand pockets & decayed wood		8	28-29	43	78	111	UC	--	502					
	0.50				w/silty sand pockets & trace of decayed wood		9	33-34	46	75	110	UC	--	702	64	18	46		
40	0.25				w/silty sand pockets & lenses		10	38-39	52	70	107	UC	--	601					
	0.50				w/silt pockets		11	43-44											
50	0.50				w/trace of decayed wood		12	48-49	47	75	110	UC	--	827					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 2 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/25 & 27/10 **Boring:** T-15 B-4 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/silty clay layers	CH													
	1.00						13	53-54											
	1.25				w/decayed wood		14	58-59	41	81	114	UC	--	949					
60					Loose to medium dense gray clayey sand	SC													
	0.75						15	63-64											
	0.75						16	68-69	26	99	125	OB	0	925					
70					Stiff light gray silty clay	CL													
	2.75						17	73-74											
	2.50						18	78-79	25	99	124	UC	--	1019	38	14	24		CONS
80					Medium stiff gray & tan sandy clay	CL													
	1.50						19	83-84	30	93	121	UC	--	886					
					Soft tan sandy clay	CL													
	0.25						20	88-89											
90																			
	0.25						21	93-94											
					Medium stiff tan & gray sandy clay	CL													
	0.25						22	98-99	24	102	127	UC	--	706					
100																			

Comments:

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/25 & 27/10 **Boring:** T-15 B-4 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
100					Loose to medium dense tan fine sand	SP													
							23	103-104	24	101	126	OB	0	566					
		65			Very dense tan silty sand w/clay pockets	SM	24	105.5-107	25										
110		61			Very dense tan silty sand		25	108.5-110											
		52					26	111.5-113	25										
		57					27	114.5-116											
120		52			w/clay pockets		28	118.5-120	24										
		50			Very dense tan silty sand		29	123.5-125											
130		63=2"			Very dense gray fine sand	SP	30	128.5-130	25										
		70=3"					31	133.5-135											
140		70=2"					32	138.5-140	24										
		54=1"					33	143.5-145											
150		45=5"					34	148.5-150	27										

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/28/10 **Boring:** T-14 B-5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.75				Stiff gray & tan clay w/silt pockets & roots	CH	1	0-3	29	93	120	UC	--	1216					
	1.50				w/silt pockets		2	5-6											
					Medium stiff gray & tan sandy clay	CL													
	0.75						3	8-9	33	88	117	UC	--	495					
10					Medium stiff tan silty clay	CL													
	0.50						4	11-12											
	0.50				Medium stiff gray clay w/silty sand pockets	CH	5	14-15	38	83	114	UC	--	417					
	0.50				Medium stiff gray silty clay	CL	6	18-19											
20					Soft gray clay	CH													
	0.25						7	23-24	58	66	105	UC	--	256					
	0.25						8	28-29											
30					Medium stiff gray clay w/silty sand pockets	CH													
	0.50						9	33-34	51	71	107	UC	--	502	64	19	45		
	0.50				Medium stiff gray clay		10	38-39											
40																			
	0.50						11	43-44	55	68	106	UC	--	586					
	0.50				w/sand pockets		12	48-49	49	72	108	UC	--	604					
50																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/28/10 **Boring:** T-14 B-5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Medium stiff gray clay w/silty sand pockets	CH													
	0.50						13	53-54											
60	1.50						14	58-59	48	74	109	UC	--	663					
	1.25				Medium stiff gray clay		15	63-64											
					Medium stiff light gray sandy clay	CL													
70	0.50						16	68-69	26	100	125	UC	--	575					
	0.50						17	73-74											
					Very stiff gray silty clay	CL													
80	2.25						18	78-79	25	99	124	UC	--	952	39	14	25		CONS
	2.25						19	83-84											
					Soft gray sandy clay	CL													
90	0.50						20	88-89	27	98	124	UC	--	460					
	0.50						21	93-94											
					Mediuim stiff gray & tan sandy clay	CL													
100	0.25						22	98-99	27	92	116	UC	--	611					

Comments:

EUSTIS ENGINEERING

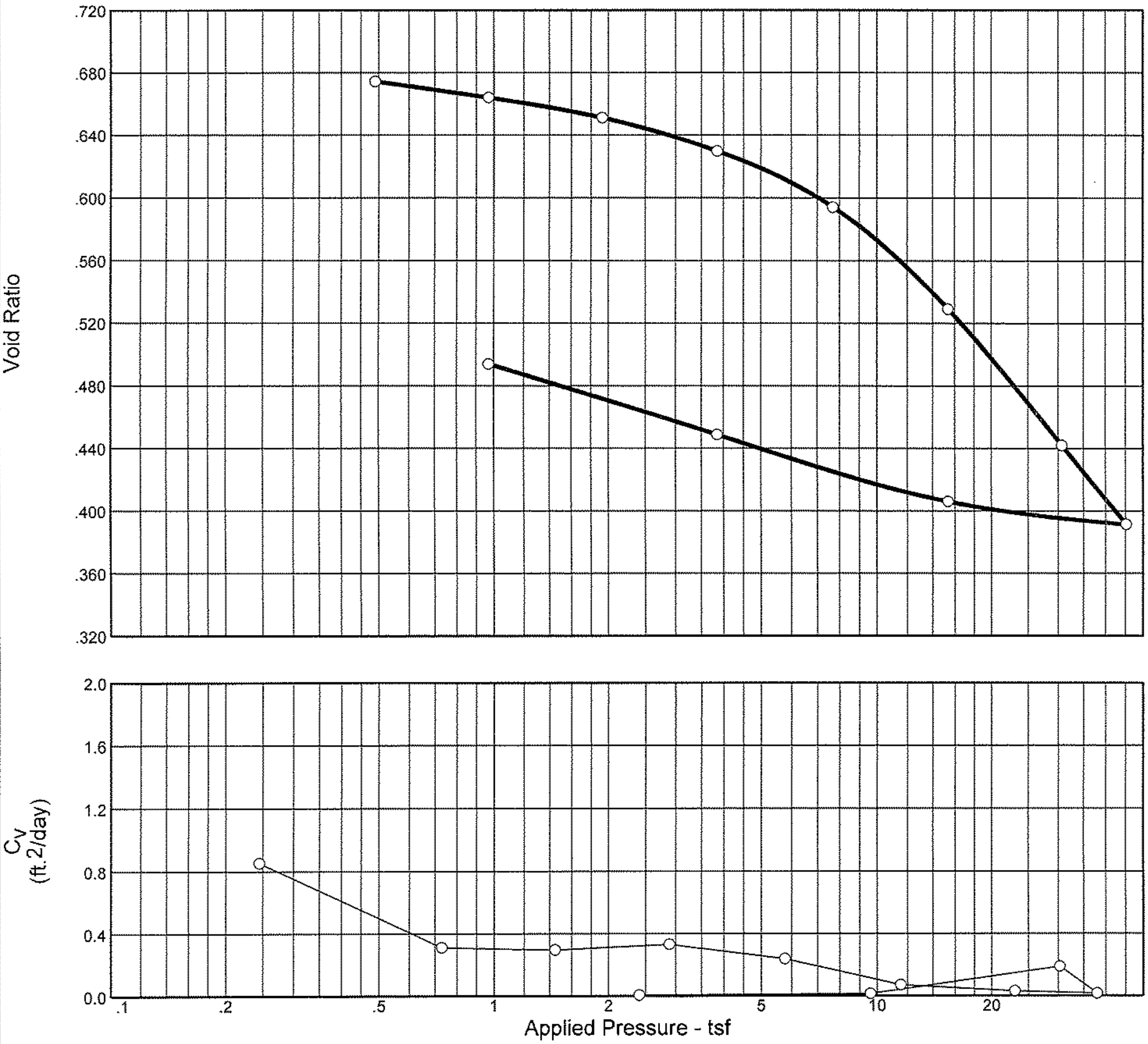
LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text **Job No.:** **Date Drilled:** 1/28/10 **Boring:** T-14 B-5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
100					Medium stiff tan & gray sandy clay	CL													
	0.25						23	103-104	31	91	119	UC	--	601	35	14	21		
		30			Stiff gray sandy clay	CL	24	106-107	26										
110		30			Medium dense gray silty sand	SM	25	109-110	28										
					Stiff gray sandy clay	CL													
		36			Soft gray sandy clay	CL	26	112-113	28										
		34					27	115-116	27										
120							28	118-119	25	102	126	UC	--	420					
					Loose gray silty sand w/clay pockets & layers	SM													
							29	123-124											
					Very stiff gray sandy clay	CL													
130		70=3"					30	129-130	25										
					Very dense gray fine sand	SP													
		66=4"					31	134-135	25										
140		63=1"					32	139-140	26										
		60=1"					33	144-145	26										
150		47=5"					34	149-150											

Comments:

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
99.6 %	25.3 %	99.0	39	25	2.69	9.54	0.30	0.684

MATERIAL DESCRIPTION	USCS	AASHTO
MST GRN-G SACL	CL	

Project N

Project:

Source: T14-5 **Sample No.:** 18 **Elev./Depth:** 78.0'

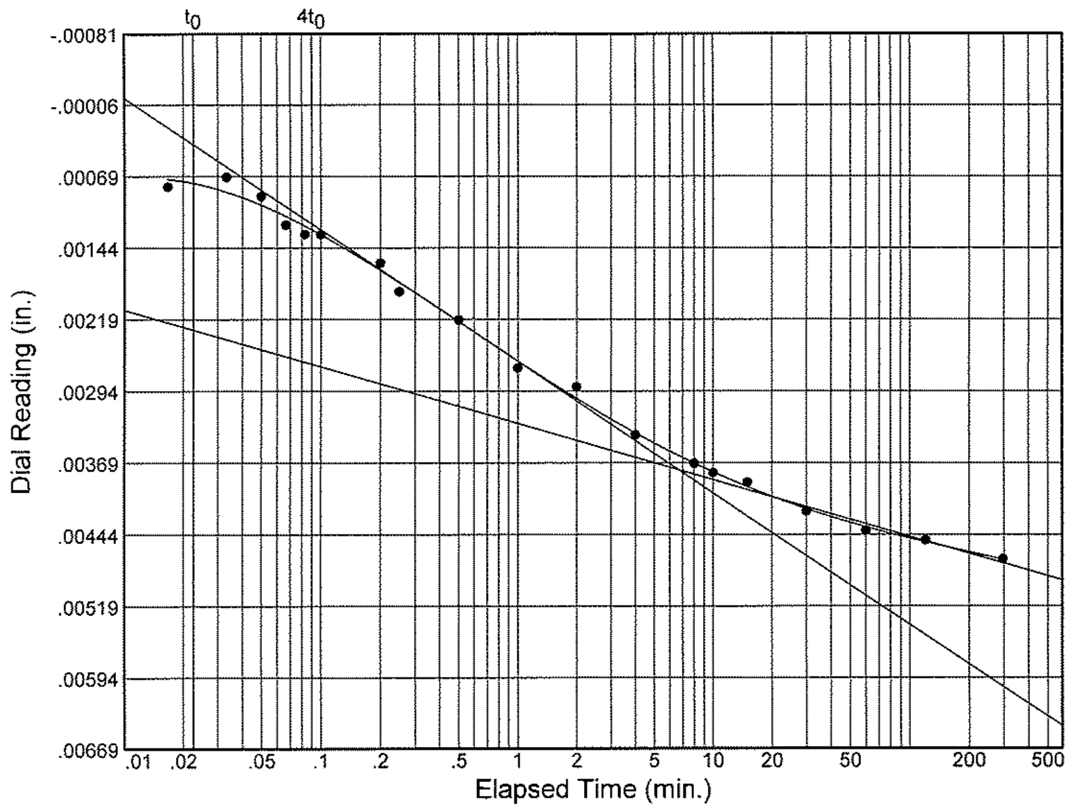
EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Remarks:
TESTED BY: RR
CHECKED BY: RNE

Figure

Dial Reading vs. Time

Source: T14-5 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 1

Load= 0.49 tsf

D_0 = 0.00027

D_{50} = 0.00202

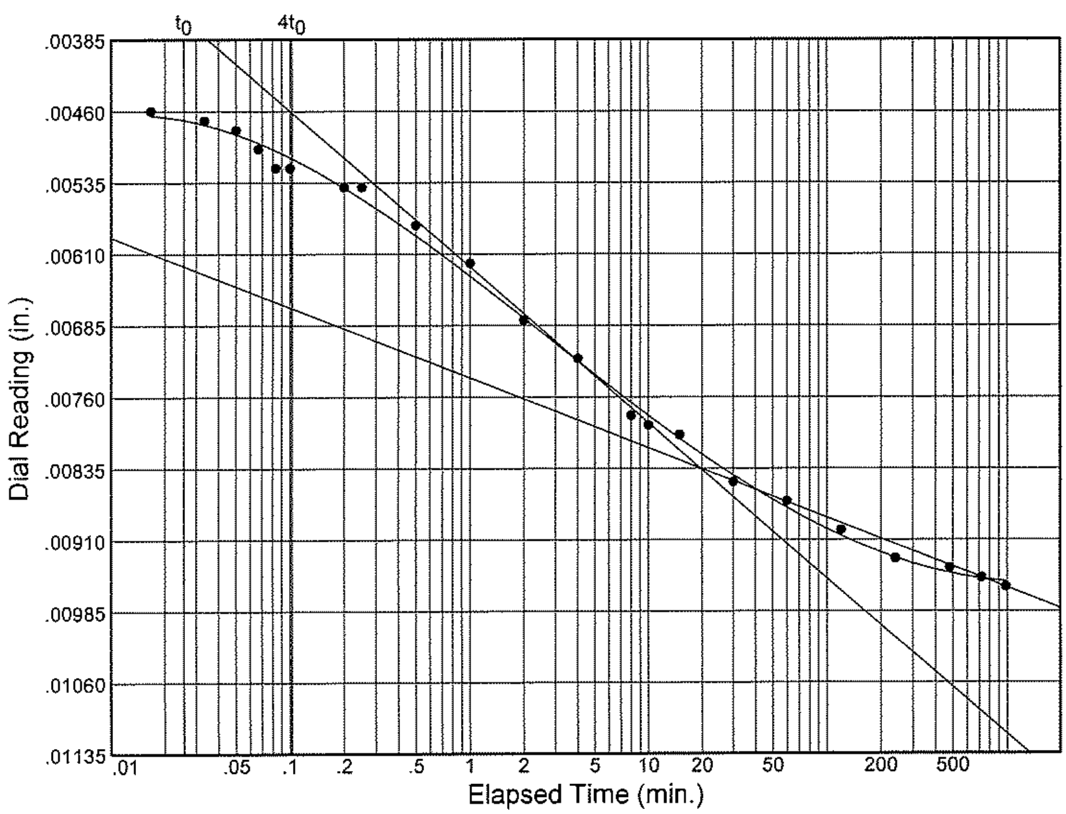
D_{100} = 0.00376

T_{50} = 0.36 min.

C_v @ T_{50}

0.85 ft.^{2}/day

C_α = 0.001



Load No.= 2

Load= 0.97 tsf

D_0 = 0.00429

D_{50} = 0.00632

D_{100} = 0.00835

T_{50} = 0.97 min.

C_v @ T_{50}

0.31 ft.^{2}/day

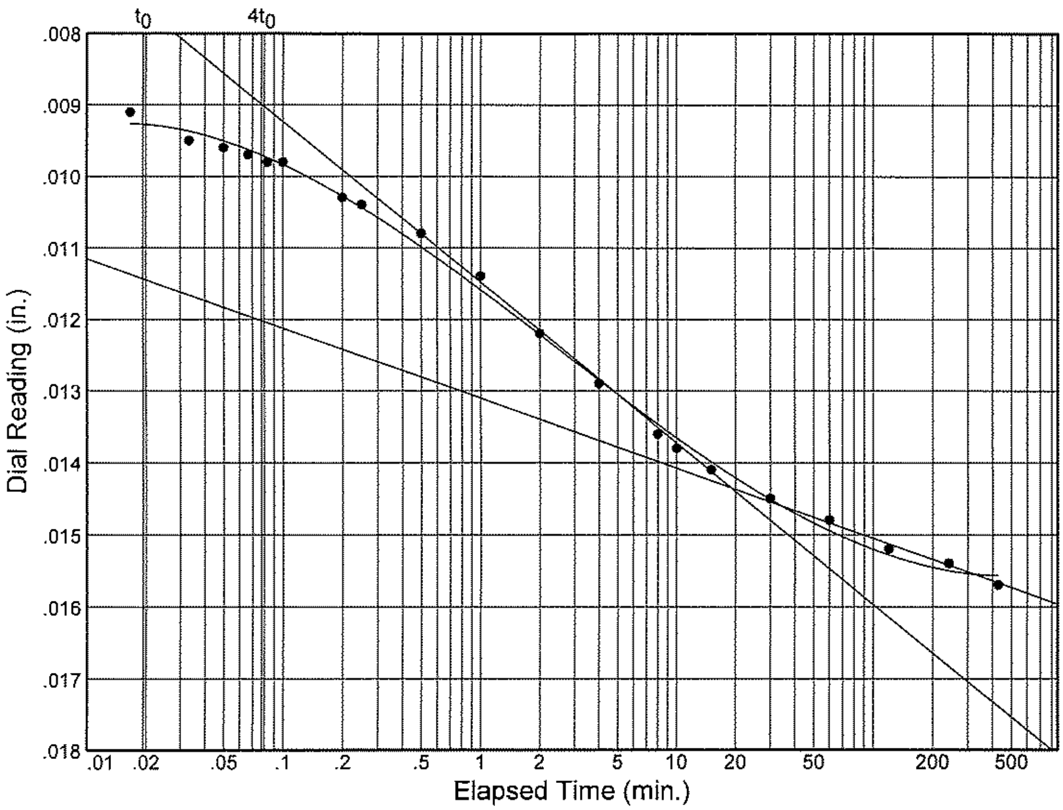
C_α = 0.001

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T14-5 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 3

Load= 1.93 tsf

D_0 = 0.00884

D_{50} = 0.01159

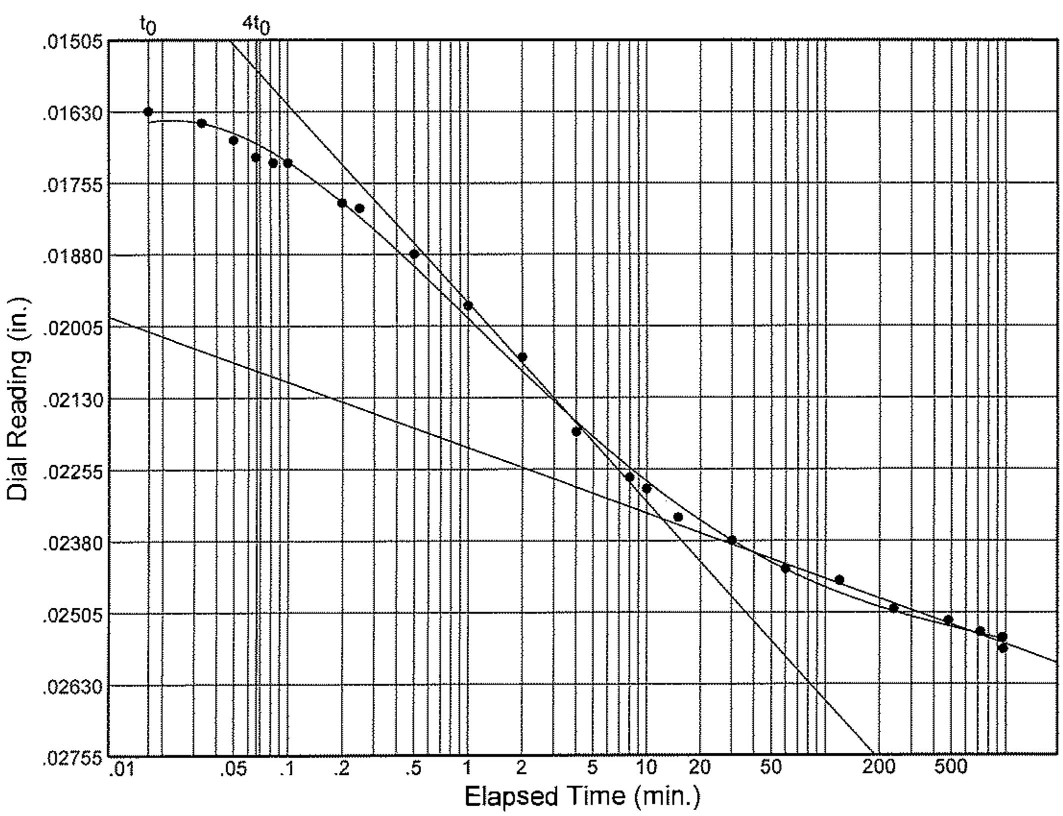
D_{100} = 0.01435

T_{50} = 1.01 min.

C_v @ T_{50}

0.30 ft.^{2}/day

C_α = 0.001



Load No.= 4

Load= 3.85 tsf

D_0 = 0.01612

D_{50} = 0.01976

D_{100} = 0.02341

T_{50} = 0.88 min.

C_v @ T_{50}

0.33 ft.^{2}/day

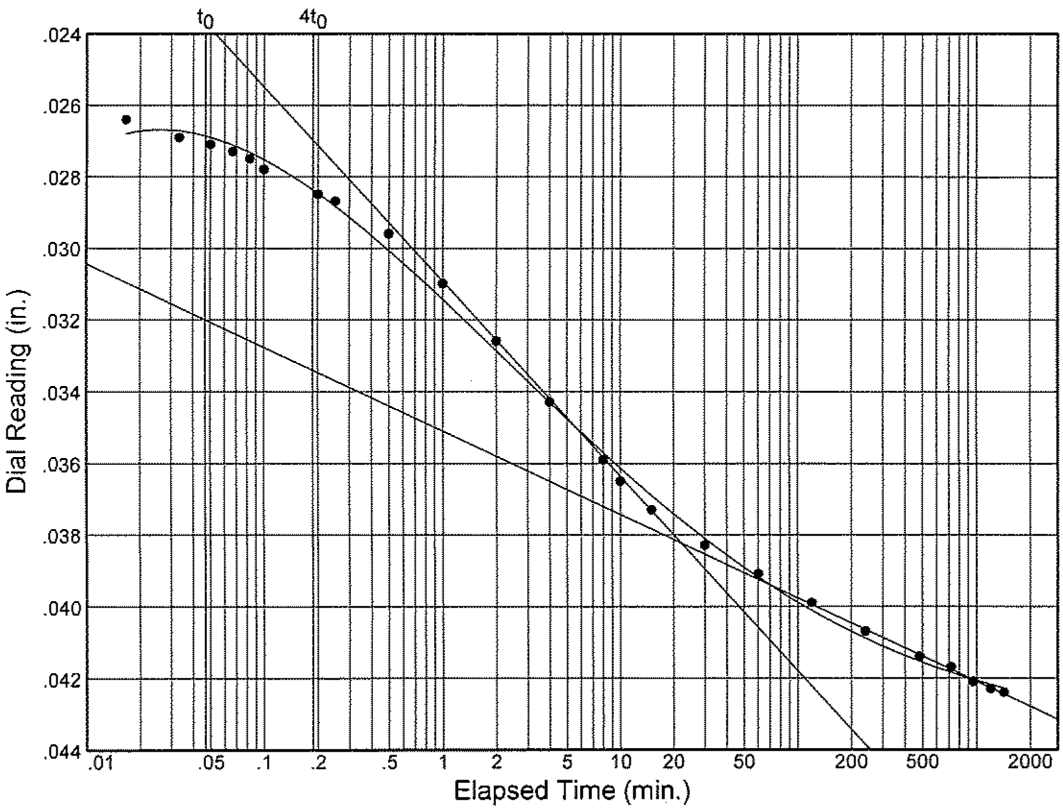
C_α = 0.001

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T14-5 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 5

Load= 7.69 tsf

D_0 = 0.02534

D_{50} = 0.03179

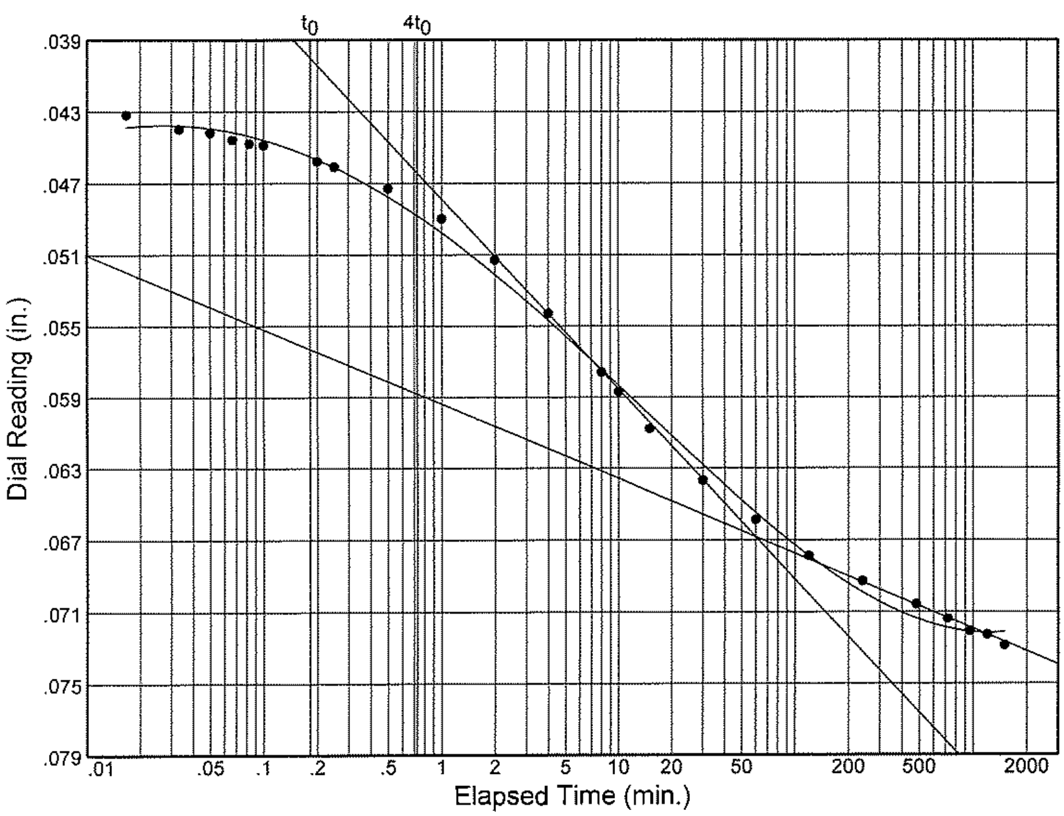
D_{100} = 0.03823

T_{50} = 1.18 min.

C_v @ T_{50}

0.24 ft.^{2}/day

C_α = 0.003



Load No.= 6

Load= 15.37 tsf

D_0 = 0.04220

D_{50} = 0.05451

D_{100} = 0.06683

T_{50} = 3.81 min.

C_v @ T_{50}

0.07 ft.^{2}/day

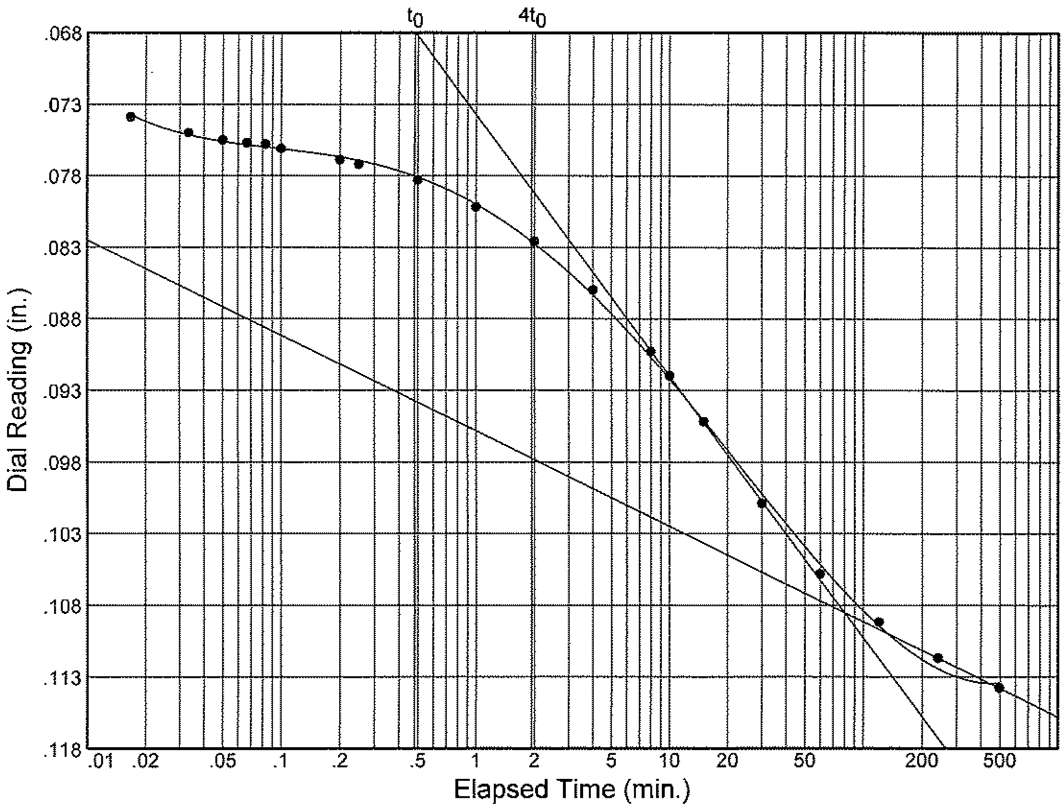
C_α = 0.006

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T14-5 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 7

Load= 30.73 tsf

D_0 = 0.07347

D_{50} = 0.09099

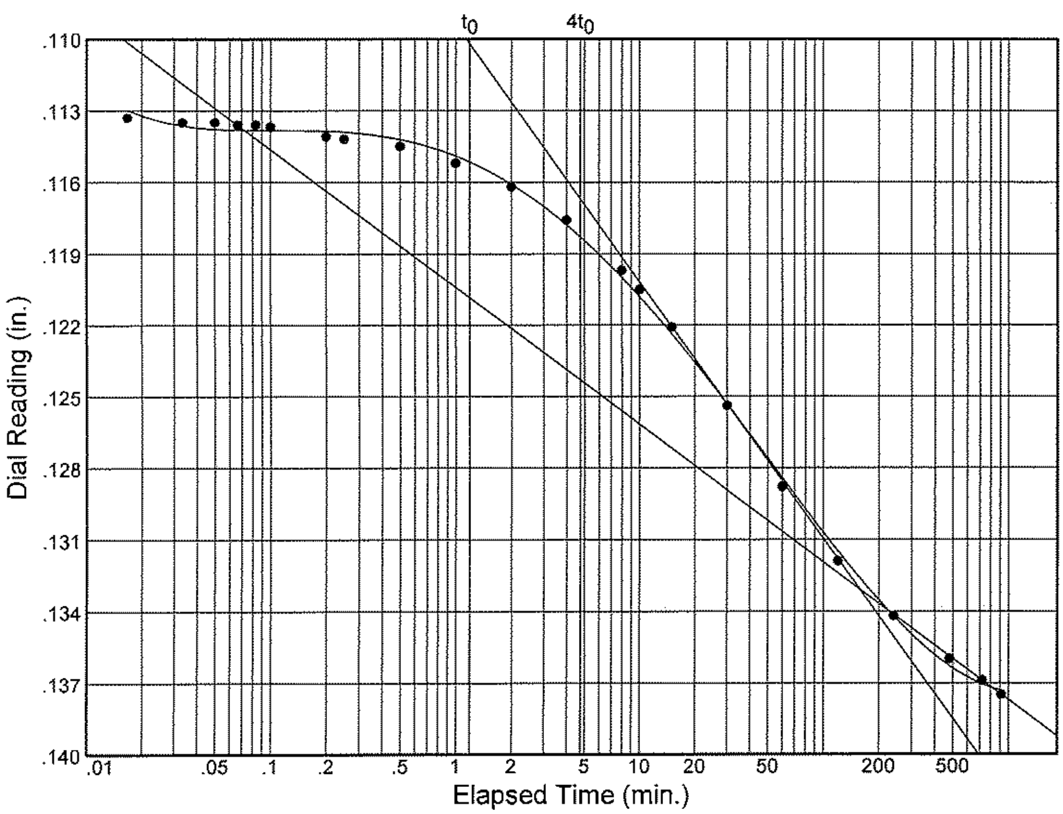
D_{100} = 0.10851

T_{50} = 8.35 min.

C_v @ T_{50}

0.03 ft.^{2}/day

C_α = 0.009



Load No.= 8

Load= 45.21 tsf

D_0 = 0.11202

D_{50} = 0.12255

D_{100} = 0.13309

T_{50} = 15.64 min.

C_v @ T_{50}

0.01 ft.^{2}/day

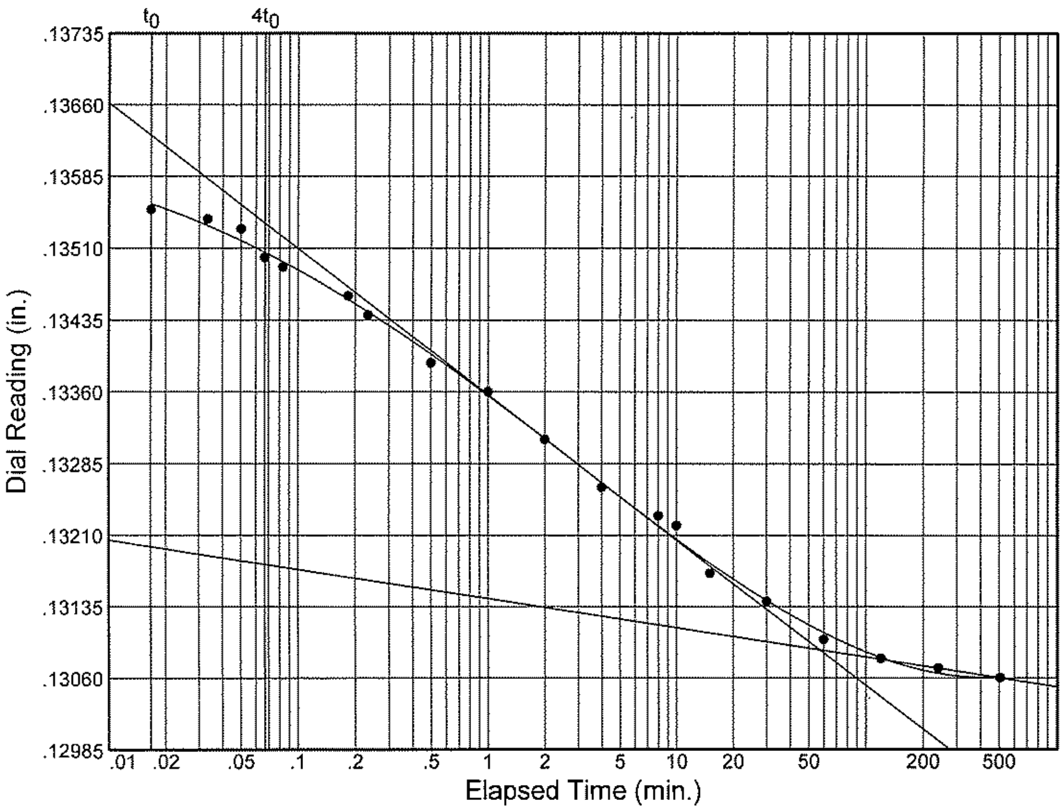
C_α = 0.009

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T14-5 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 9

Load= 15.37 tsf

D_0 = 0.13607

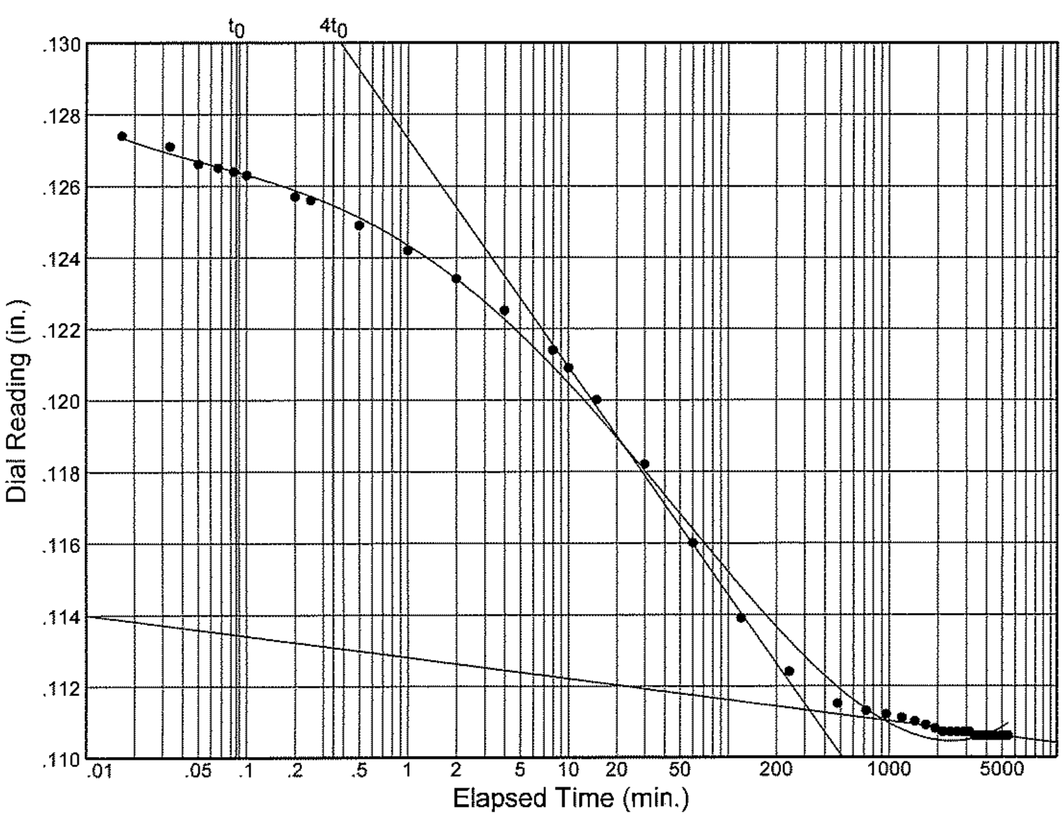
D_{50} = 0.13348

D_{100} = 0.13089

T_{50} = 1.13 min.

C_v @ T_{50}

0.19 ft.^{2}/day



Load No.= 10

Load= 3.85 tsf

D_0 = 0.12733

D_{50} = 0.11932

D_{100} = 0.11131

T_{50} = 17.00 min.

C_v @ T_{50}

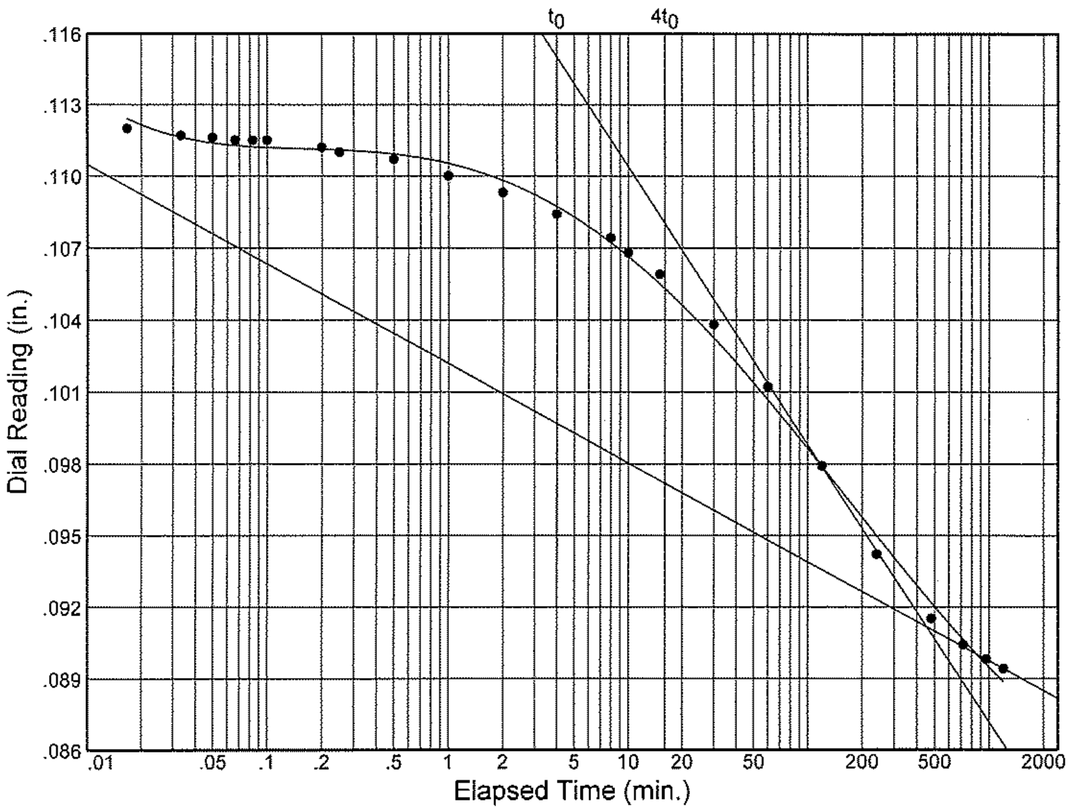
0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T14-5 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 11

Load= 0.97 tsf

D_0 = 0.11214

D_{50} = 0.10165

D_{100} = 0.09116

T_{50} = 46.48 min.

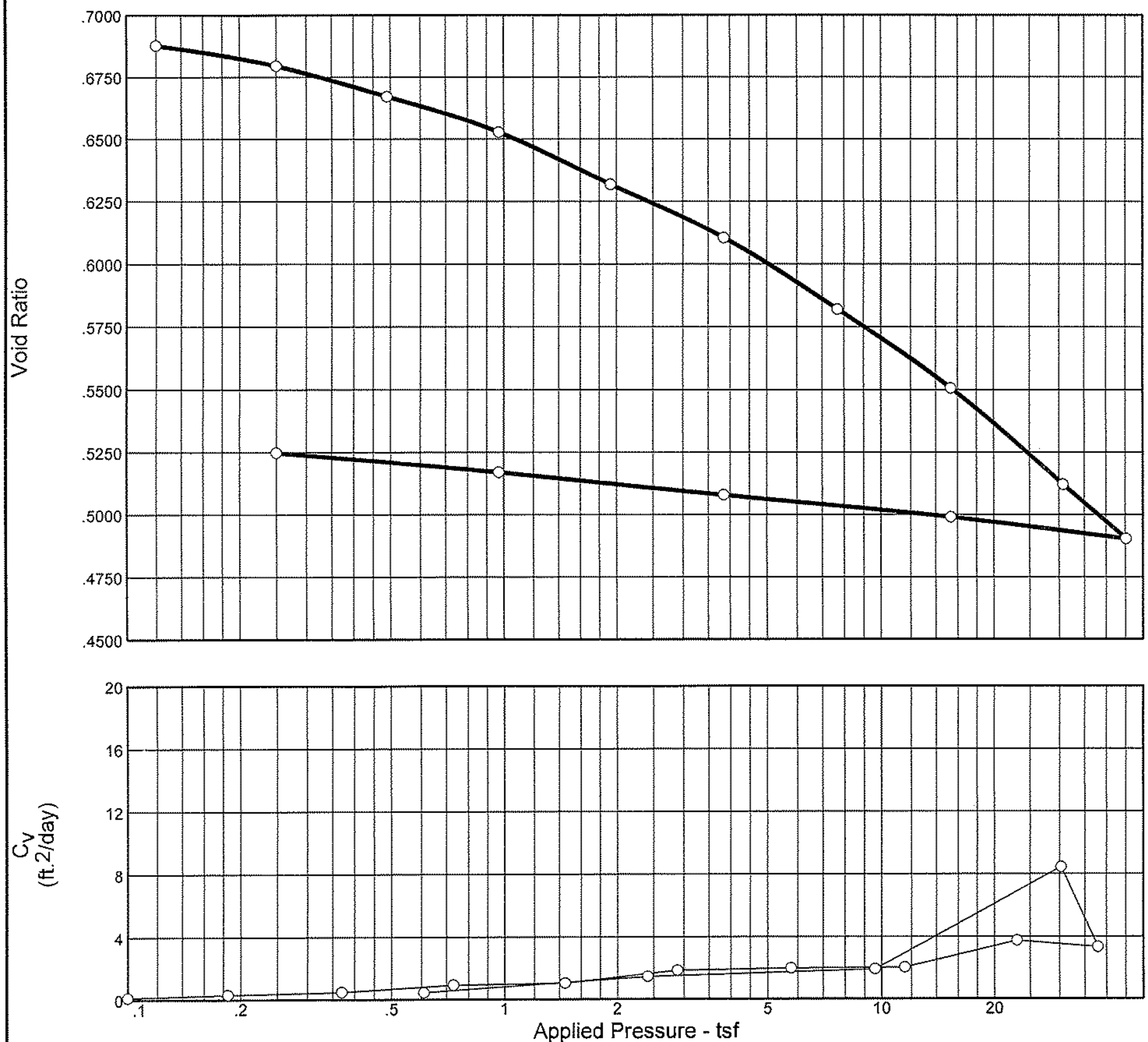
C_v @ T_{50}

0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
99.8 %	26.9 %	97.2	33	16	2.70	4.93	0.13	0.728

MATERIAL DESCRIPTION	USCS	AASHTO
SO G SICL	CL	

Proje

Proje

Source: T15-2 **Sample No.:** 7 **Elev./Depth:** 19.0'

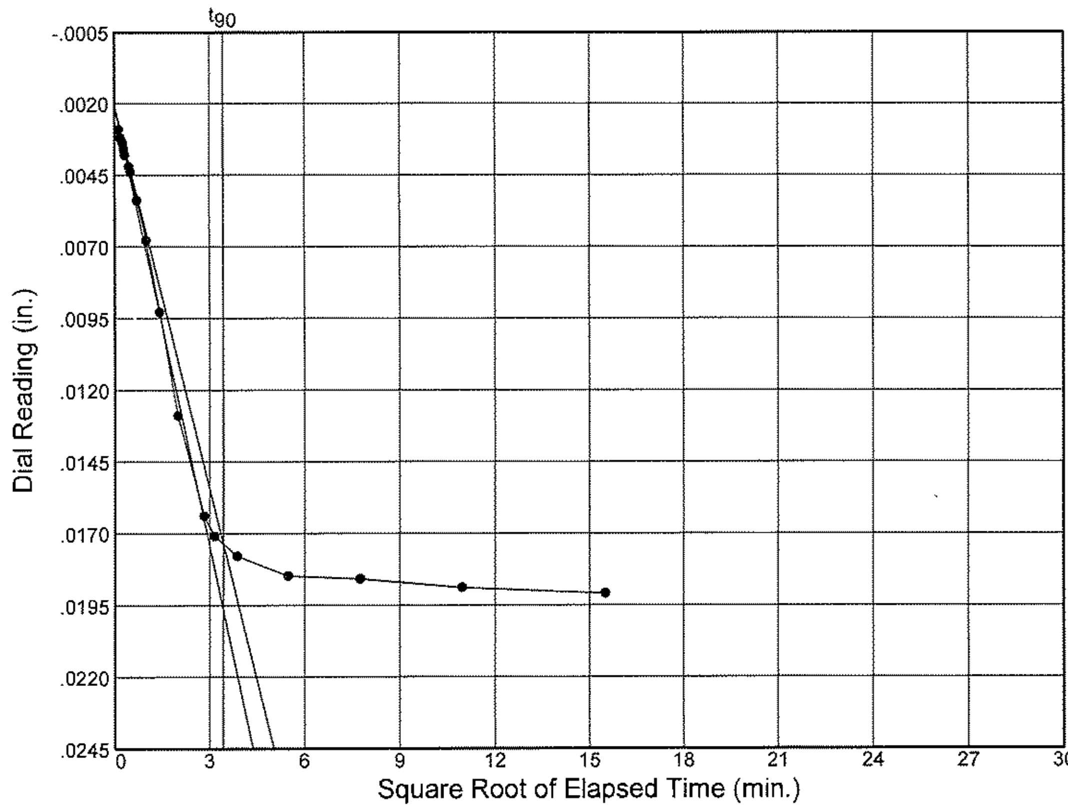
EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Remarks:
TESTED BY: RR, LWR
CHECKED BY: RNE

Figure

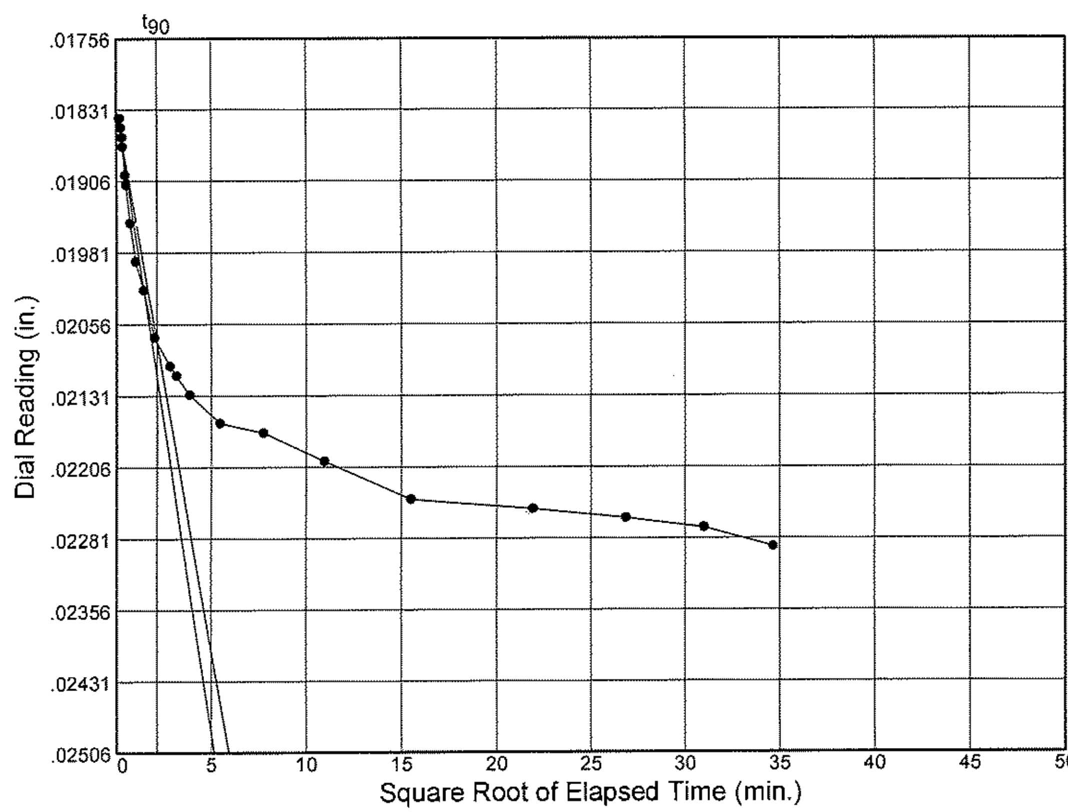
Dial Reading vs. Time

Source: T15-2 | Sample No.: 7 | Elev./Depth: 19.0'



Load No.= 1
Load= 0.12 tsf
D_0 = 0.00206
D_{90} = 0.01737
D_{100} = 0.01907
T_{90} = 11.80 min.

C_v @ T_{90}
0.12 ft.^{2}/day



Load No.= 2
Load= 0.25 tsf
D_0 = 0.01832
D_{90} = 0.02075
D_{100} = 0.02102
T_{90} = 4.58 min.

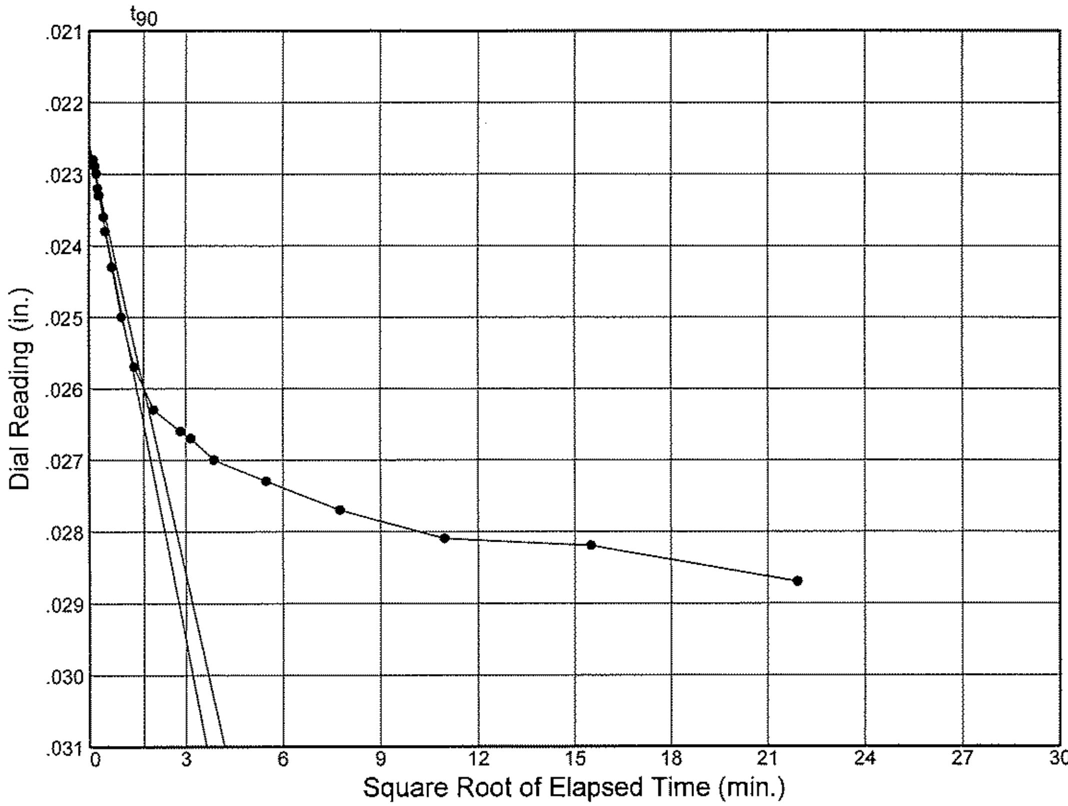
C_v @ T_{90}
0.29 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 7 | Elev./Depth: 19.0'



Load No.= 3

Load= 0.49 tsf

D_0 = 0.02257

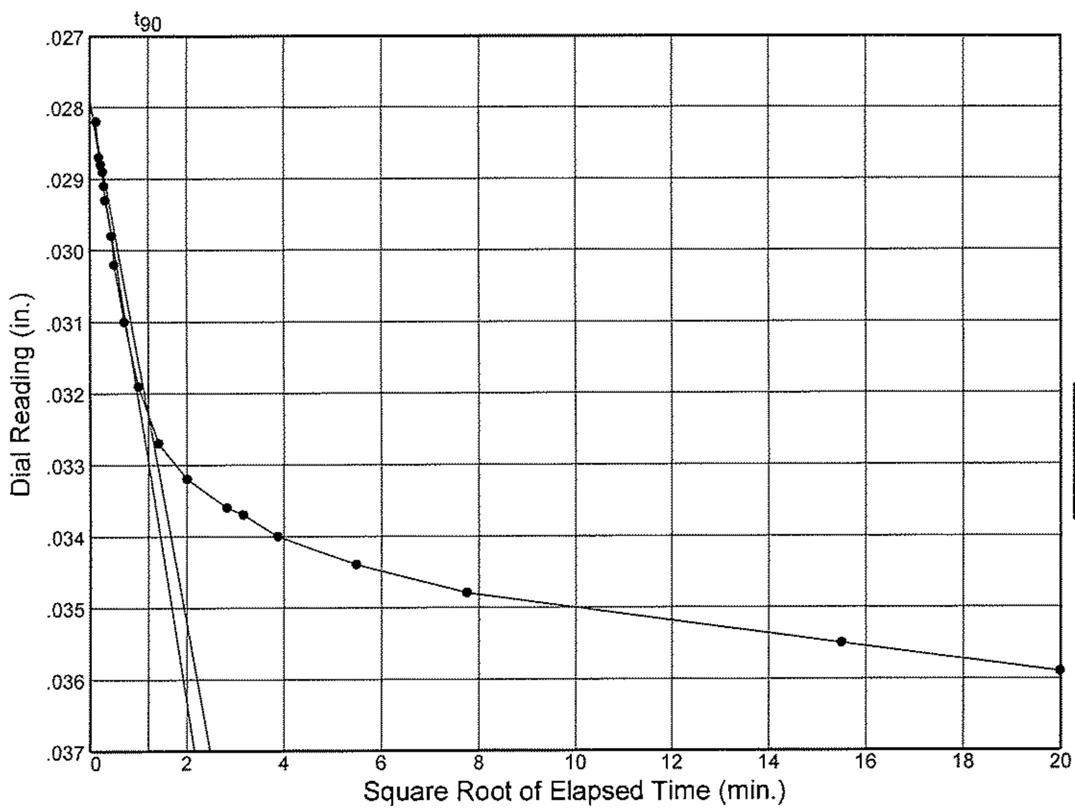
D_{90} = 0.02599

D_{100} = 0.02637

T_{90} = 2.89 min.

C_v @ T_{90}

0.46 ft.^{2}/day



Load No.= 4

Load= 0.97 tsf

D_0 = 0.02788

D_{90} = 0.03229

D_{100} = 0.03278

T_{90} = 1.44 min.

C_v @ T_{90}

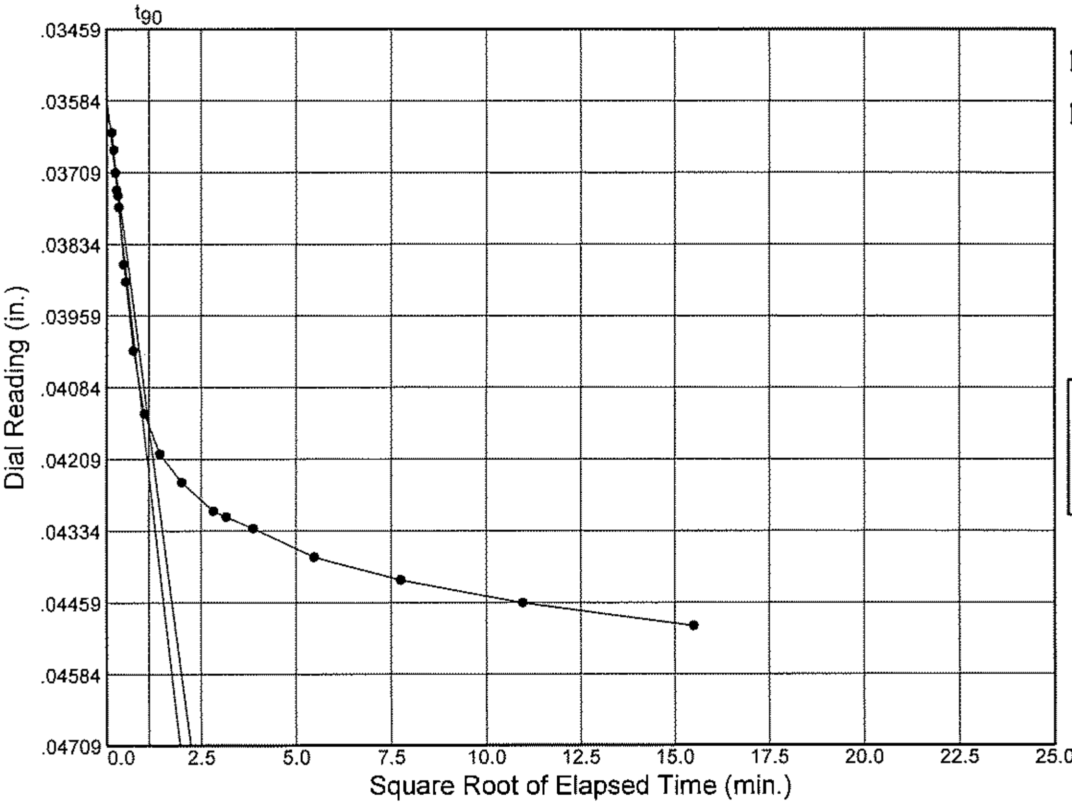
0.91 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 Sample No.: 7 Elev./Depth: 19.0'



Load No.= 5

Load= 1.93 tsf

D_0 = 0.03585

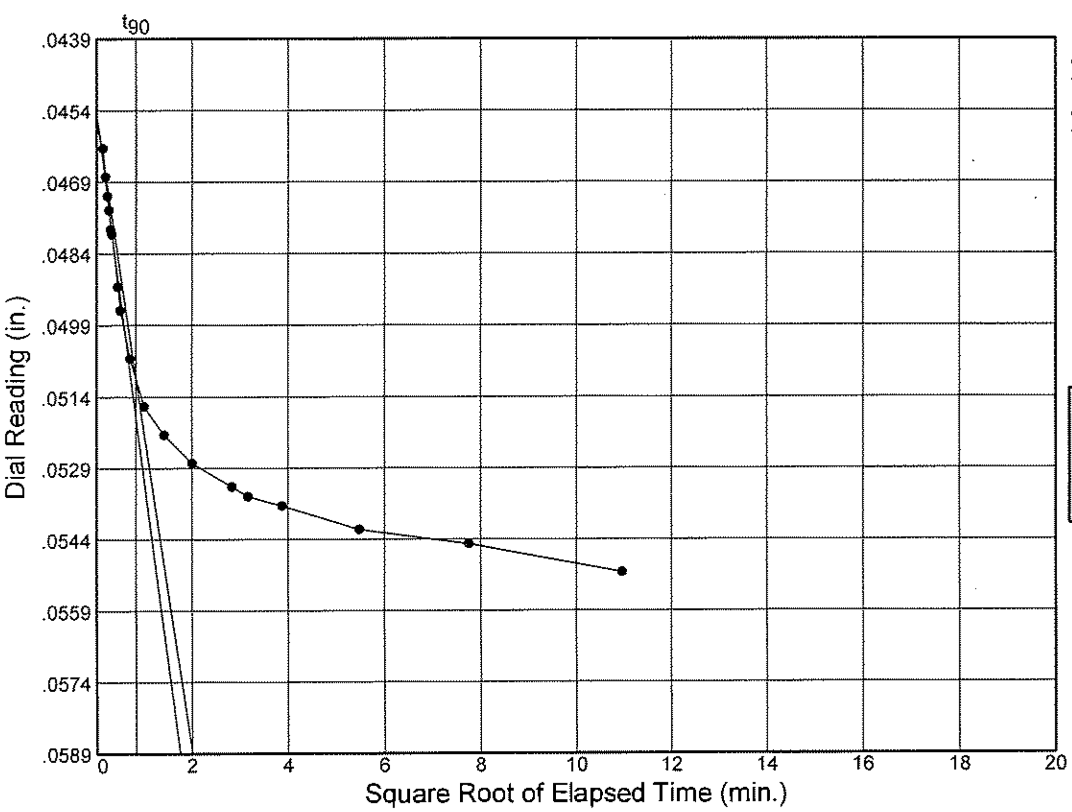
D_{90} = 0.04150

D_{100} = 0.04213

T_{90} = 1.25 min.

C_v @ T_{90}

1.02 ft.^{2}/day



Load No.= 6

Load= 3.85 tsf

D_0 = 0.04549

D_{90} = 0.05099

D_{100} = 0.05160

T_{90} = 0.68 min.

C_v @ T_{90}

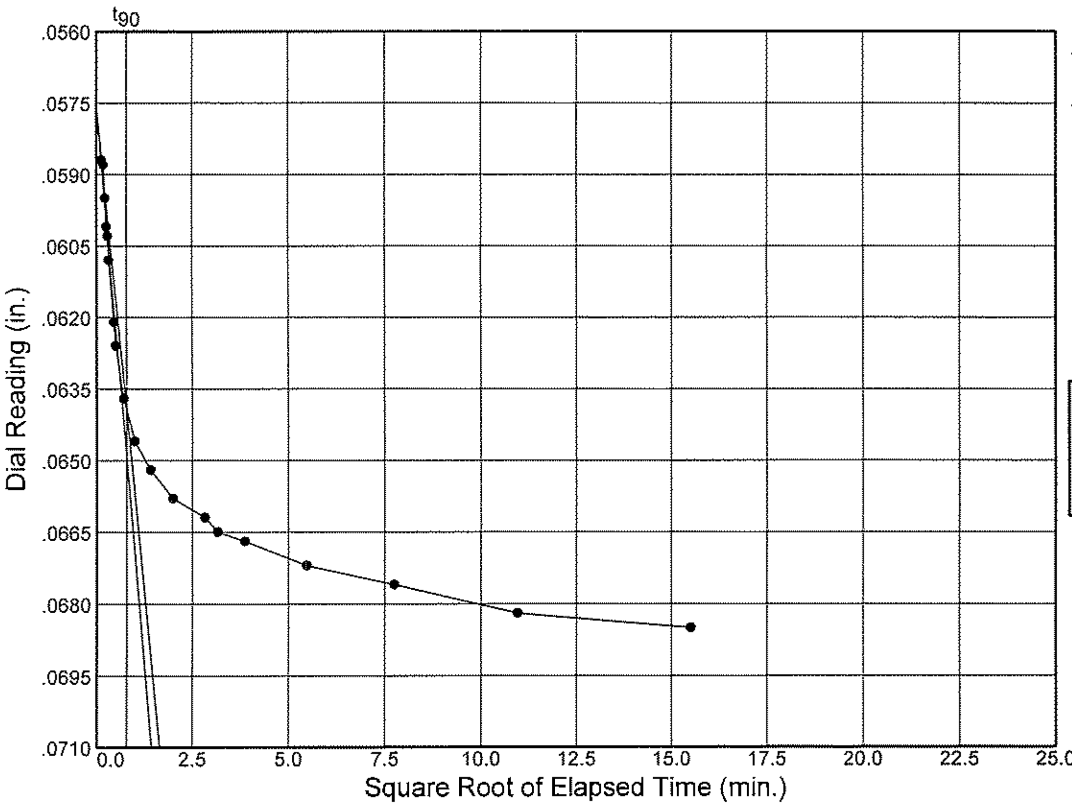
1.85 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 7 | Elev./Depth: 19.0'



Load No.= 7

Load= 7.69 tsf

D_0 = 0.05755

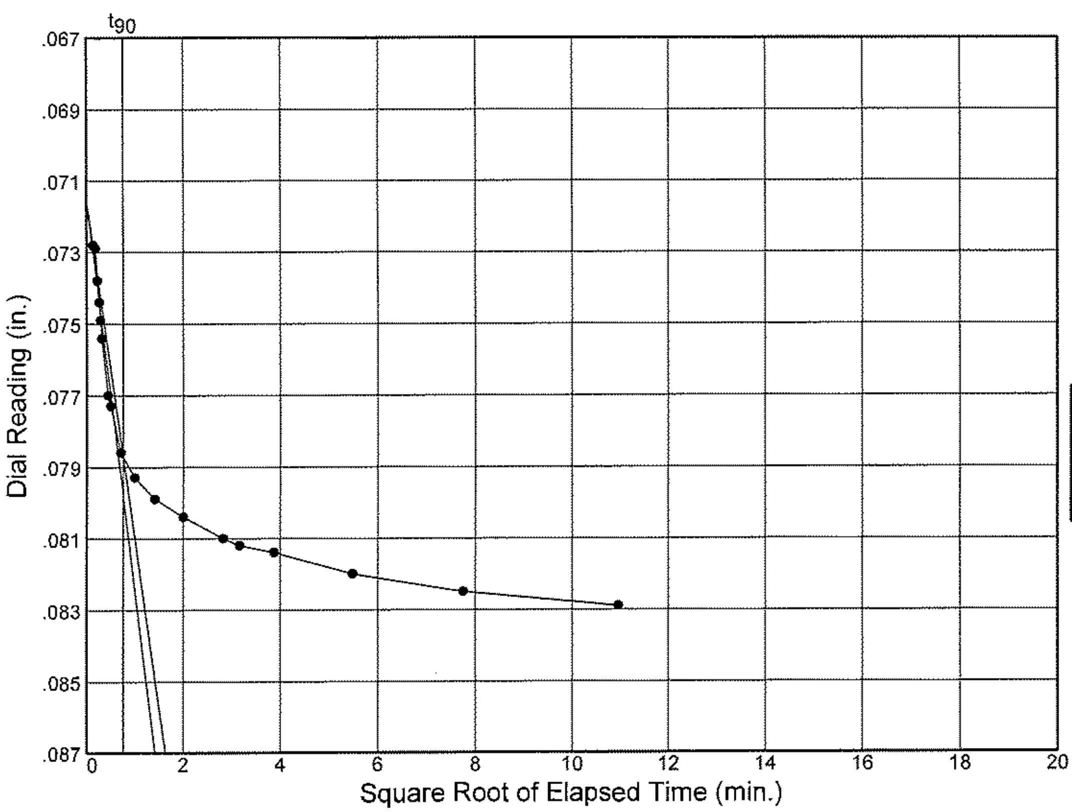
D_{90} = 0.06393

D_{100} = 0.06464

T_{90} = 0.61 min.

C_v @ T_{90}

1.98 ft.^{2}/day



Load No.= 8

Load= 15.37 tsf

D_0 = 0.07153

D_{90} = 0.07872

D_{100} = 0.07952

T_{90} = 0.57 min.

C_v @ T_{90}

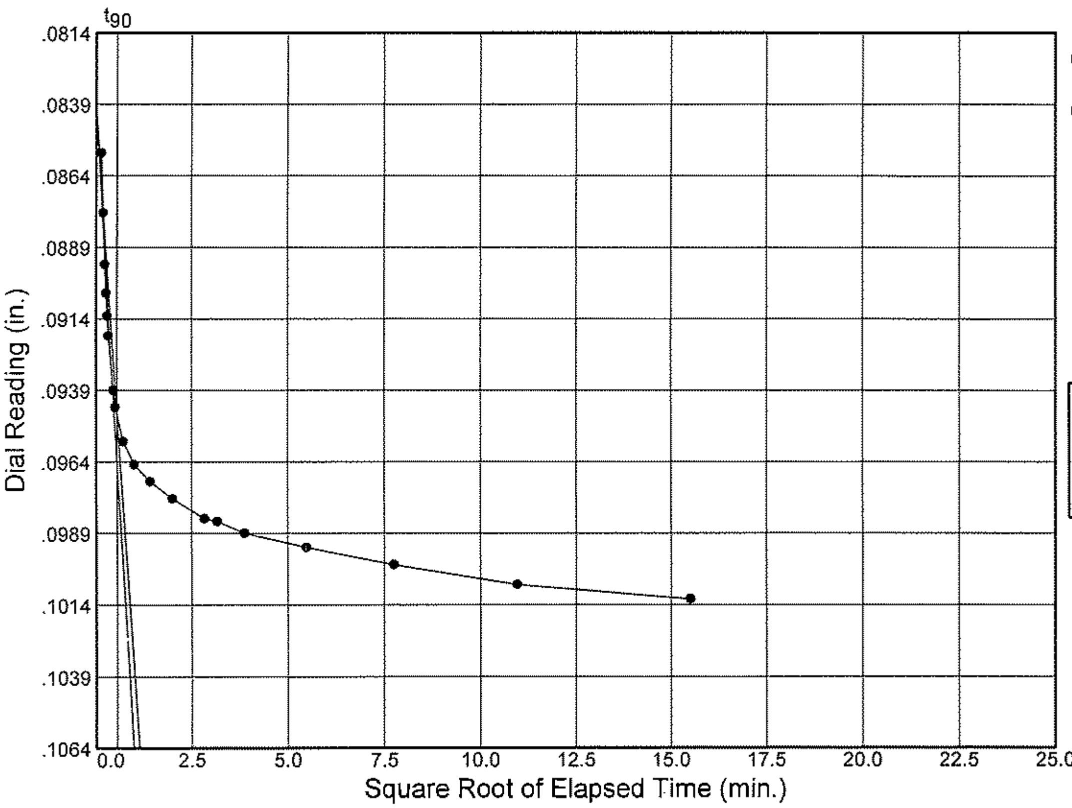
2.03 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

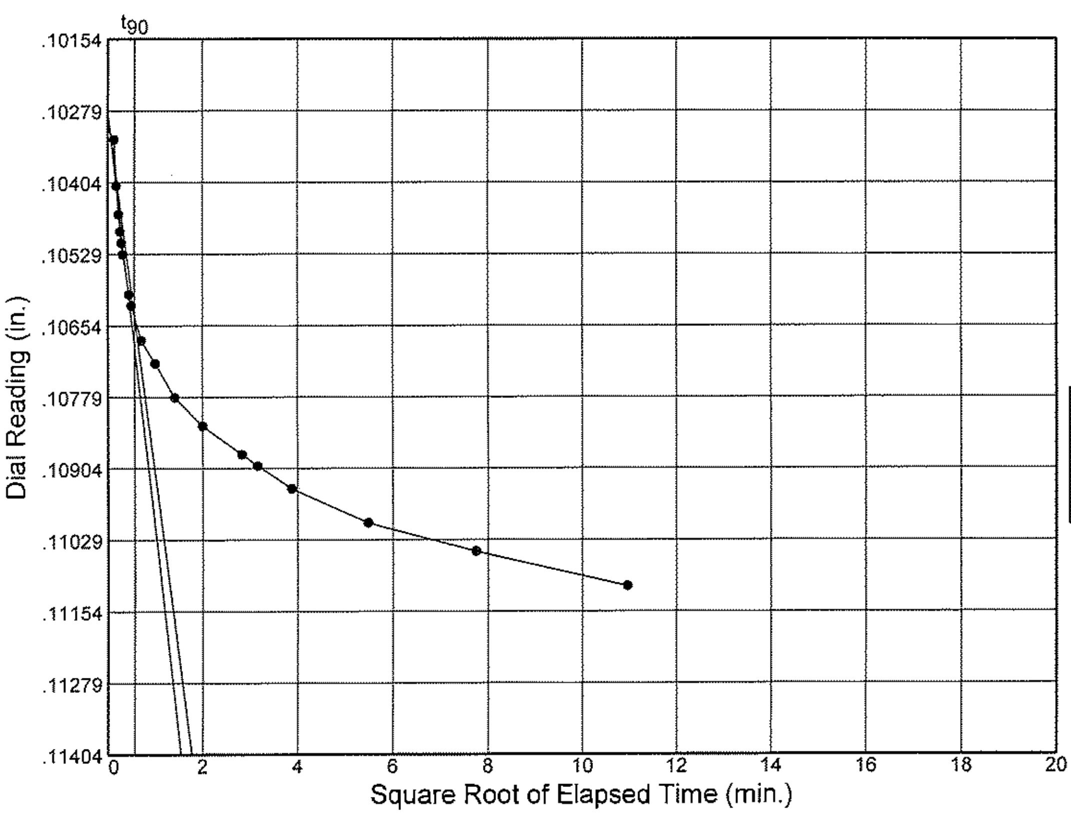
Dial Reading vs. Time

Source: T15-2 Sample No.: 7 Elev./Depth: 19.0'



Load No.= 9
Load= 30.73 tsf
D_0 = 0.08393
D_{90} = 0.09476
D_{100} = 0.09597
T_{90} = 0.30 min.

C_v @ T_{90}
3.75 ft.^{2}/day



Load No.= 10
Load= 45.21 tsf
D_0 = 0.10280
D_{90} = 0.10639
D_{100} = 0.10679
T_{90} = 0.32 min.

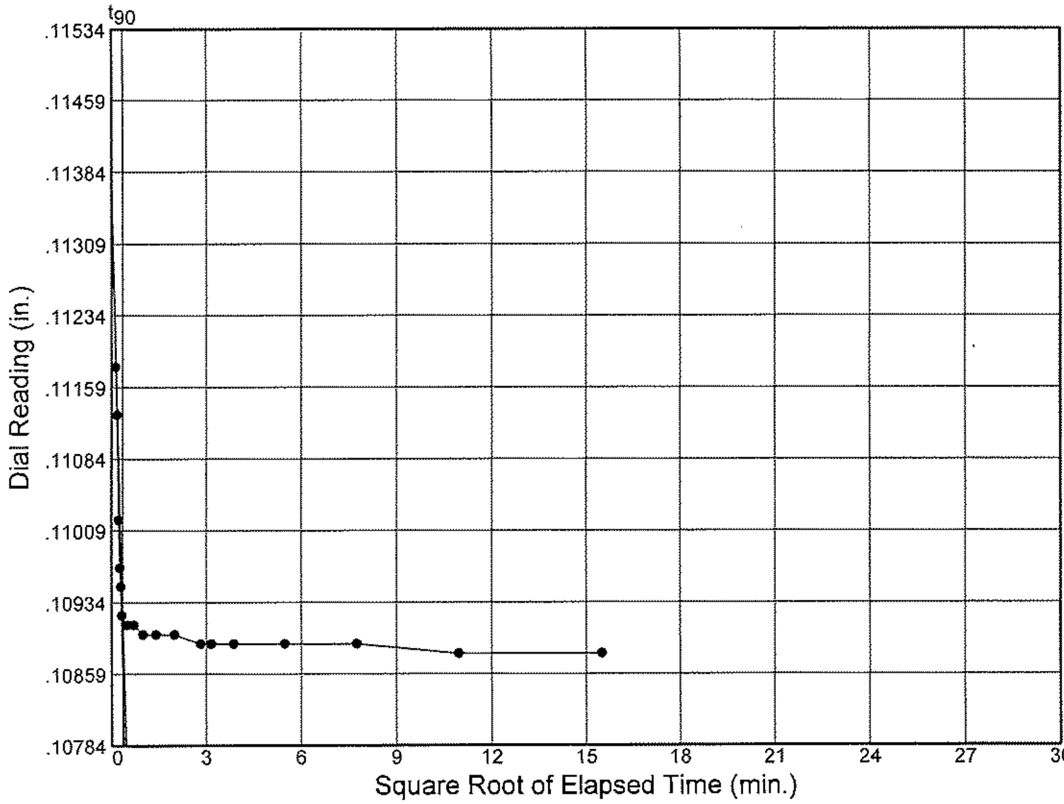
C_v @ T_{90}
3.33 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 7 | Elev./Depth: 19.0'



Load No.= 11

Load= 15.37 tsf

D_0 = 0.11374

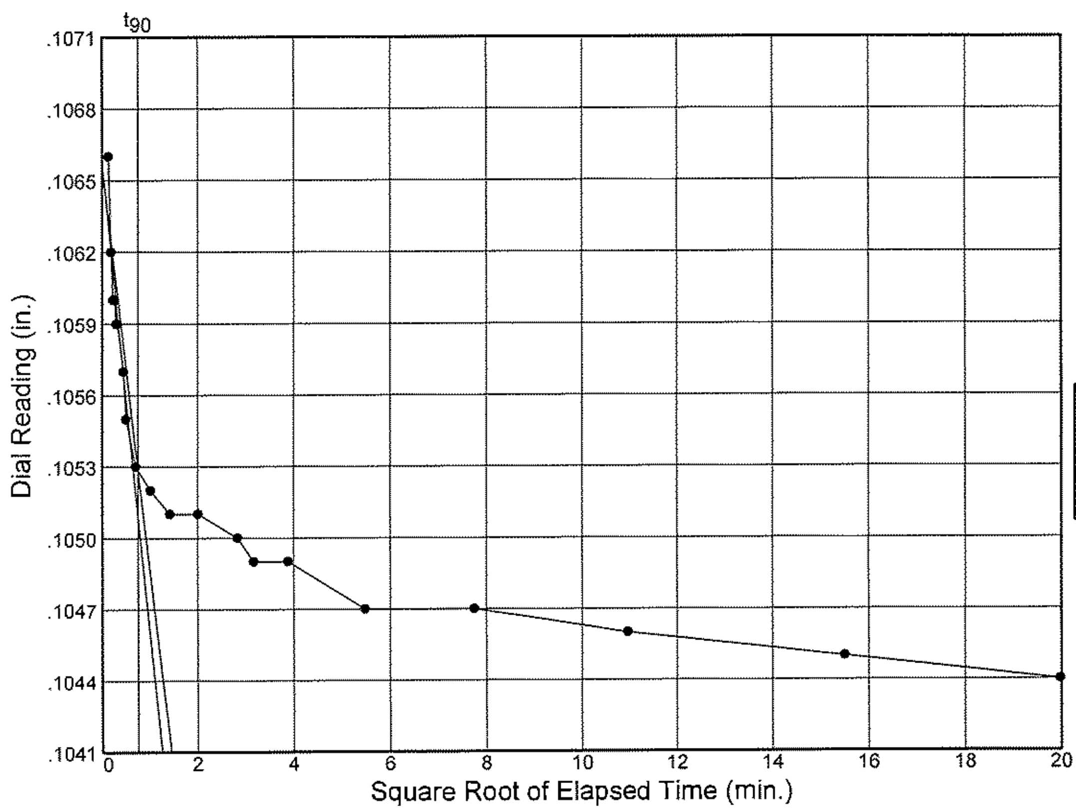
D_{90} = 0.10917

D_{100} = 0.10866

T_{90} = 0.13 min.

C_v @ T_{90}

8.43 ft.^{2}/day



Load No.= 12

Load= 3.85 tsf

D_0 = 0.10657

D_{90} = 0.10529

D_{100} = 0.10514

T_{90} = 0.56 min.

C_v @ T_{90}

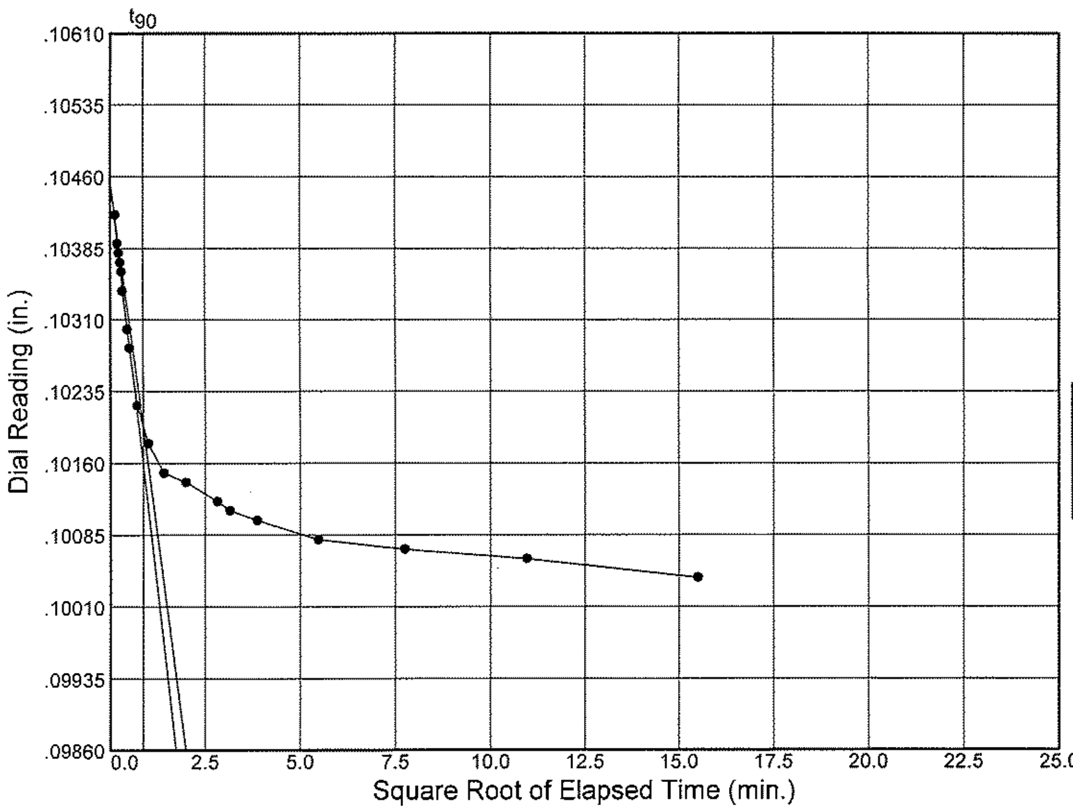
1.91 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

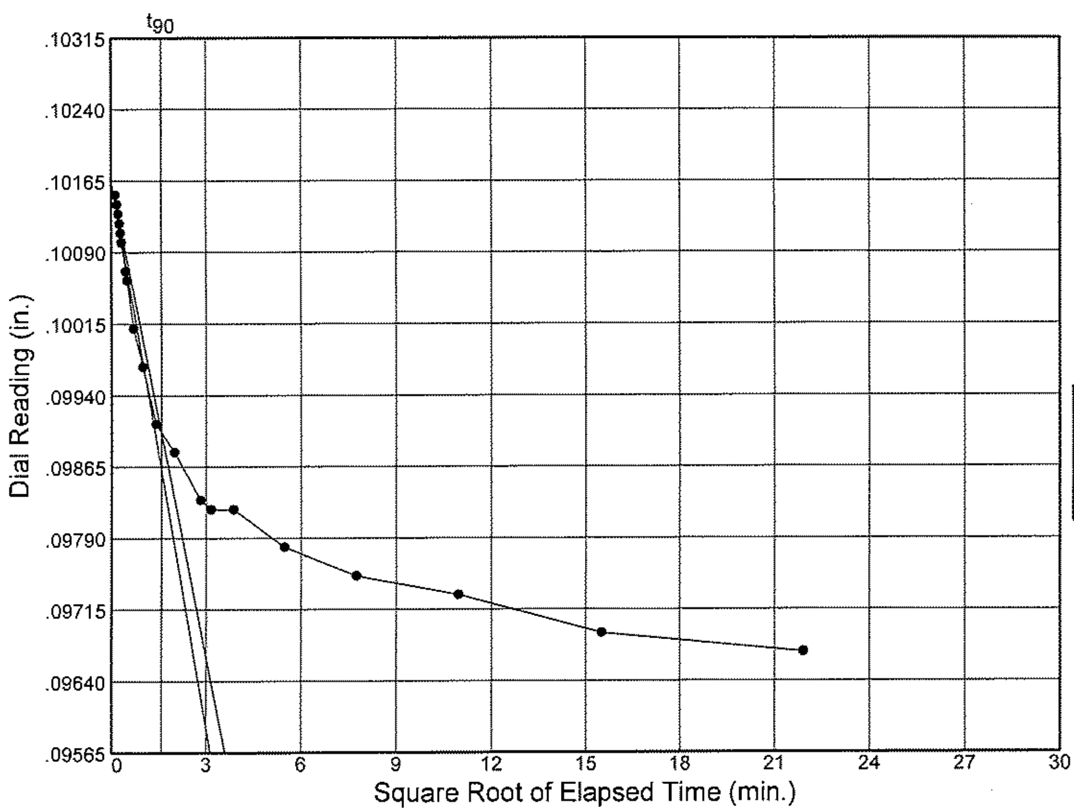
Dial Reading vs. Time

Source: T15-2 | Sample No.: 7 | Elev./Depth: 19.0'



Load No.= 13
Load= 0.97 tsf
D_0 = 0.10456
D_{90} = 0.10199
D_{100} = 0.10170
T_{90} = 0.75 min.

C_v @ T_{90}
1.45 ft.^{2}/day



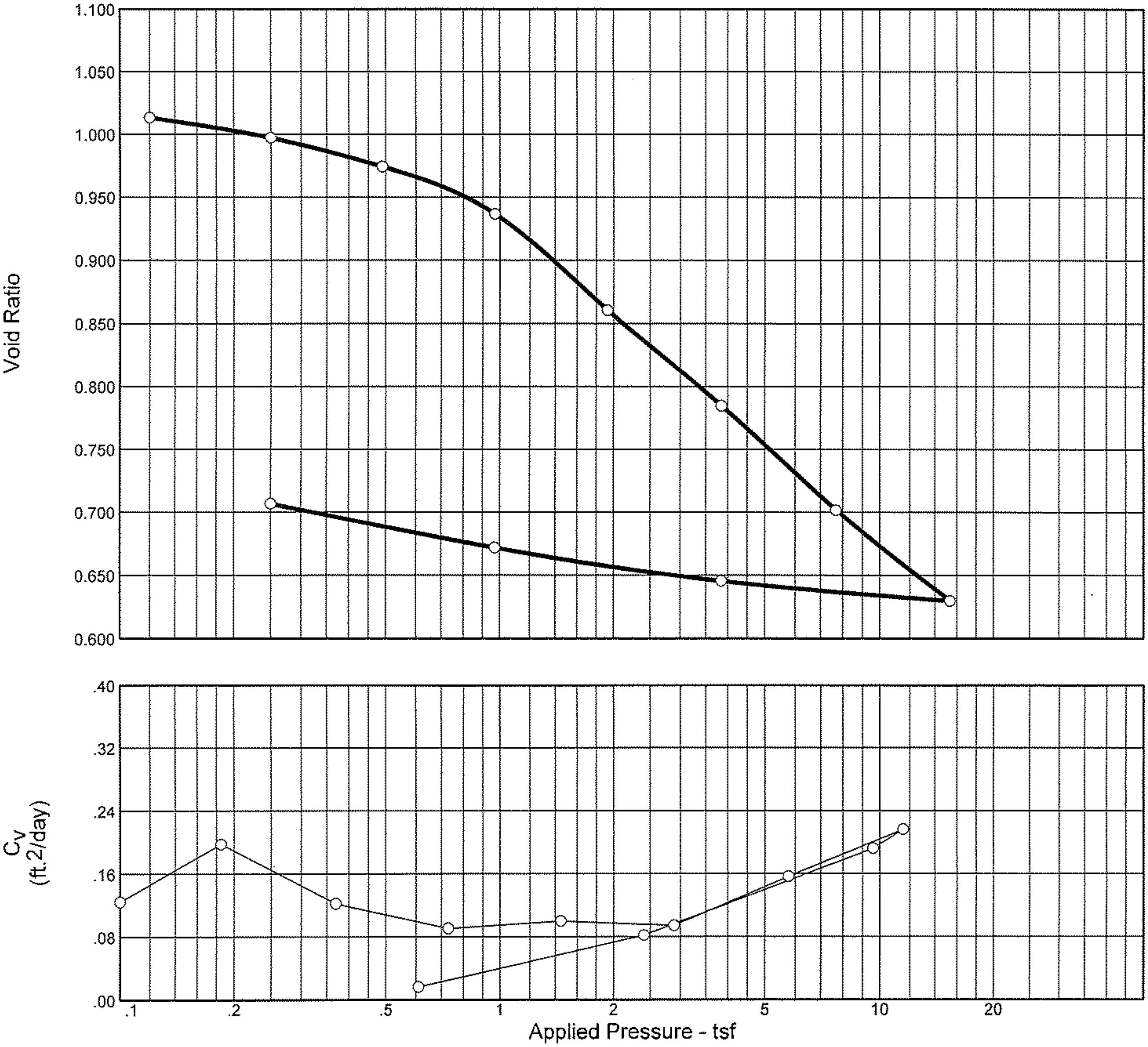
Load No.= 14
Load= 0.25 tsf
D_0 = 0.10165
D_{90} = 0.09901
D_{100} = 0.09872
T_{90} = 2.51 min.

C_v @ T_{90}
0.44 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
99.9 %	38.0 %	82.7	39	26	2.70	1.01	0.27	1.027

MATERIAL DESCRIPTION	USCS	AASHTO
MST G SACL W/ SH FRAG	CL	

Pr

Pr

Source: T15-2 **Sample No.:** 12 **Elev./Depth:** 44.0'

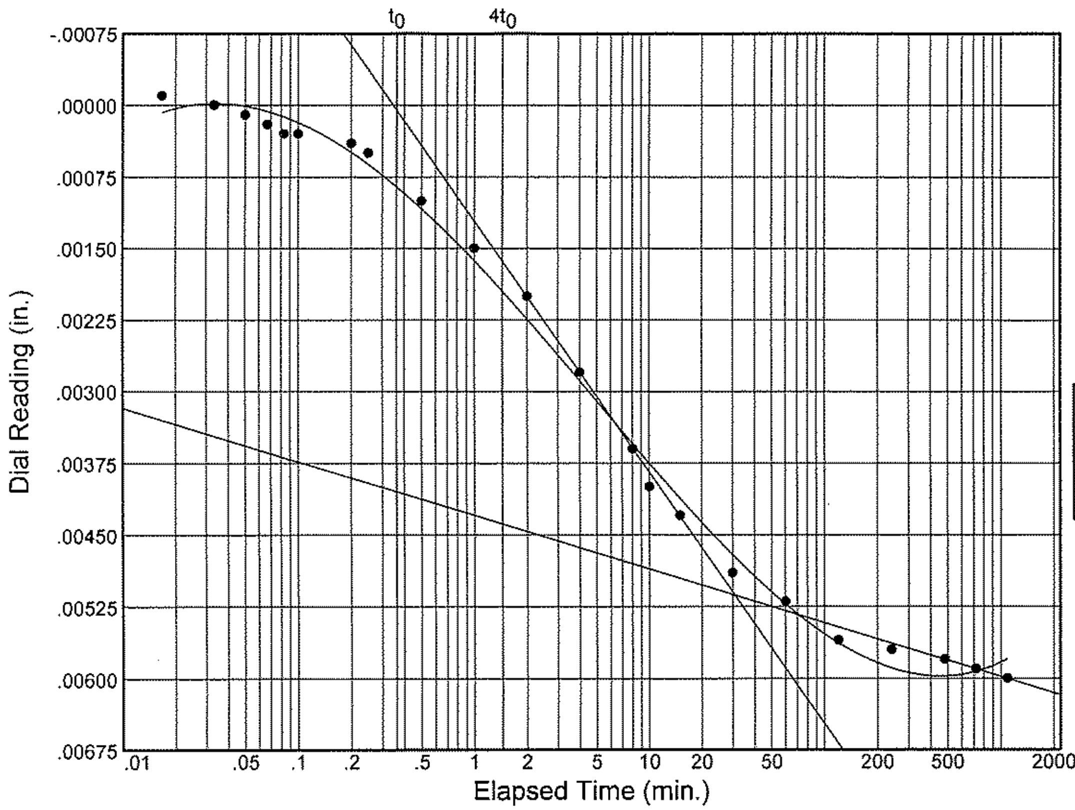
EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Remarks:
TESTED BY: RR, LWR
CHECKED BY: RNE

Figure

Dial Reading vs. Time

Source: T15-2 | Sample No.: 12 | Elev./Depth: 44.0'



Load No.= 1

Load= 0.12 tsf

D_0 = -0.00024

D_{50} = 0.00244

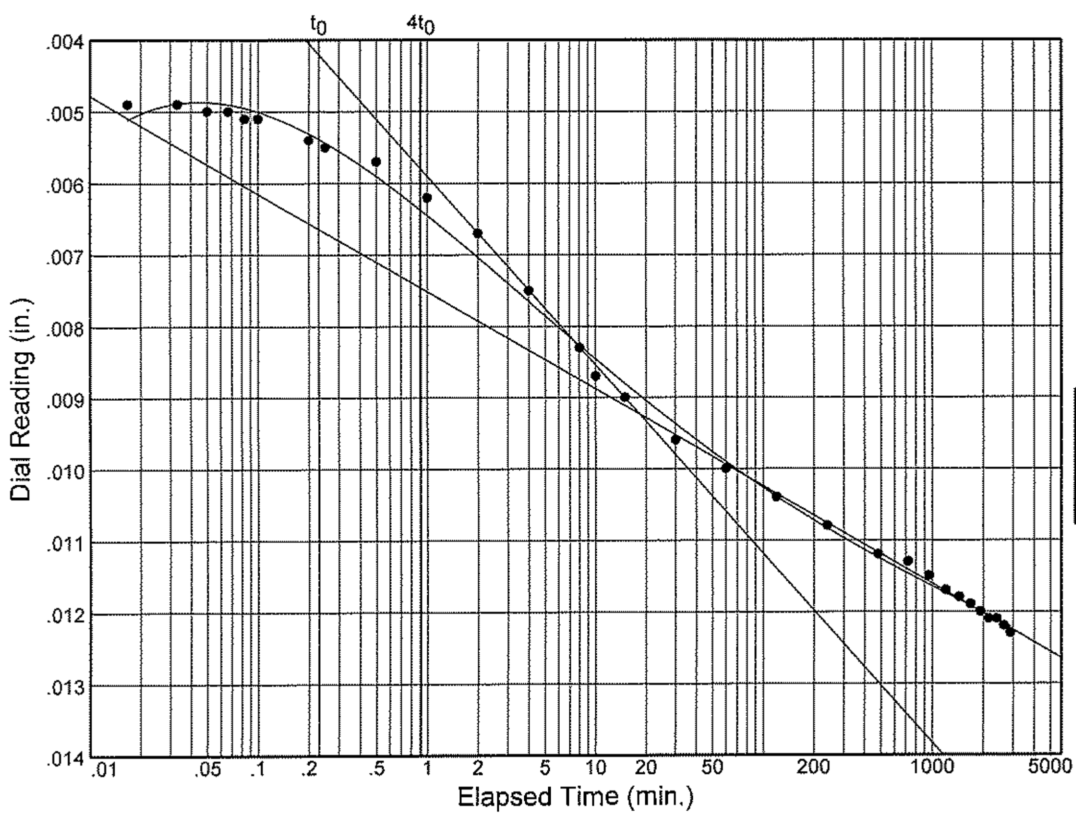
D_{100} = 0.00513

T_{50} = 2.49 min.

C_v @ T_{50}

0.12 ft.^{2}/day

C_α = 0.001



Load No.= 2

Load= 0.25 tsf

D_0 = 0.00440

D_{50} = 0.00682

D_{100} = 0.00924

T_{50} = 1.55 min.

C_v @ T_{50}

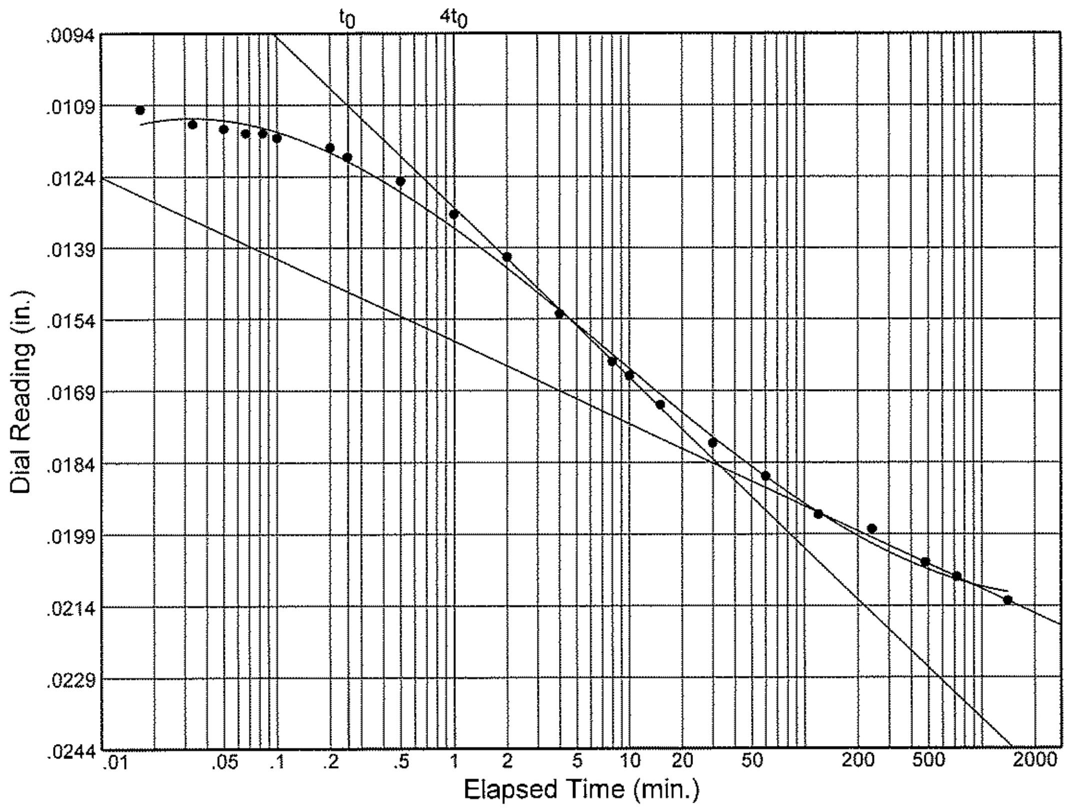
0.20 ft.^{2}/day

C_α = 0.002

Figure

Dial Reading vs. Time

Source: T15-2 Sample No.: 12 Elev./Depth: 44.0'



Load No.= 3

Load= 0.49 tsf

D_0 = 0.01069

D_{50} = 0.01459

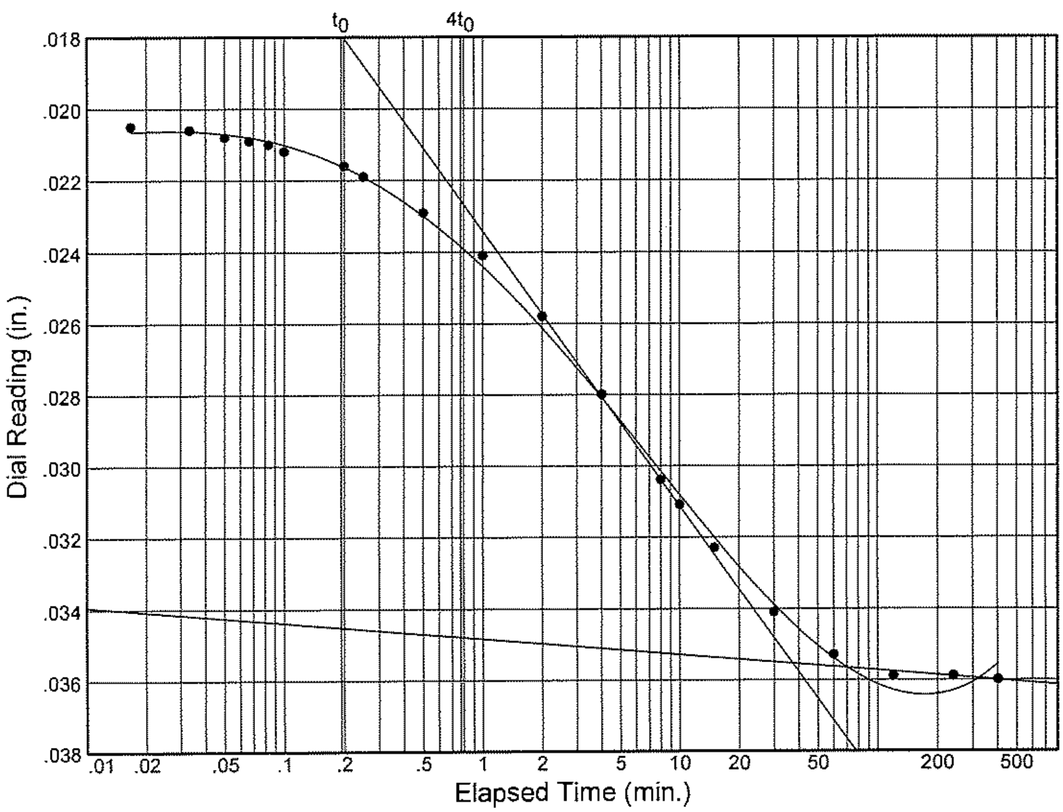
D_{100} = 0.01849

T_{50} = 2.45 min.

C_v @ T_{50}

0.12 ft.^{2}/day

C_α = 0.002



Load No.= 4

Load= 0.97 tsf

D_0 = 0.01935

D_{50} = 0.02745

D_{100} = 0.03554

T_{50} = 3.21 min.

C_v @ T_{50}

0.09 ft.^{2}/day

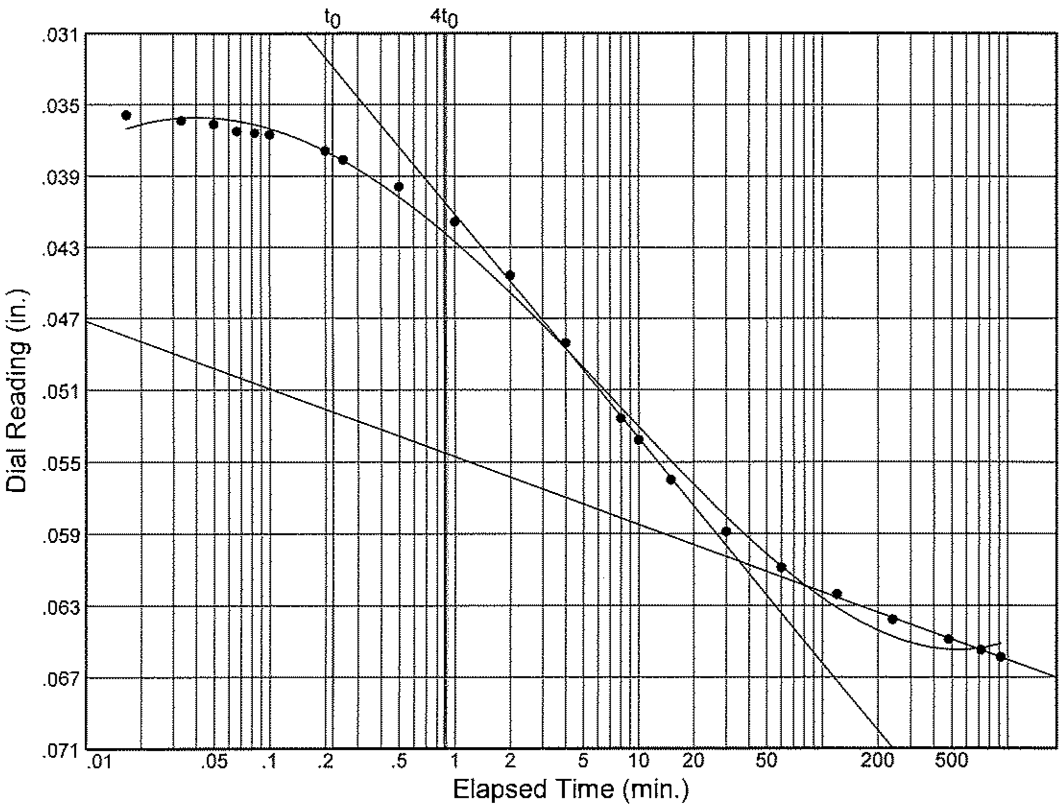
C_α = 0.001

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 12 | Elev./Depth: 44.0'



Load No.= 5

Load= 1.93 tsf

D_0 = 0.03346

D_{50} = 0.04701

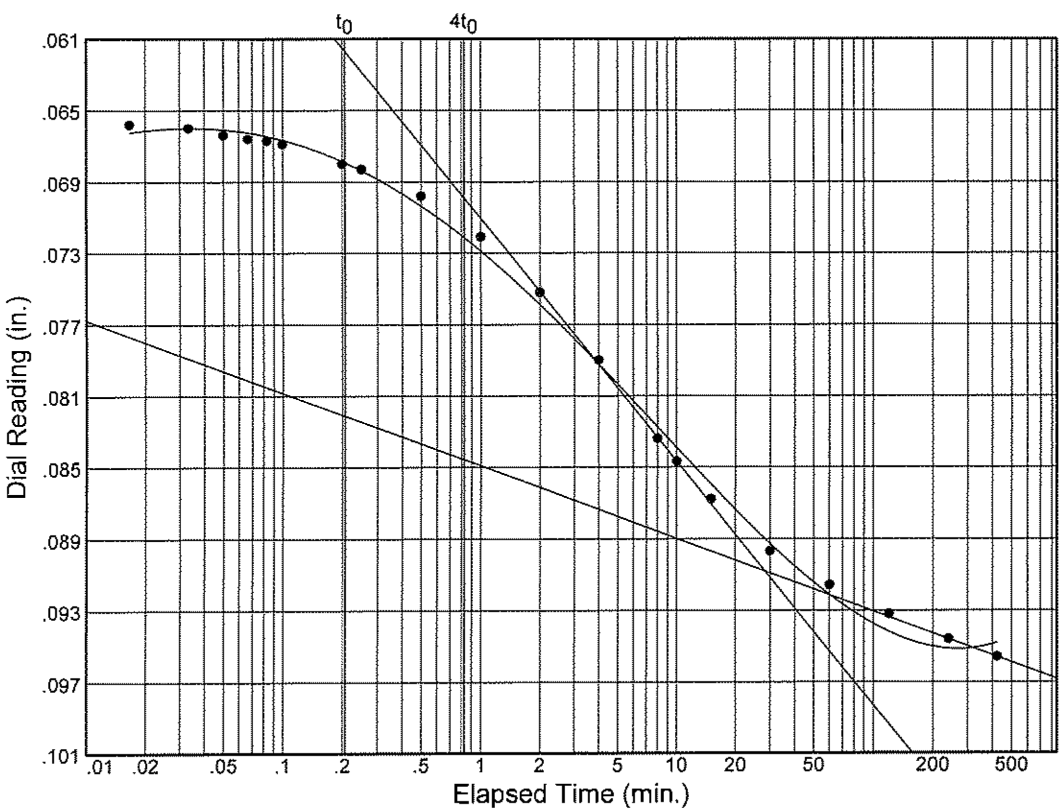
D_{100} = 0.06055

T_{50} = 2.75 min.

C_v @ T_{50}

0.10 ft.^{2}/day

C_α = 0.005



Load No.= 6

Load= 3.85 tsf

D_0 = 0.06372

D_{50} = 0.07726

D_{100} = 0.09081

T_{50} = 2.68 min.

C_v @ T_{50}

0.09 ft.^{2}/day

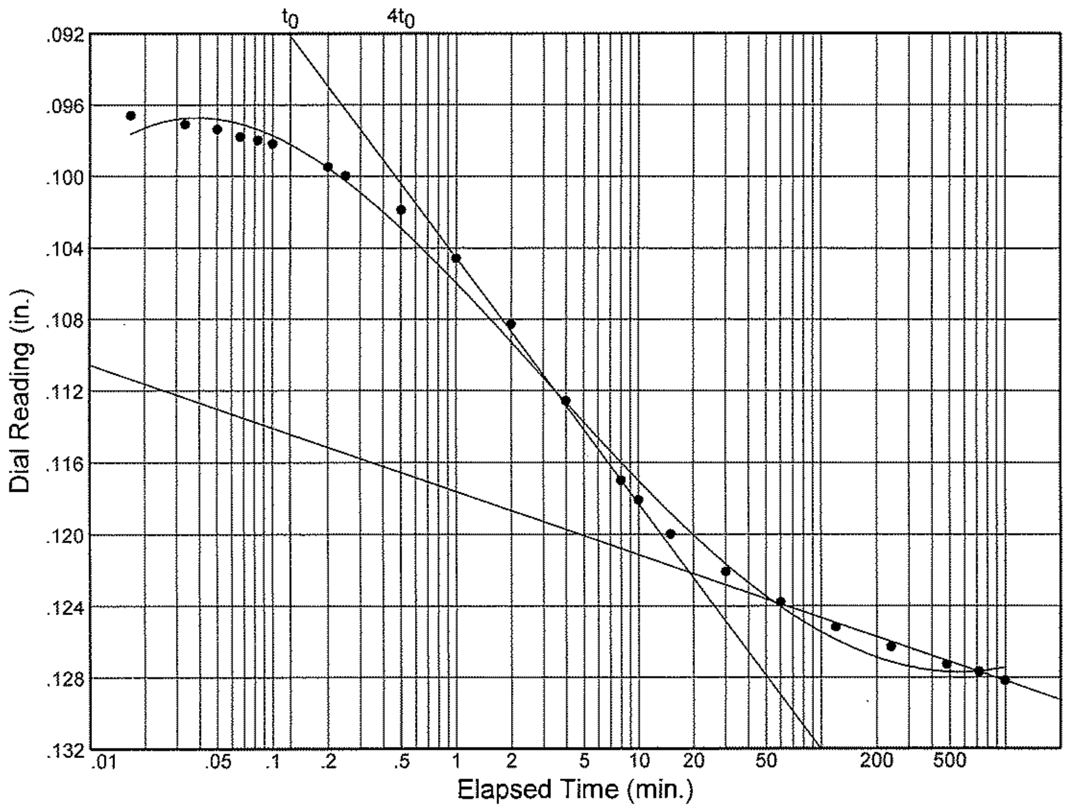
C_α = 0.006

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 12 | Elev./Depth: 44.0'



Load No.= 7

Load= 7.69 tsf

D_0 = 0.09355

D_{50} = 0.10784

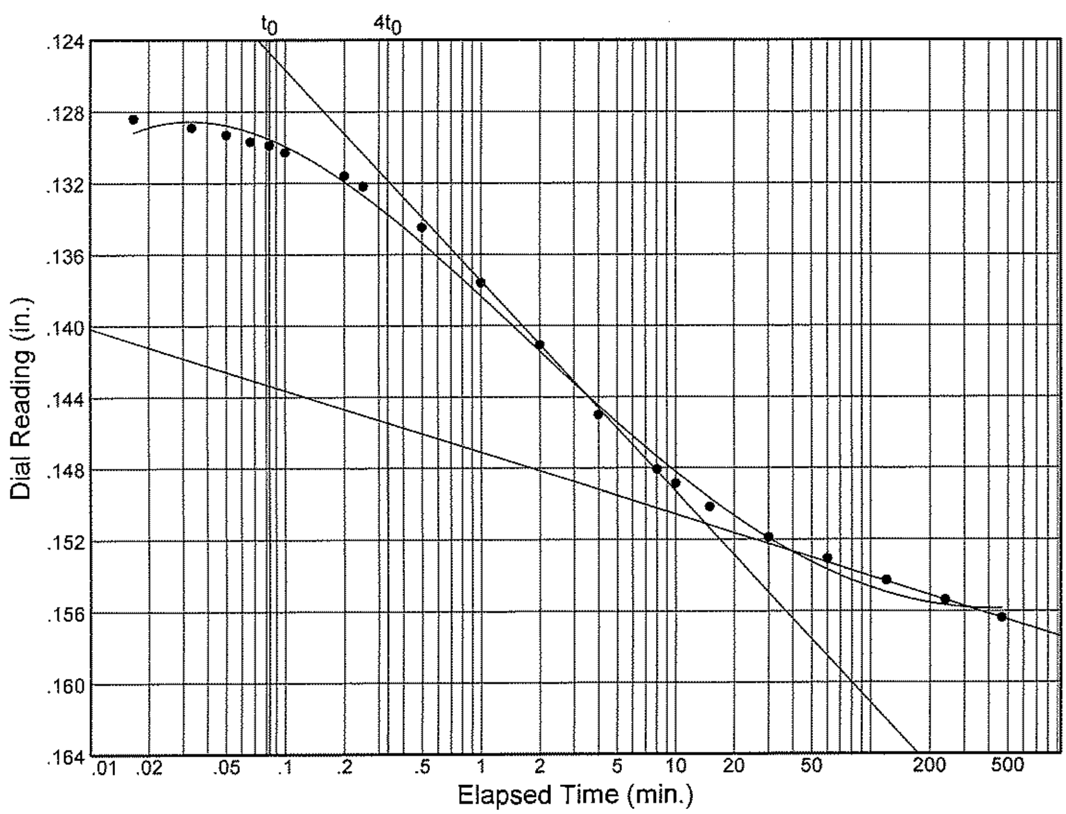
D_{100} = 0.12213

T_{50} = 1.48 min.

C_v @ T_{50}

0.16 $ft.^2$/day

C_α = 0.005



Load No.= 8

Load= 15.37 tsf

D_0 = 0.12535

D_{50} = 0.13824

D_{100} = 0.15113

T_{50} = 0.98 min.

C_v @ T_{50}

0.22 $ft.^2$/day

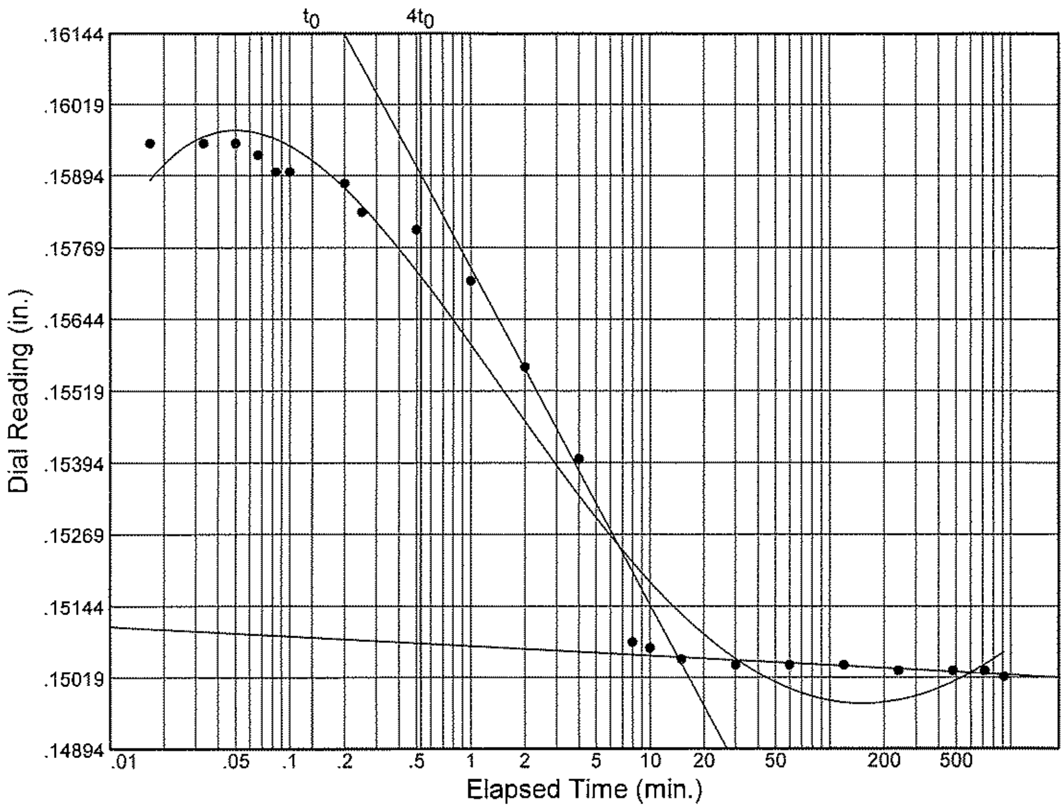
C_α = 0.005

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 | Sample No.: 12 | Elev./Depth: 44.0'



Load No.= 9

Load= 3.85 tsf

D_0 = 0.16124

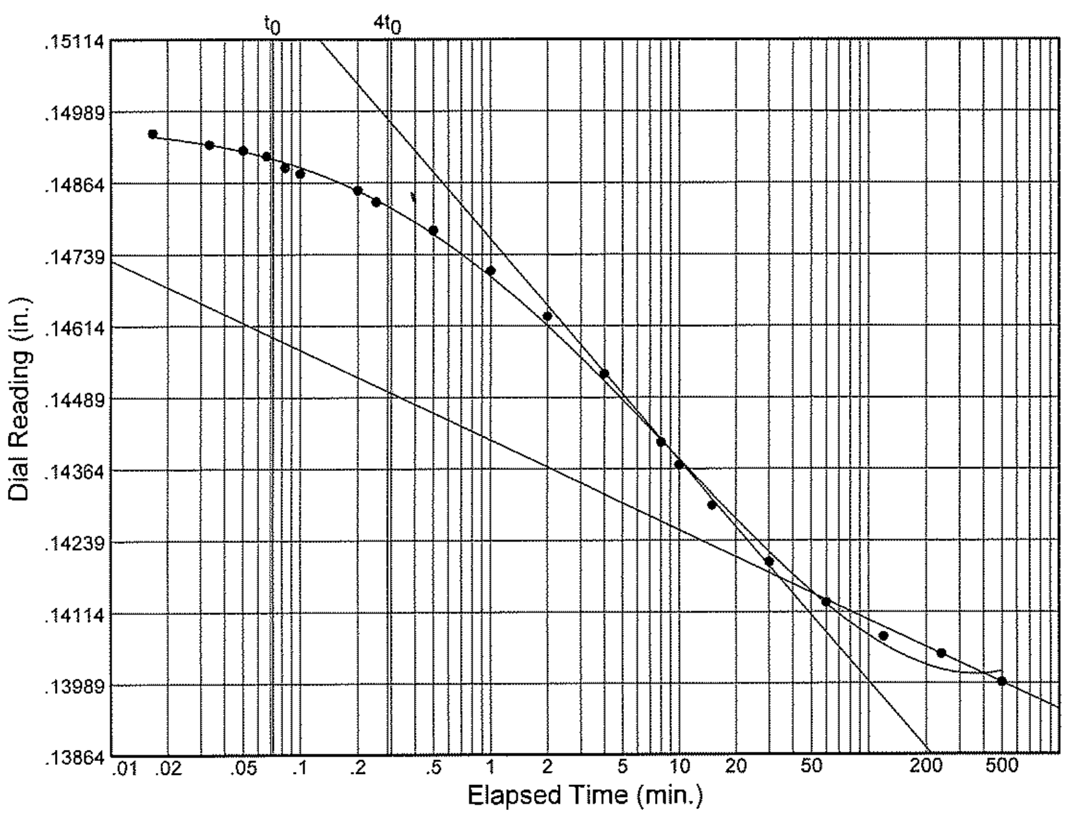
D_{50} = 0.15589

D_{100} = 0.15054

T_{50} = 1.05 min.

C_V @ T_{50}

0.19 ft.^{2}/day



Load No.= 10

Load= 0.97 tsf

D_0 = 0.14988

D_{50} = 0.14581

D_{100} = 0.14174

T_{50} = 2.55 min.

C_V @ T_{50}

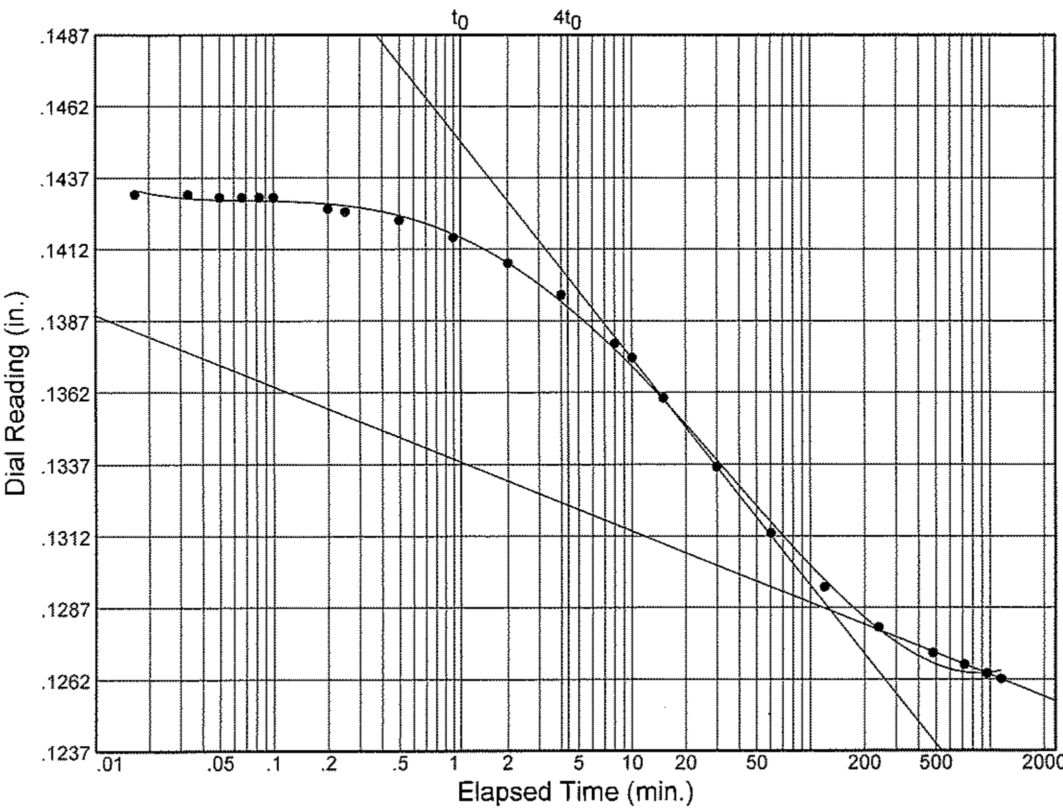
0.08 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-2 Sample No.: 12 Elev./Depth: 44.0'



Load No.= 11

Load= 0.25 tsf

D_0 = 0.14405

D_{50} = 0.13632

D_{100} = 0.12858

T_{50} = 13.17 min.

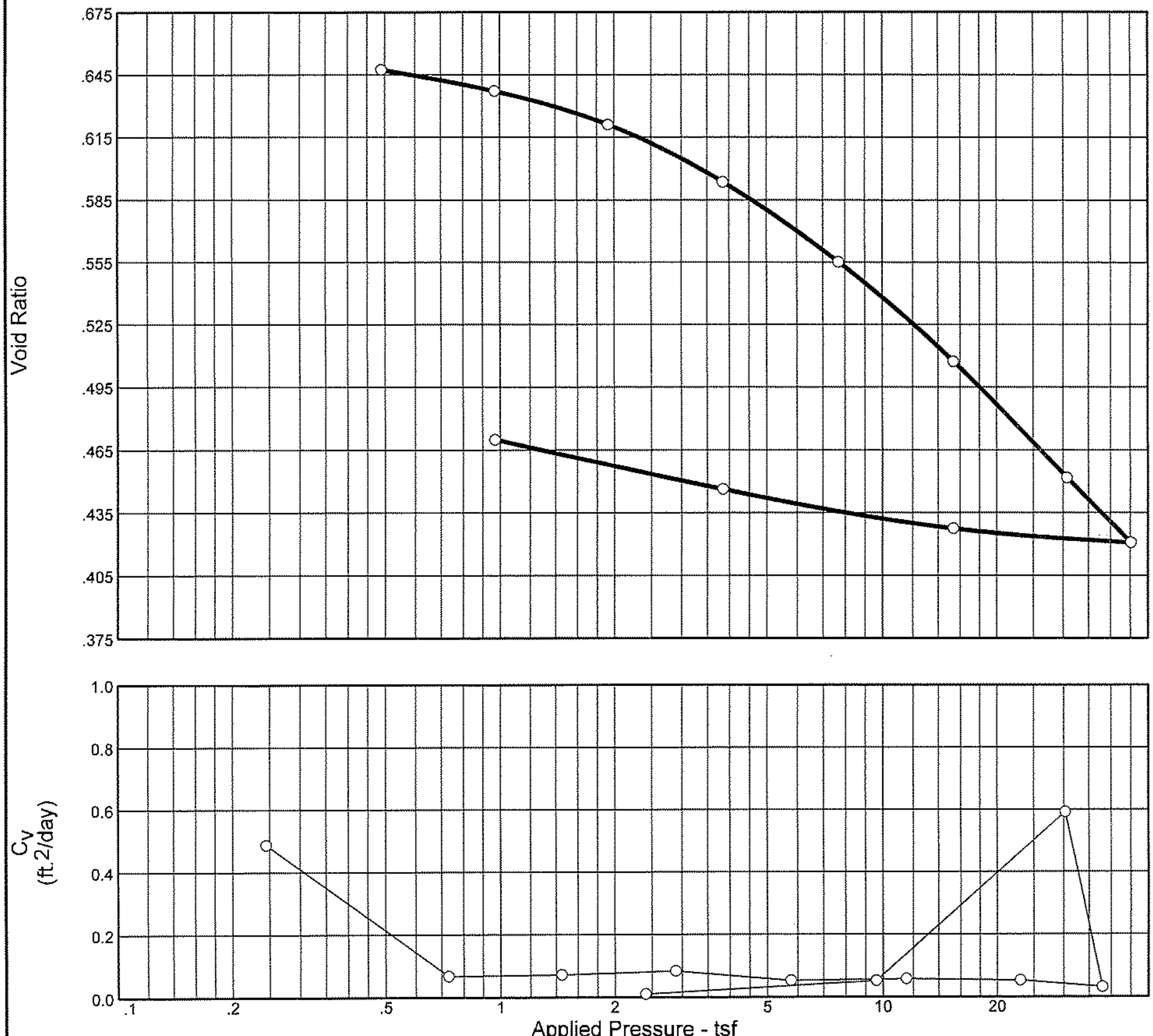
C_V @ T_{50}

0.02 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
95.6 %	23.6 %	101.1	47	29	2.70	5.32	0.19	0.668

MATERIAL DESCRIPTION	USCS	AASHTO
MST BR SICL W/ CONC, RTS	CL	

Source: T15-4 **Sample No.:** 1 **Elev./Depth:** 2.0'

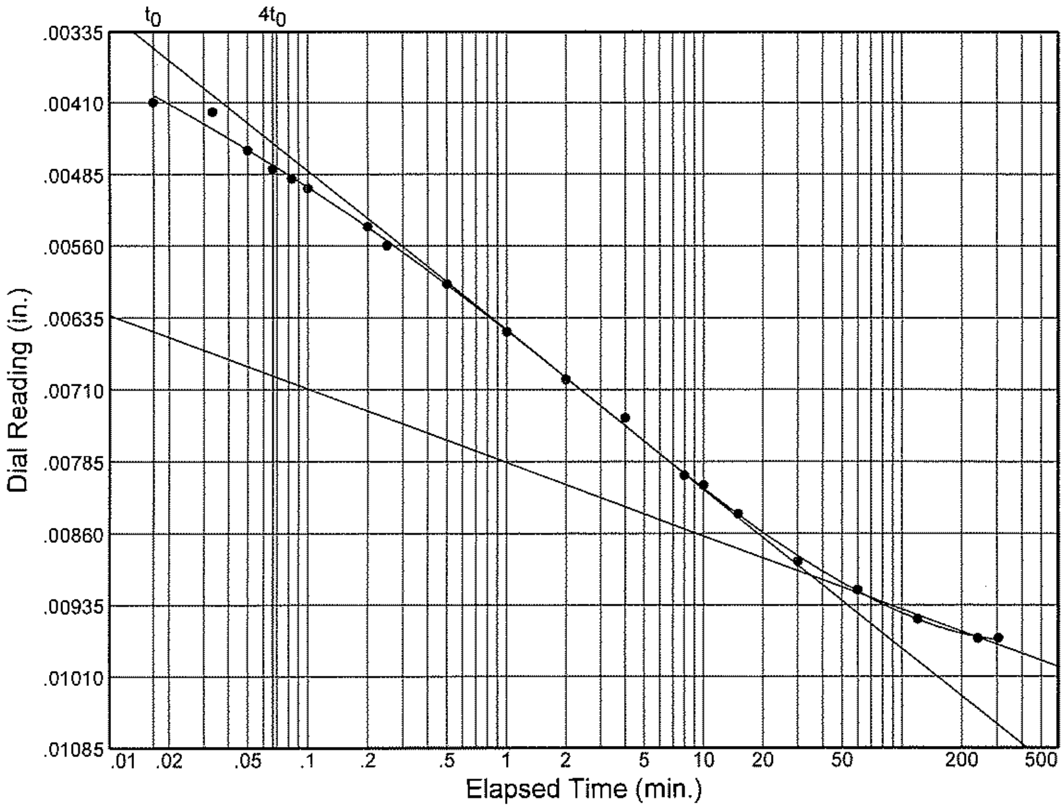
EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Remarks:
TESTED BY: RR
CHECKED BY: RNE

Figure

Dial Reading vs. Time

Source: T15-4 | Sample No.: 1 | Elev./Depth: 2.0'



Load No.= 1

Load= 0.49 tsf

D_0 = 0.00329

D_{50} = 0.00617

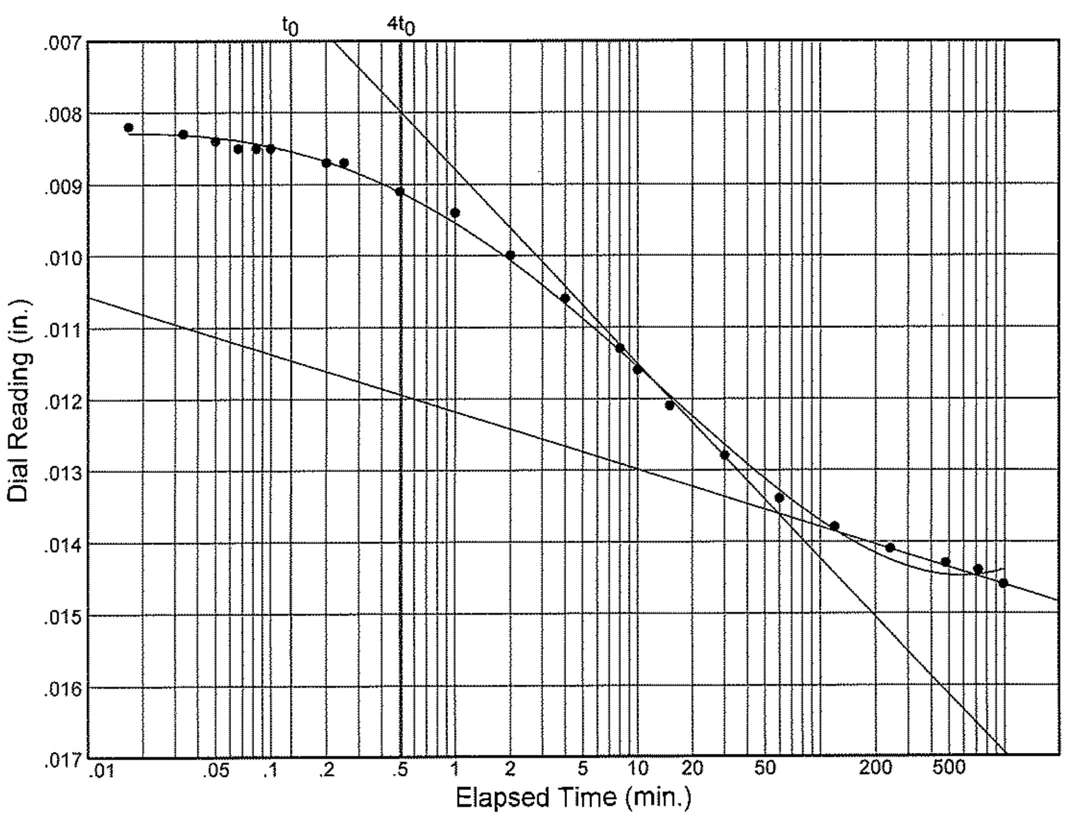
D_{100} = 0.00904

T_{50} = 0.63 min.

C_v @ T_{50}

0.49 ft.^{2}/day

C_α = 0.001



Load No.= 2

Load= 0.97 tsf

D_0 = 0.00795

D_{50} = 0.01078

D_{100} = 0.01361

T_{50} = 4.49 min.

C_v @ T_{50}

0.07 ft.^{2}/day

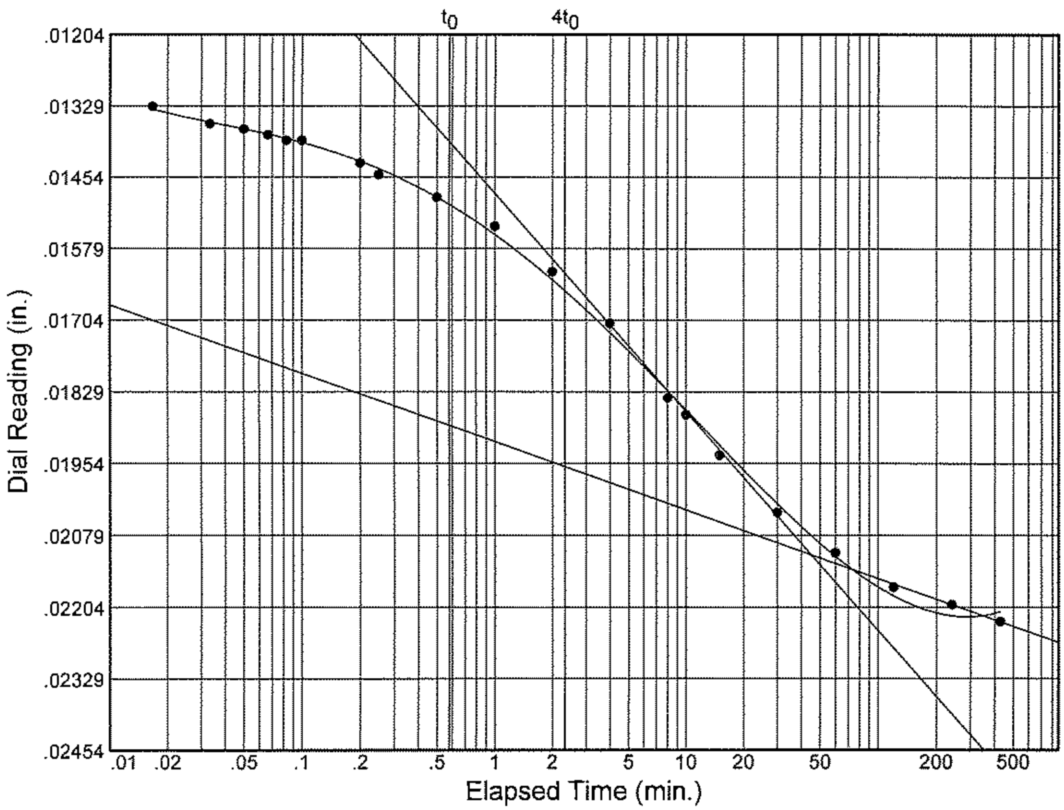
C_α = 0.001

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 1 | Elev./Depth: 2.0'



Load No.= 3

Load= 1.93 tsf

D_0 = 0.01351

D_{50} = 0.01732

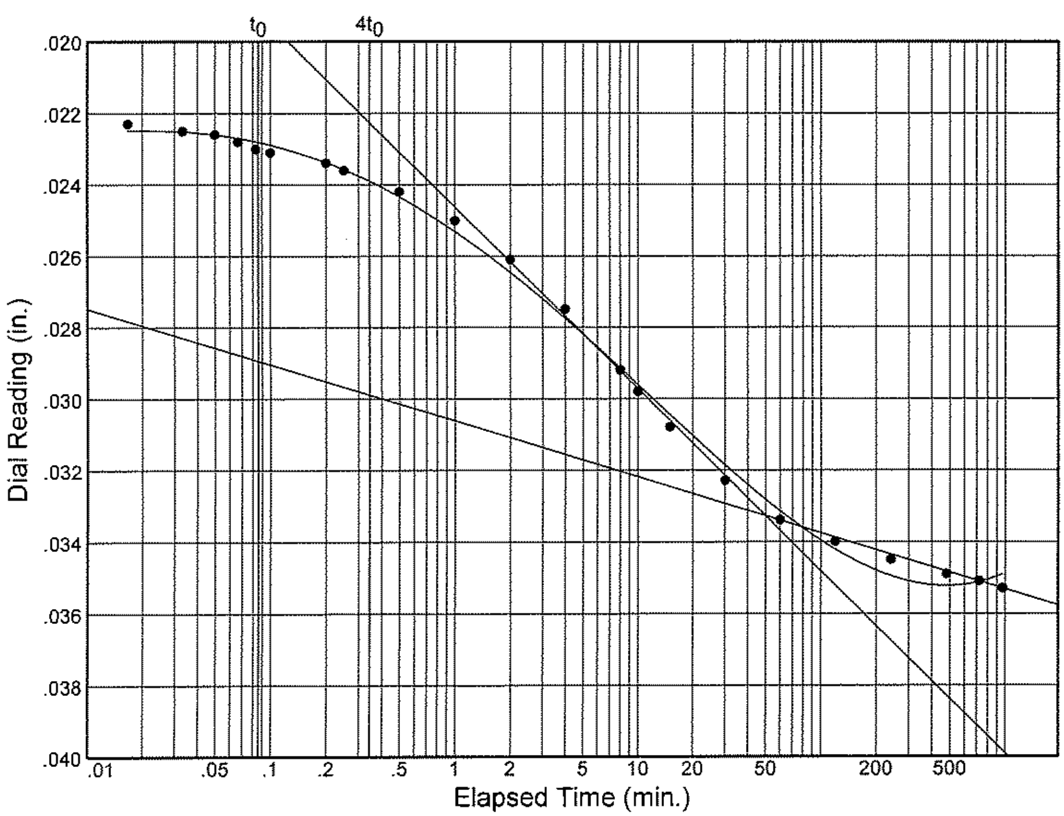
D_{100} = 0.02113

T_{50} = 4.18 min.

C_v @ T_{50}

0.07 ft.^{2}/day

C_α = 0.002



Load No.= 4

Load= 3.85 tsf

D_0 = 0.02171

D_{50} = 0.02749

D_{100} = 0.03328

T_{50} = 3.50 min.

C_v @ T_{50}

0.08 ft.^{2}/day

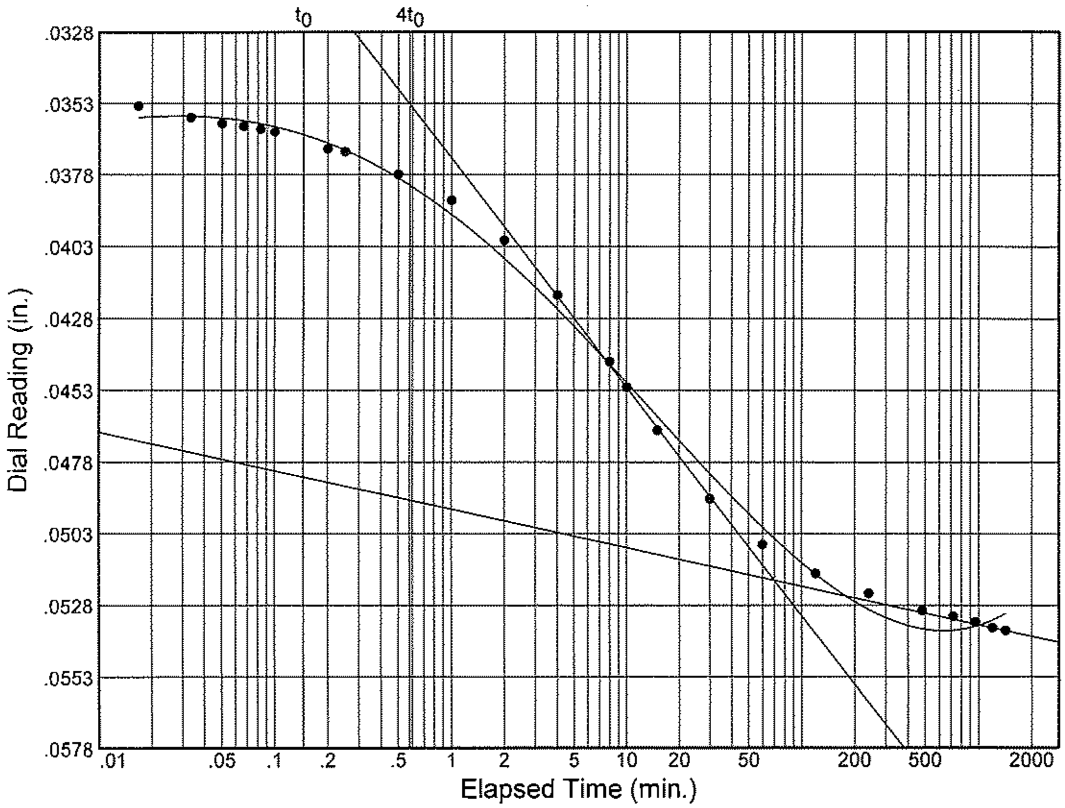
C_α = 0.002

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 1 | Elev./Depth: 2.0'



Load No.= 5

Load= 7.69 tsf

D_0 = 0.03461

D_{50} = 0.04327

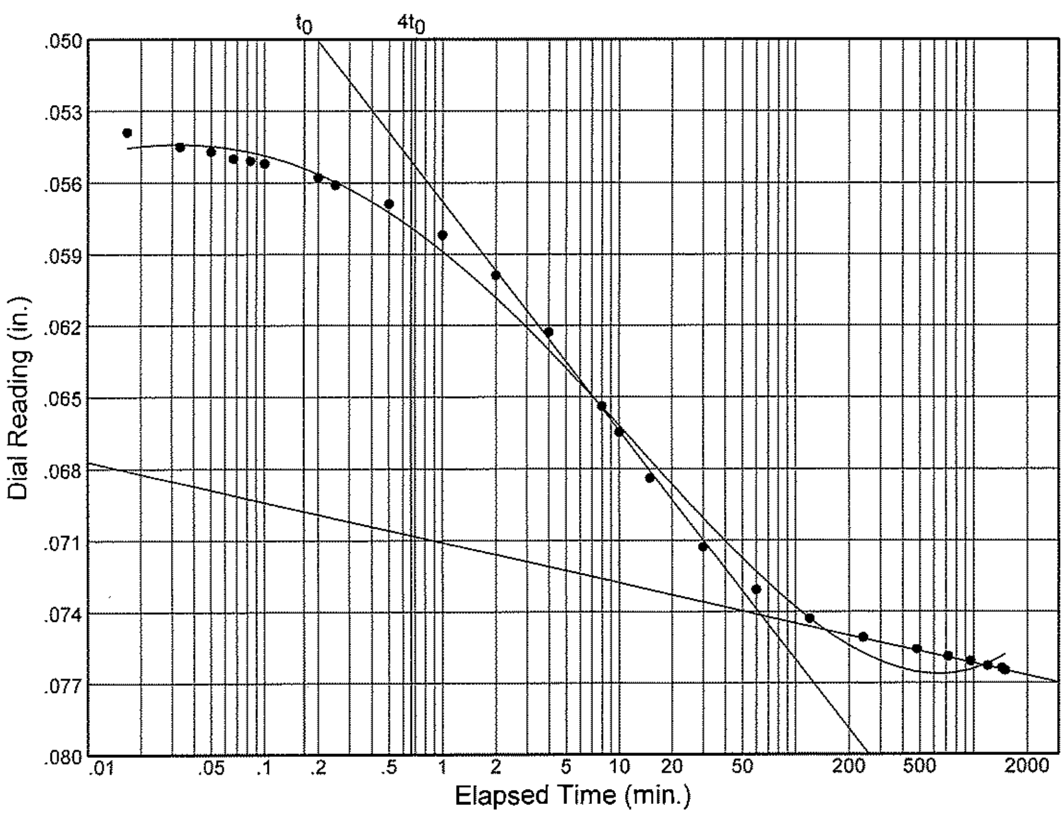
D_{100} = 0.05194

T_{50} = 5.36 min.

C_V @ T_{50}

0.05 ft.^{2}/day

C_α = 0.002



Load No.= 6

Load= 15.37 tsf

D_0 = 0.05291

D_{50} = 0.06354

D_{100} = 0.07416

T_{50} = 4.63 min.

C_V @ T_{50}

0.06 ft.^{2}/day

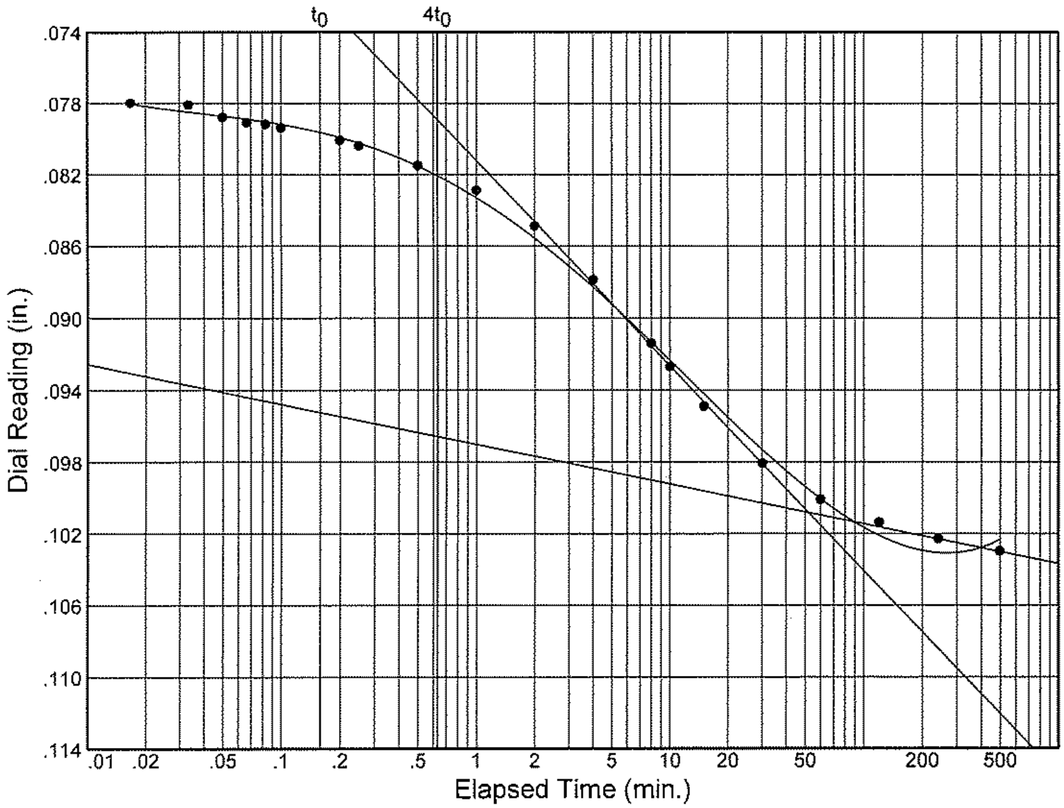
C_α = 0.002

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 Sample No.: 1 Elev./Depth: 2.0'



Load No.= 7

Load= 30.73 tsf

D_0 = 0.07720

D_{50} = 0.08901

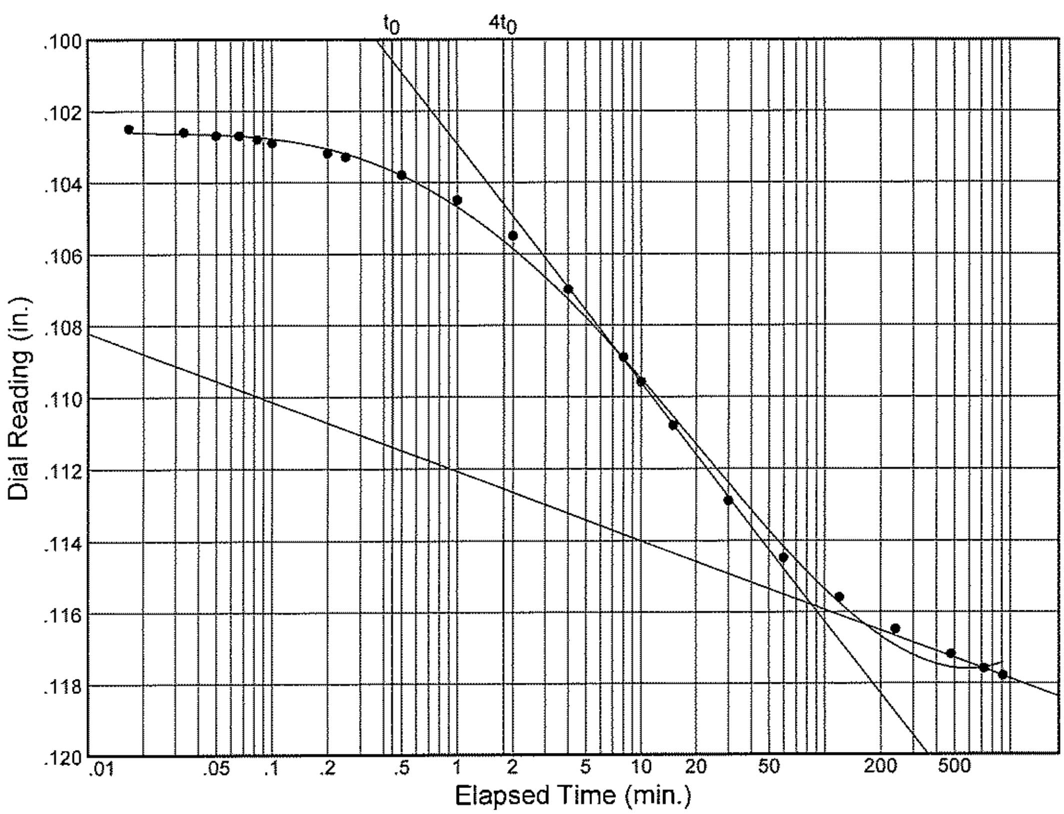
D_{100} = 0.10082

T_{50} = 4.72 min.

C_v @ T_{50}

0.05 ft.^{2}/day

C_α = 0.003



Load No.= 8

Load= 45.21 tsf

D_0 = 0.10174

D_{50} = 0.10877

D_{100} = 0.11580

T_{50} = 7.48 min.

C_v @ T_{50}

0.03 ft.^{2}/day

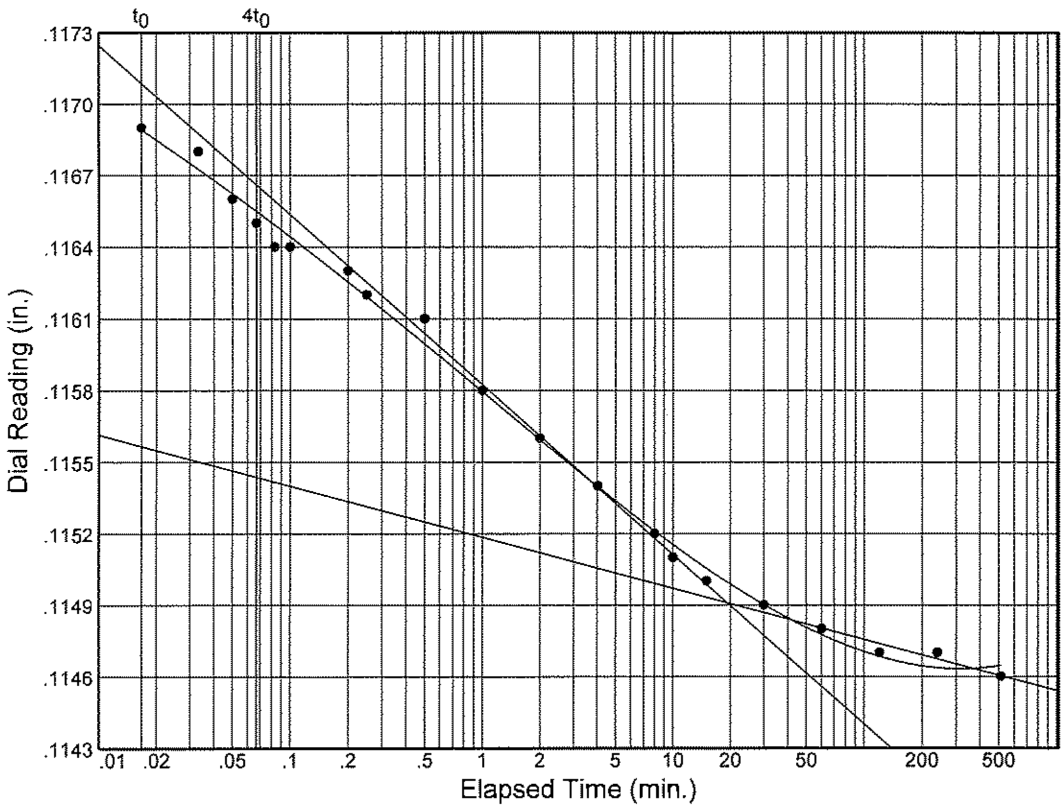
C_α = 0.003

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 1 | Elev./Depth: 2.0'



Load No.= 9

Load= 15.37 tsf

D_0 = 0.11723

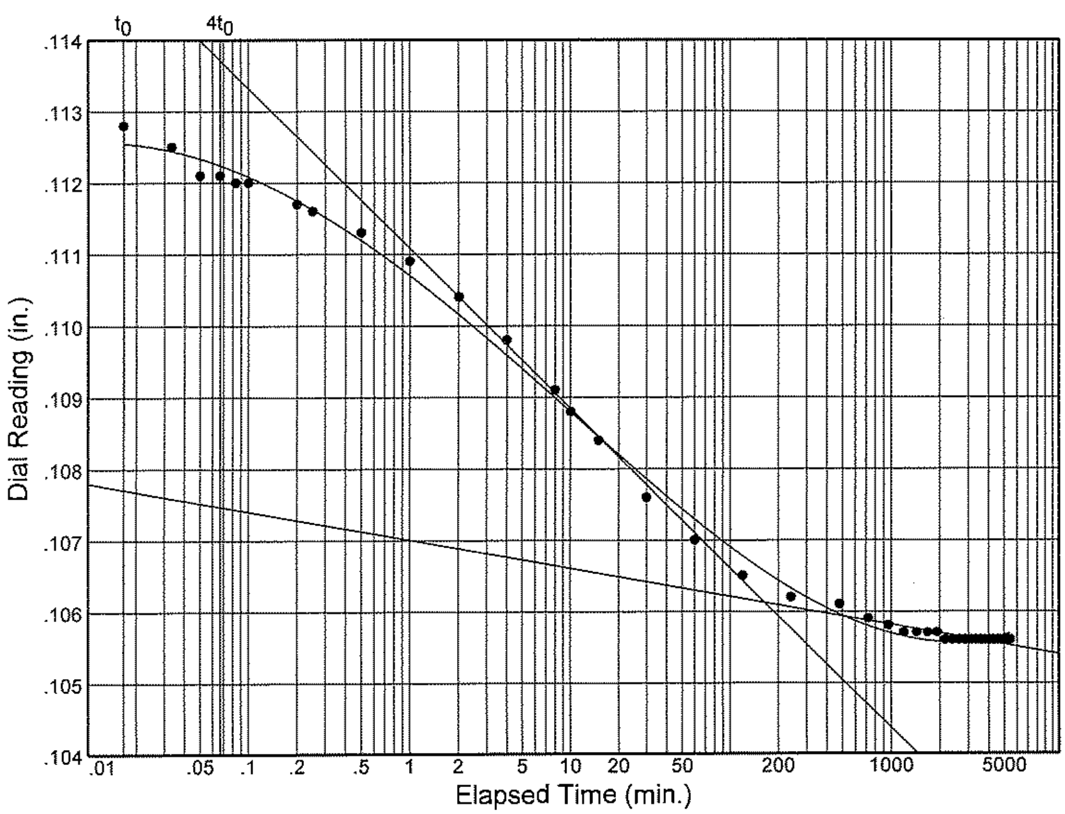
D_{50} = 0.11607

D_{100} = 0.11491

T_{50} = 0.38 min.

C_v @ T_{50}

0.59 ft.^{2}/day



Load No.= 10

Load= 3.85 tsf

D_0 = 0.11285

D_{50} = 0.10949

D_{100} = 0.10613

T_{50} = 4.49 min.

C_v @ T_{50}

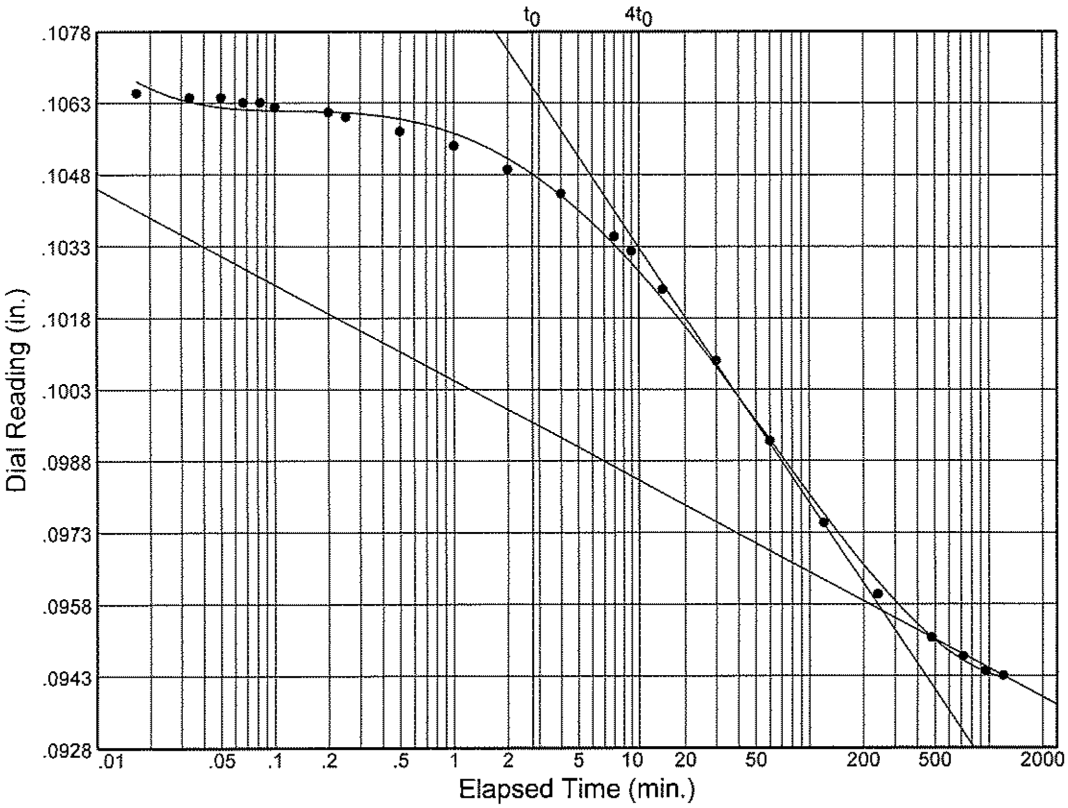
0.05 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 1 | Elev./Depth: 2.0'



Load No.= 11

Load= 0.97 tsf

D_0 = 0.10684

D_{50} = 0.10125

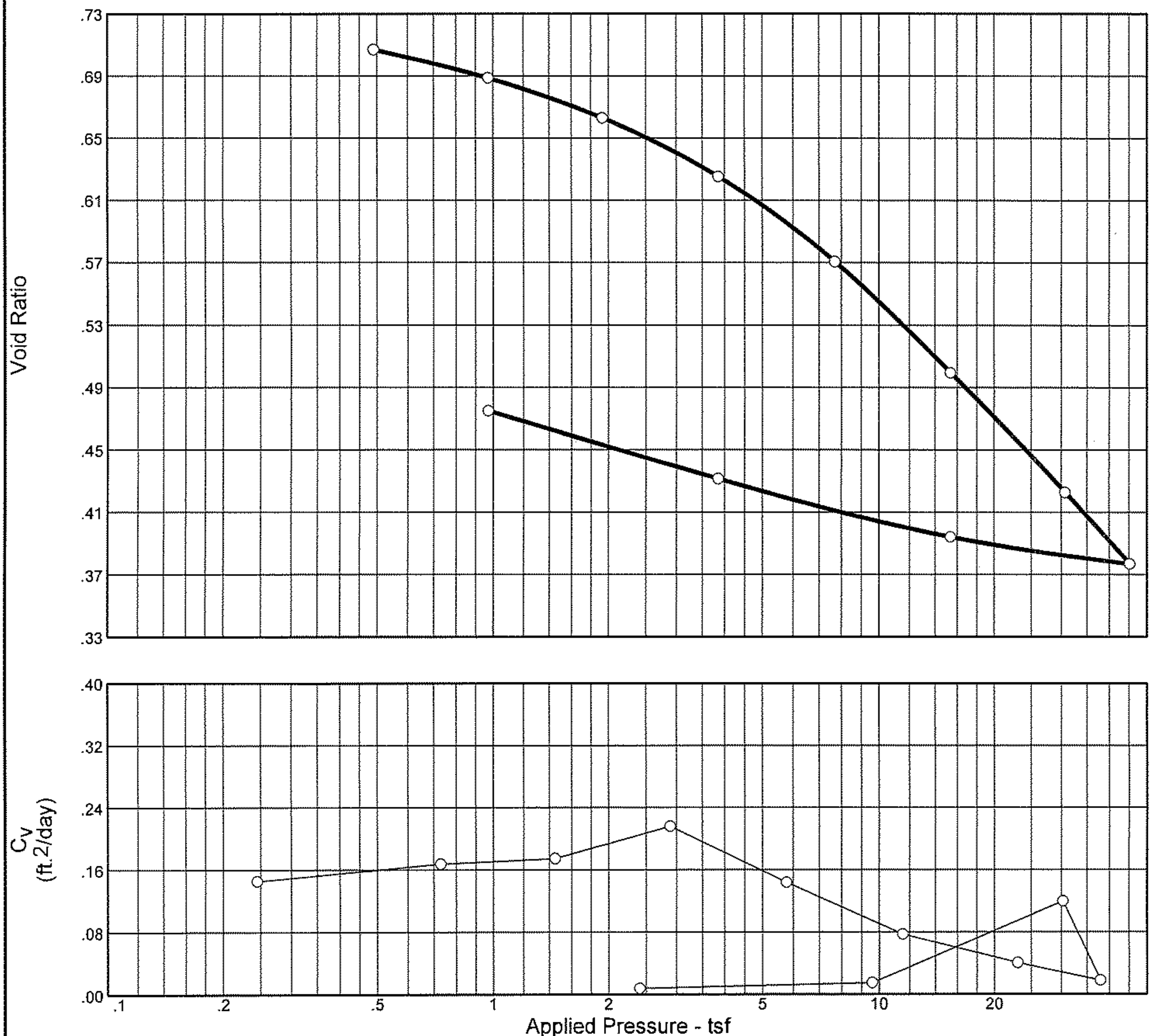
D_{100} = 0.09565

T_{50} = 24.01 min.

C_v @ T_{50}

0.01 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
100.0 %	26.9 %	96.9	38	24	2.69	5.81	0.26	0.723

MATERIAL DESCRIPTION	USCS	AASHTO
ST LT-G SACL	CL	

P

P

Source: T15-4 **Sample No.:** 18 **Elev./Depth:** 78.0'

Remarks:

TESTED BY: RR

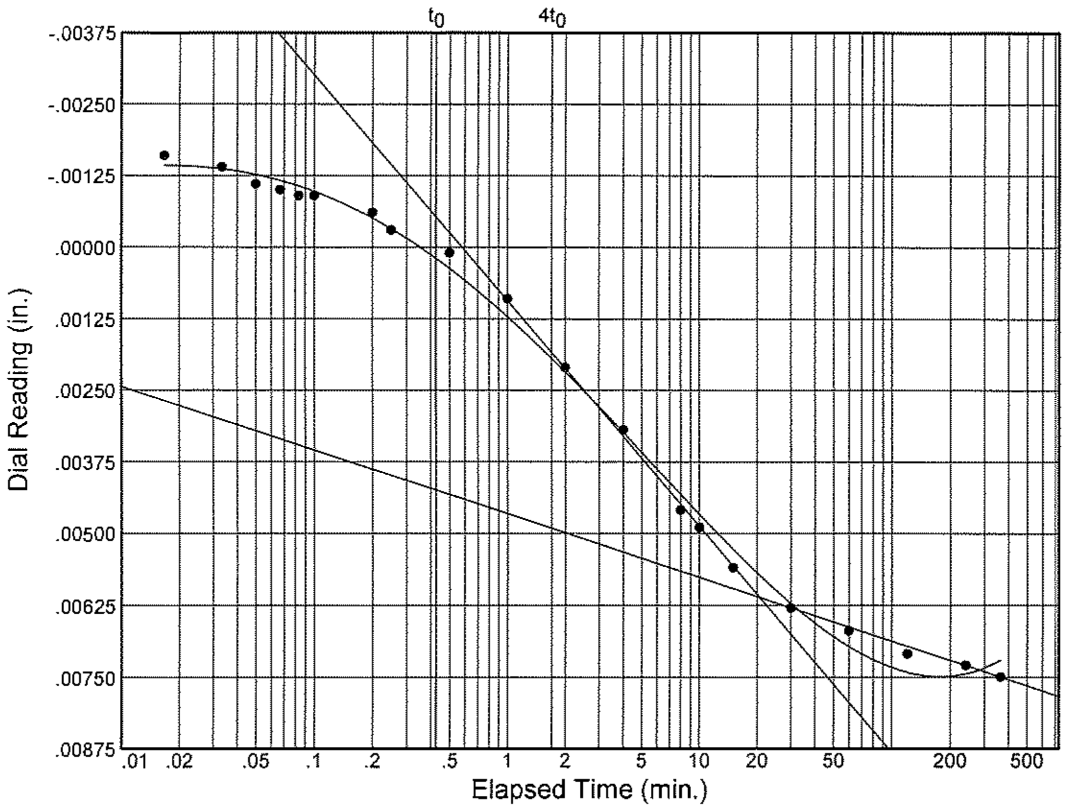
CHECKED BY: RNE

EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Figure

Dial Reading vs. Time

Source: T15-4 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 1

Load= 0.49 tsf

D_0 = -0.00156

D_{50} = 0.00228

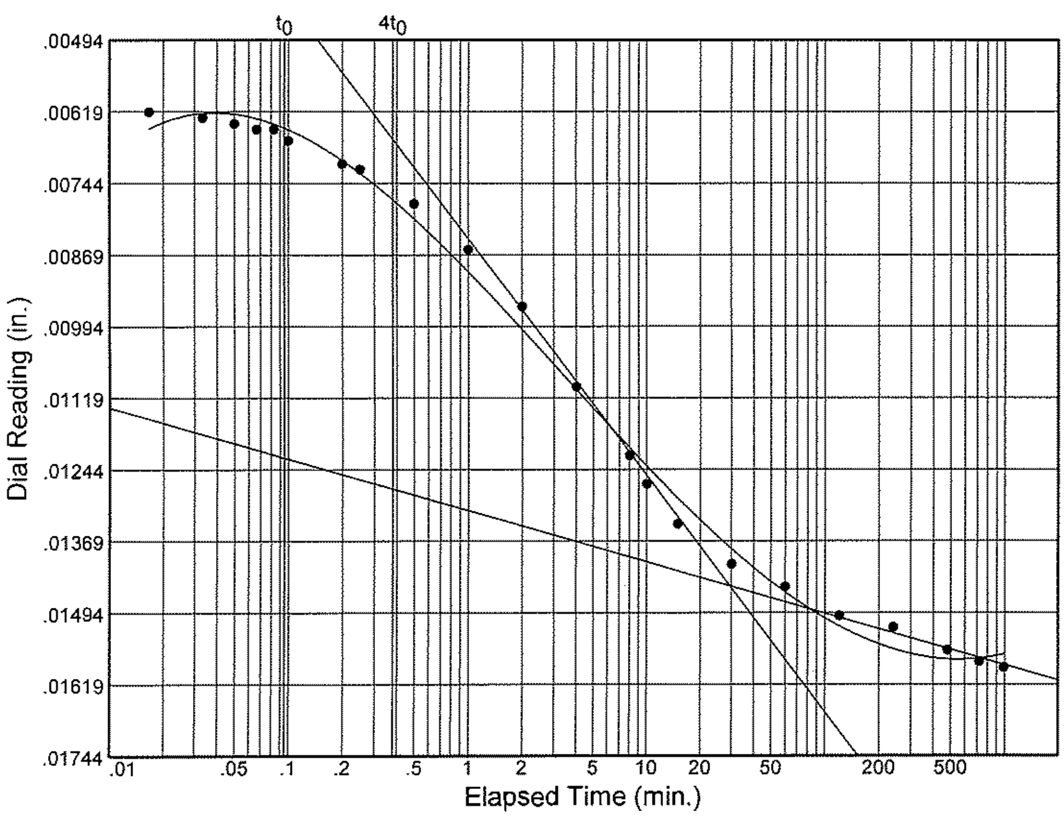
D_{100} = 0.00612

T_{50} = 2.12 min.

C_v @ T_{50}

0.15 ft.^{2}/day

C_α = 0.001



Load No.= 2

Load= 0.97 tsf

D_0 = 0.00523

D_{50} = 0.00985

D_{100} = 0.01448

T_{50} = 1.81 min.

C_v @ T_{50}

0.17 ft.^{2}/day

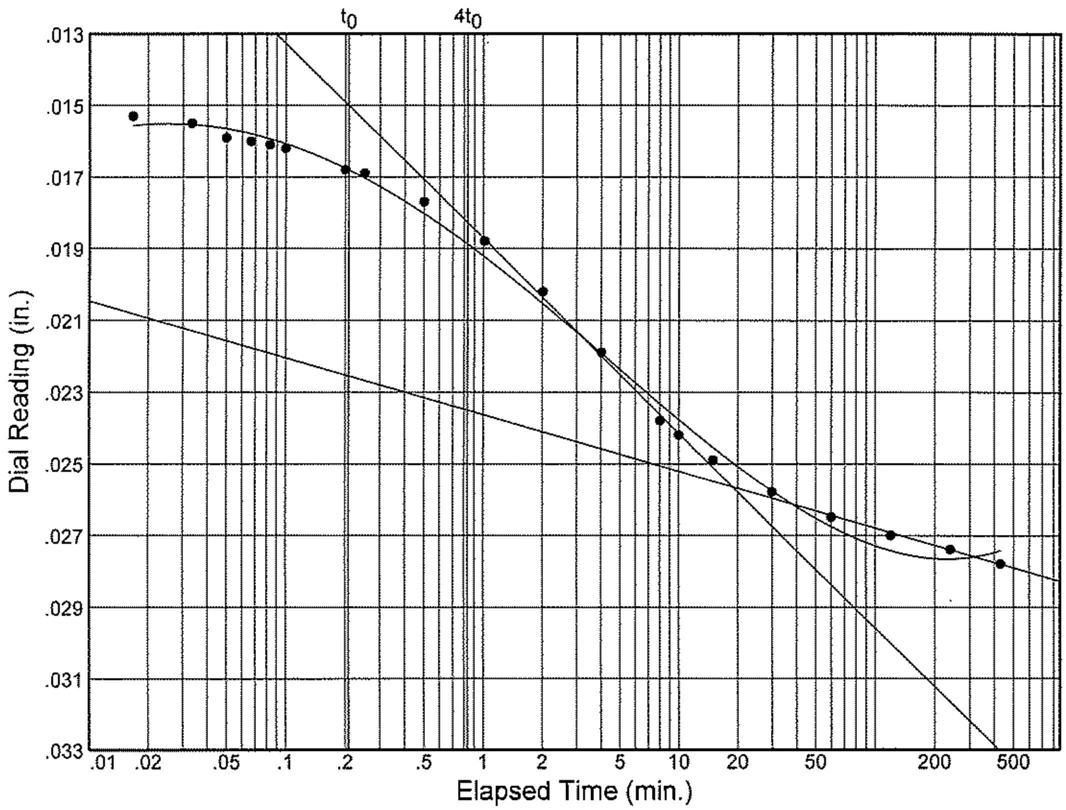
C_α = 0.001

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 3

Load= 1.93 tsf

D_0 = 0.01473

D_{50} = 0.02019

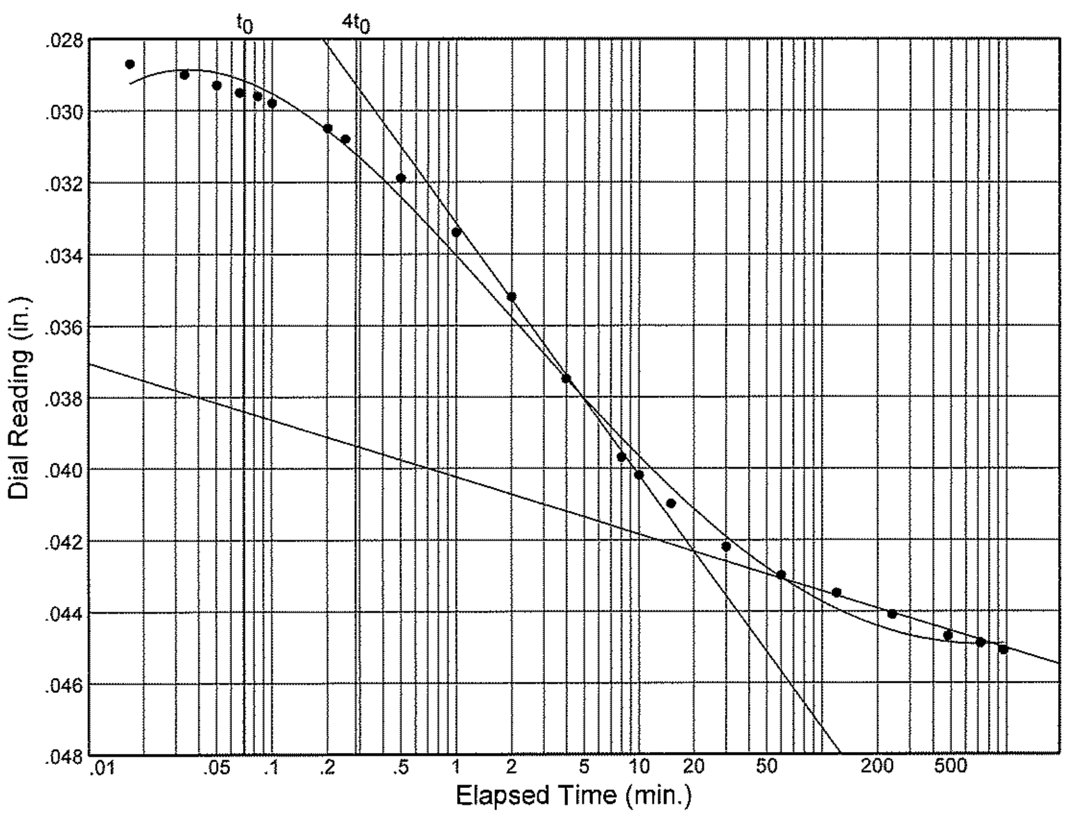
D_{100} = 0.02565

T_{50} = 1.69 min.

C_v @ T_{50}

0.17 ft.^{2}/day

C_α = 0.002



Load No.= 4

Load= 3.85 tsf

D_0 = 0.02713

D_{50} = 0.03473

D_{100} = 0.04232

T_{50} = 1.32 min.

C_v @ T_{50}

0.22 ft.^{2}/day

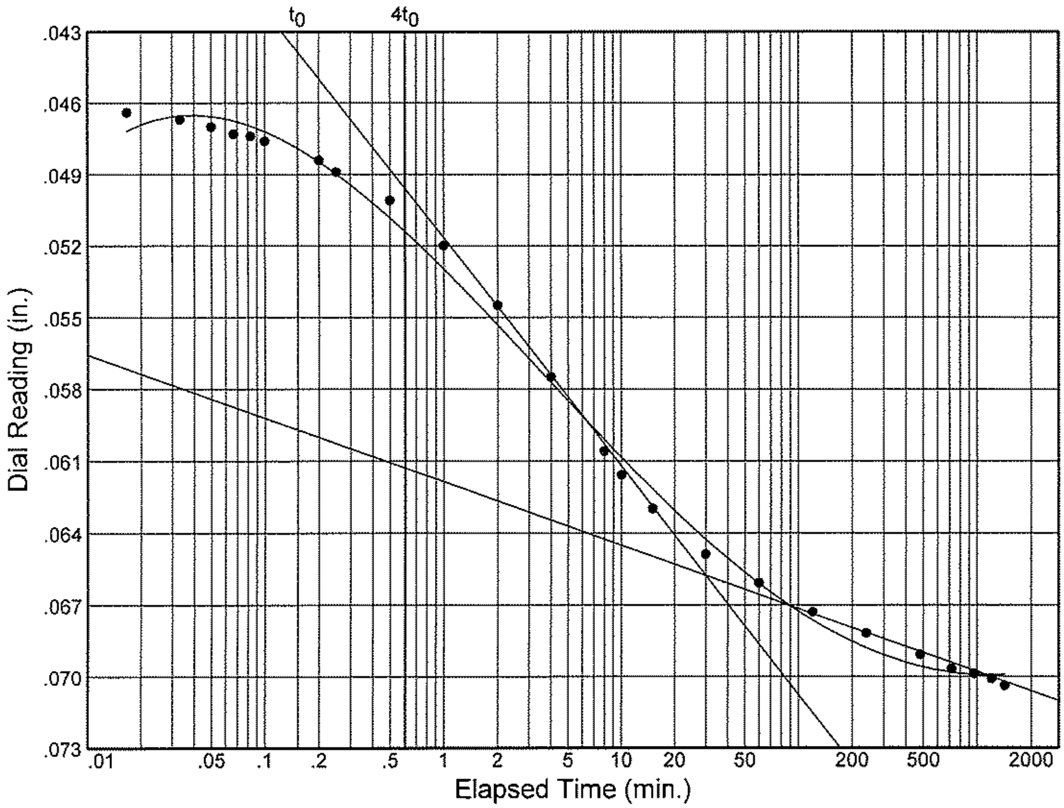
C_α = 0.002

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 5

Load= 7.69 tsf

D_0 = 0.04439

D_{50} = 0.05508

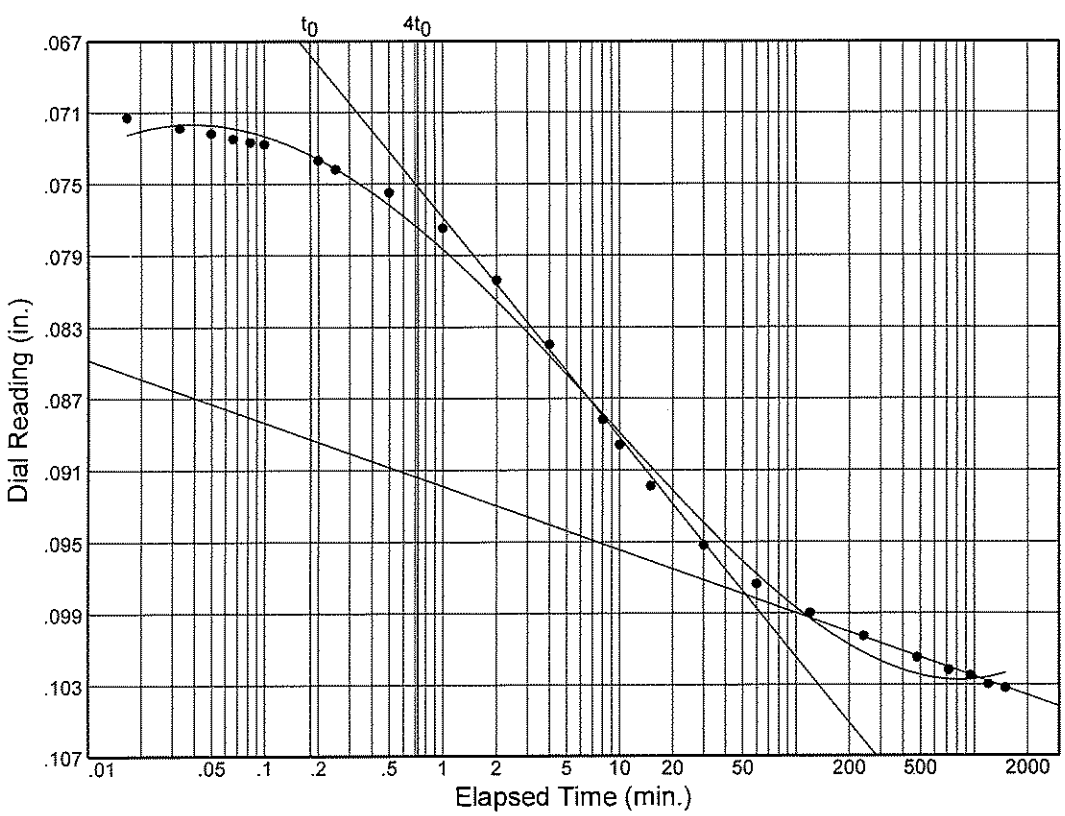
D_{100} = 0.06578

T_{50} = 1.87 min.

C_v @ T_{50}

0.14 ft.^{2}/day

C_α = 0.004



Load No.= 6

Load= 15.37 tsf

D_0 = 0.06933

D_{50} = 0.08366

D_{100} = 0.09799

T_{50} = 3.23 min.

C_v @ T_{50}

0.08 ft.^{2}/day

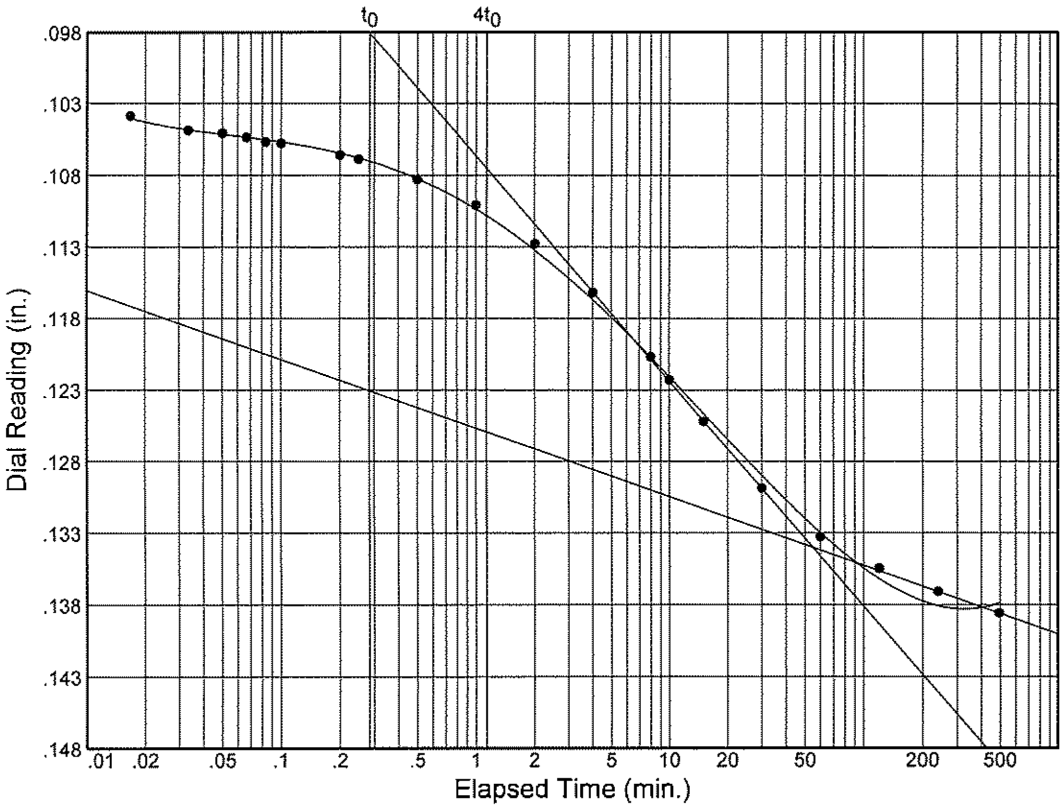
C_α = 0.005

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 7

Load= 30.73 tsf

D_0 = 0.10320

D_{50} = 0.11861

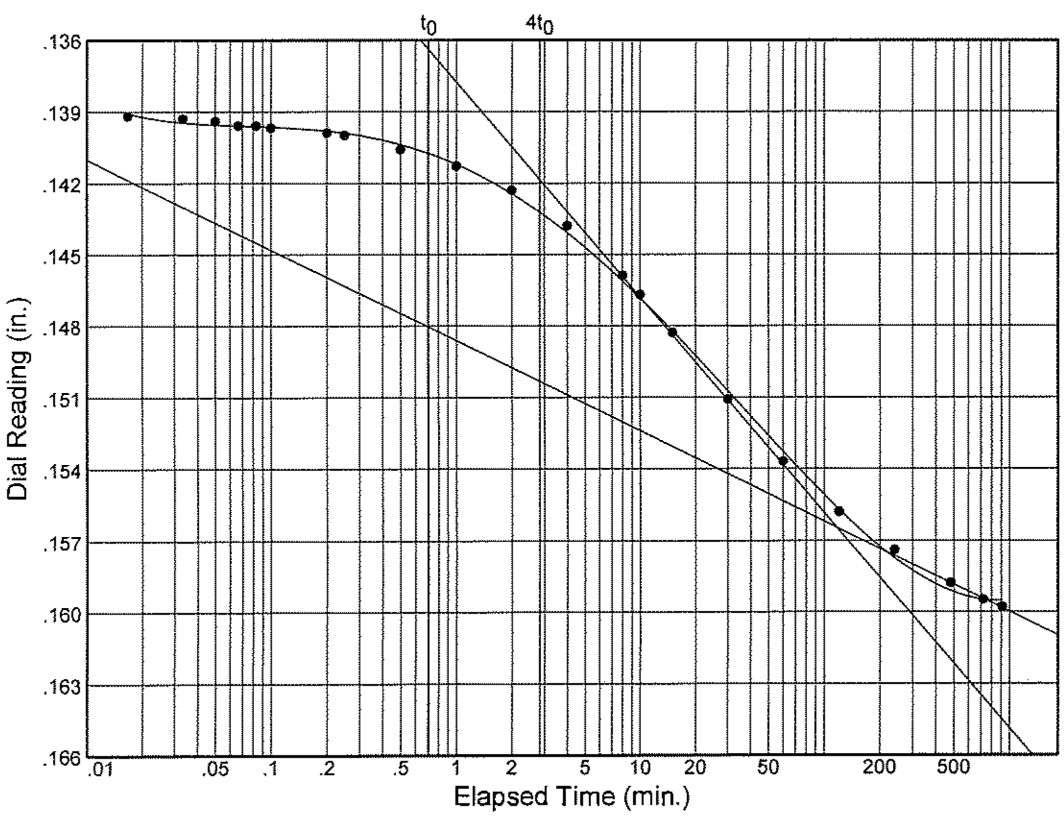
D_{100} = 0.13401

T_{50} = 5.60 min.

C_v @ T_{50}

0.04 ft.^{2}/day

C_α = 0.007



Load No.= 8

Load= 45.21 tsf

D_0 = 0.13828

D_{50} = 0.14737

D_{100} = 0.15645

T_{50} = 11.69 min.

C_v @ T_{50}

0.02 ft.^{2}/day

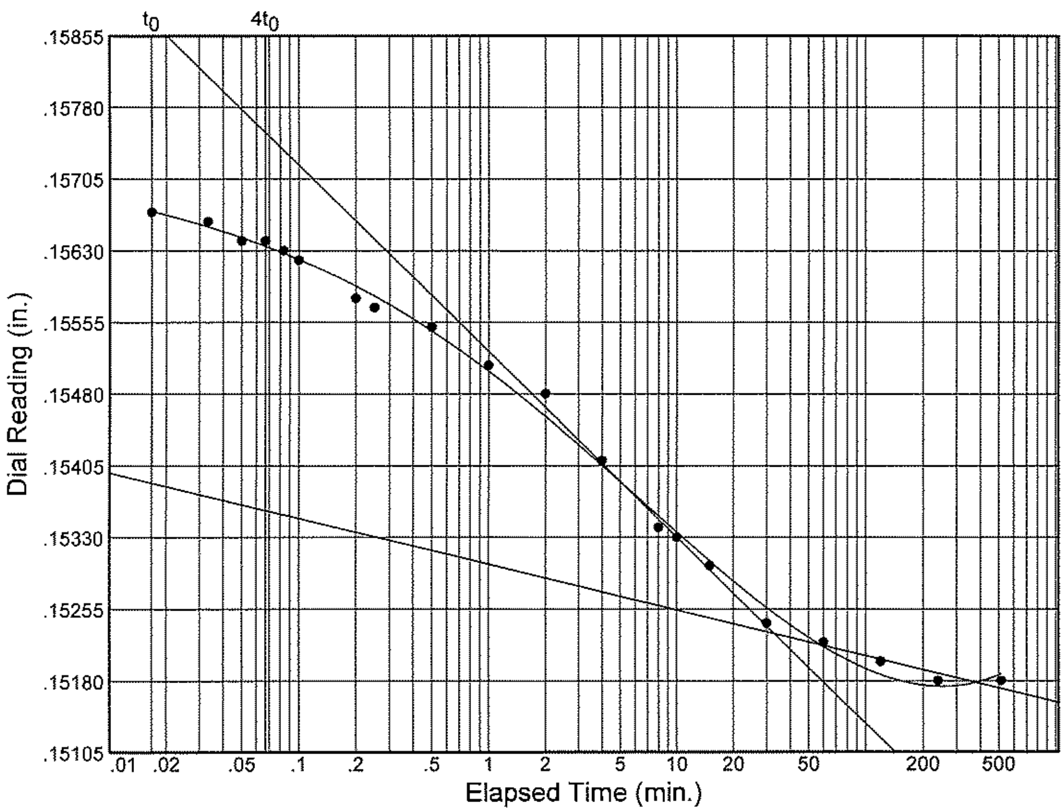
C_α = 0.006

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 Sample No.: 18 Elev./Depth: 78.0'



Load No.= 9

Load= 15.37 tsf

D_0 = 0.15708

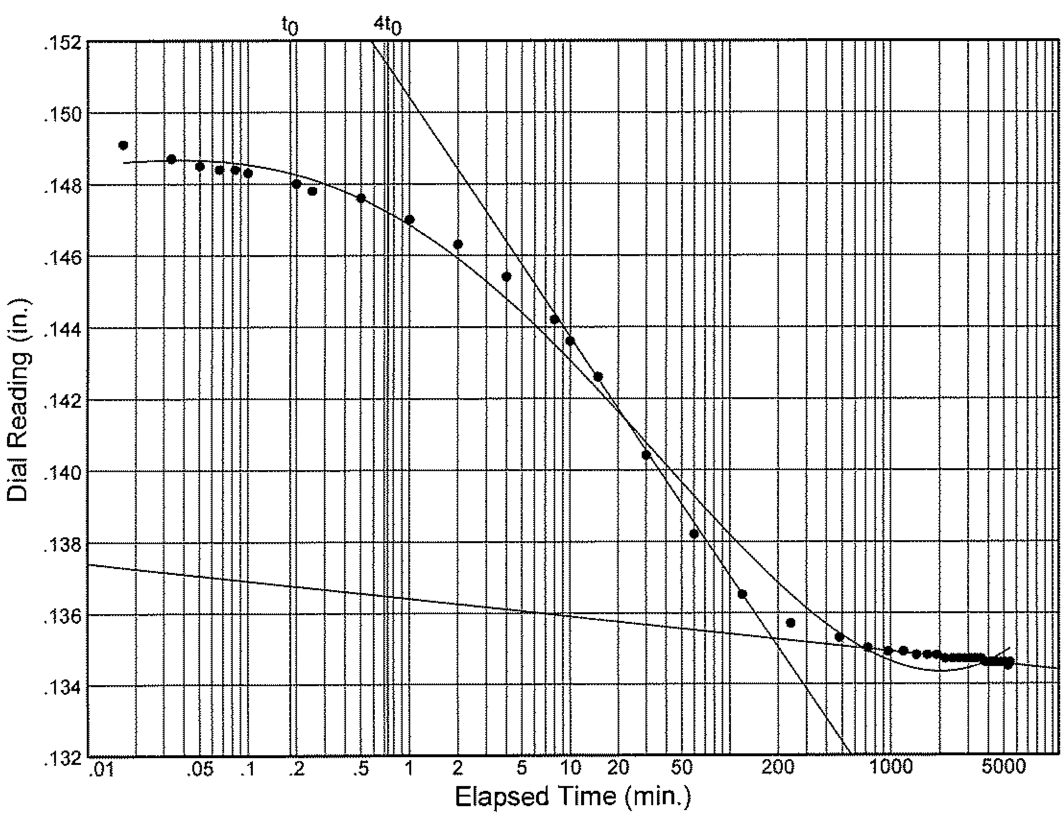
D_{50} = 0.15469

D_{100} = 0.15229

T_{50} = 1.68 min.

C_v @ T_{50}

0.12 ft.^{2}/day



Load No.= 10

Load= 3.85 tsf

D_0 = 0.14940

D_{50} = 0.14234

D_{100} = 0.13528

T_{50} = 14.26 min.

C_v @ T_{50}

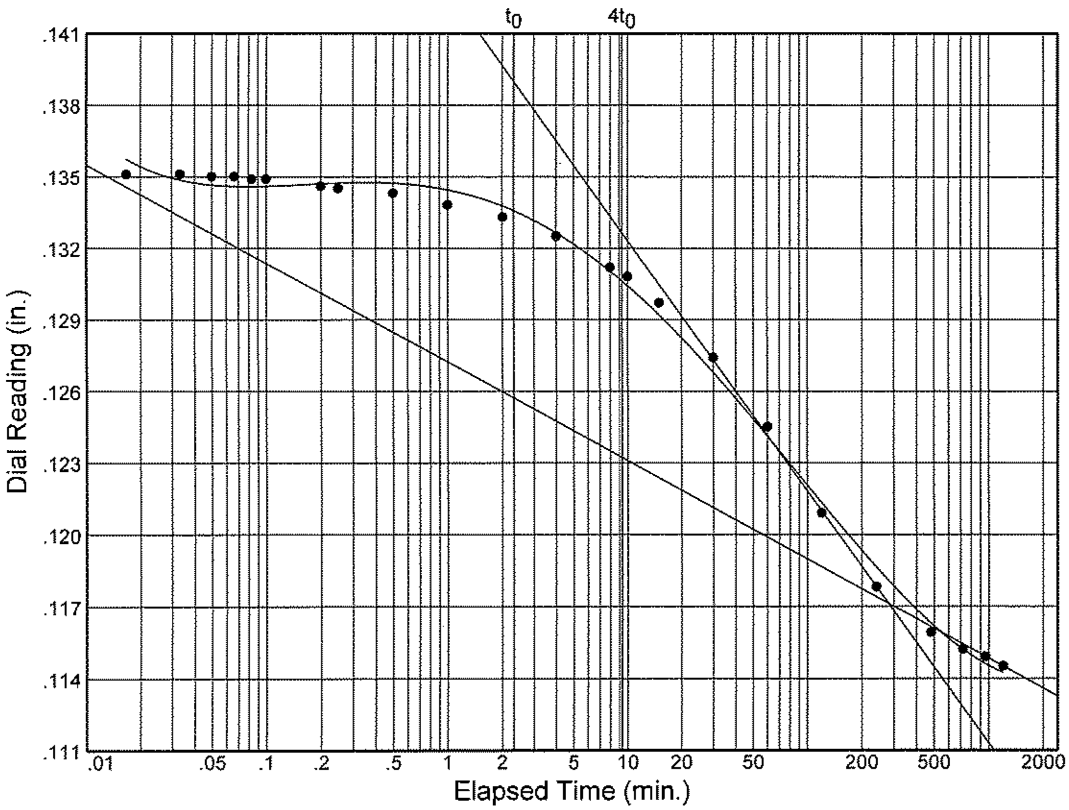
0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T15-4 | Sample No.: 18 | Elev./Depth: 78.0'



Load No.= 11

Load= 0.97 tsf

D_0 = 0.13651

D_{50} = 0.12681

D_{100} = 0.11711

T_{50} = 29.76 min.

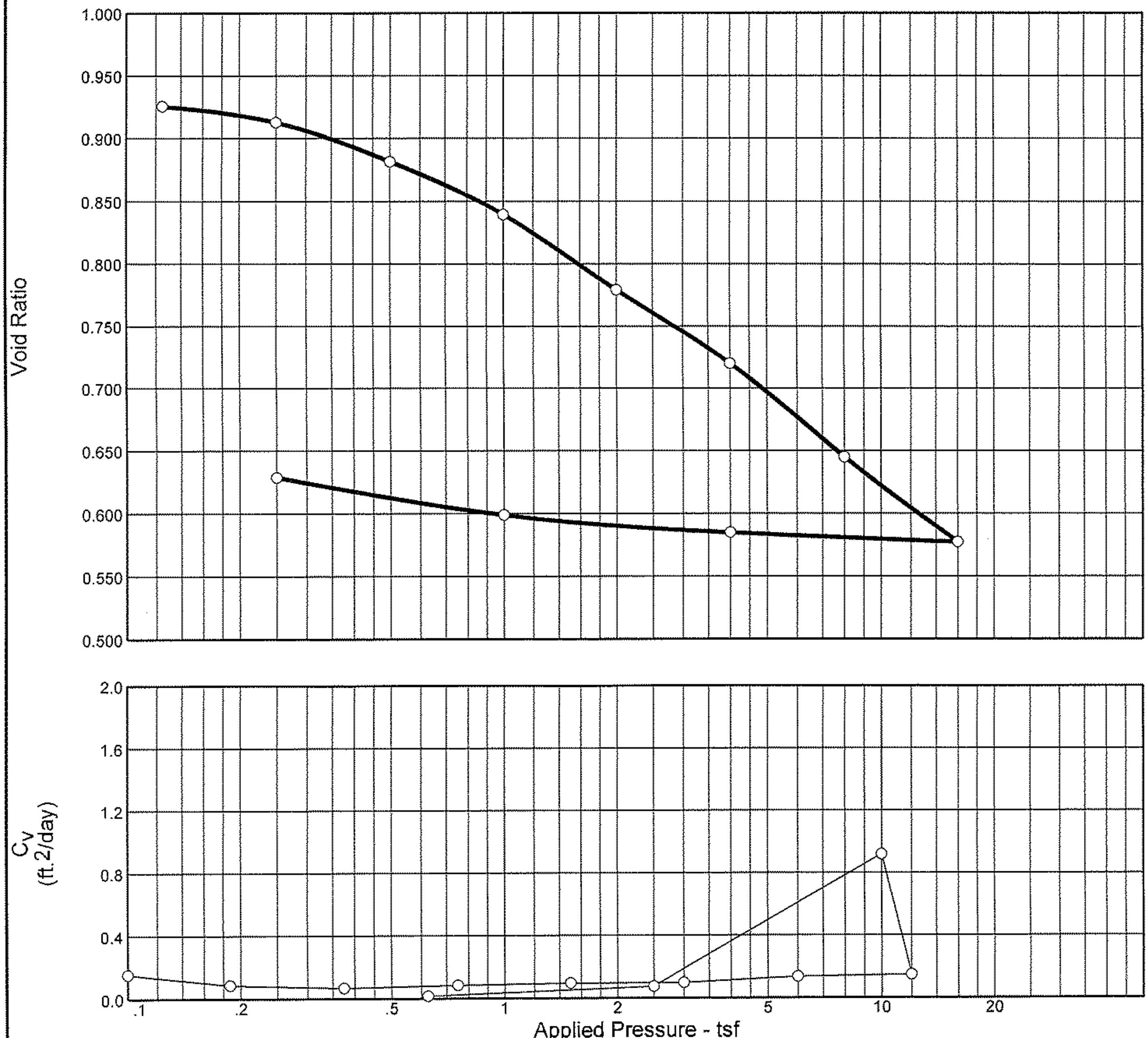
C_v @ T_{50}

0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
99.6 %	34.3 %	87.3	45	27	2.70	1.02	0.25	0.931

MATERIAL DESCRIPTION	USCS	AASHTO
SO G SACL W/ SH FRAG	CL	

Projec

Projec

Source: T16-1 **Sample No.:** 8 **Elev./Depth:** 28.0'

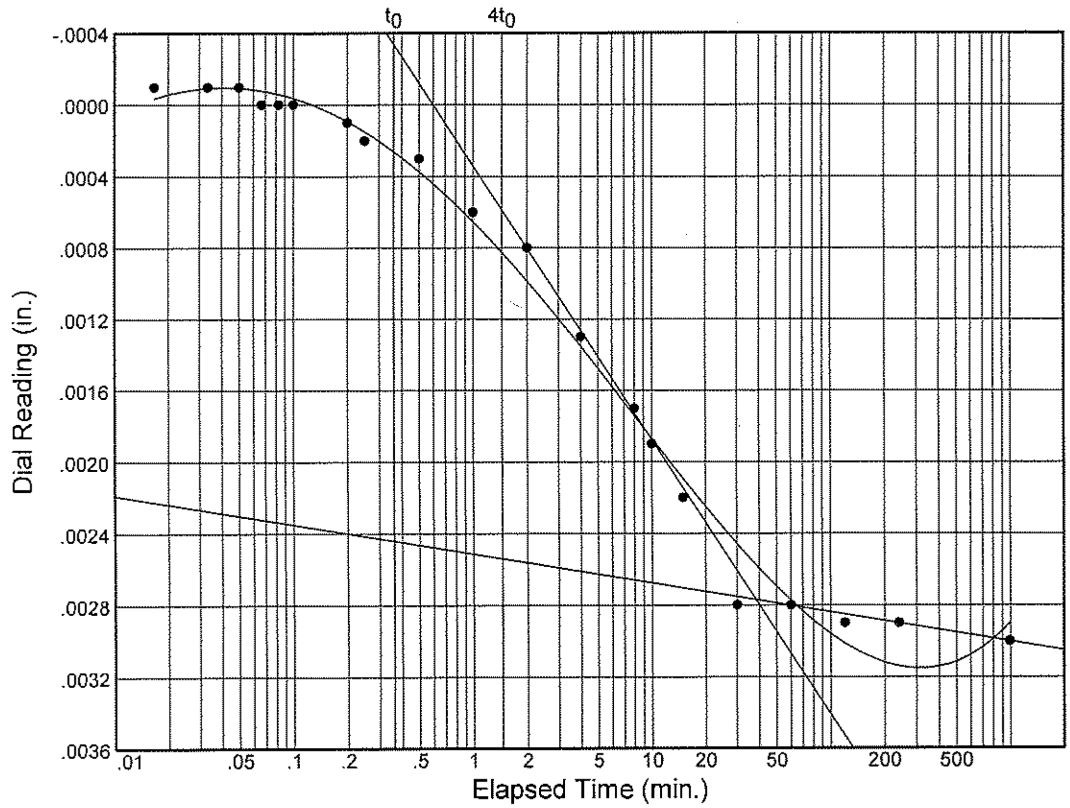
EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Remarks:
TESTED BY: RR
CHECKED BY: RNE

Figure

Dial Reading vs. Time

Source: T16-1 | Sample No.: 8 | Elev./Depth: 28.0'



Load No.= 1

Load= 0.13 tsf

D_0 = -0.00030

D_{50} = 0.00123

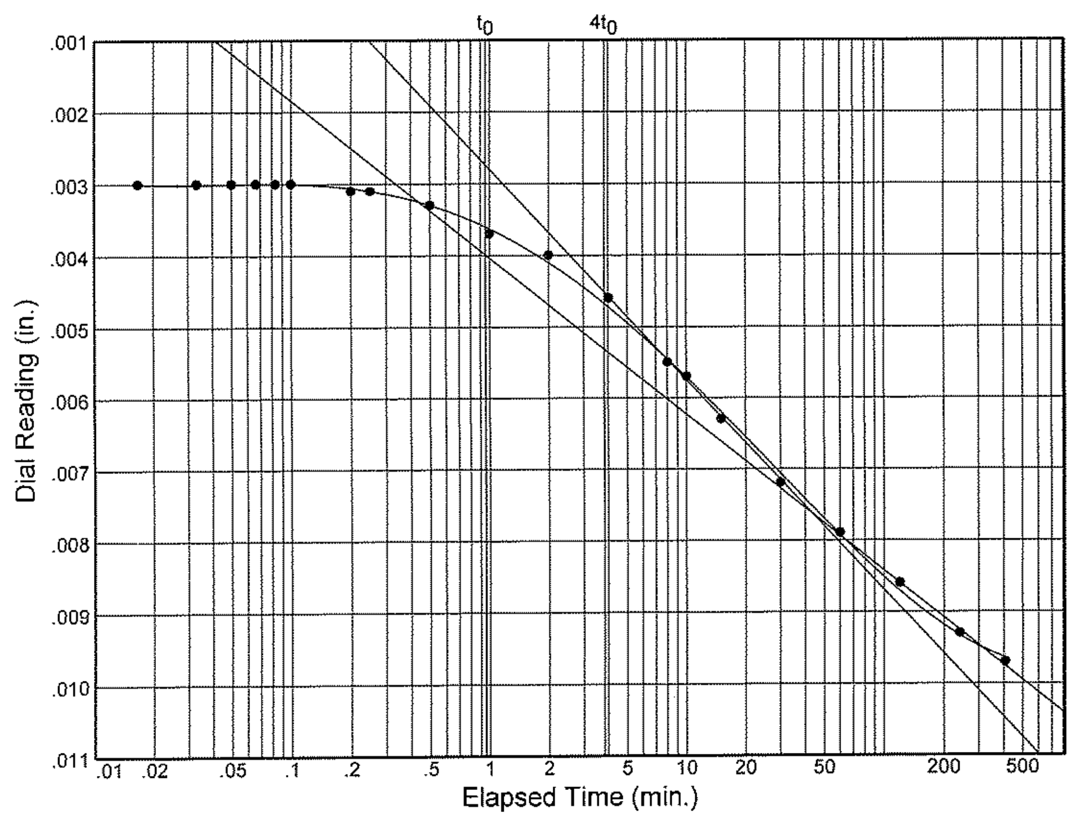
D_{100} = 0.00277

T_{50} = 3.20 min.

C_v @ T_{50}

0.15 ft.^{2}/day

C_α = 0.000



Load No.= 2

Load= 0.25 tsf

D_0 = 0.00253

D_{50} = 0.00509

D_{100} = 0.00764

T_{50} = 5.74 min.

C_v @ T_{50}

0.08 ft.^{2}/day

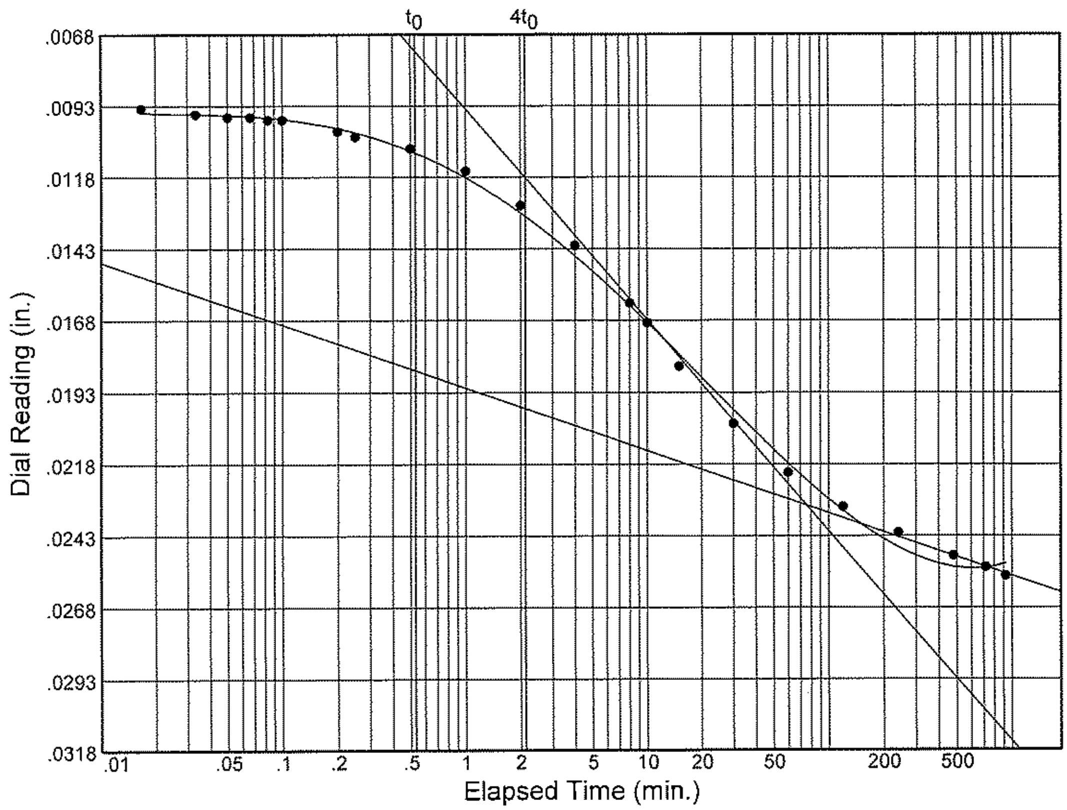
C_α = 0.002

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 Sample No.: 8 Elev./Depth: 28.0'



Load No.= 3

Load= 0.50 tsf

D_0 = 0.00874

D_{50} = 0.01599

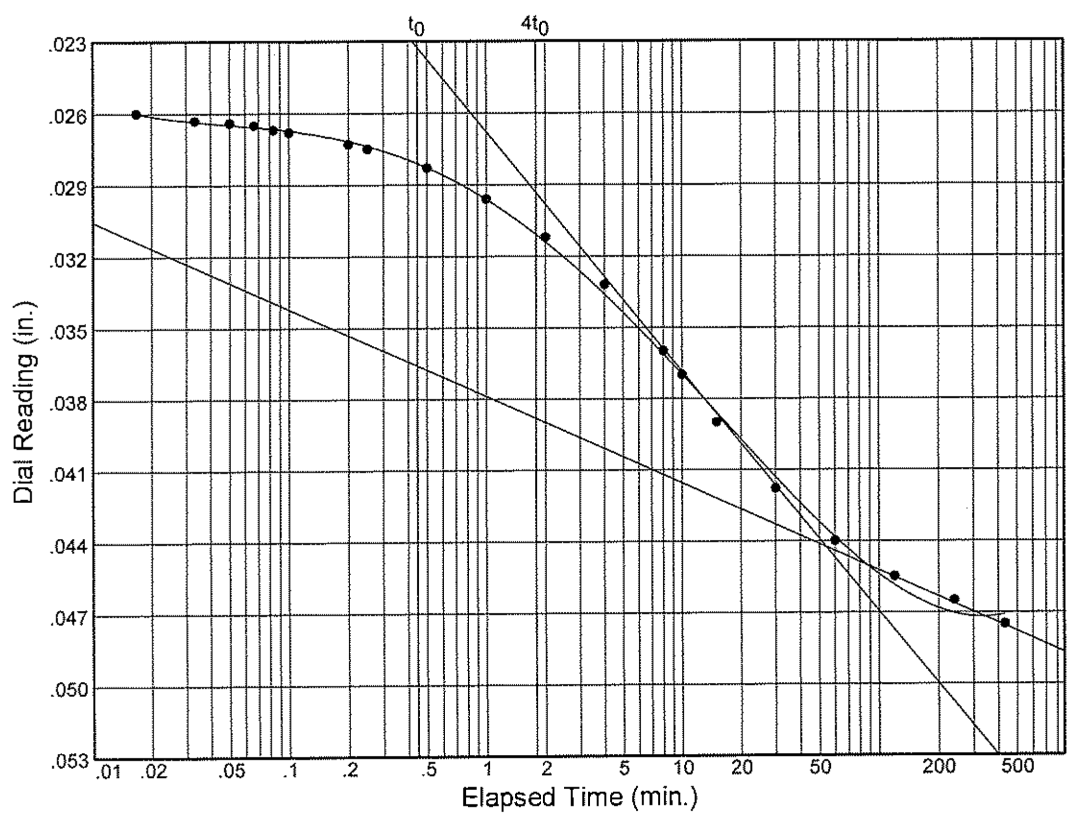
D_{100} = 0.02325

T_{50} = 7.15 min.

C_v @ T_{50}

0.07 ft.^{2}/day

C_α = 0.002



Load No.= 4

Load= 1.00 tsf

D_0 = 0.02514

D_{50} = 0.03470

D_{100} = 0.04425

T_{50} = 5.46 min.

C_v @ T_{50}

0.08 ft.^{2}/day

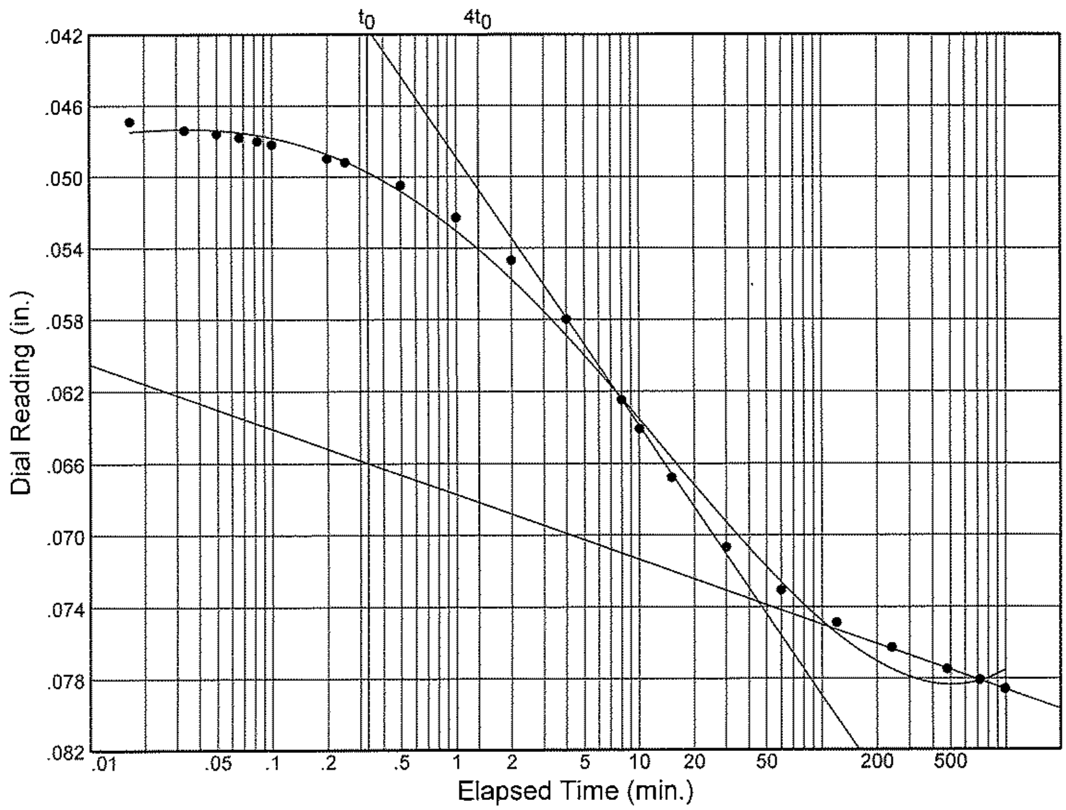
C_α = 0.004

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 | Sample No.: 8 | Elev./Depth: 28.0'



Load No.= 5

Load= 2.00 tsf

D_0 = 0.04545

D_{50} = 0.05959

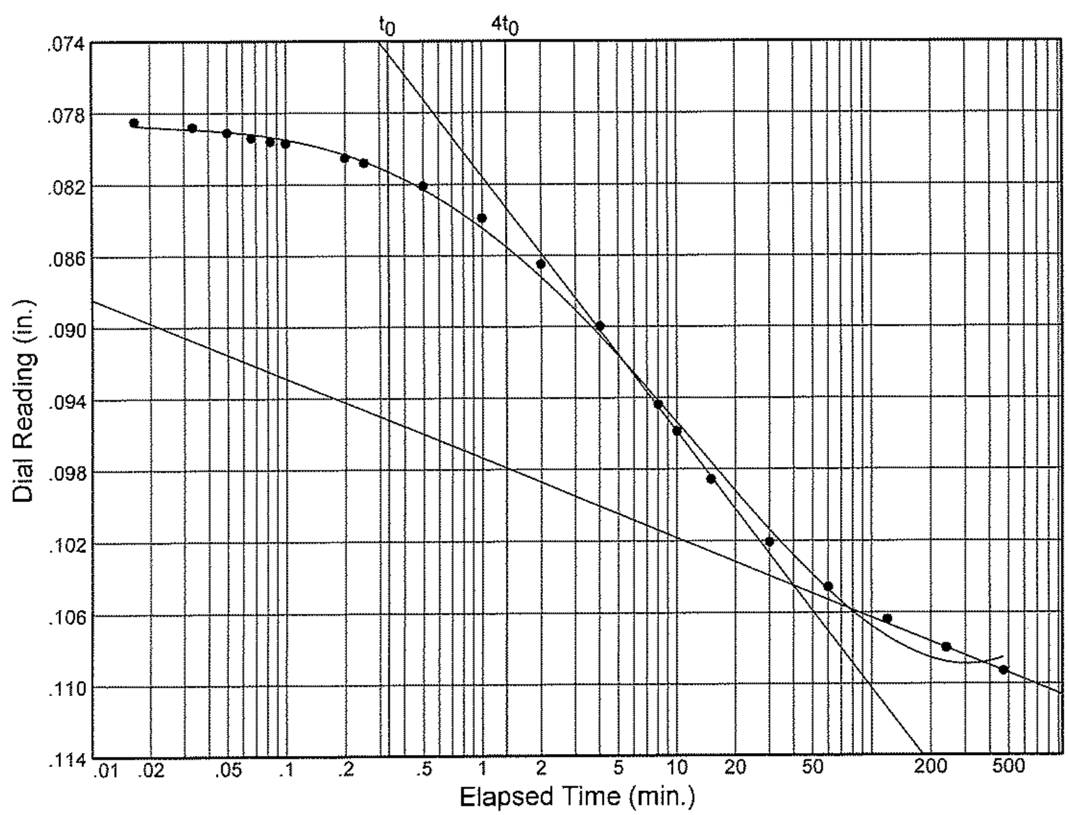
D_{100} = 0.07373

T_{50} = 4.59 min.

C_v @ T_{50}

0.09 ft.^{2}/day

C_α = 0.004



Load No.= 6

Load= 4.00 tsf

D_0 = 0.07704

D_{50} = 0.09078

D_{100} = 0.10451

T_{50} = 4.22 min.

C_v @ T_{50}

0.10 ft.^{2}/day

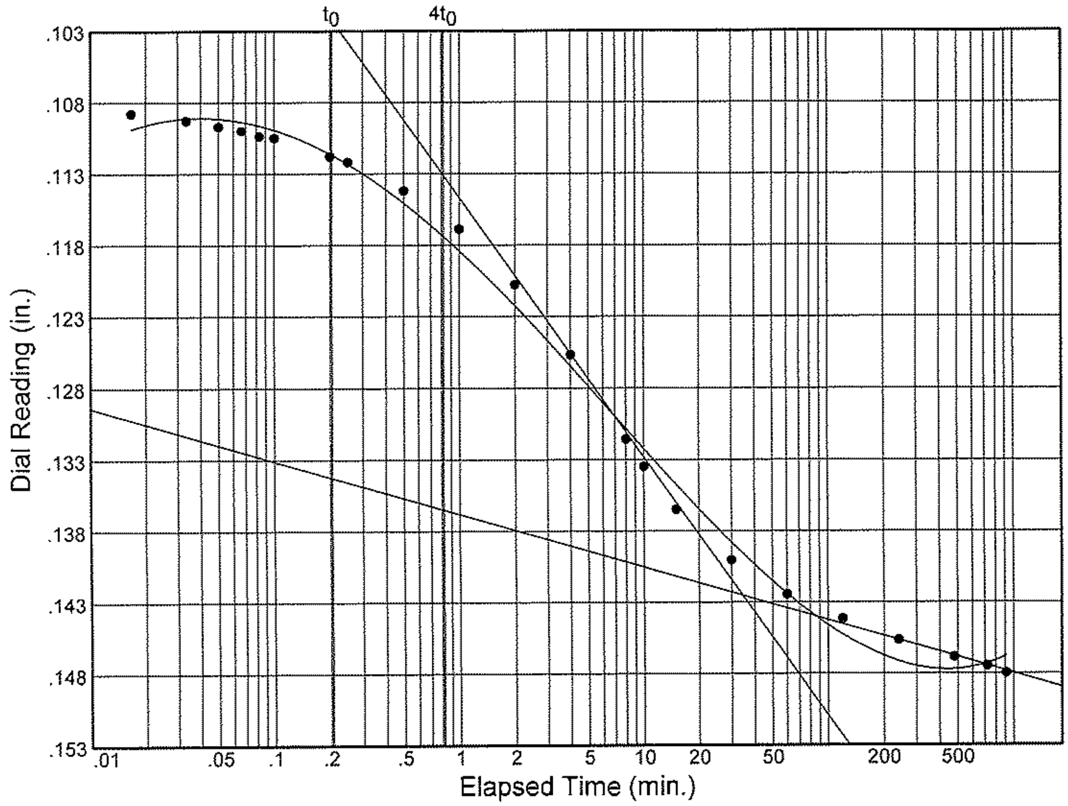
C_α = 0.005

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 | Sample No.: 8 | Elev./Depth: 28.0'



Load No.= 7

Load= 8.00 tsf

D_0 = 0.10600

D_{50} = 0.12427

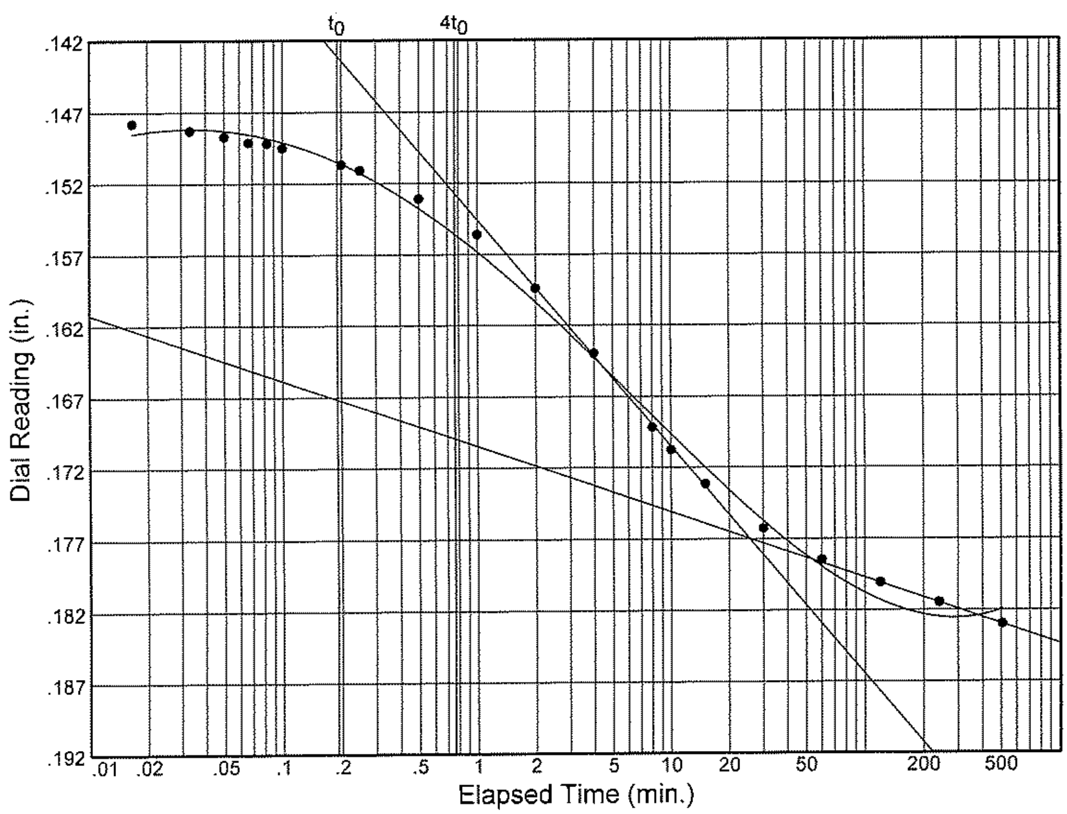
D_{100} = 0.14255

T_{50} = 2.79 min.

C_V @ T_{50}

0.13 ft.^{2}/day

C_α = 0.004



Load No.= 8

Load= 16.00 tsf

D_0 = 0.14546

D_{50} = 0.16122

D_{100} = 0.17698

T_{50} = 2.33 min.

C_V @ T_{50}

0.15 ft.^{2}/day

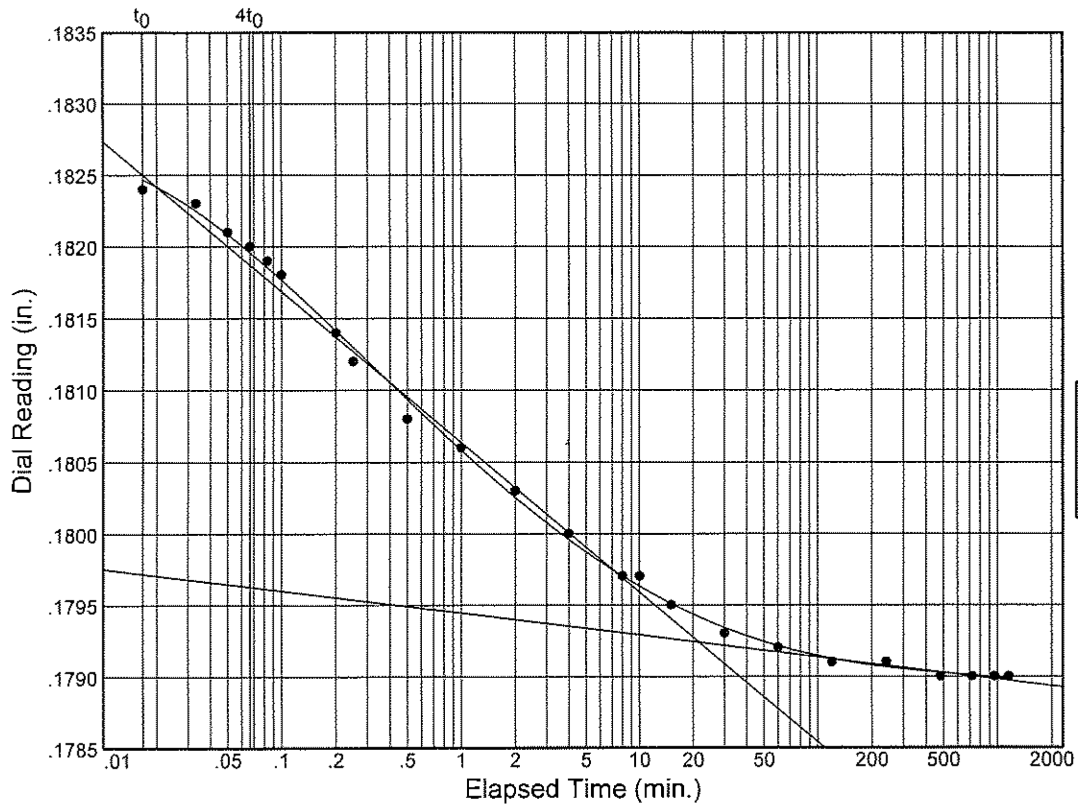
C_α = 0.005

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 | Sample No.: 8 | Elev./Depth: 28.0'



Load No.= 9

Load= 4.00 tsf

D_0 = 0.18298

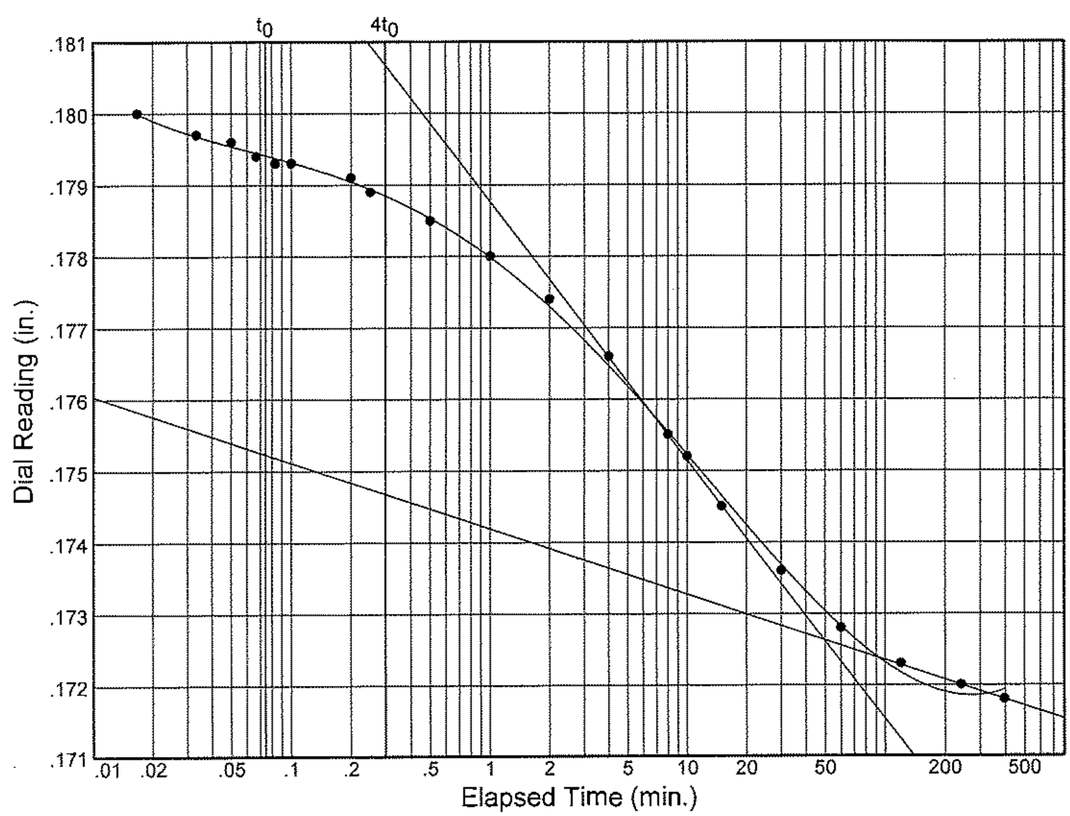
D_{50} = 0.18111

D_{100} = 0.17924

T_{50} = 0.36 min.

C_v @ T_{50}

0.92 ft.^{2}/day



Load No.= 10

Load= 1.00 tsf

D_0 = 0.17998

D_{50} = 0.17630

D_{100} = 0.17263

T_{50} = 4.54 min.

C_v @ T_{50}

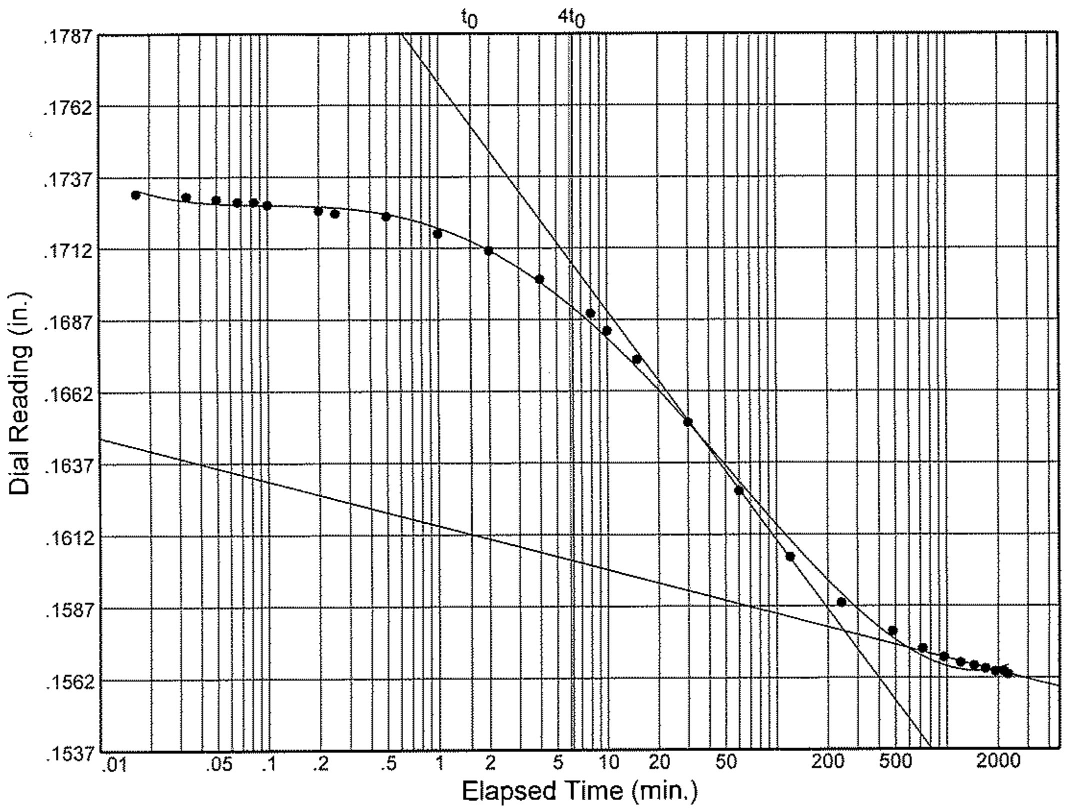
0.07 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 | Sample No.: 8 | Elev./Depth: 28.0'



Load No.= 11

Load= 0.25 tsf

D_0 = 0.17375

D_{50} = 0.16578

D_{100} = 0.15781

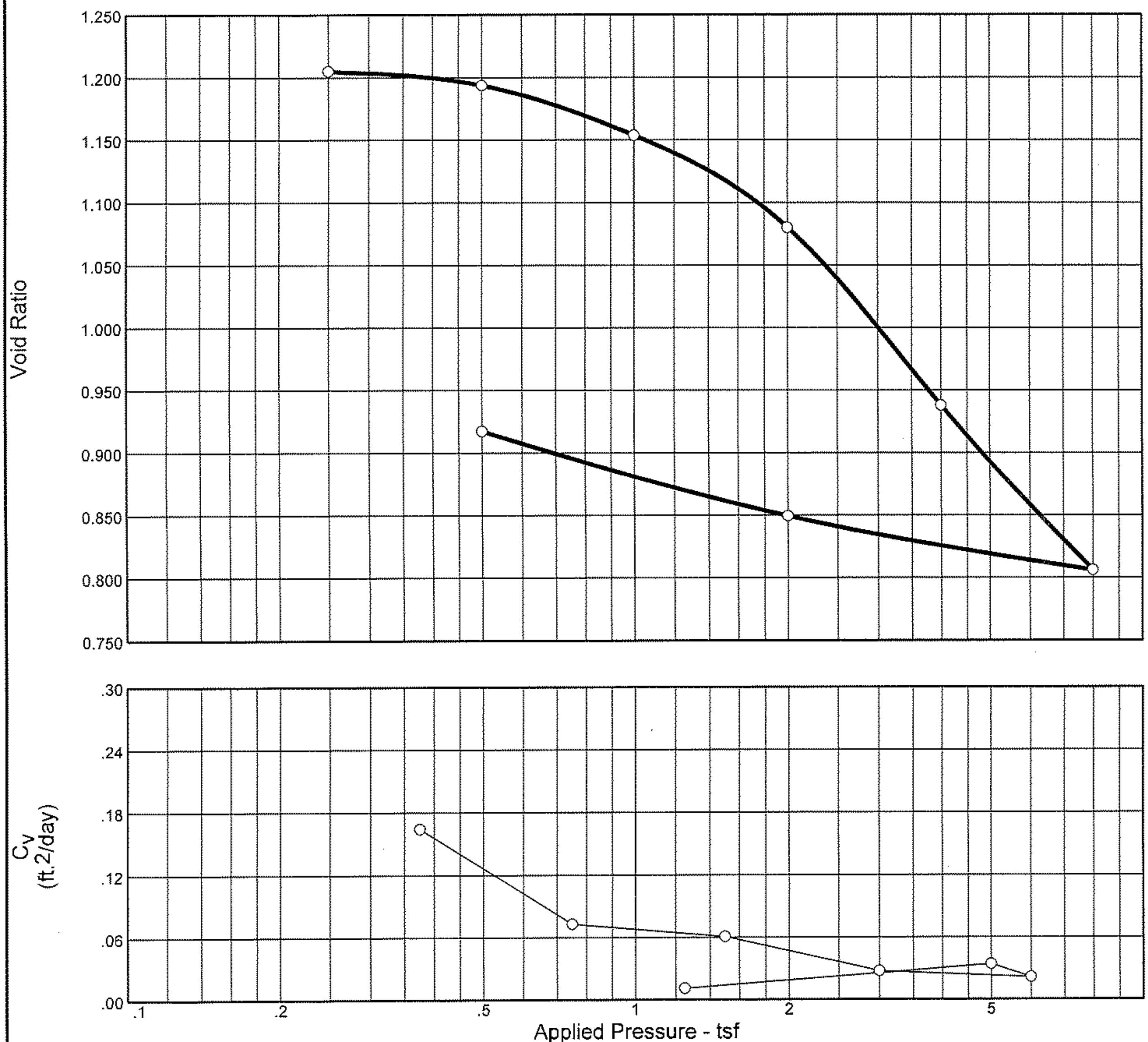
T_{50} = 23.65 min.

C_v @ T_{50}
0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (tsf)	C_c	Initial Void Ratio
Saturation	Moisture							
99.8 %	44.8 %	76.2	64	46	2.70	1.60	0.49	1.212

MATERIAL DESCRIPTION	USCS	AASHTO
MST G CL W/ SISA POC, WD	CH	

Pro

Pro

Source: T16-1 **Sample No.:** 14 **Elev./Depth:** 58.0'

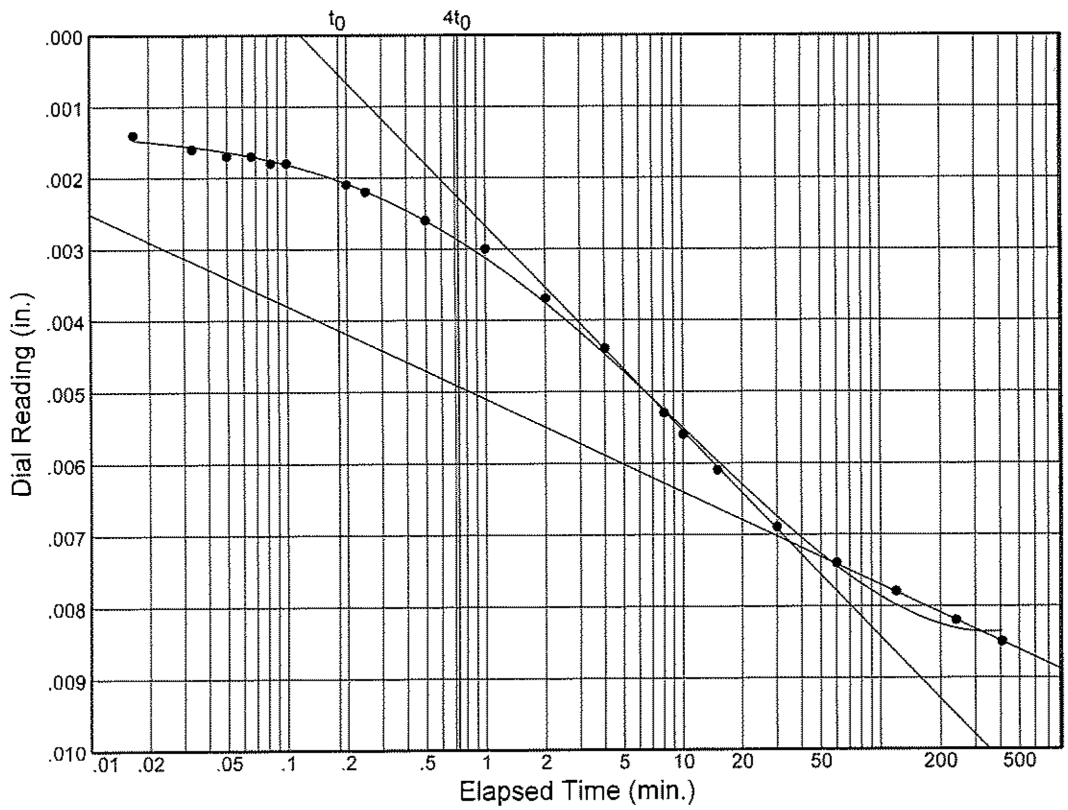
Remarks:
TESTED BY: RR
CHECKED BY: RNE

EUSTIS
Metairie, Louisiana
Lafayette, Louisiana
Gulfport, Mississippi

Figure

Dial Reading vs. Time

Source: T16-1 | Sample No.: 14 | Elev./Depth: 58.0'



Load No.= 2

Load= 0.50 tsf

D_0 = 0.00121

D_{50} = 0.00416

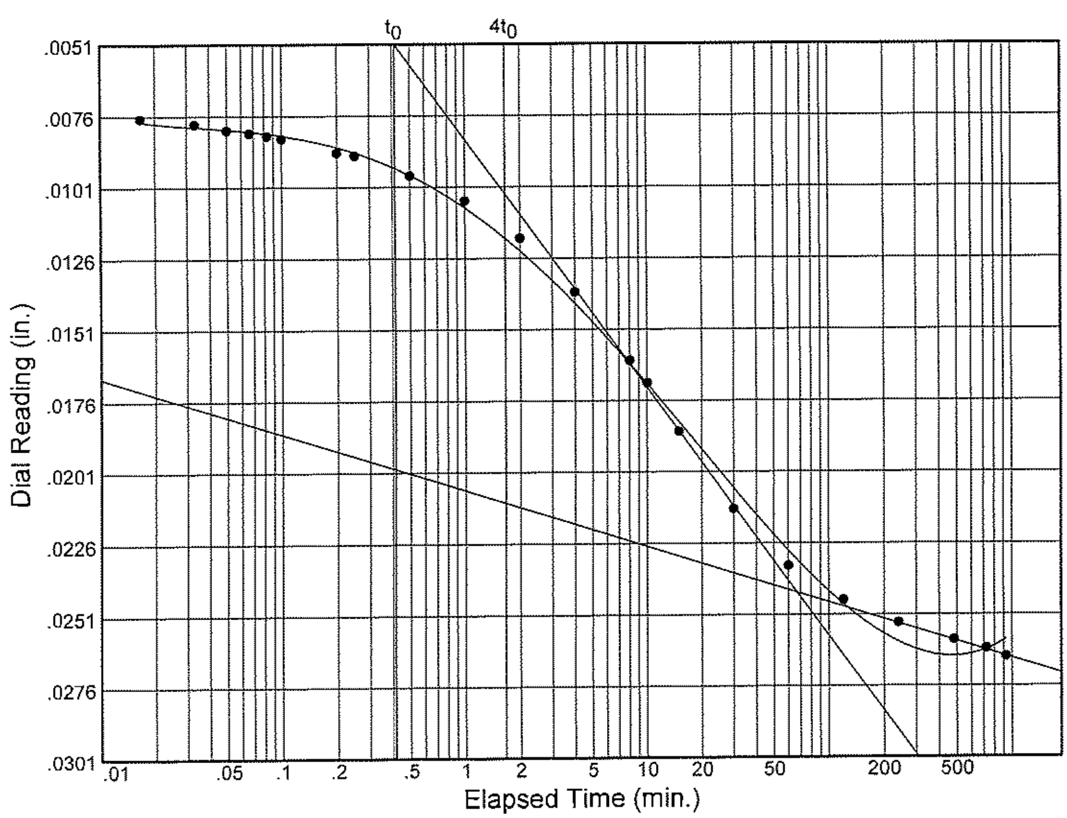
D_{100} = 0.00711

T_{50} = 2.96 min.

C_v @ T_{50}

0.16 ft.^{2}/day

C_α = 0.001



Load No.= 3

Load= 1.00 tsf

D_0 = 0.00697

D_{50} = 0.01565

D_{100} = 0.02433

T_{50} = 6.51 min.

C_v @ T_{50}

0.07 ft.^{2}/day

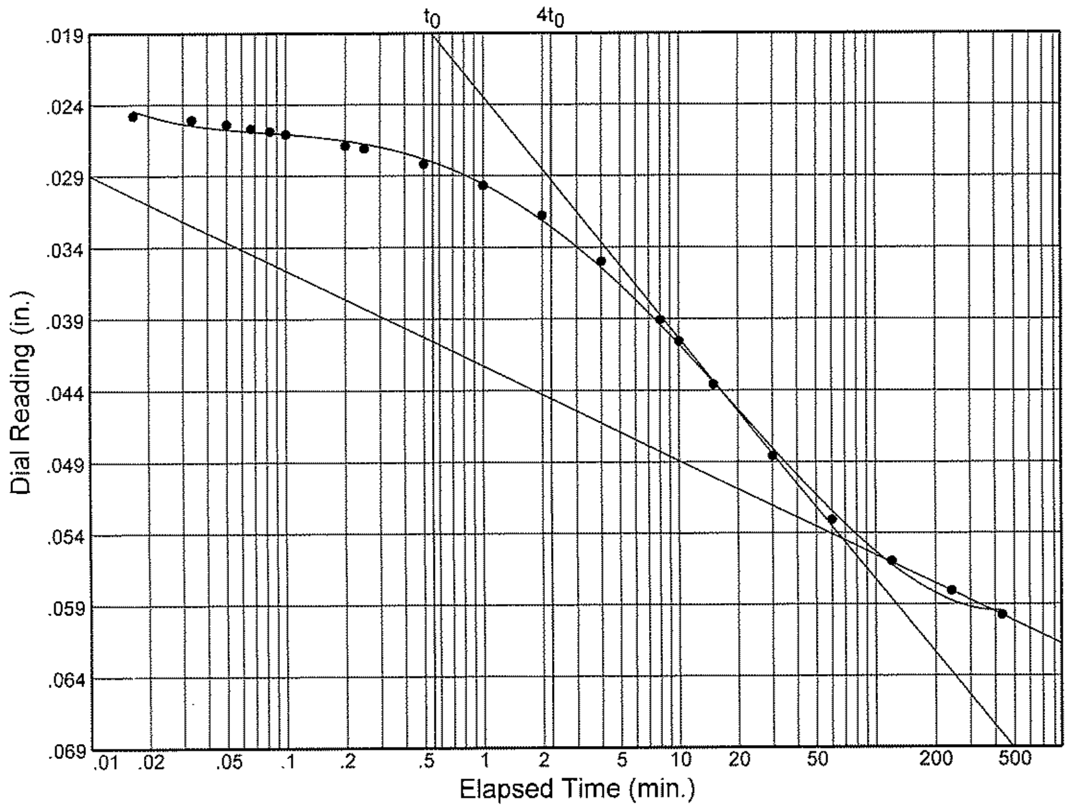
C_α = 0.002

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 Sample No.: 14 Elev./Depth: 58.0'



Load No.= 4

Load= 2.00 tsf

D_0 = 0.02351

D_{50} = 0.03898

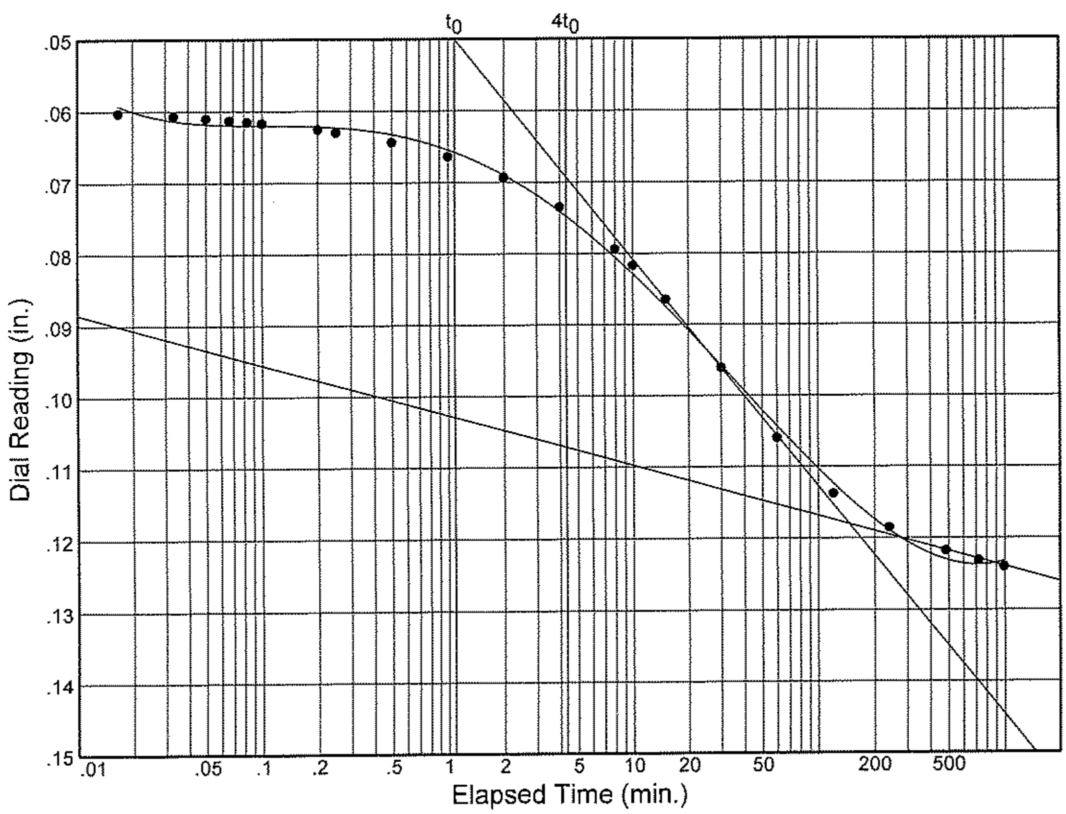
D_{100} = 0.05445

T_{50} = 7.45 min.

C_v @ T_{50}

0.06 ft.^{2}/day

C_α = 0.007



Load No.= 5

Load= 4.00 tsf

D_0 = 0.05678

D_{50} = 0.08740

D_{100} = 0.11803

T_{50} = 14.96 min.

C_v @ T_{50}

0.03 ft.^{2}/day

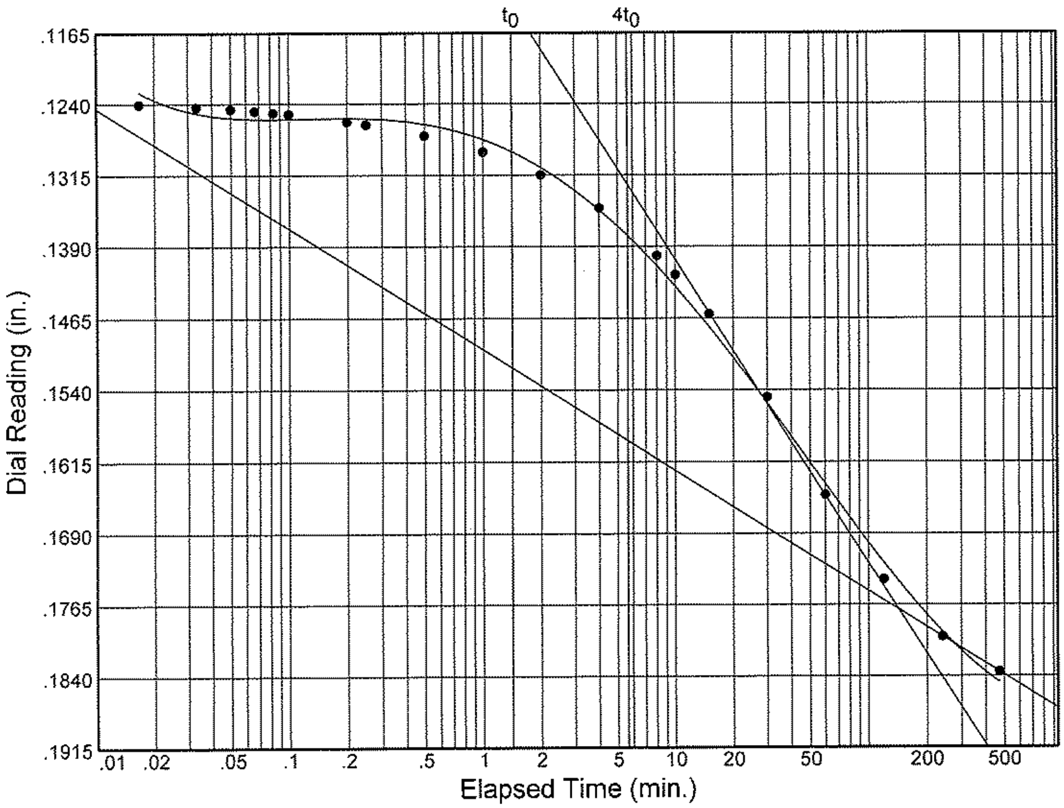
C_α = 0.008

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

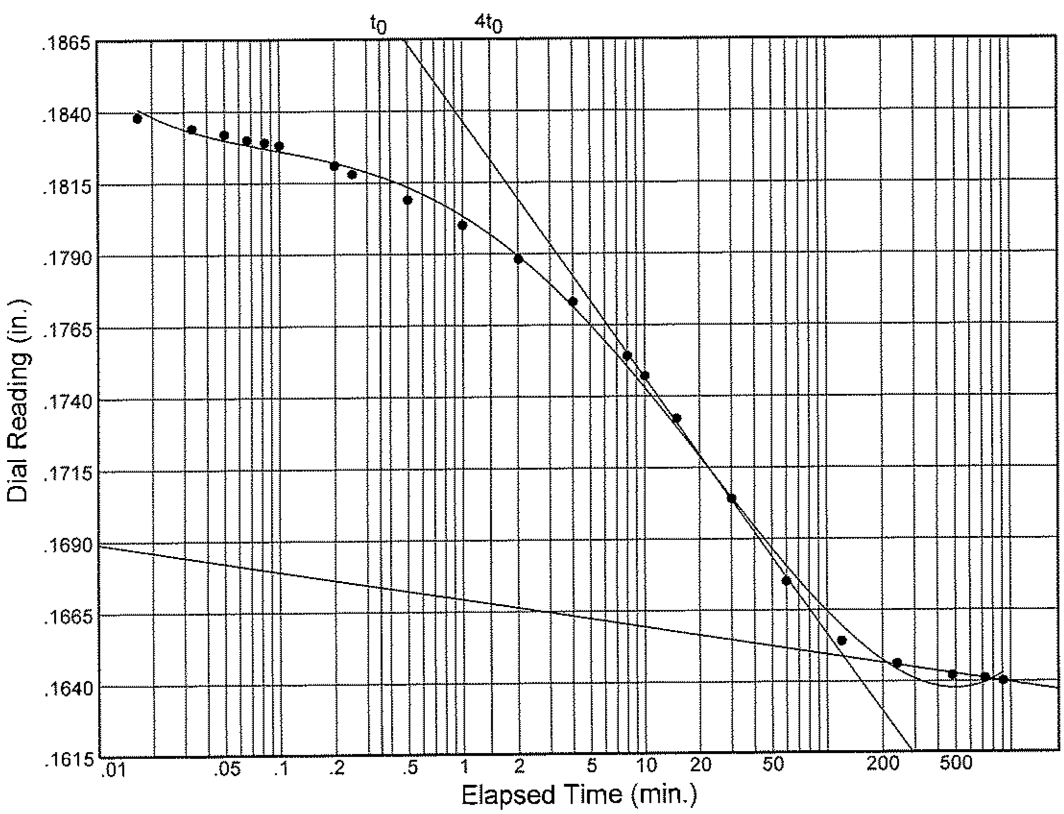
Source: T16-1 | Sample No.: 14 | Elev./Depth: 58.0'



Load No.= 6
Load= 8.00 tsf
D_0 = 0.12022
D_{50} = 0.14863
D_{100} = 0.17703
T_{50} = 16.69 min.

C_v @ T_{50}
0.02 ft.^{2}/day

C_α = 0.014



Load No.= 7
Load= 2.00 tsf
D_0 = 0.18376
D_{50} = 0.17431
D_{100} = 0.16486
T_{50} = 9.96 min.

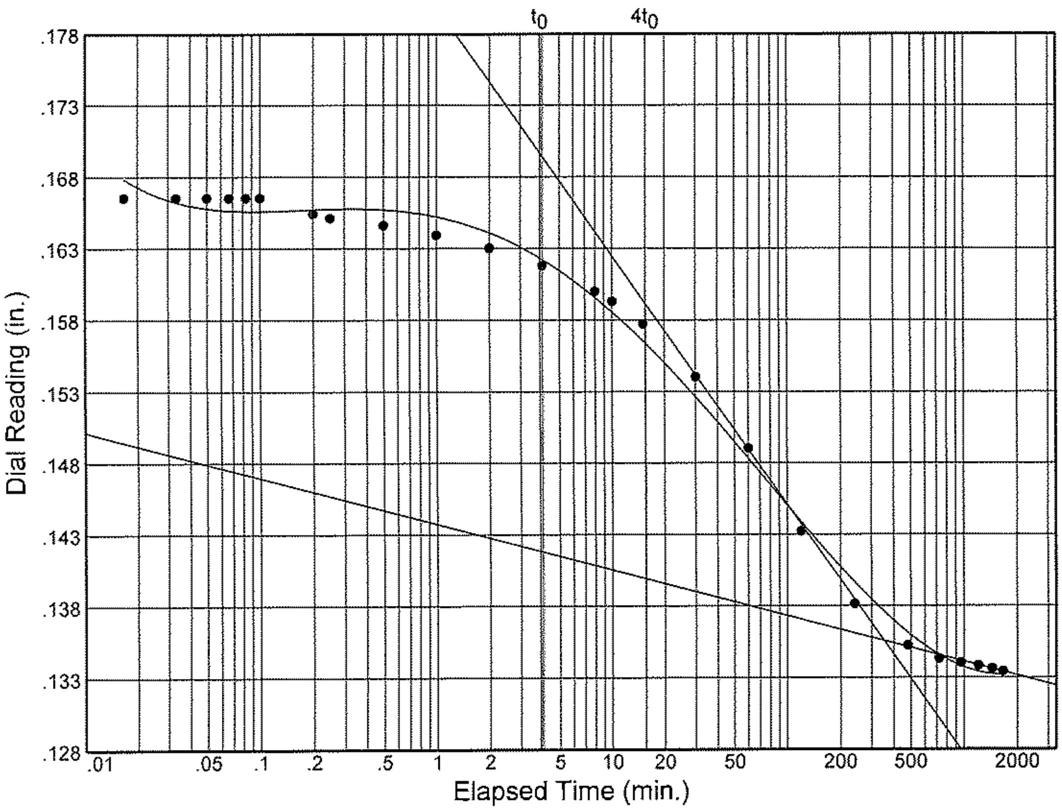
C_v @ T_{50}
0.03 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

Dial Reading vs. Time

Source: T16-1 | Sample No.: 14 | Elev./Depth: 58.0'



Load No.= 8

Load= 0.50 tsf

D_0 = 0.16826

D_{50} = 0.15191

D_{100} = 0.13556

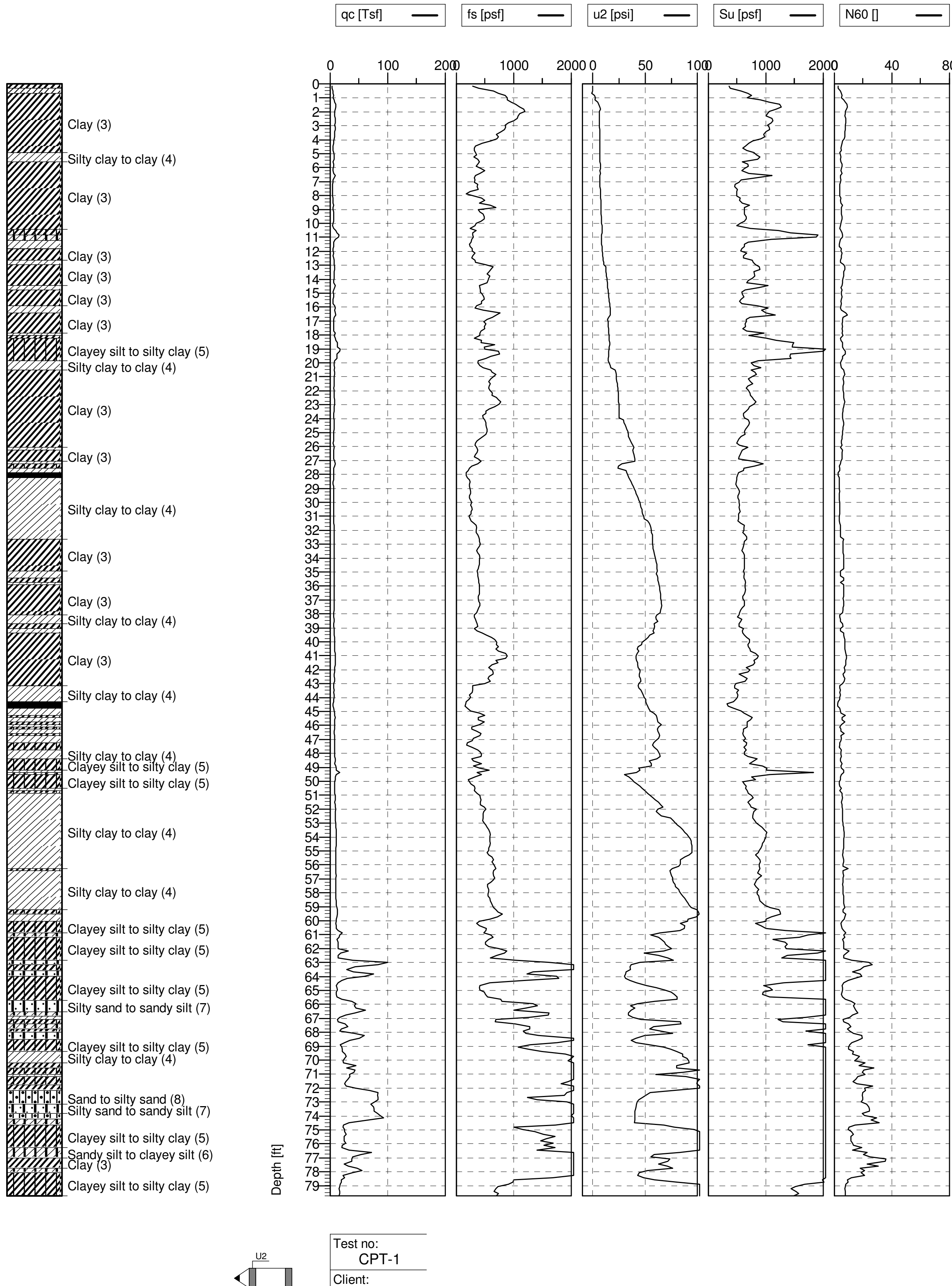
T_{50} = 33.72 min.

C_v @ T_{50}

0.01 ft.^{2}/day

Figure

EUSTIS ENGINEERING COMPANY, INC.

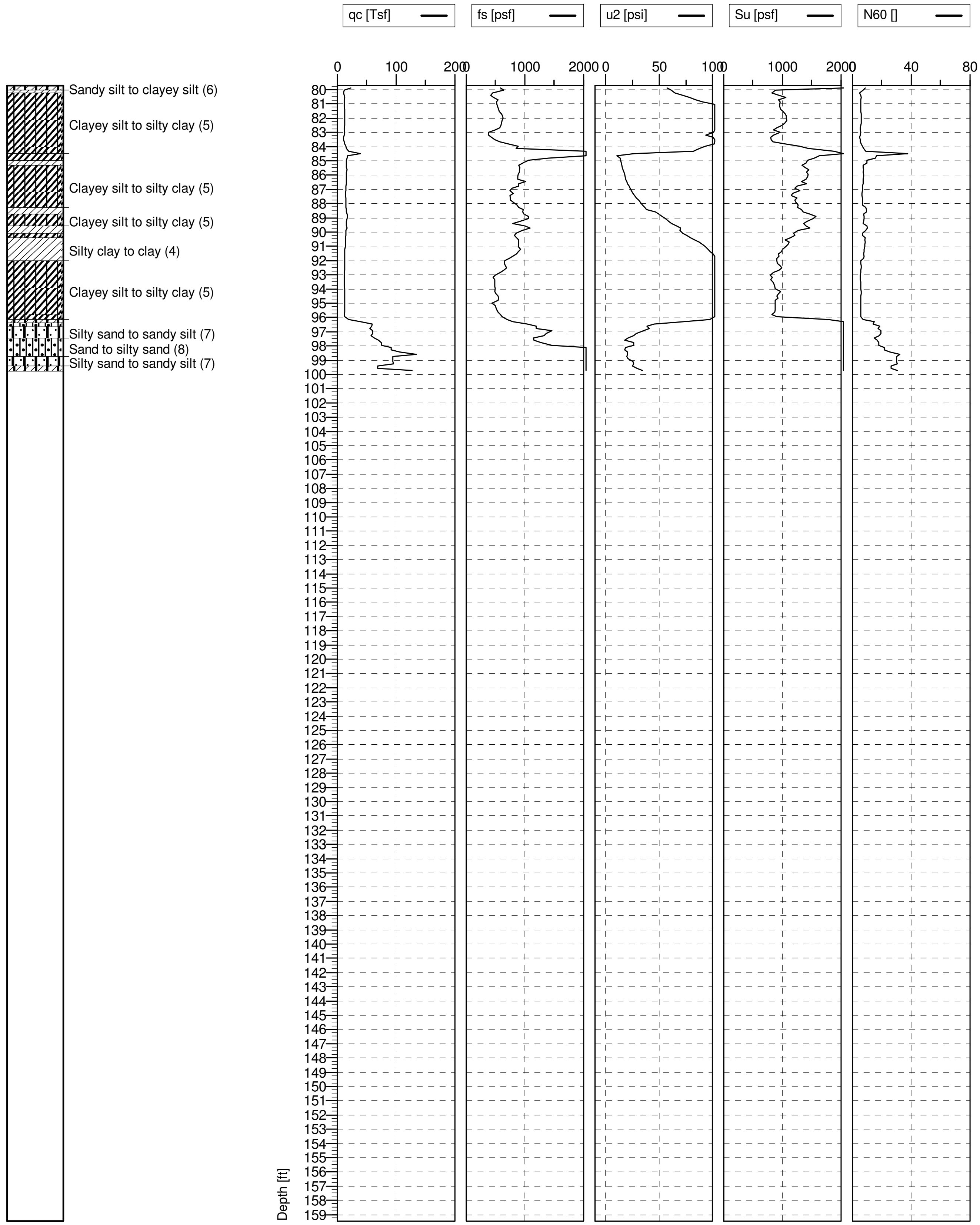


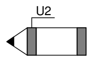
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-1

Client:

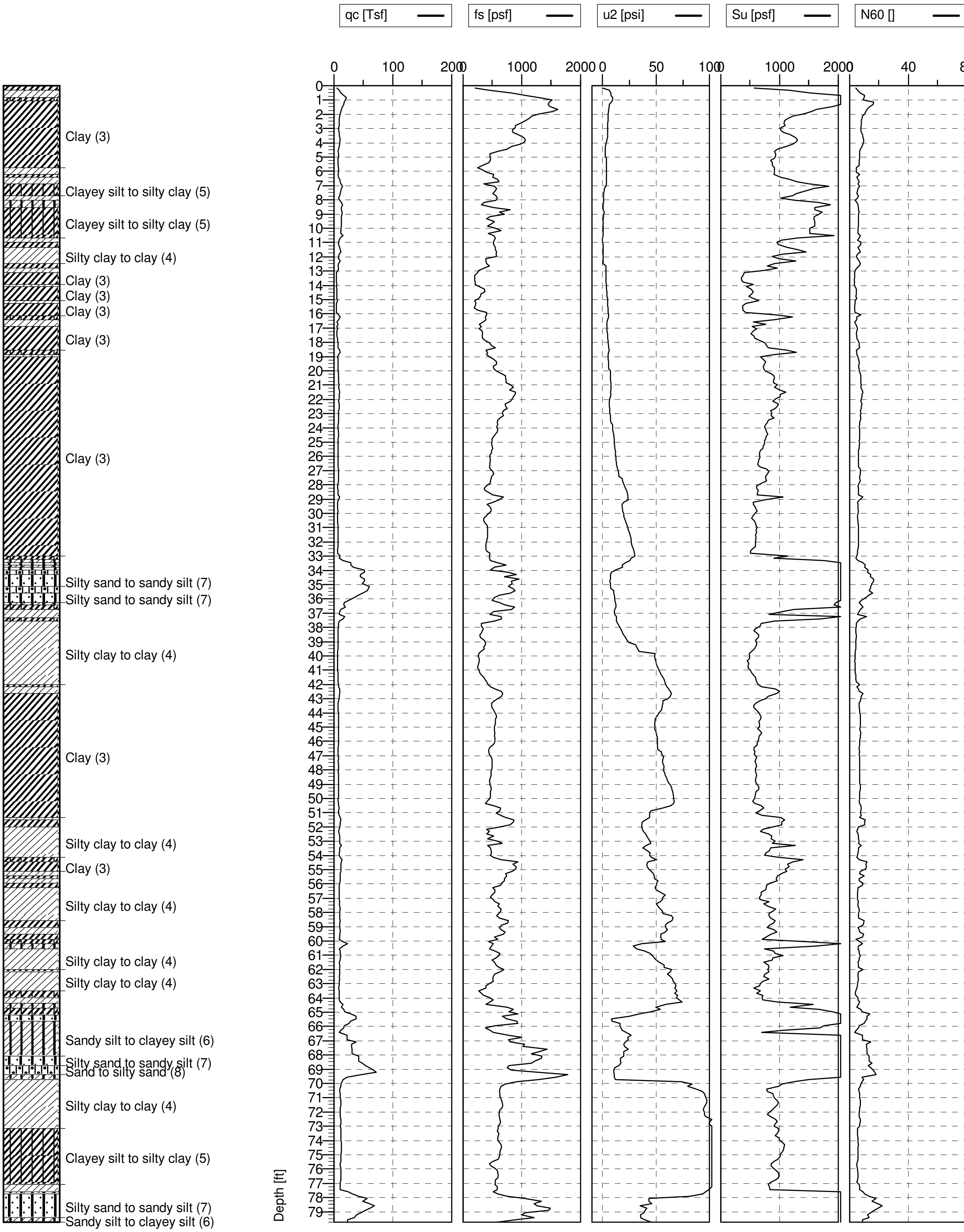
Project:

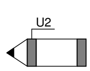




Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

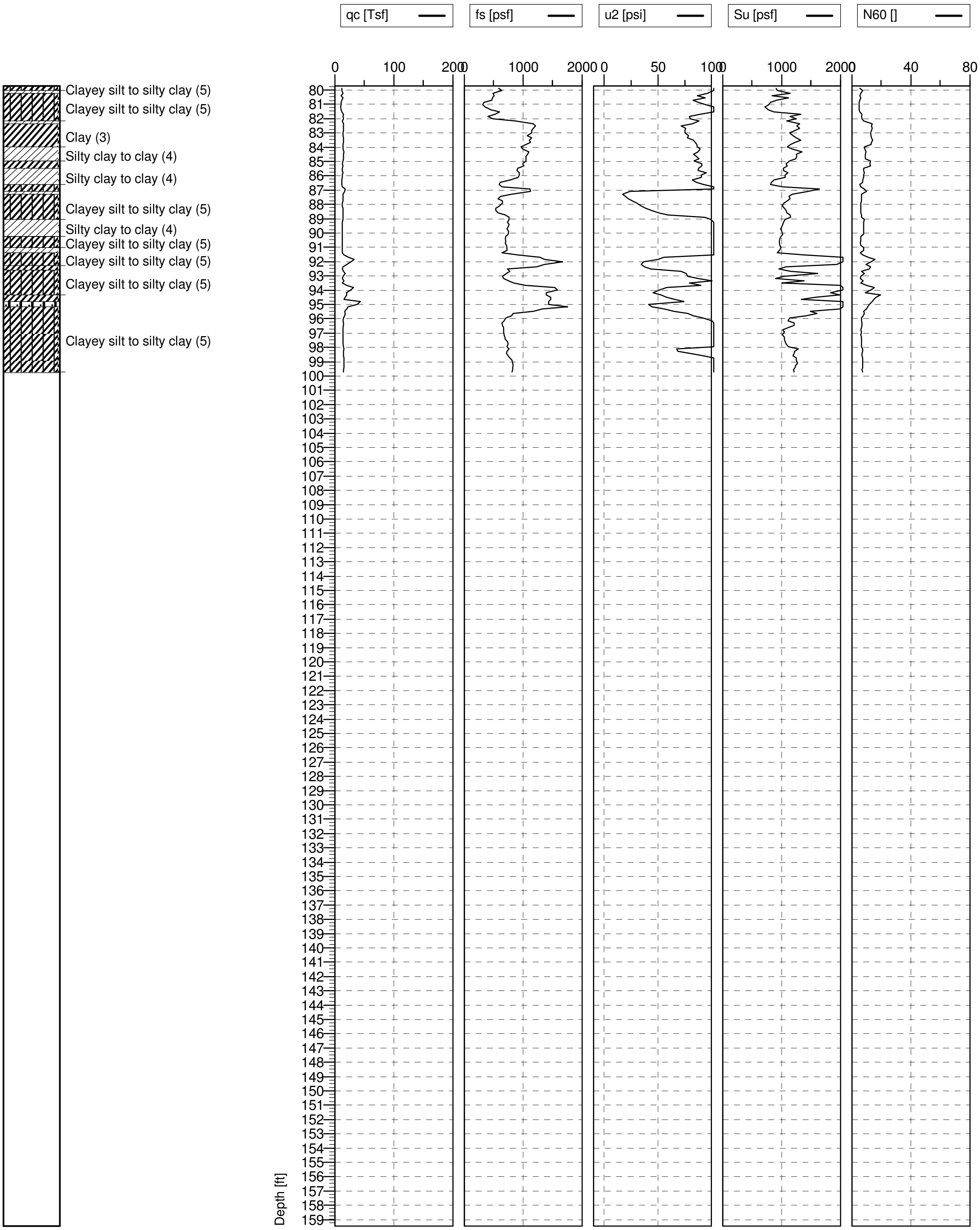
Test no:
CPT-26
Client:
Project:

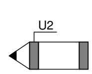




Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-26
Client:
Project:



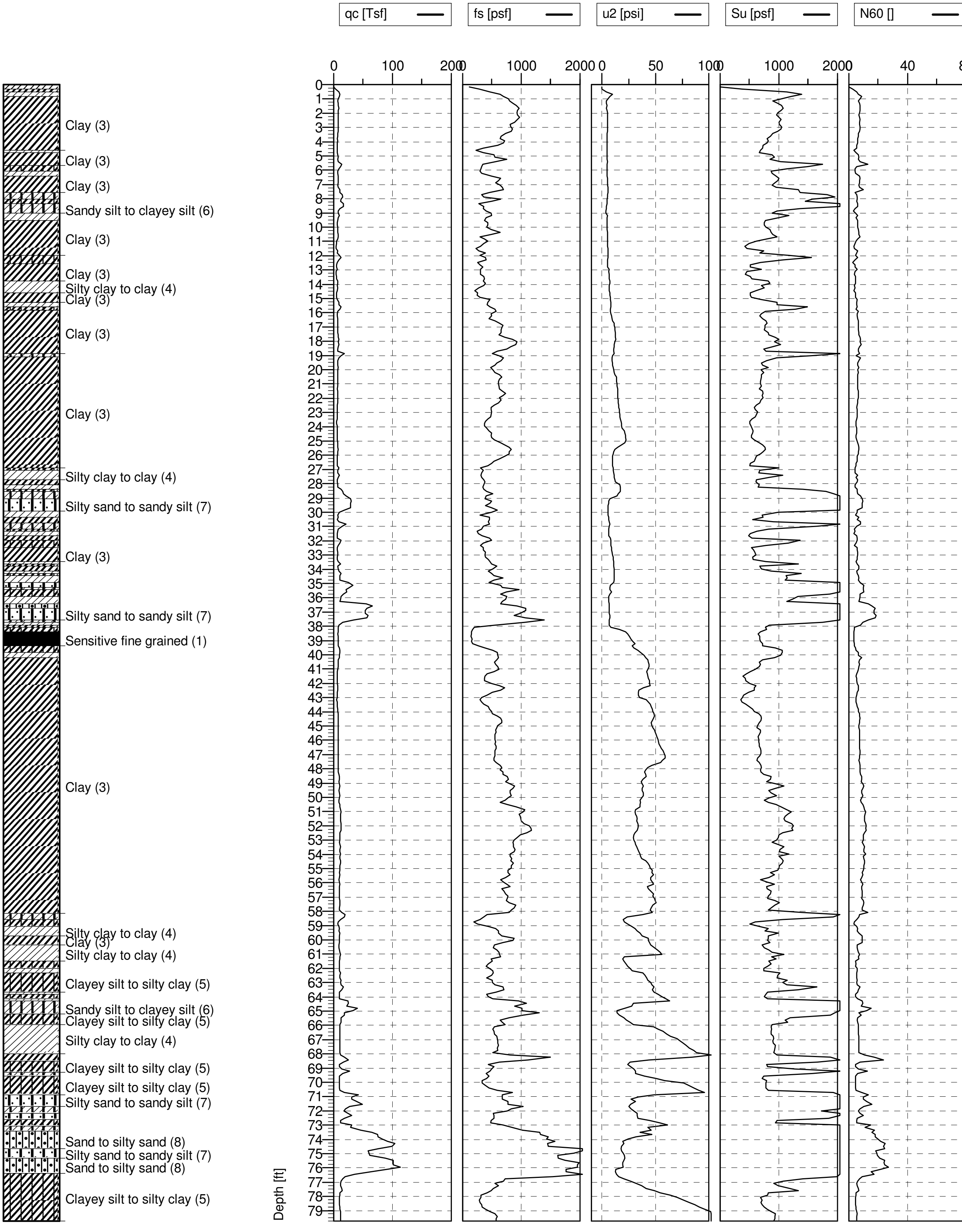


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-24

Client:

Project:



Cone No: DDG1068

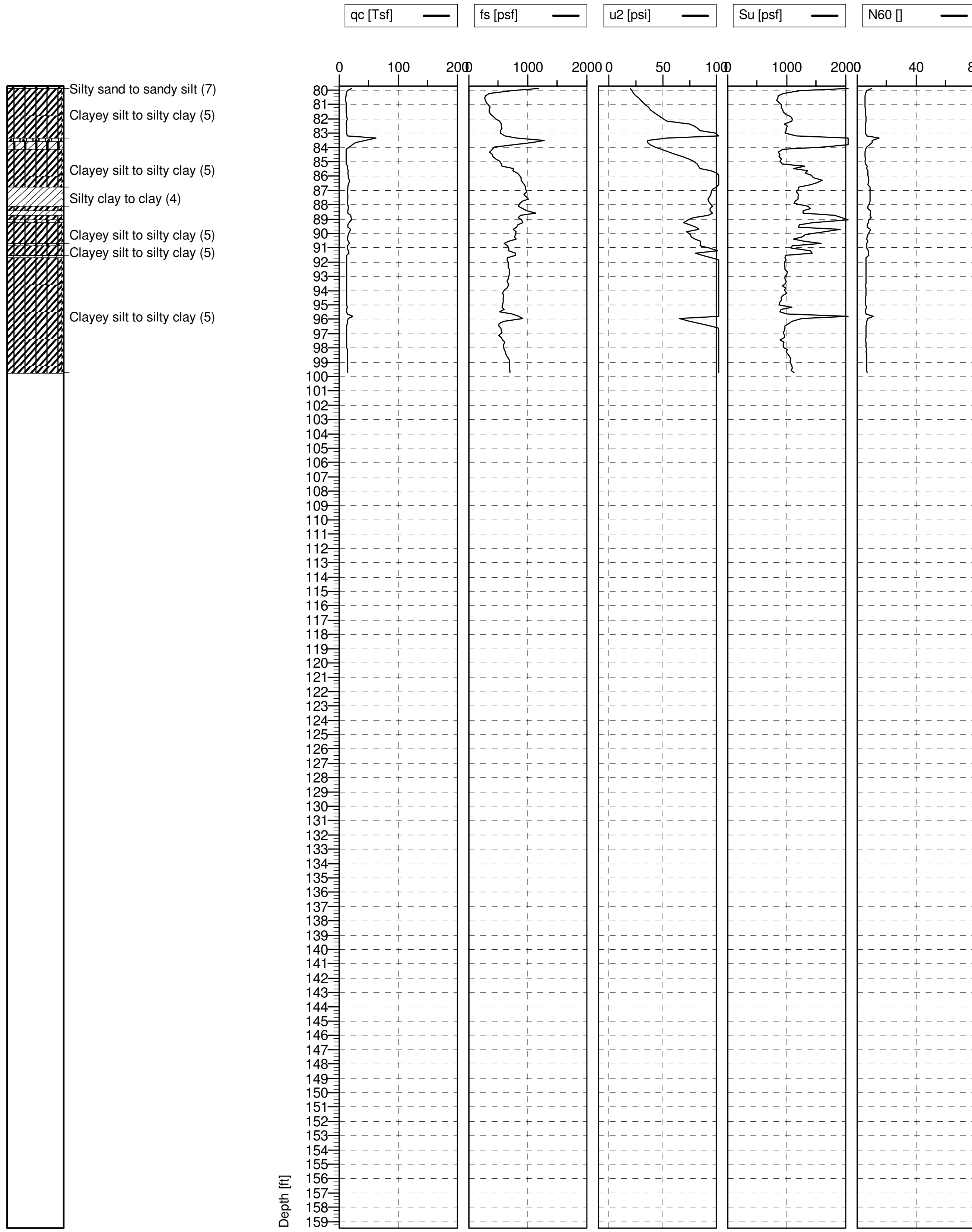
Tip area [cm2]: 10

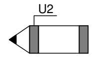
Sleeve area [cm2]: 150

Test no: CPT-24

Client:

Project:



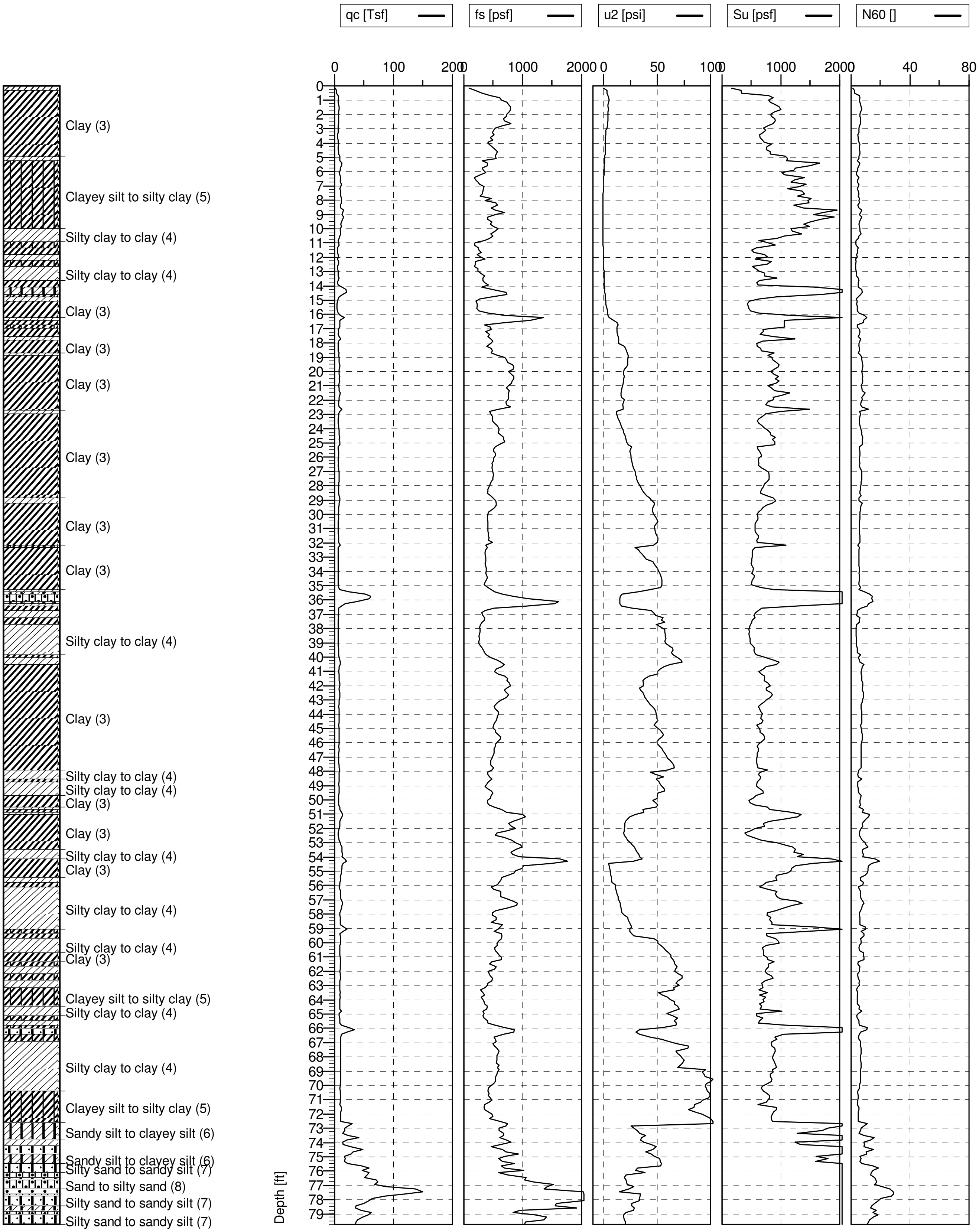


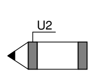
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-23

Client:

Project:





Cone No: DDG1068

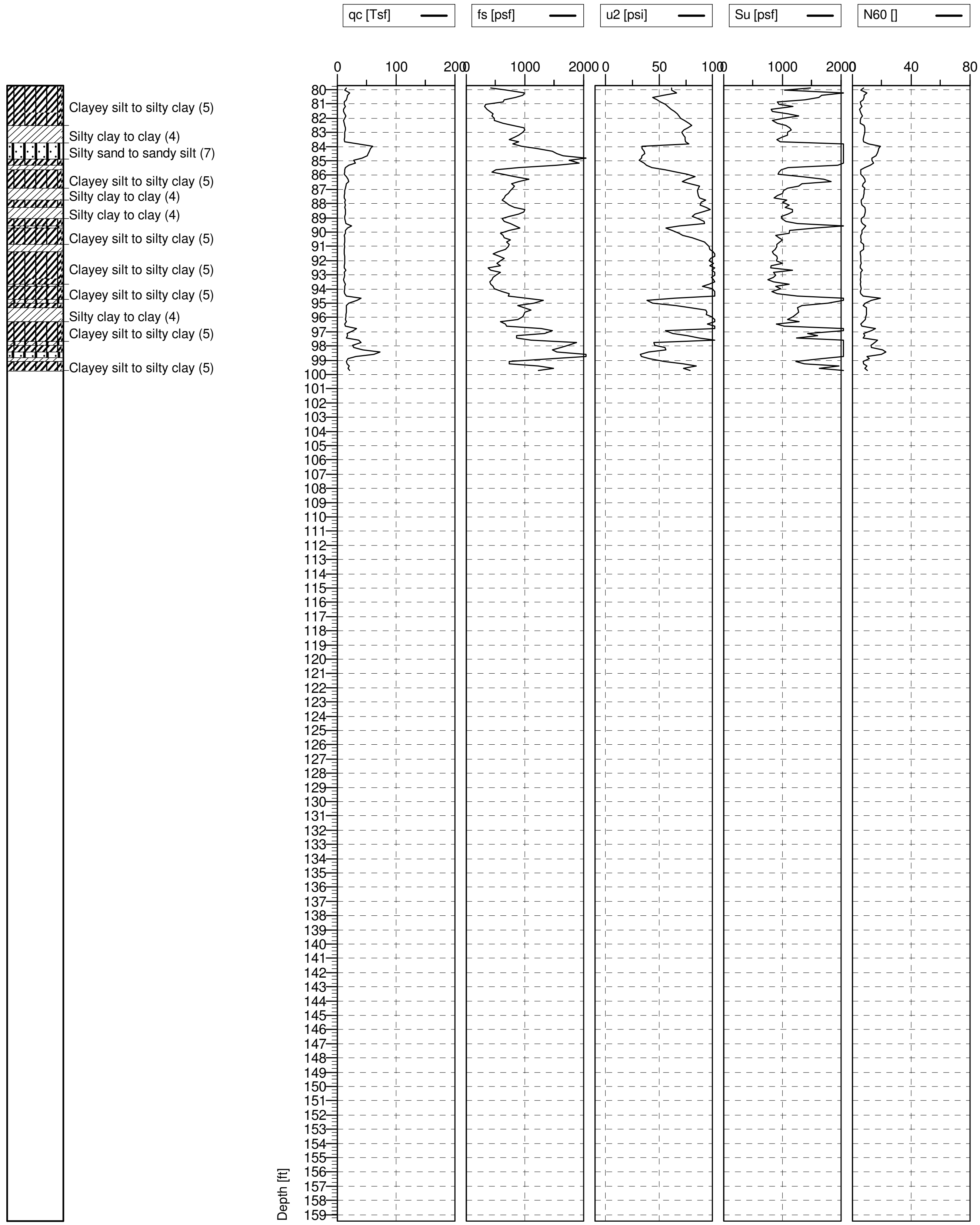
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no: CPT-23

Client:

Project:

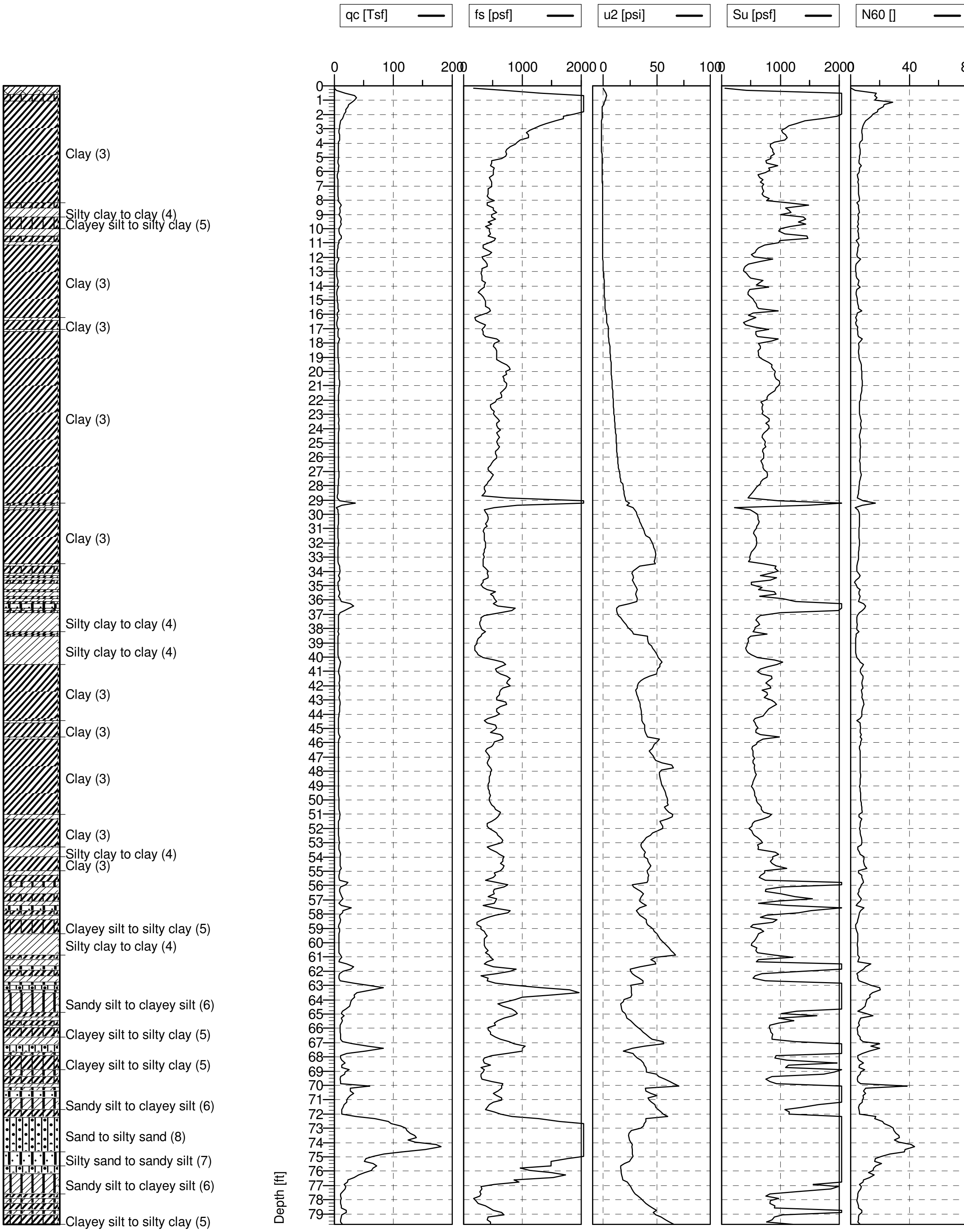


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-22

Client:

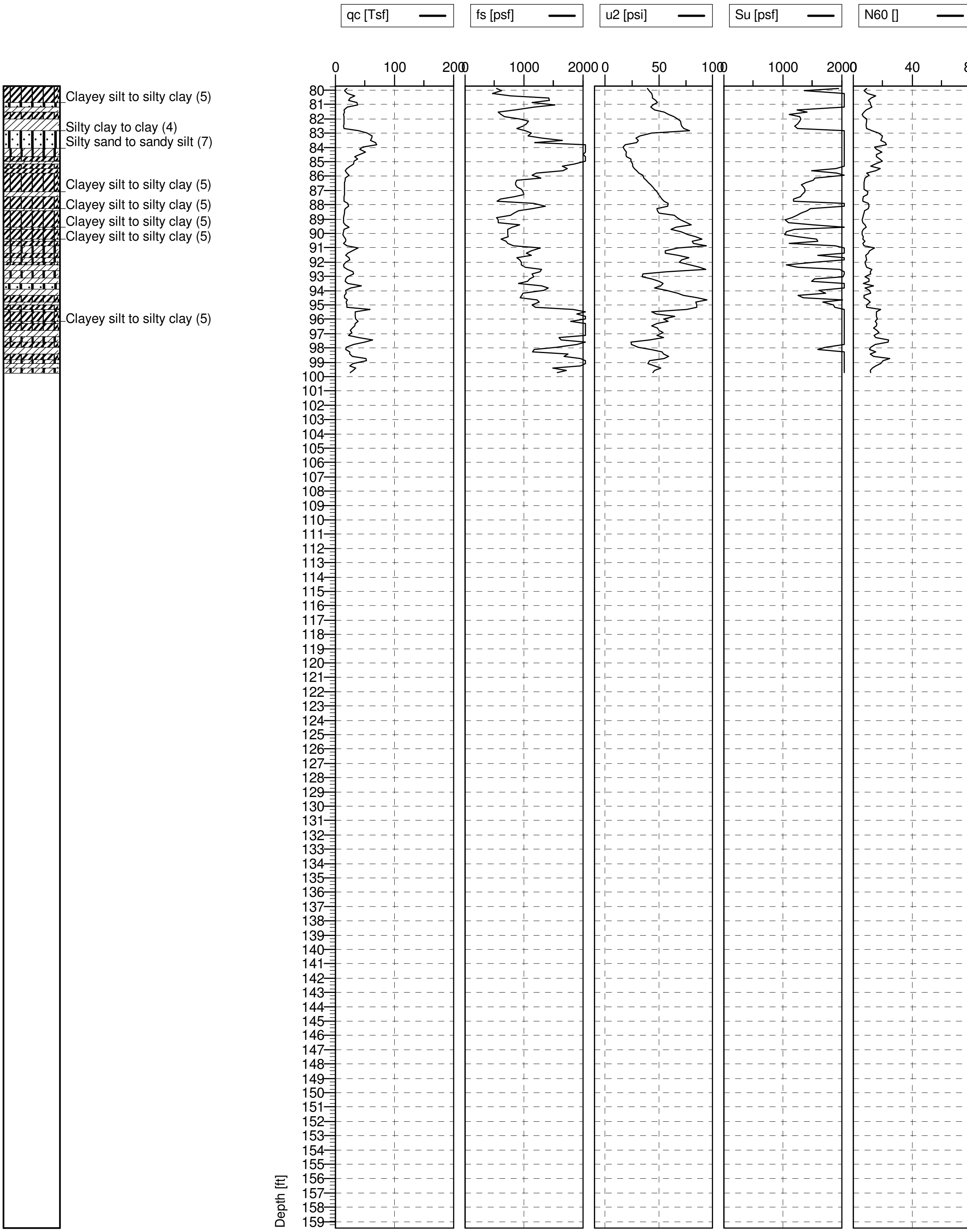
Project:

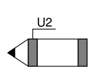


U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

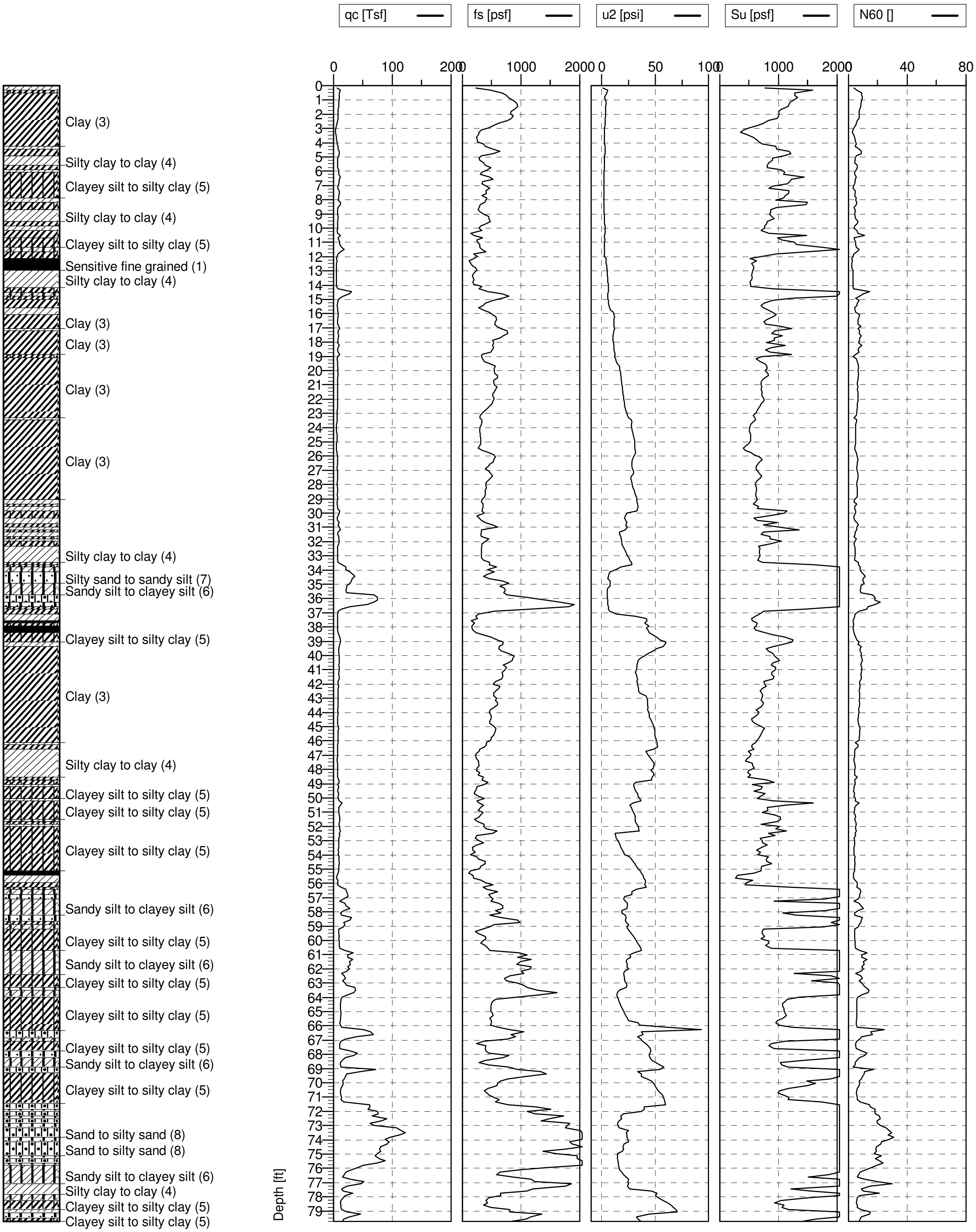
Test no:
CPT-22
Client:
Project:





Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

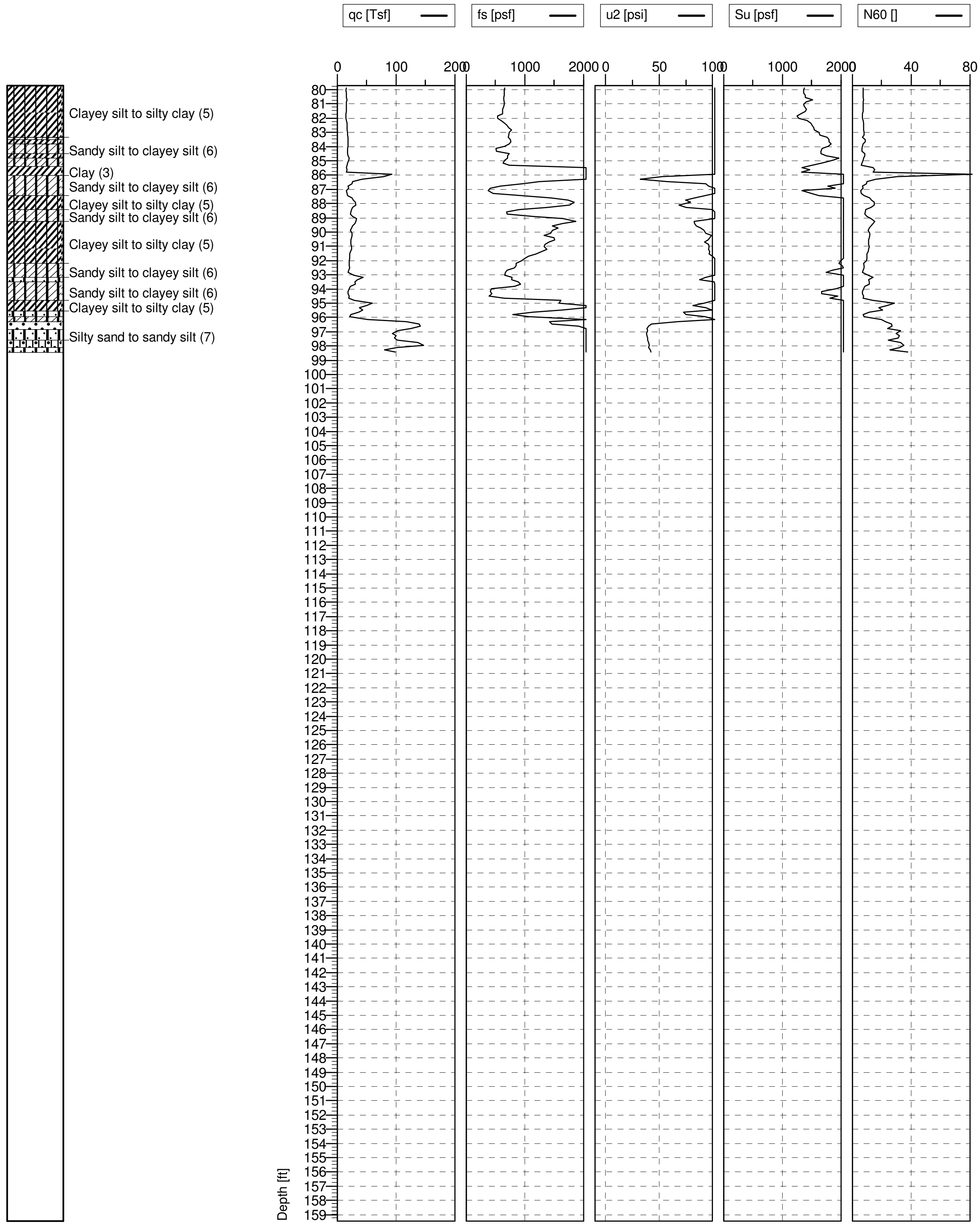
Test no:
CPT-21
Client:
Project:

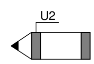


U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-21
Client:
Project:



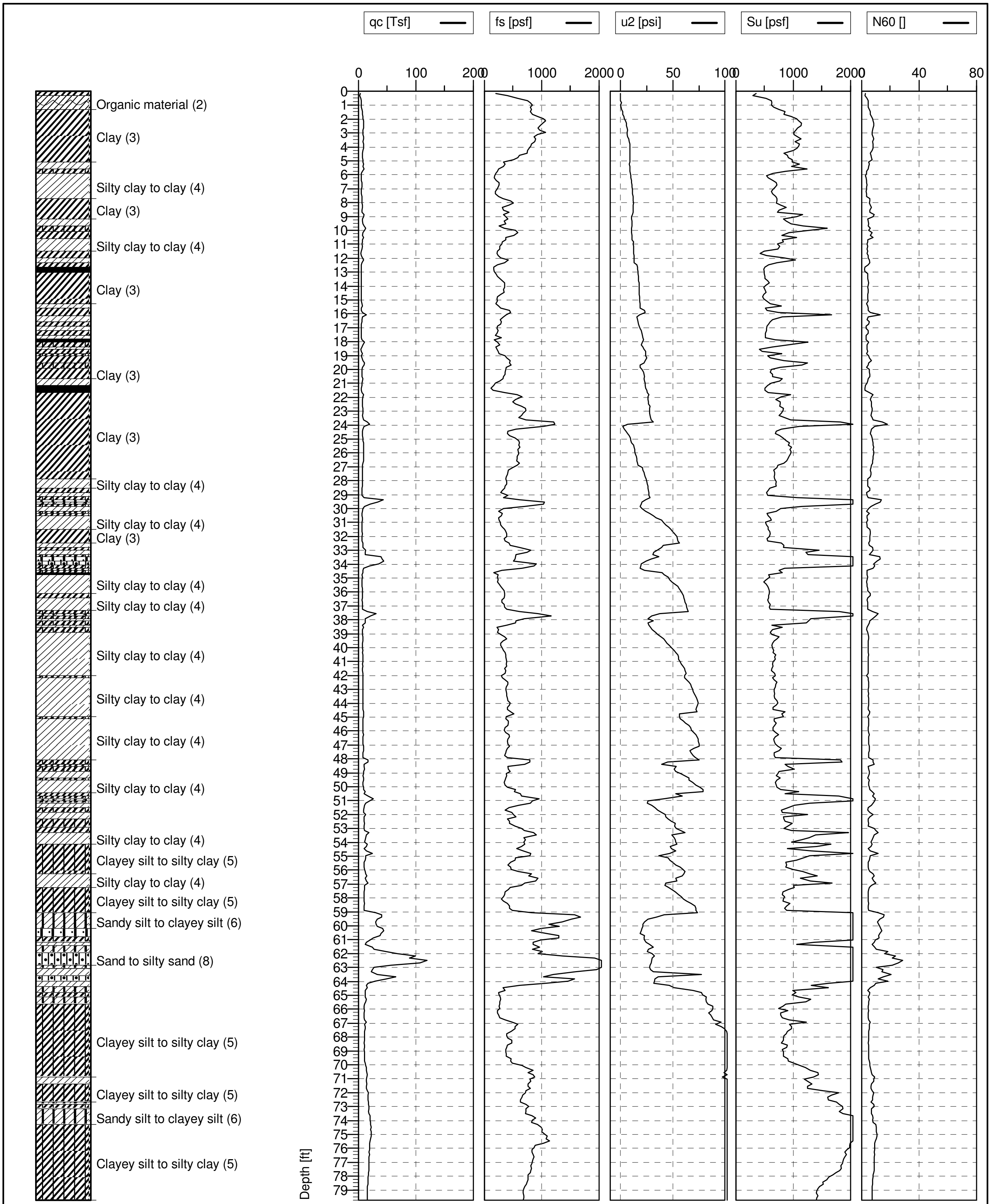


Test no: CPT-20

Client:

Project:

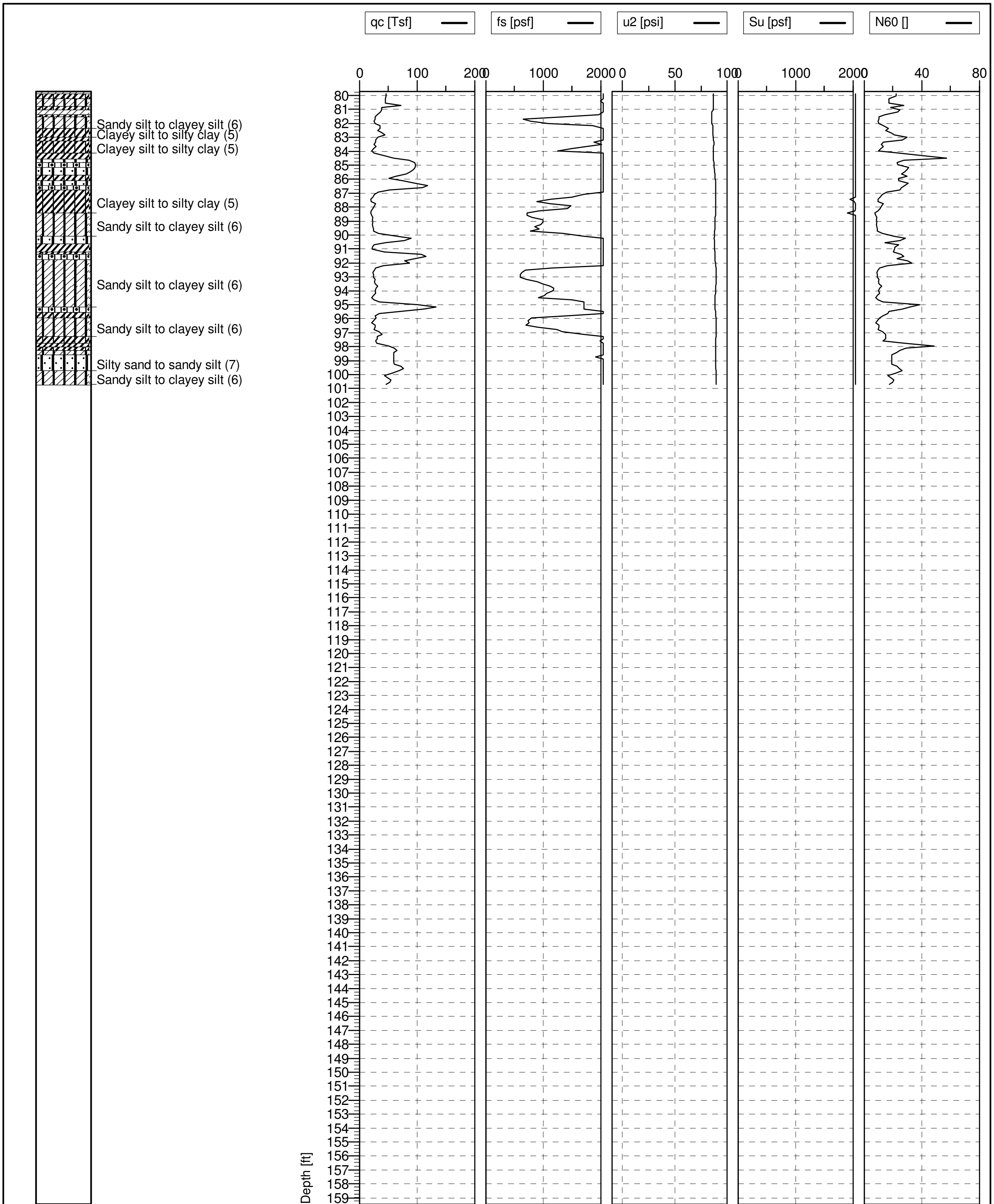
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

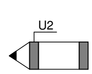


U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-20
Client:
Project:



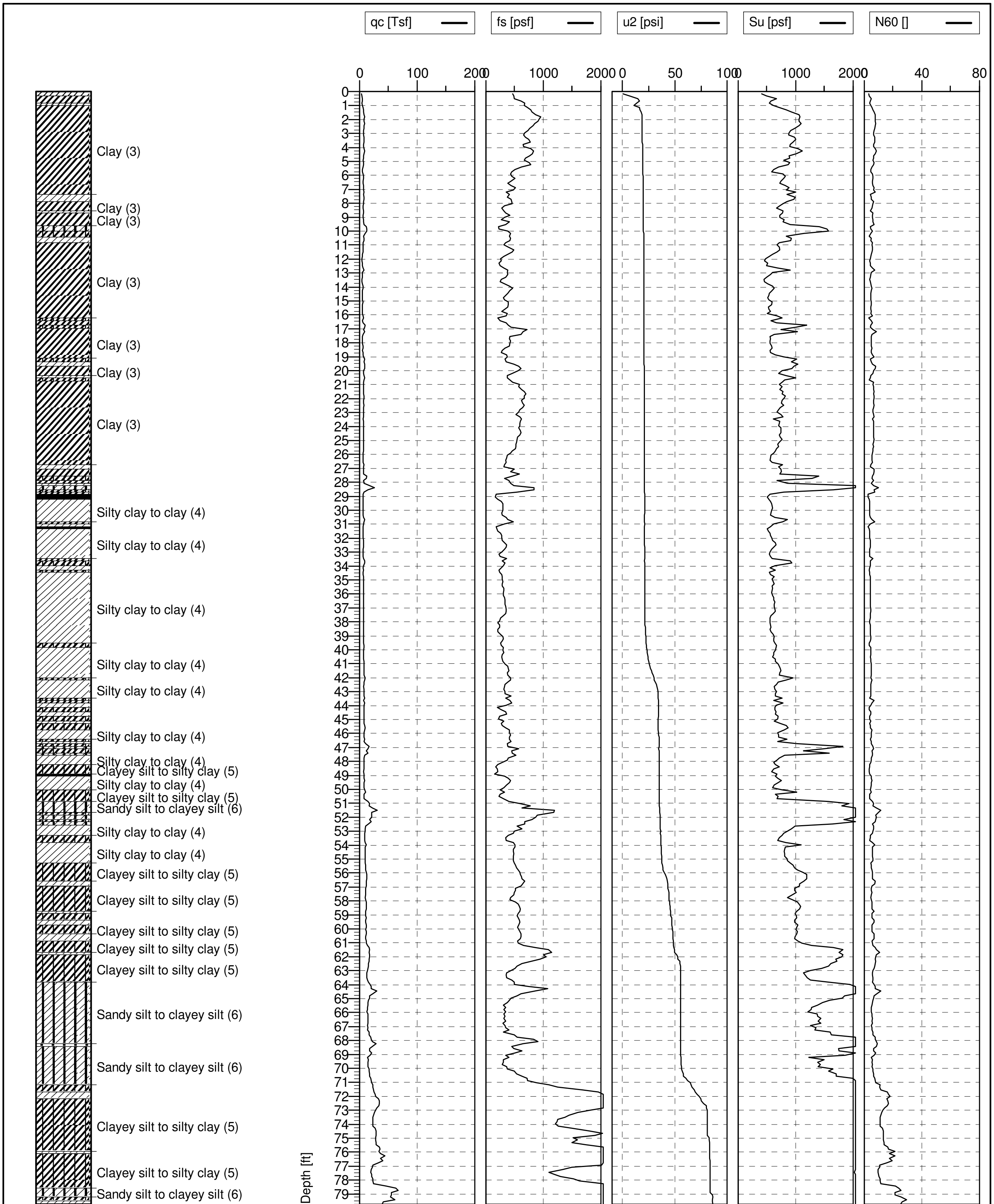


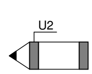
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-19

Client:

Project:



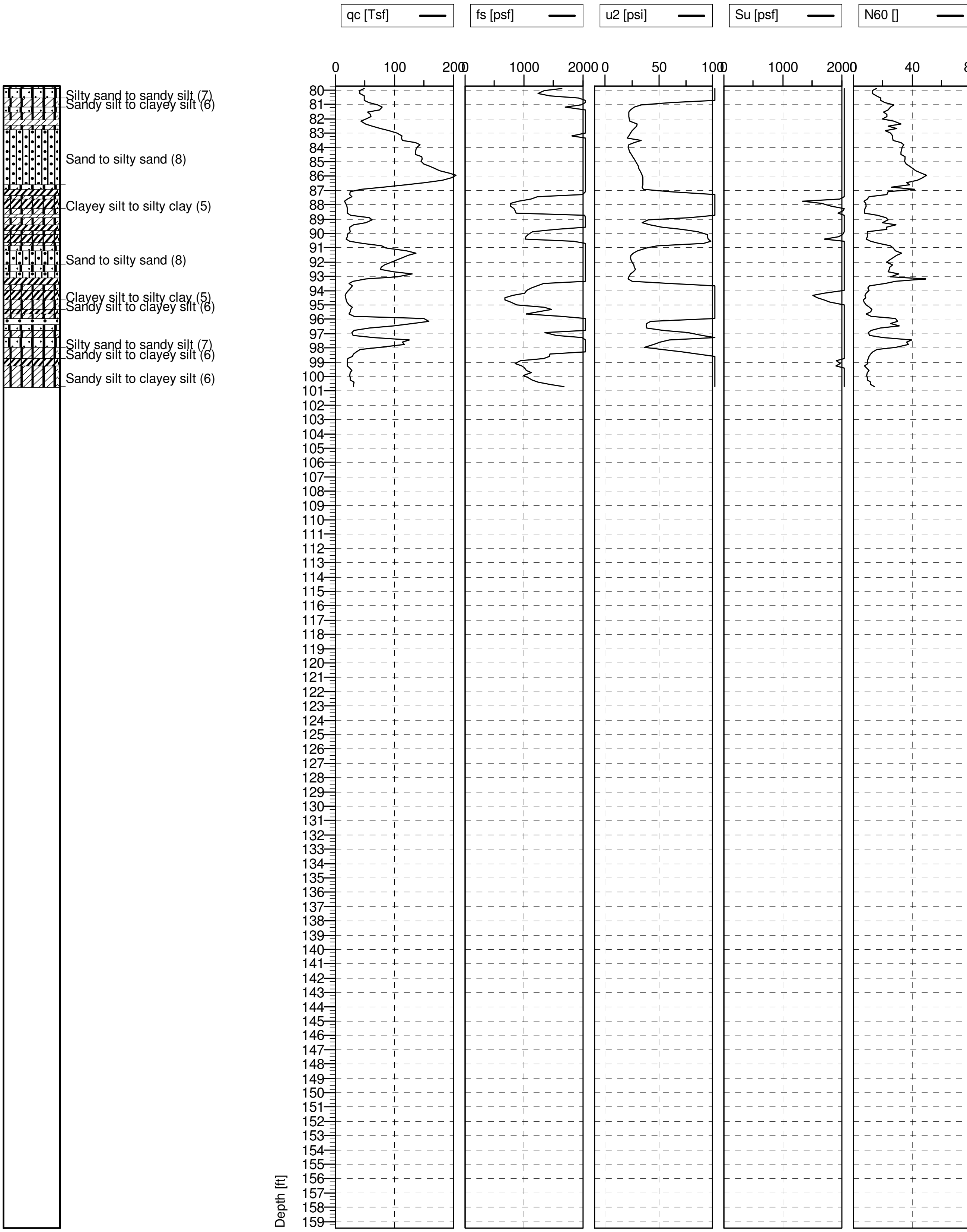


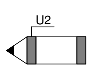
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-19

Client:

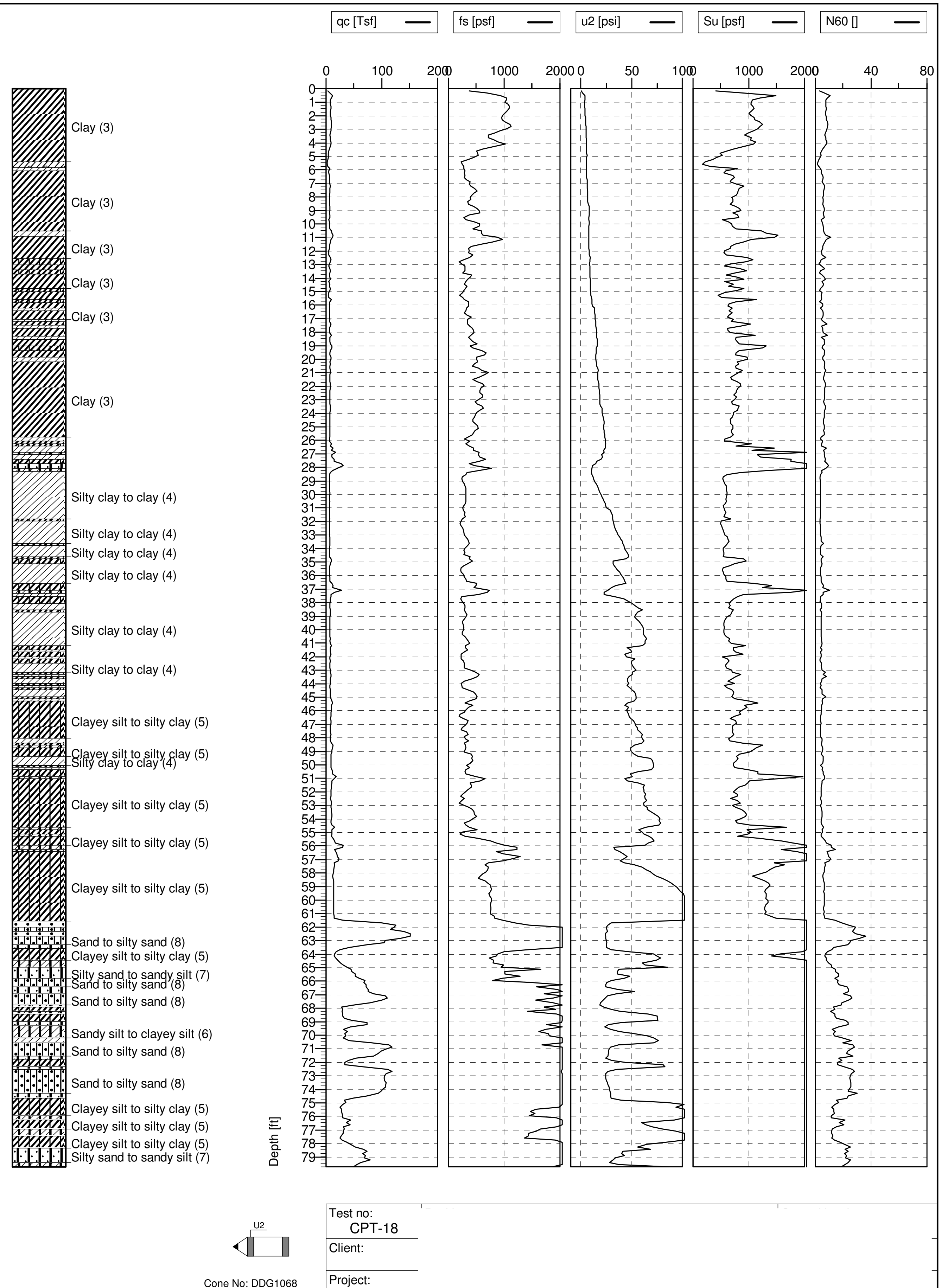
Project:





Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

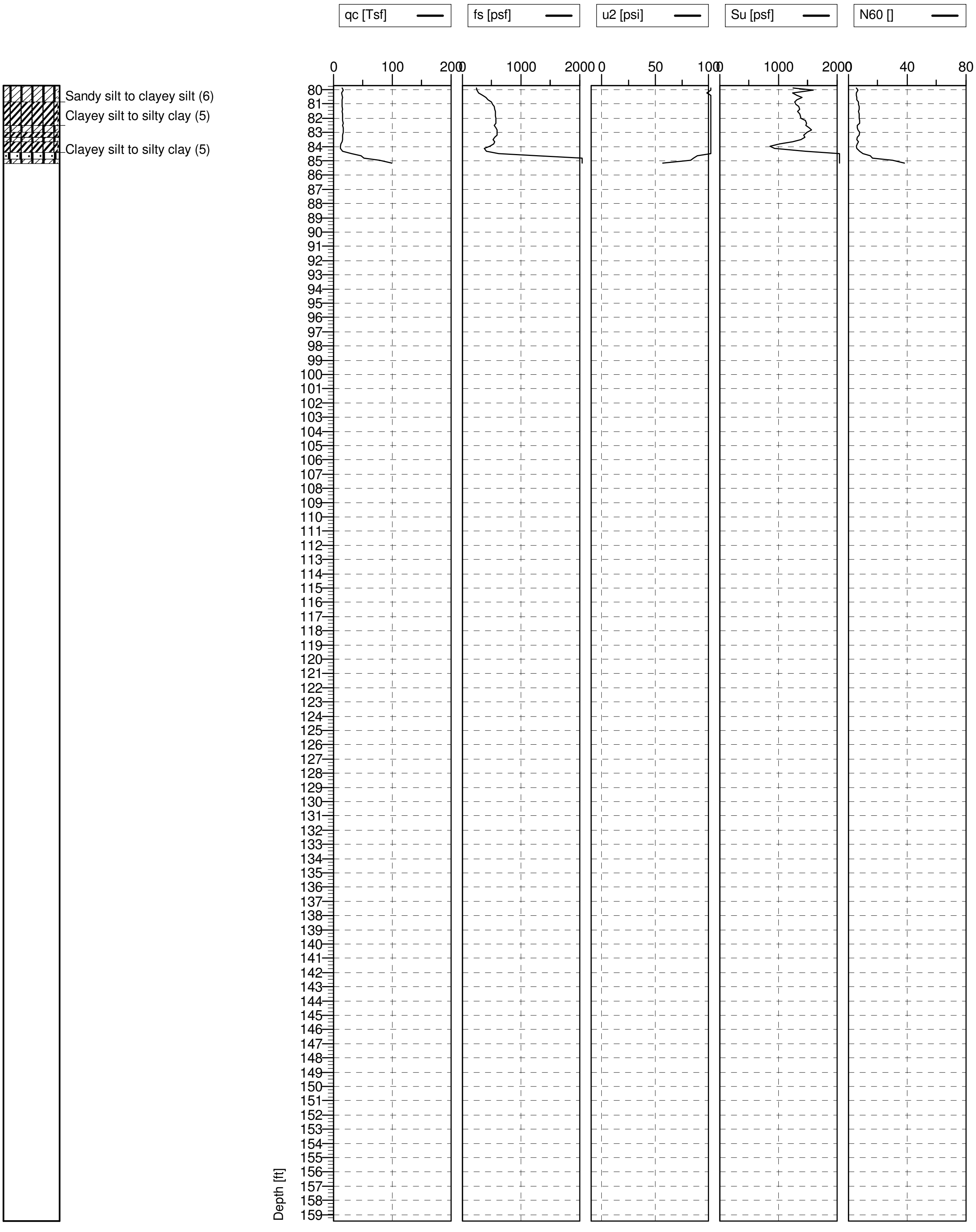
Test no: CPT-18
Client:
Project:



Test no: CPT-18

Client:

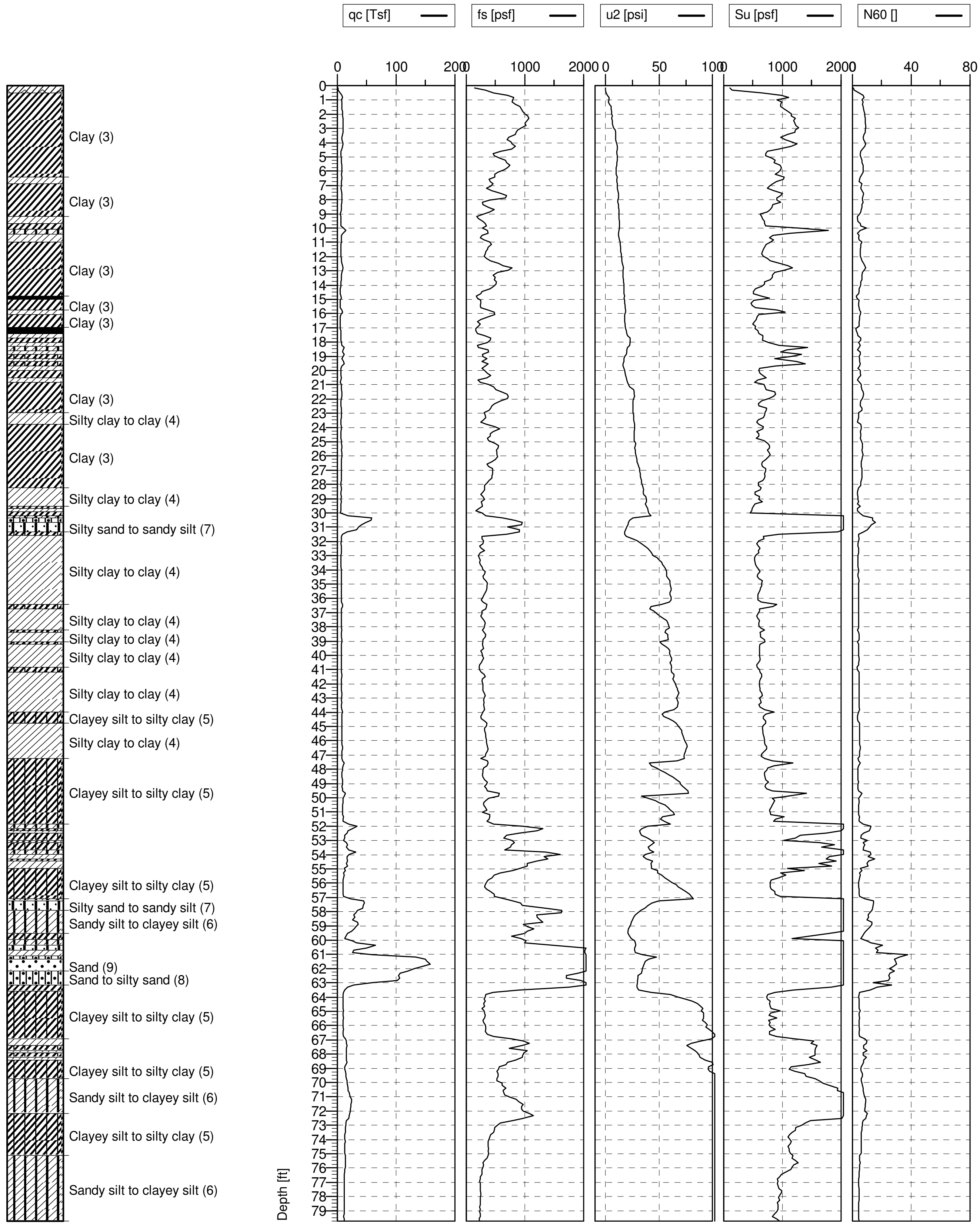
Project:

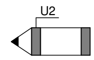


U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-17
Client:
Project:



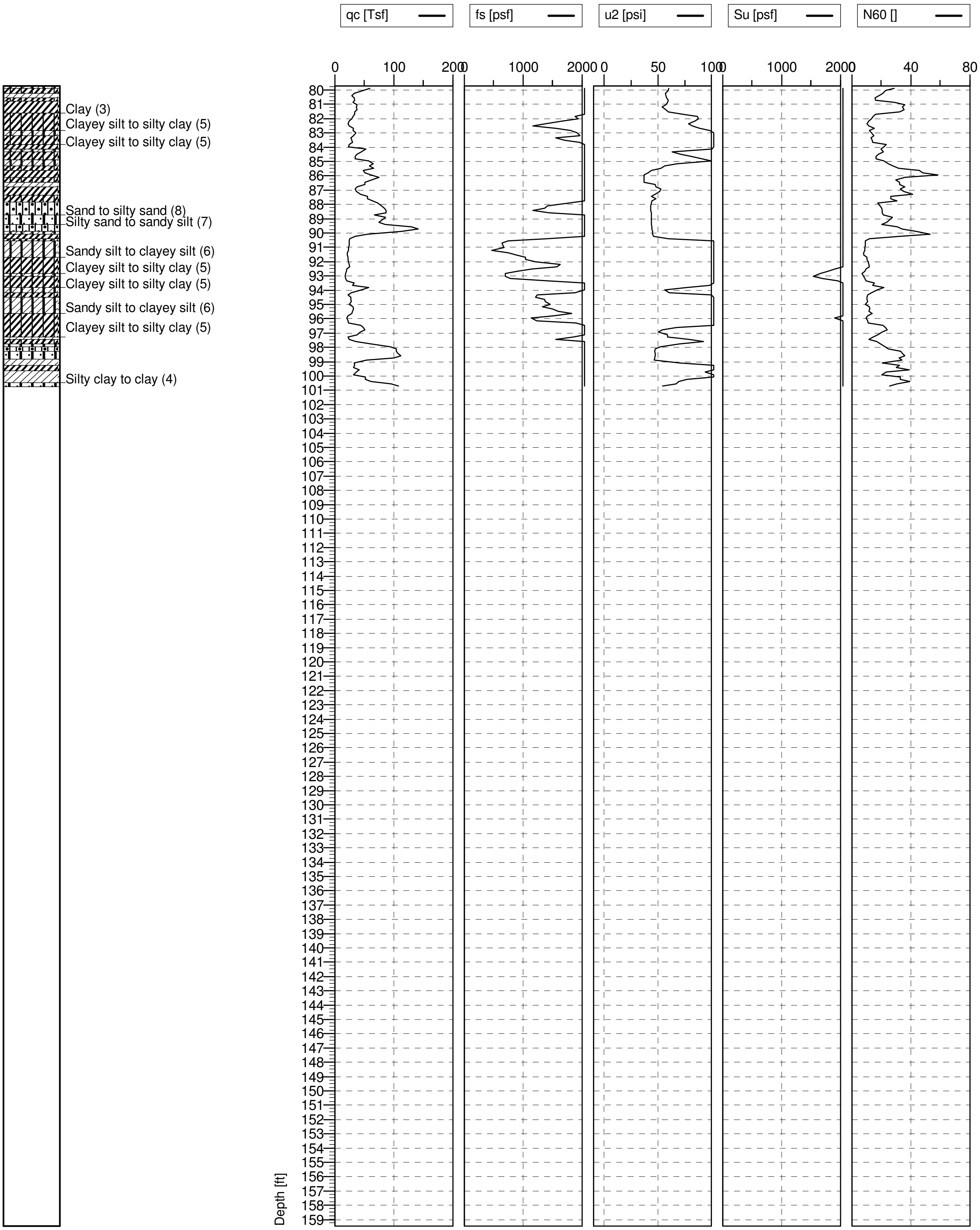


Test no:
CPT-17

Client:

Project:

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

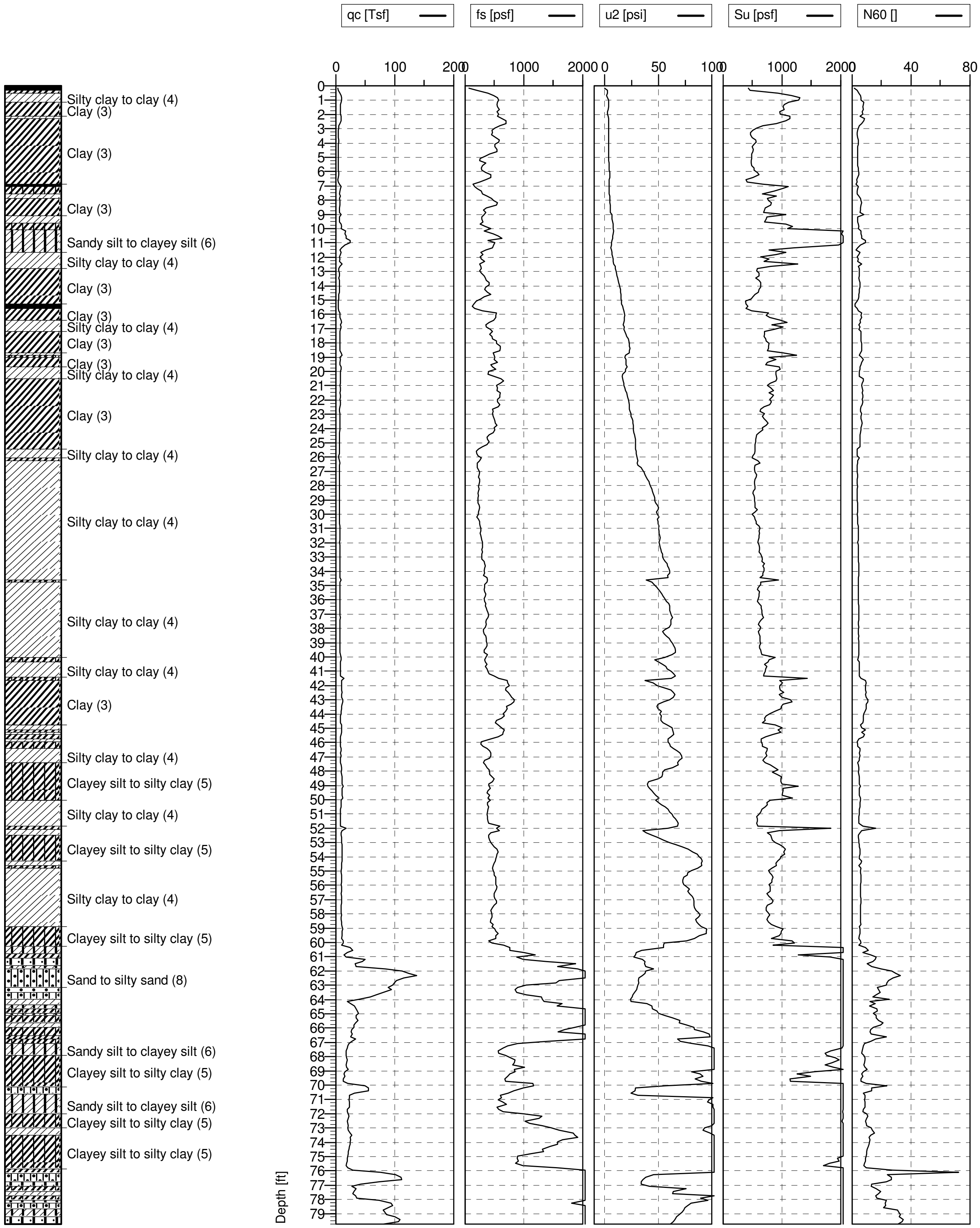


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-16

Client:

Project:

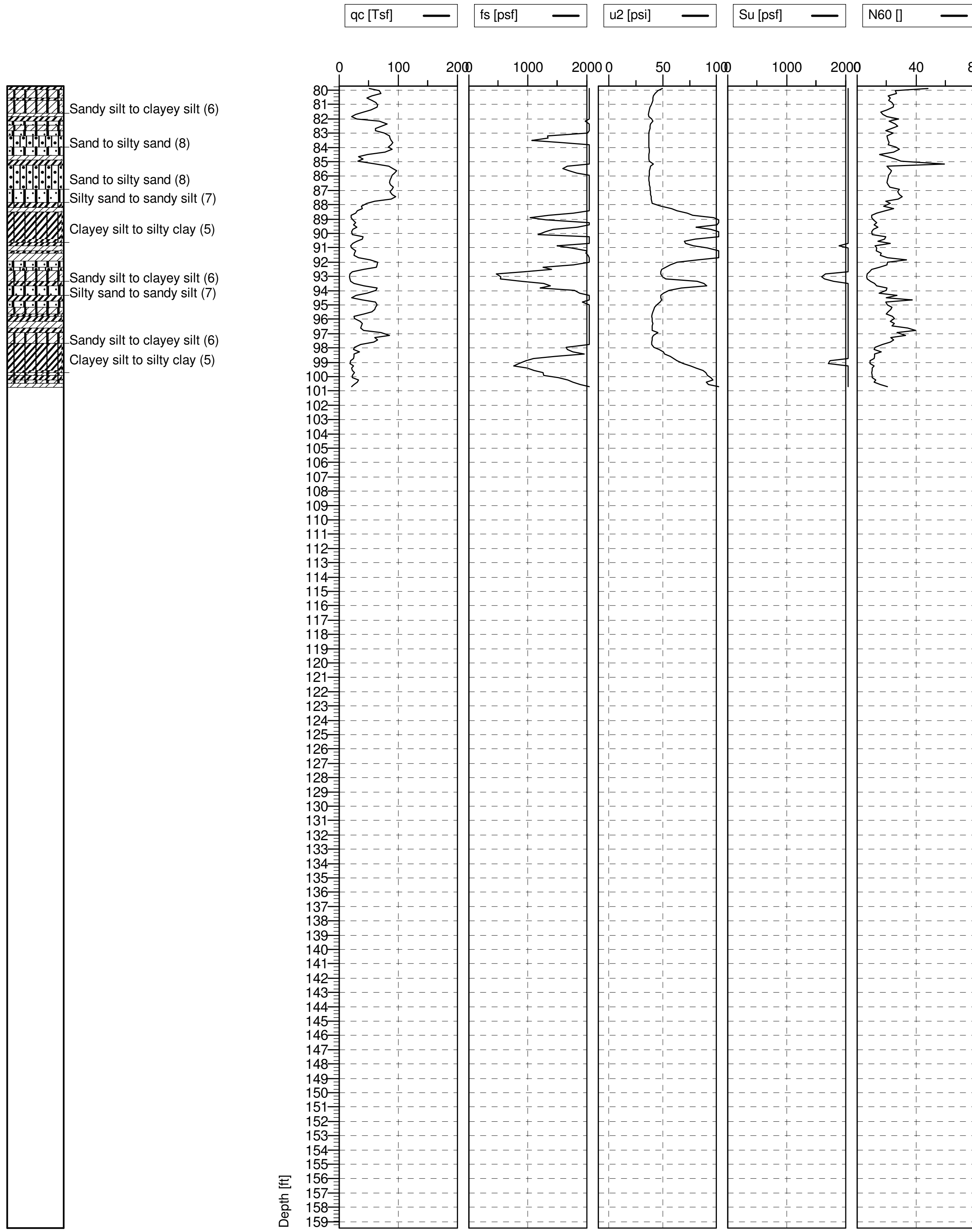


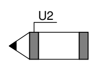
Cone No: DDG1068

Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no: CPT-16	
Client:	
Project:	



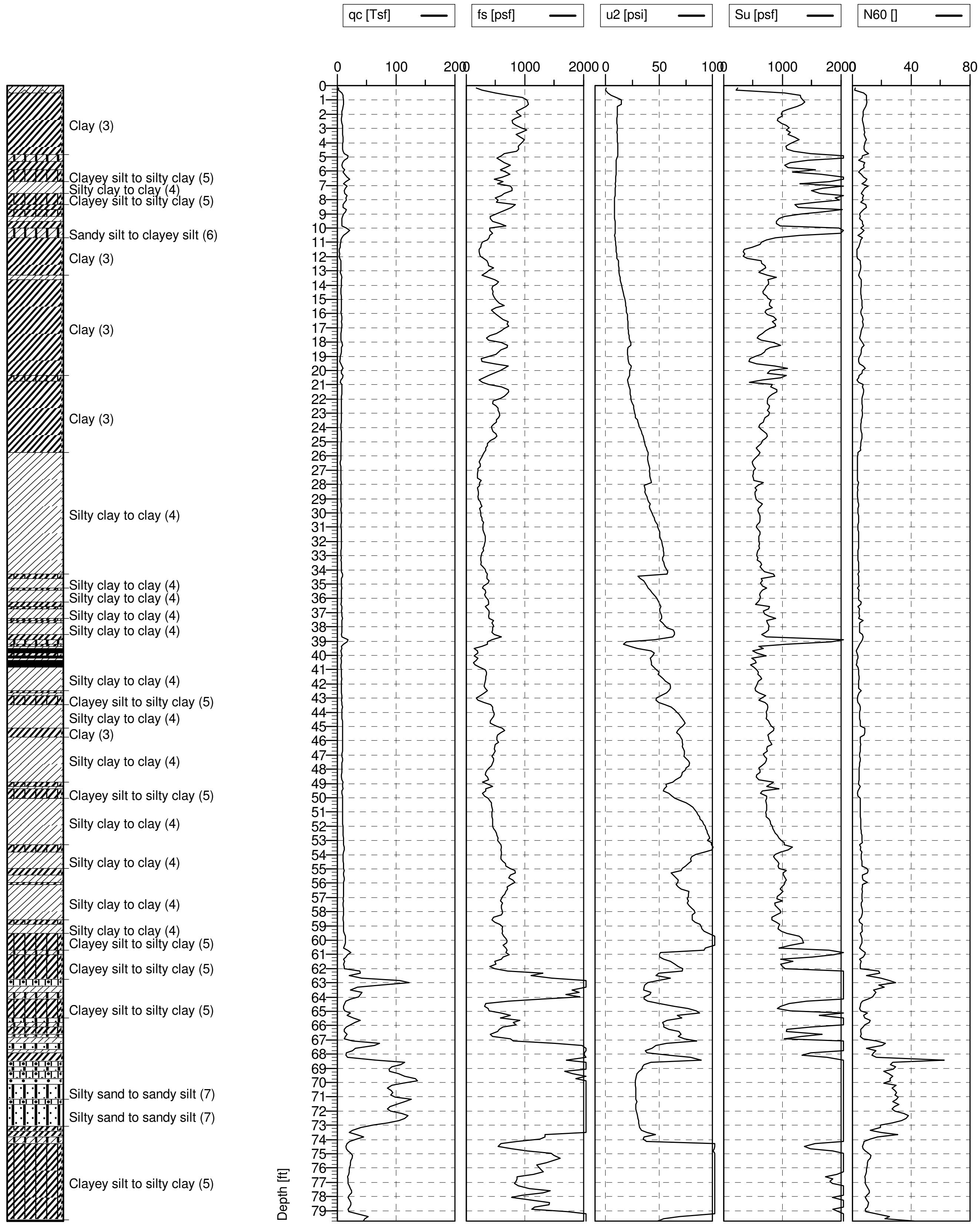


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-15

Client:

Project:

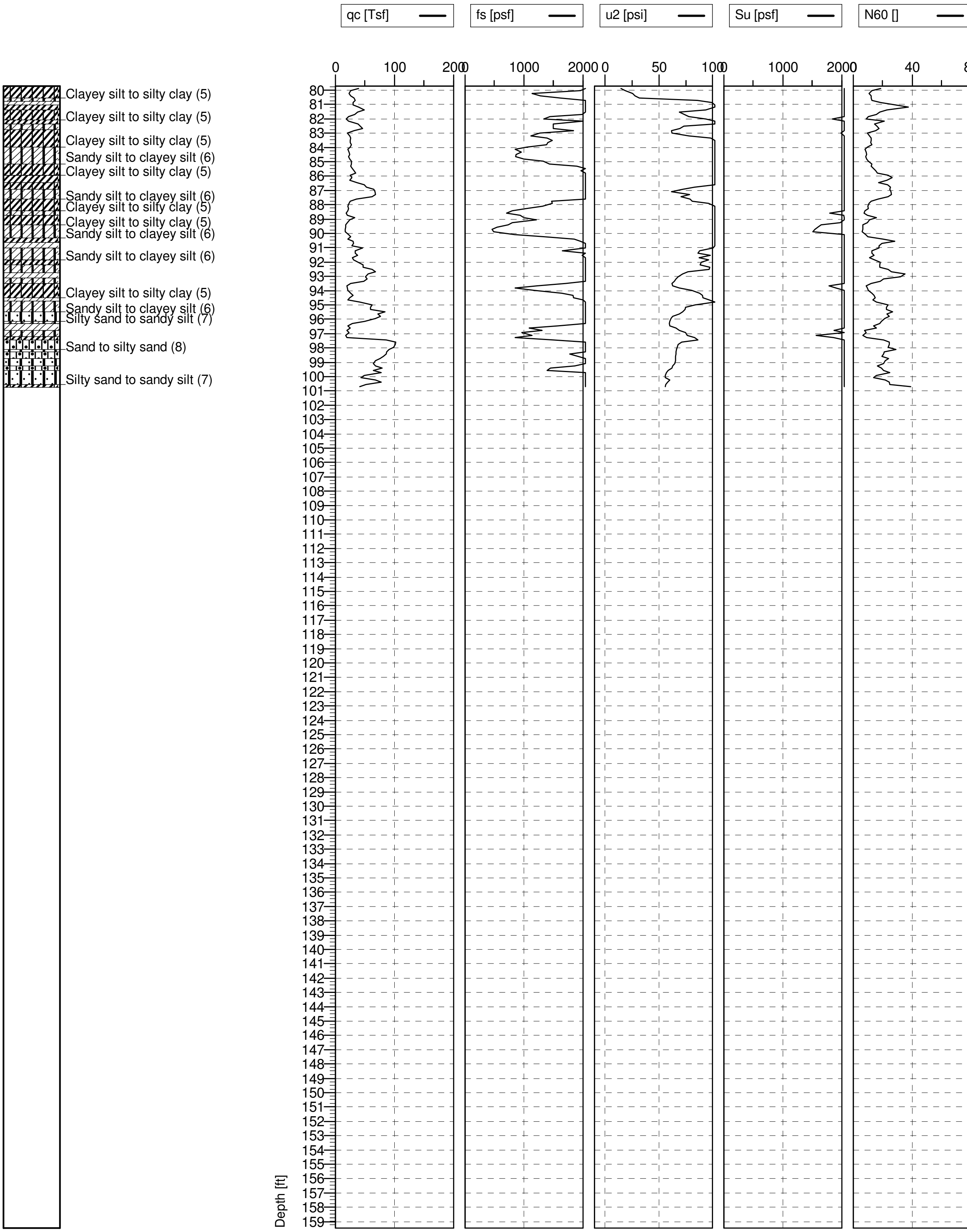


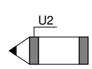
Test no: CPT-15

Client:

Project:

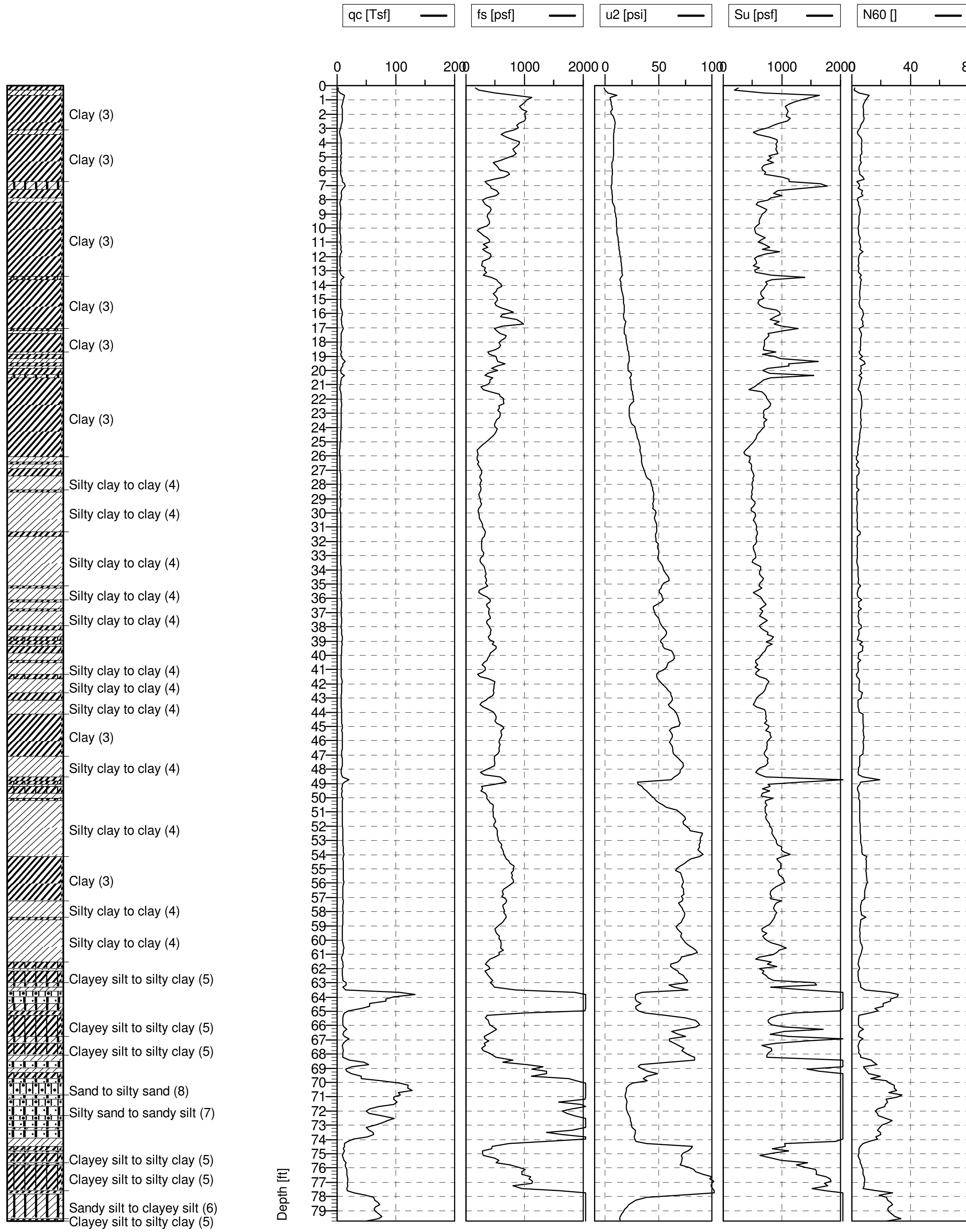
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

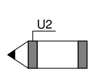




Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-14
Client:
Project:



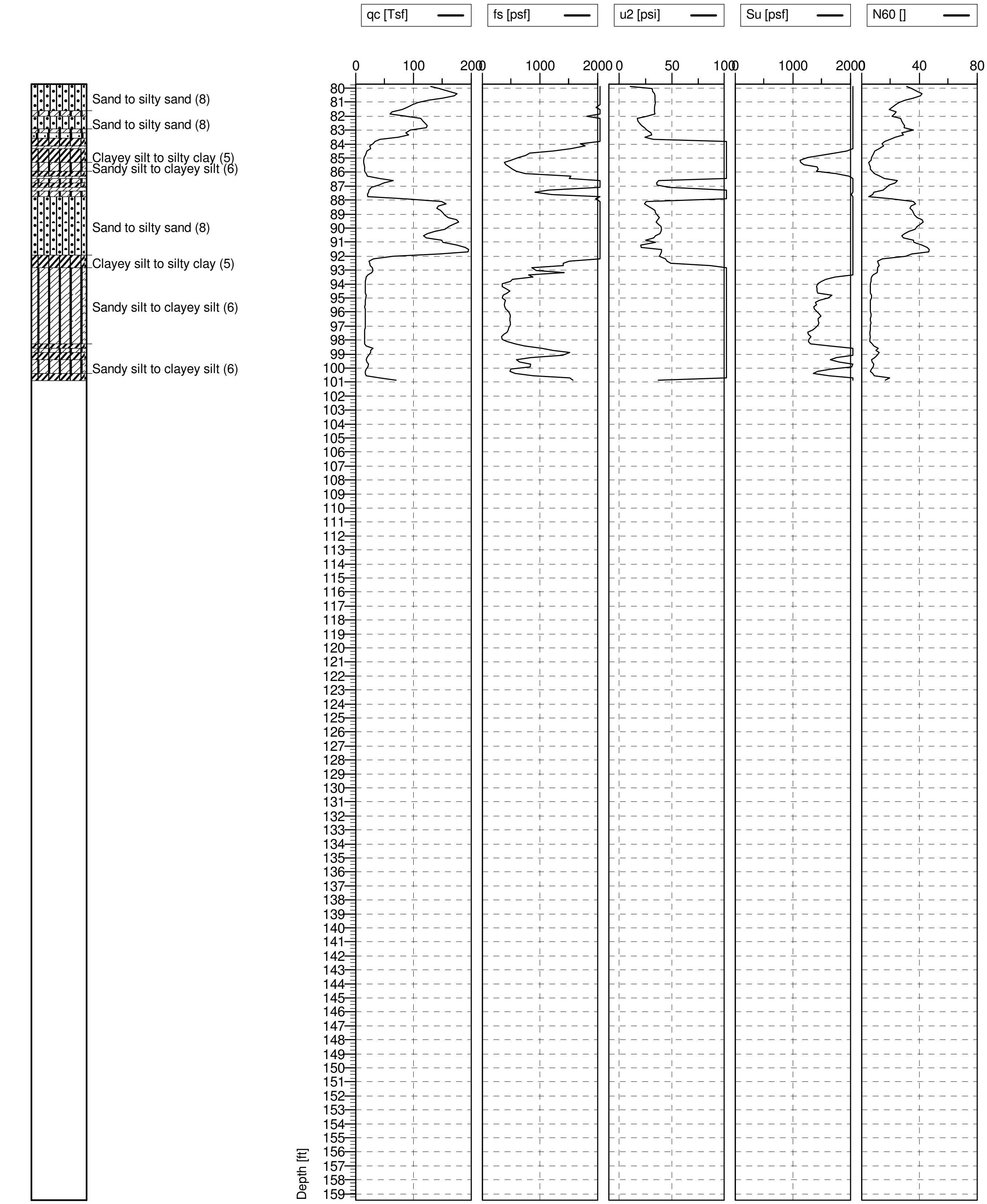


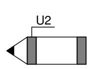
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-14

Client:

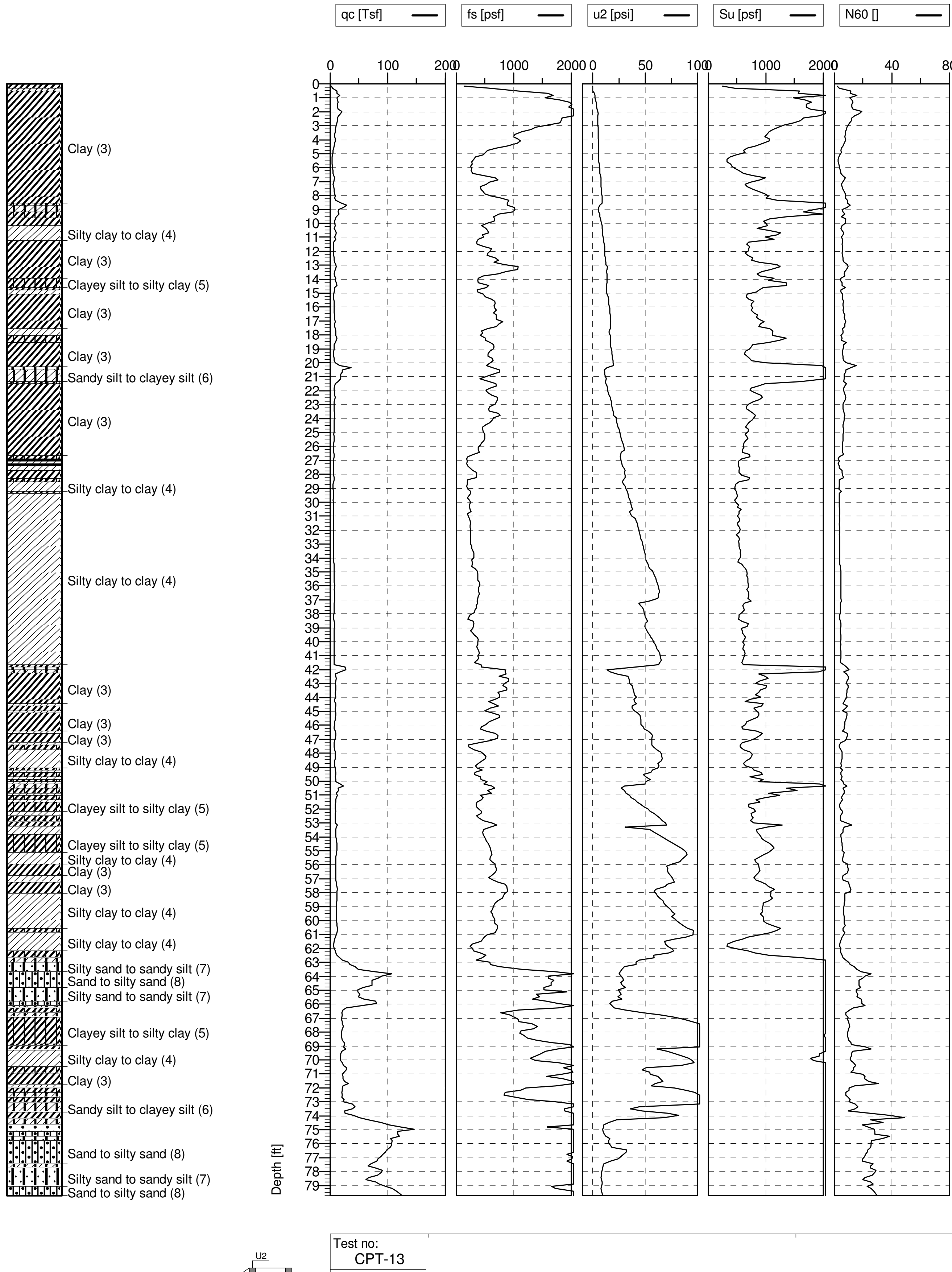
Project:





Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-13
Client:
Project:

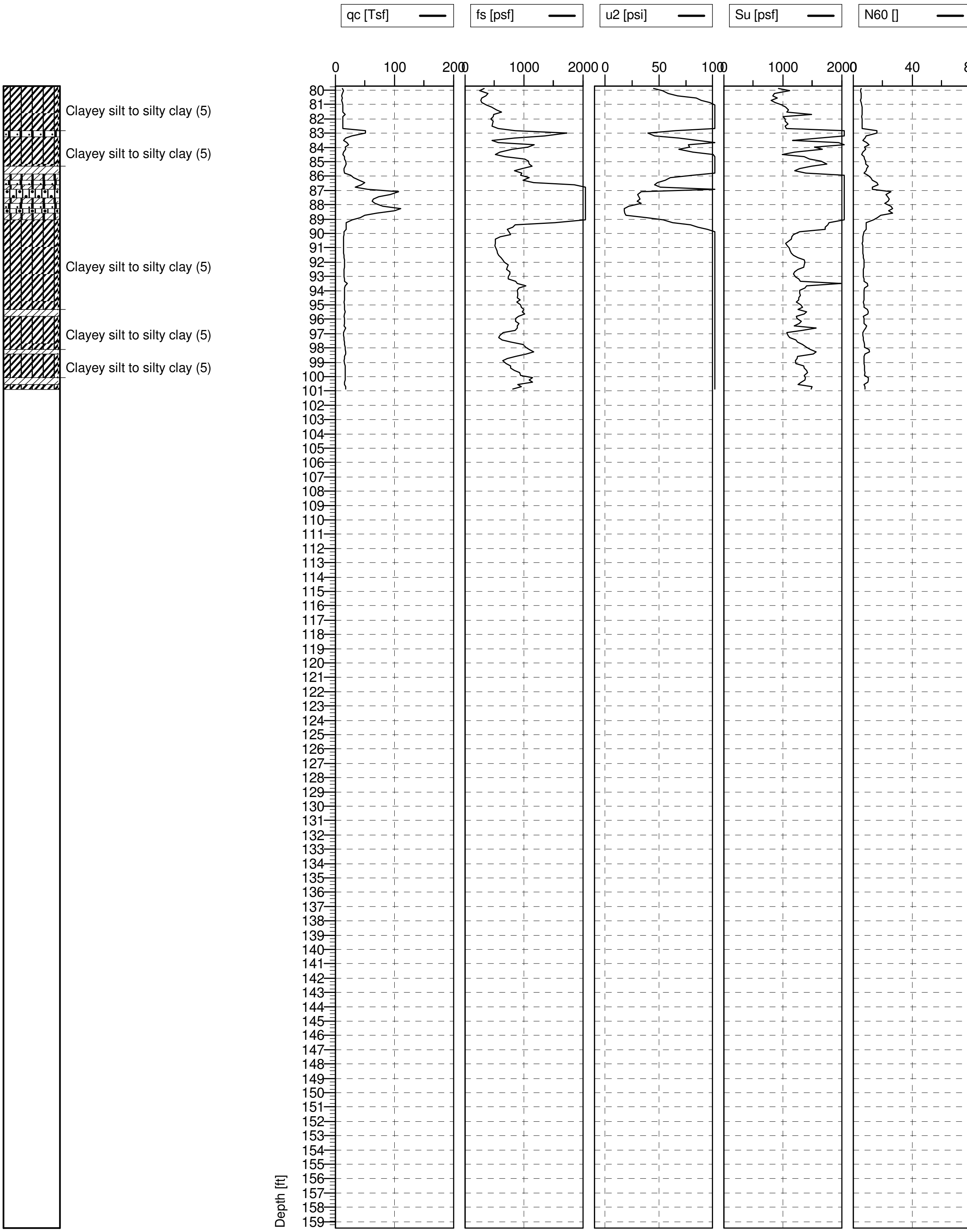


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-13

Client:

Project:

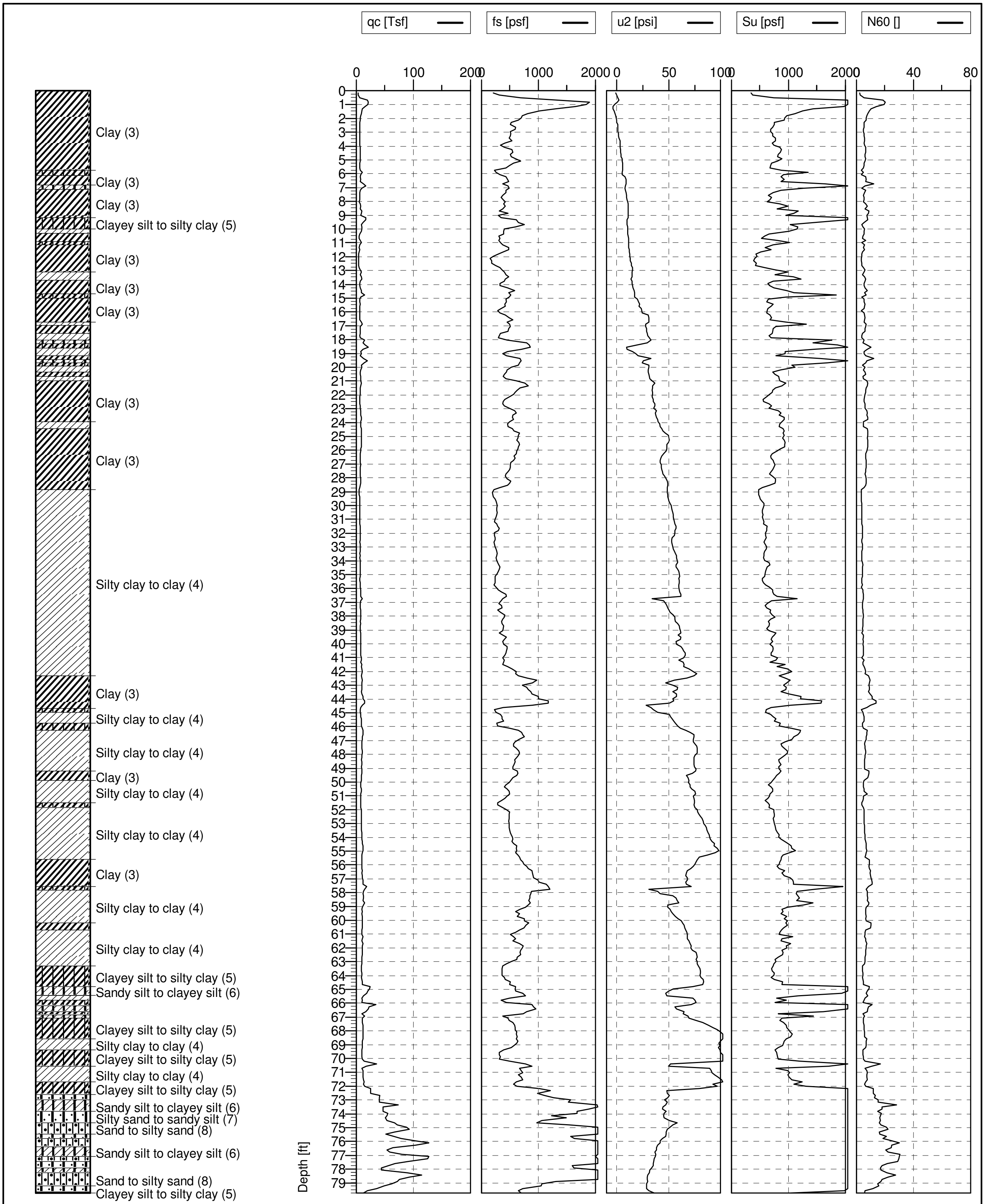


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-12

Client:

Project:



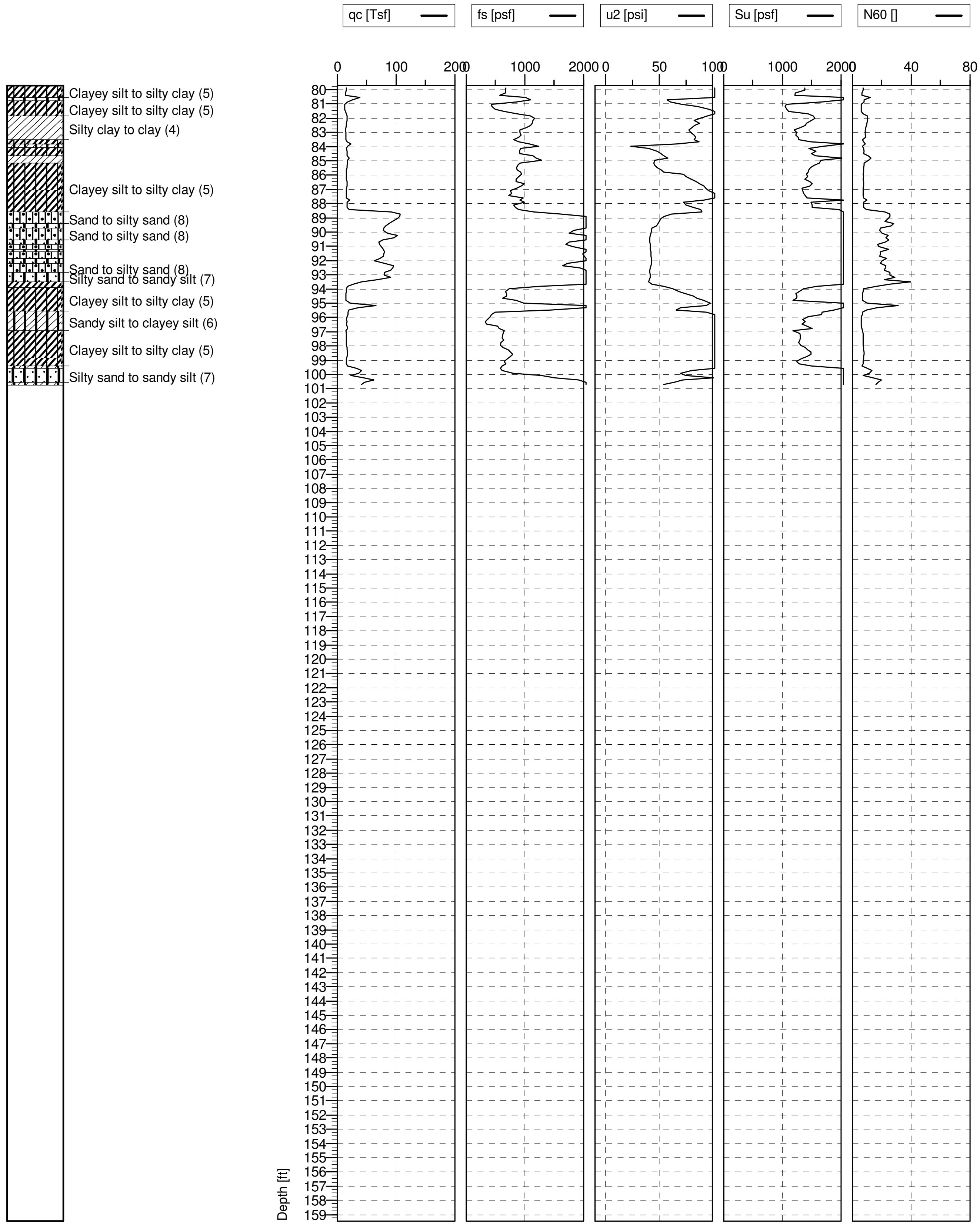
U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-12

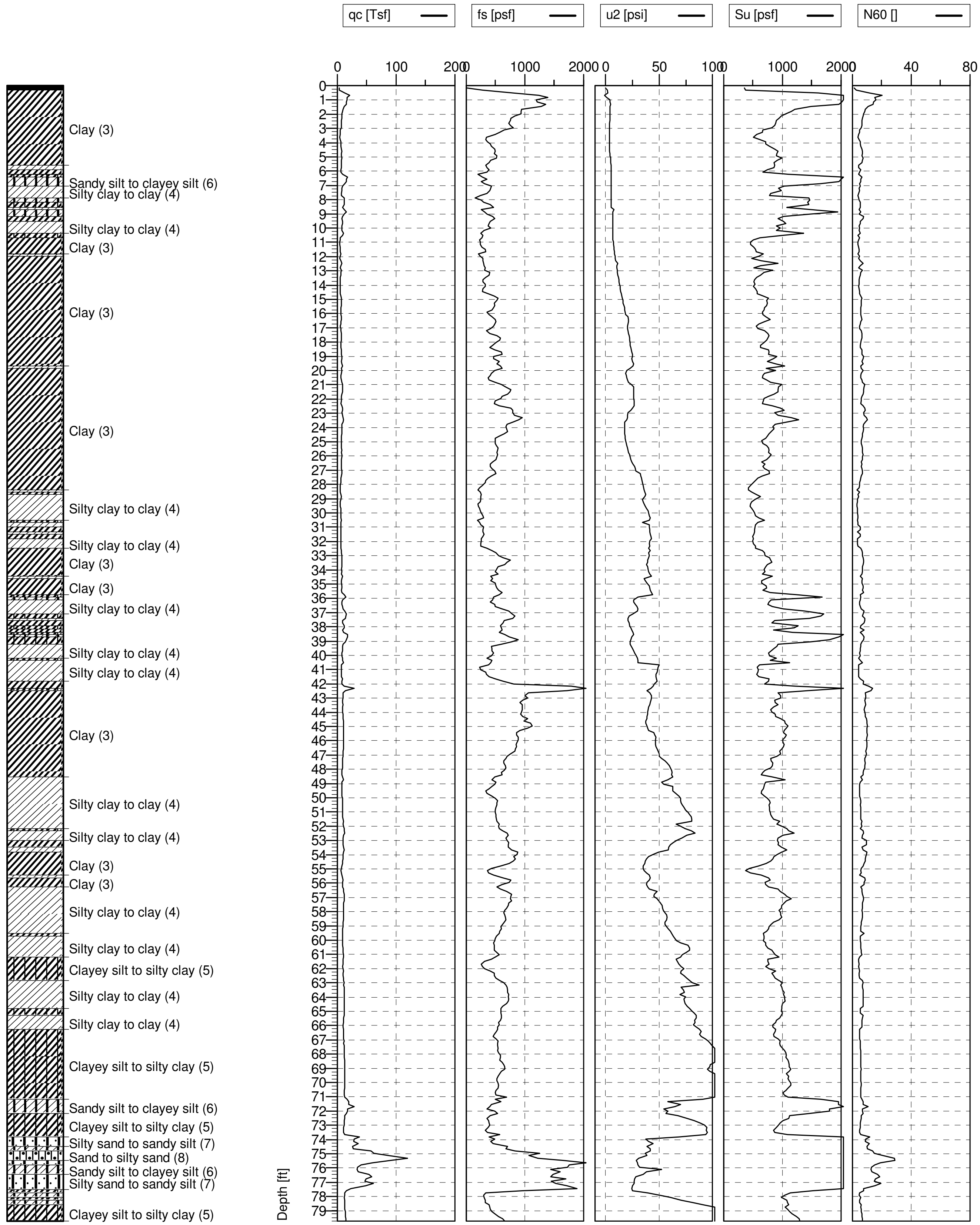
Client:

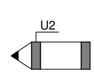
Project:



Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-11
Client:
Project:



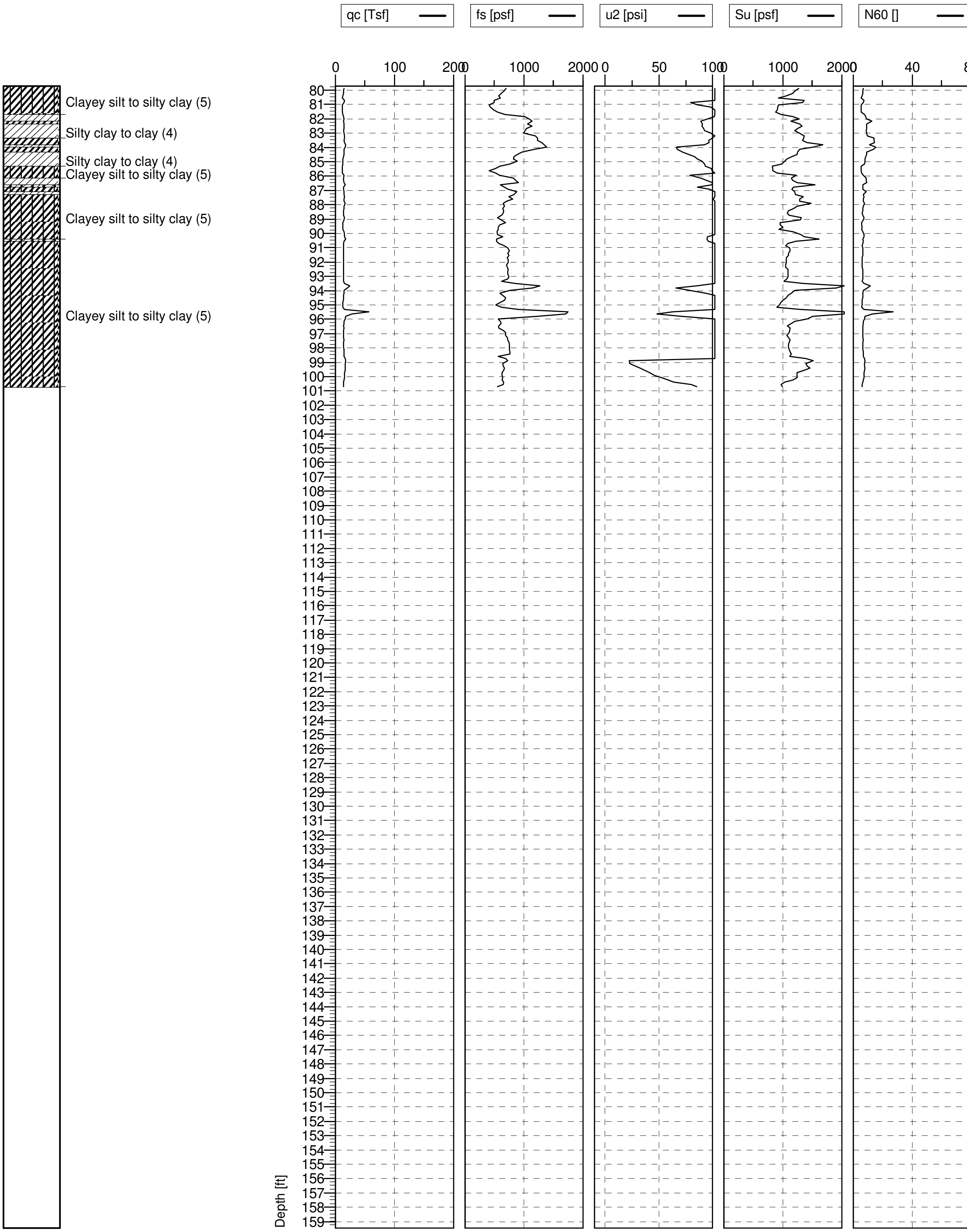


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-11

Client:

Project:

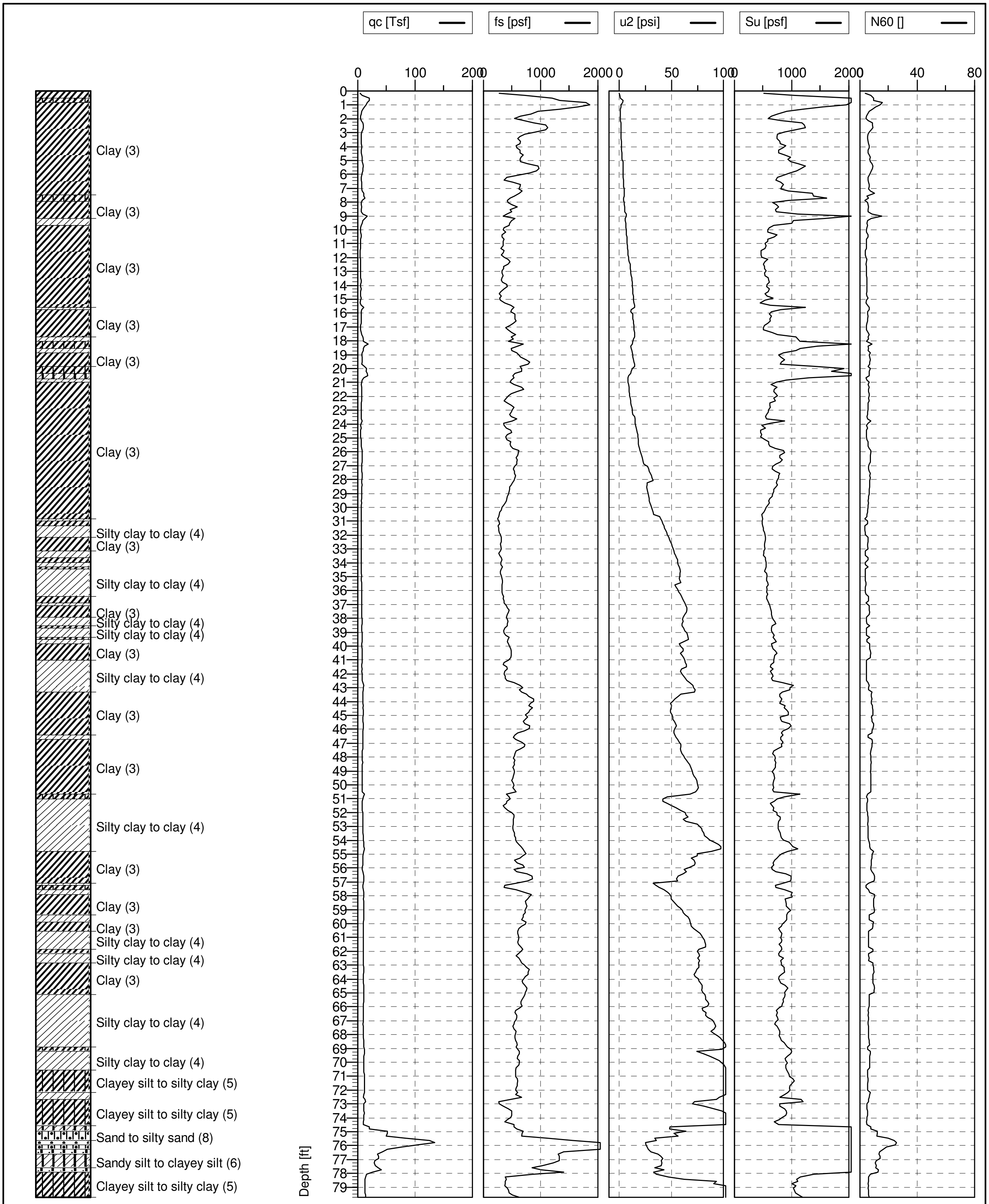


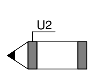
Test no: CPT-10

Client:

Project:

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150



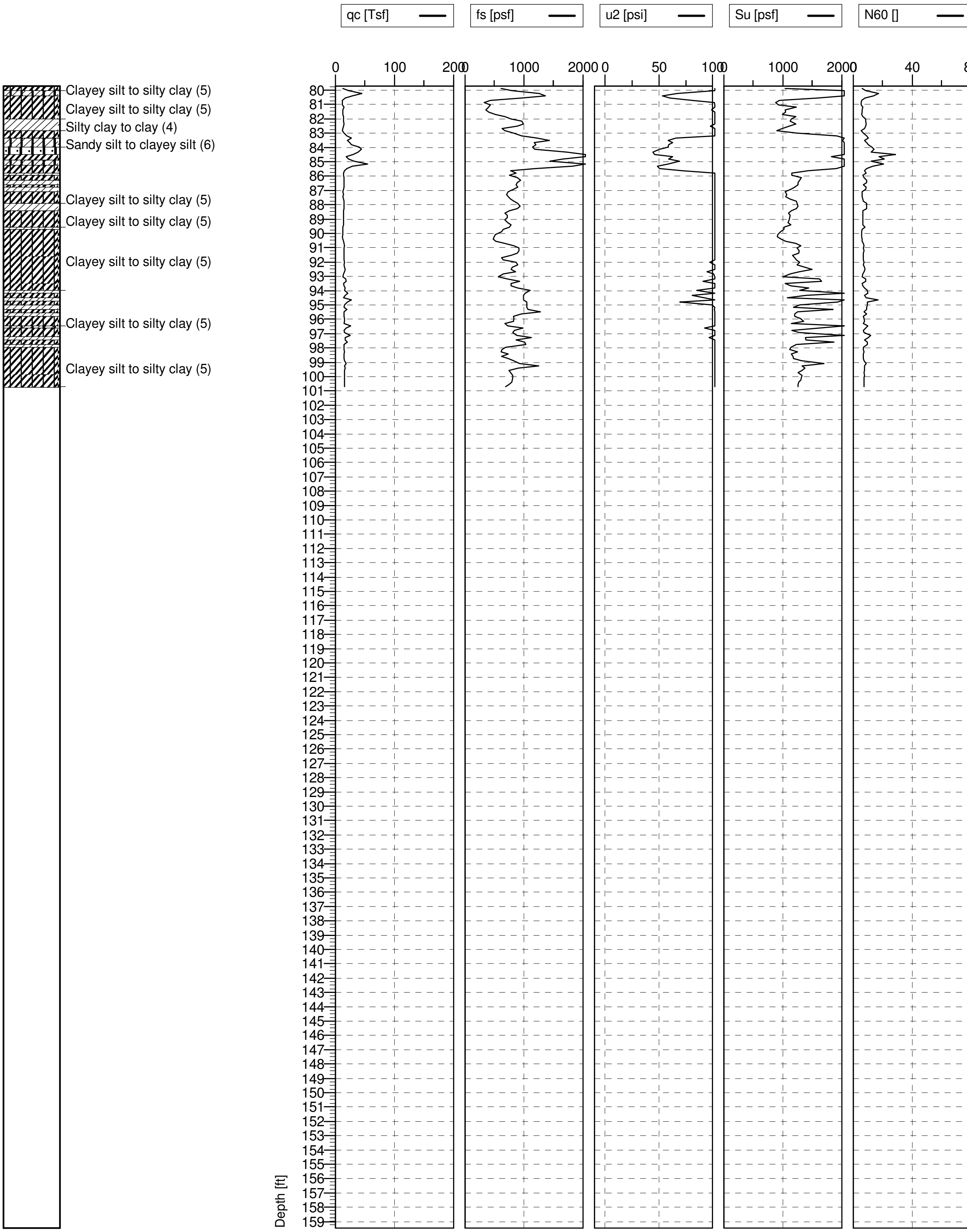


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-10

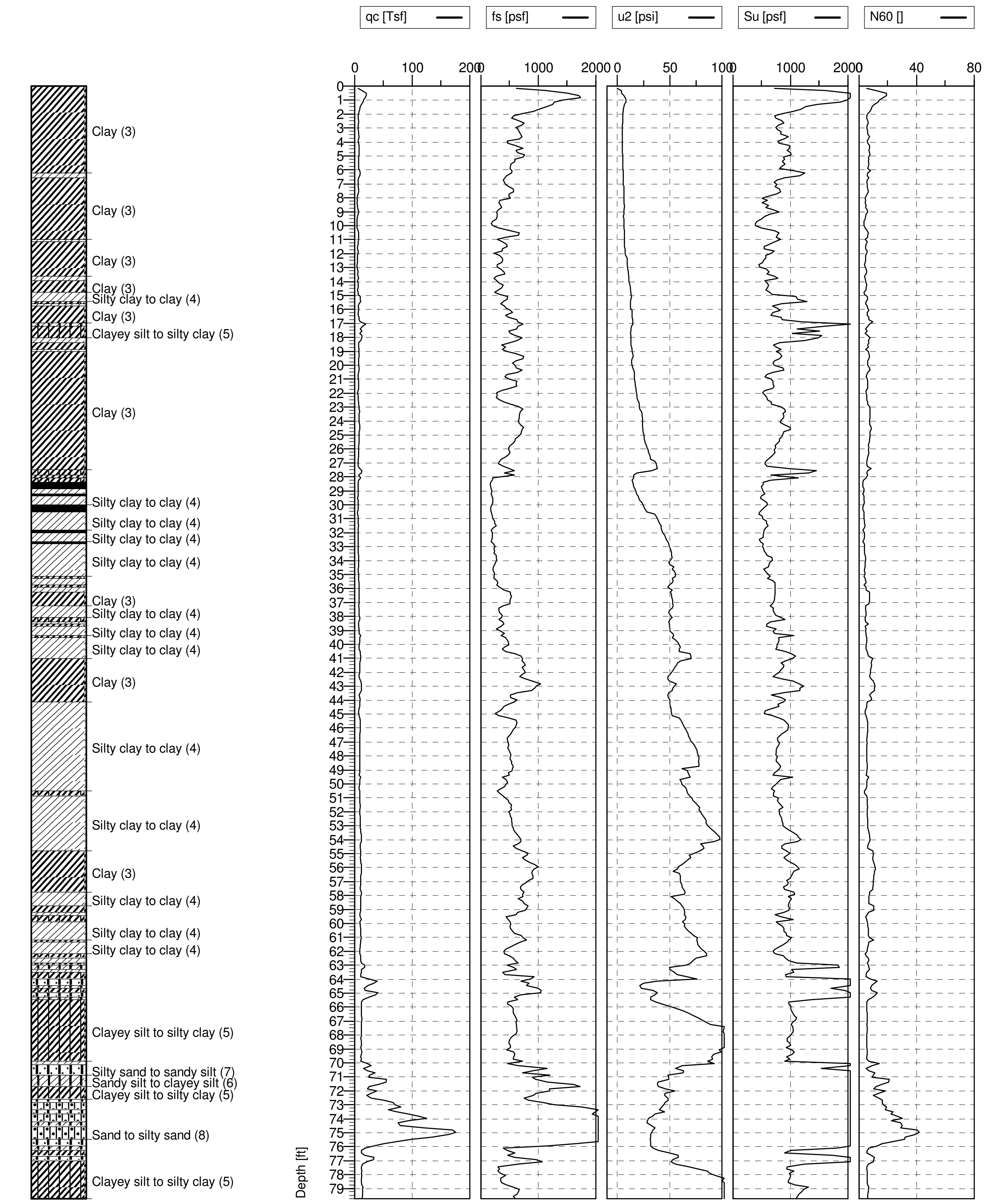
Client:

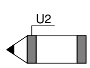
Project:



Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-9
Client:
Project:





Cone No: DDG1068

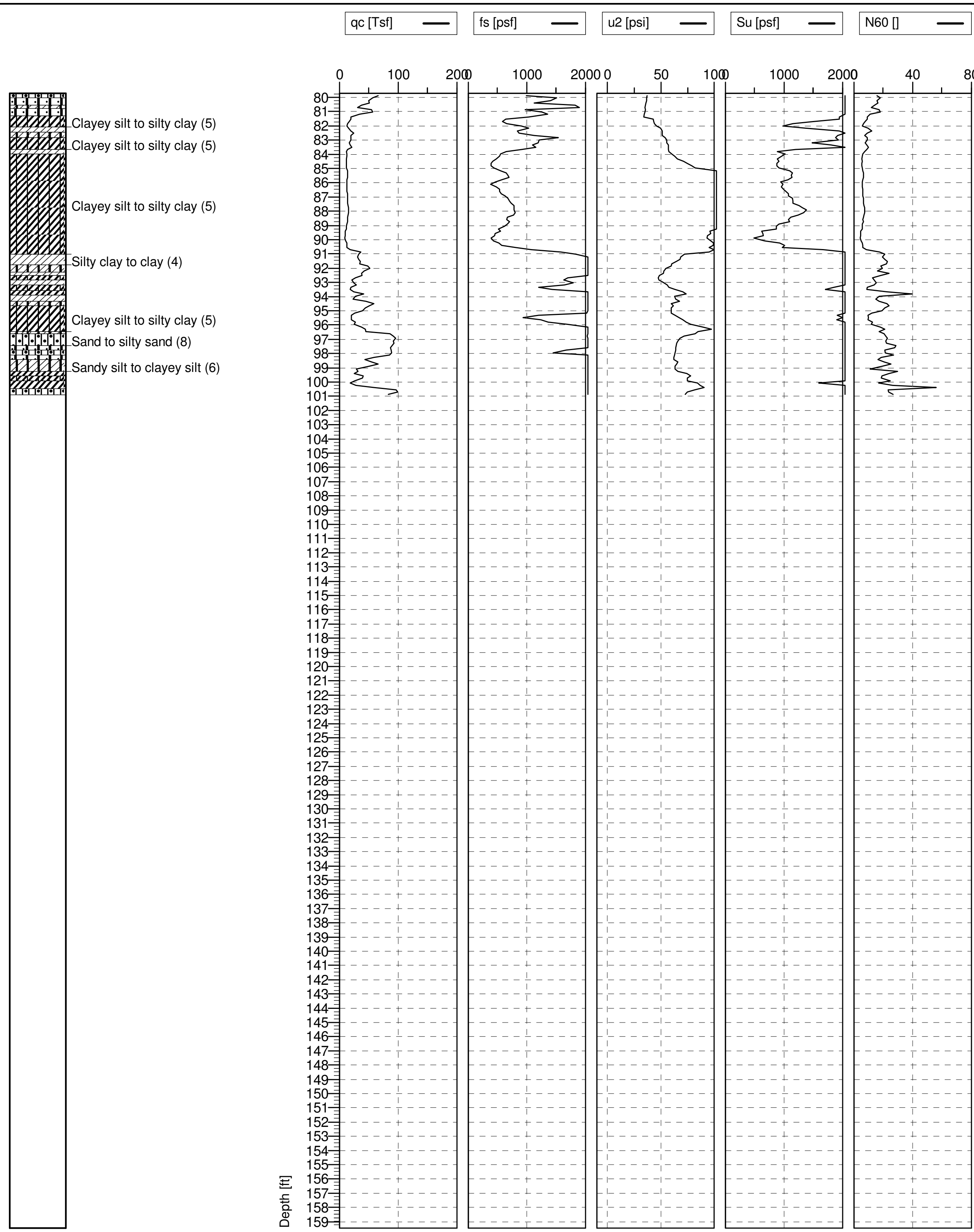
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no: CPT-9

Client:

Project:



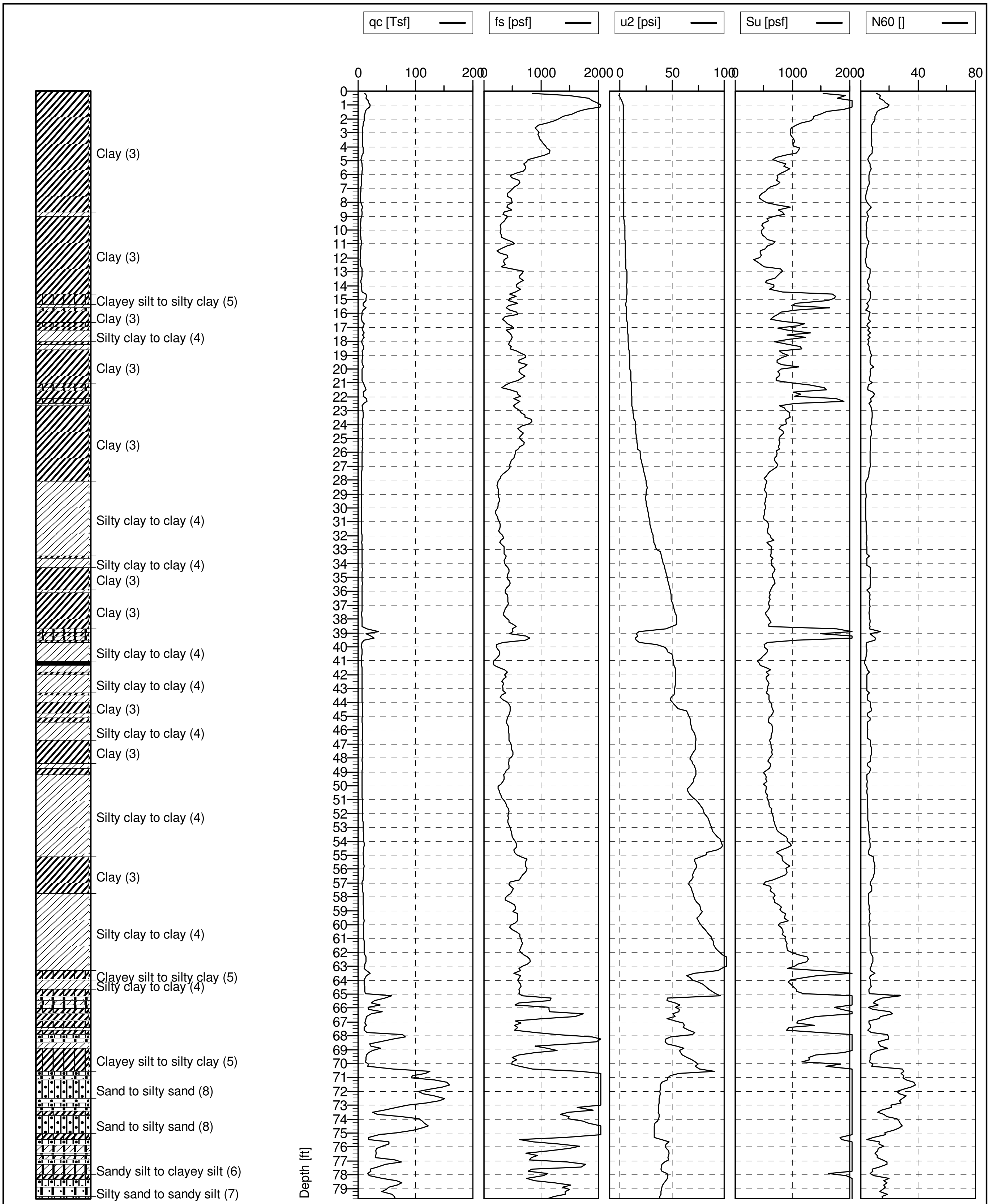
U2

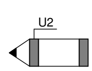
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-8

Client:

Project:



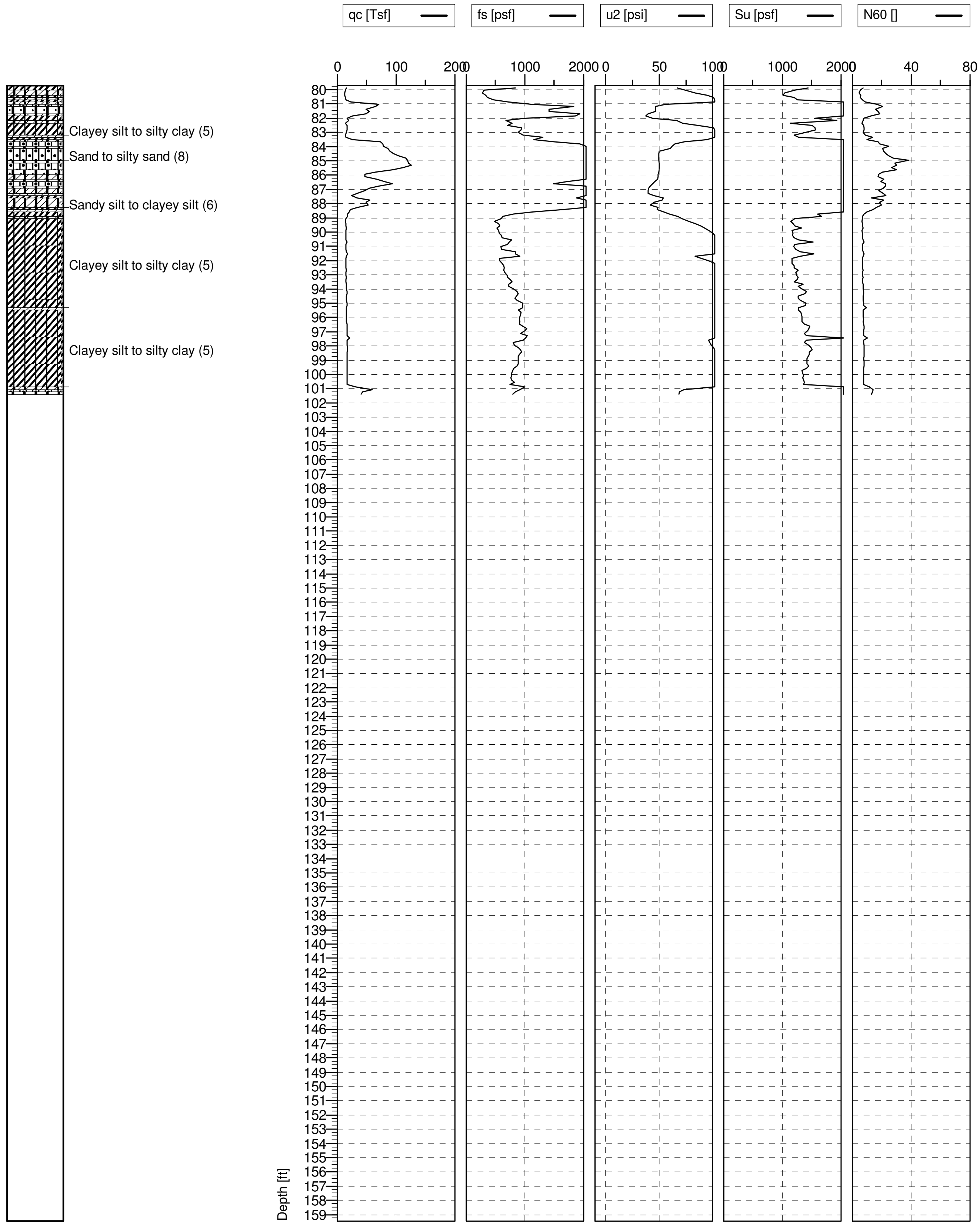


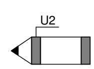
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-8

Client:

Project:



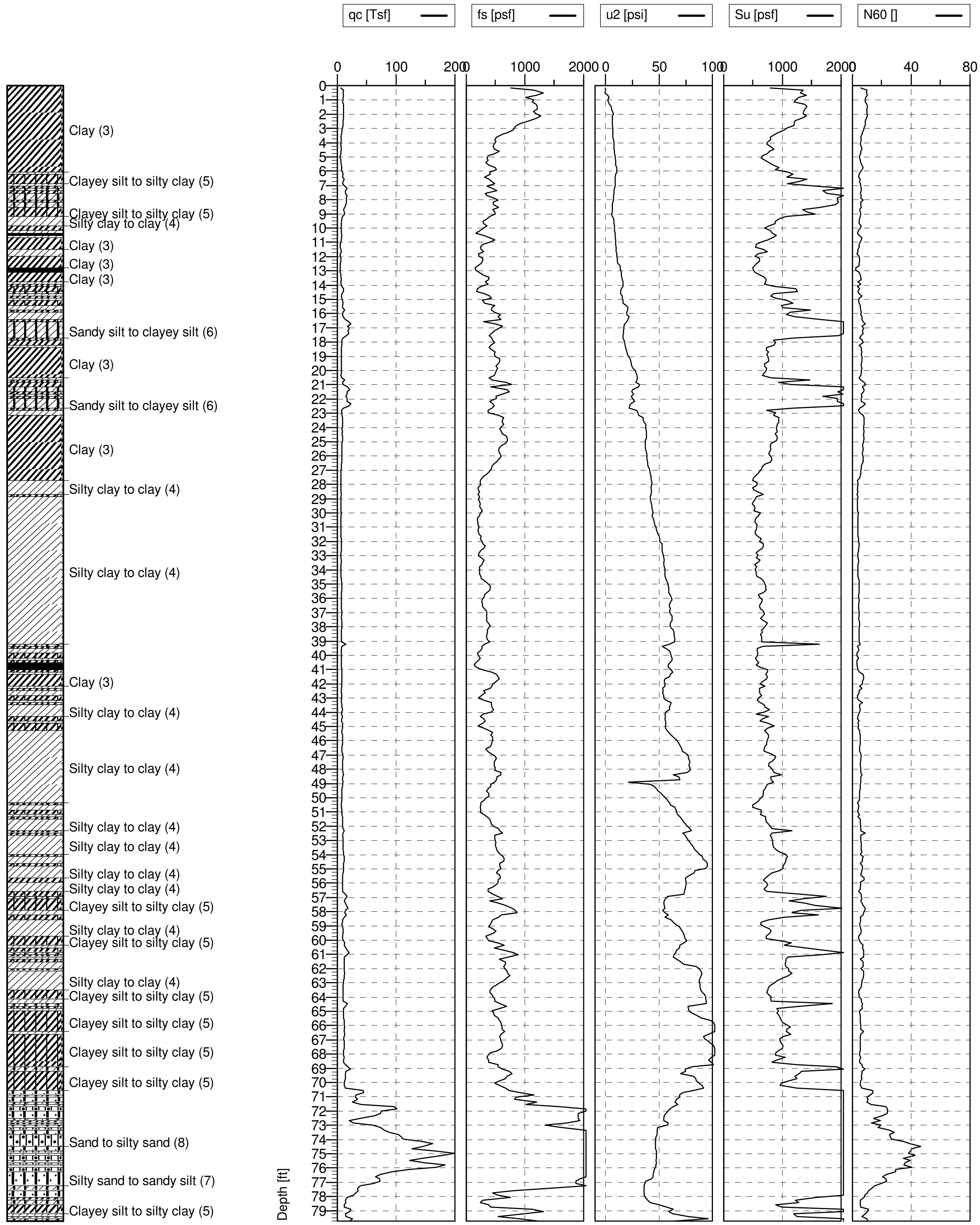


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-7

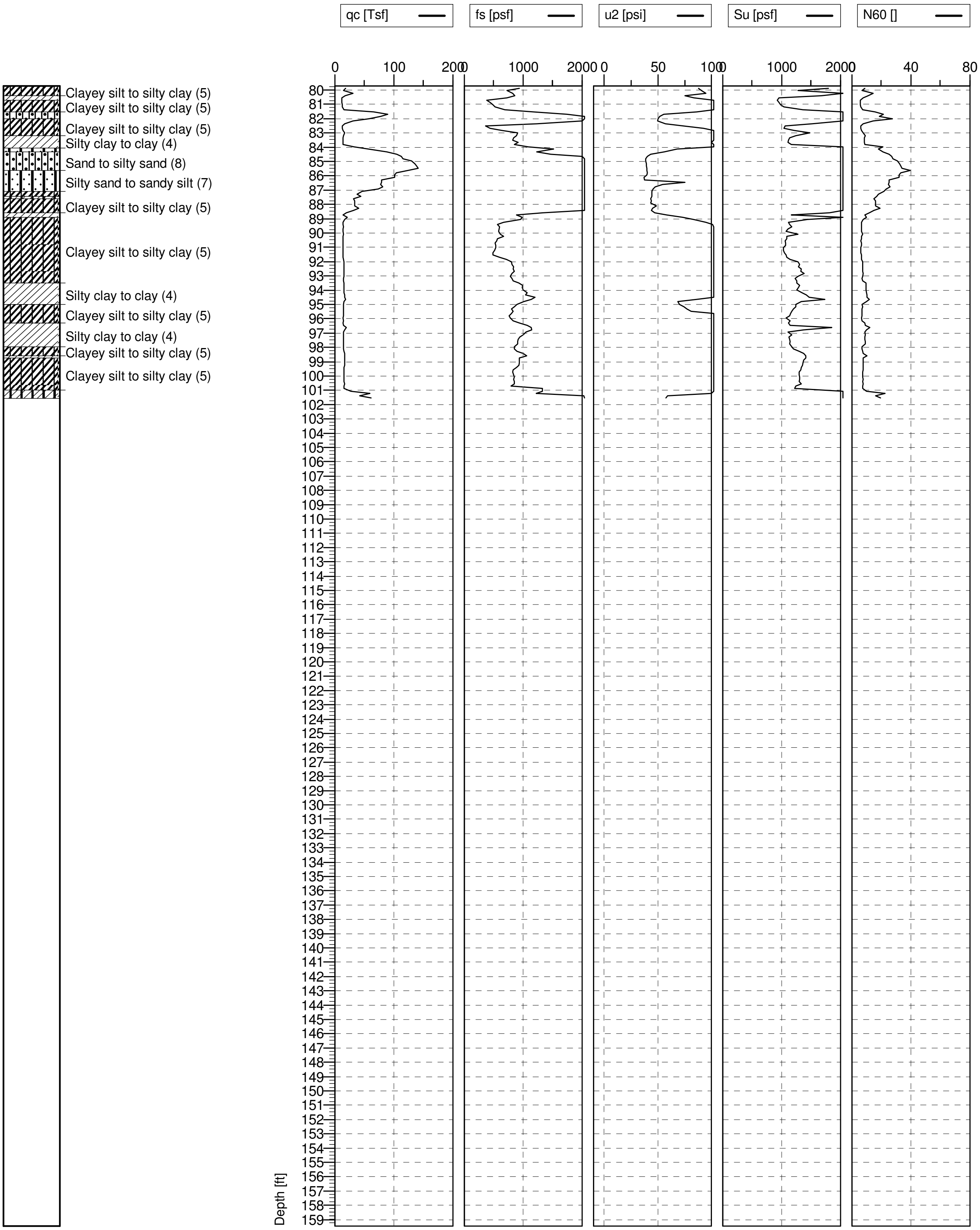
Client:

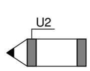
Project:



Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-7
Client:
Project:



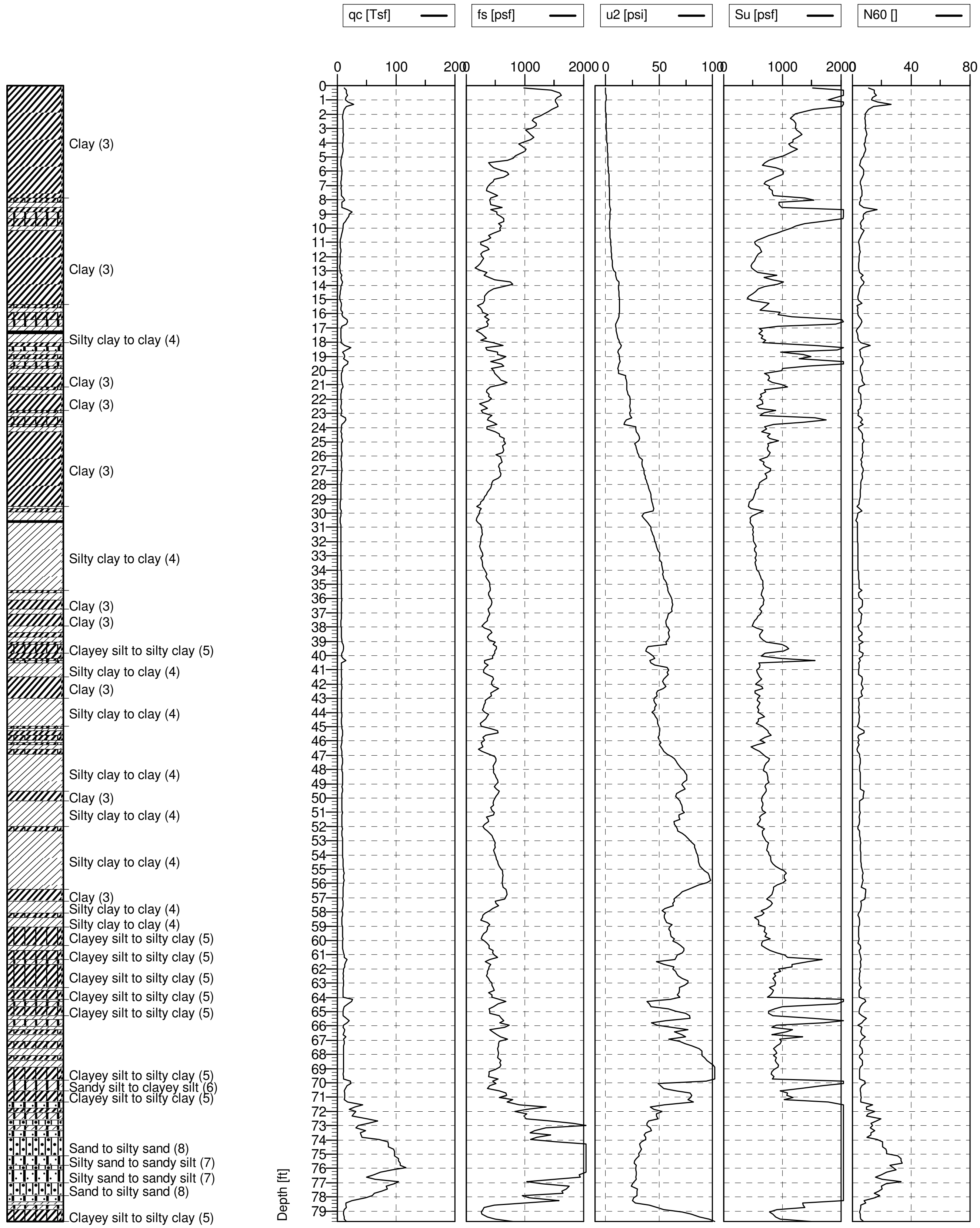


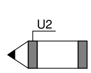
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-6

Client:

Project:





Cone No: DDG1068

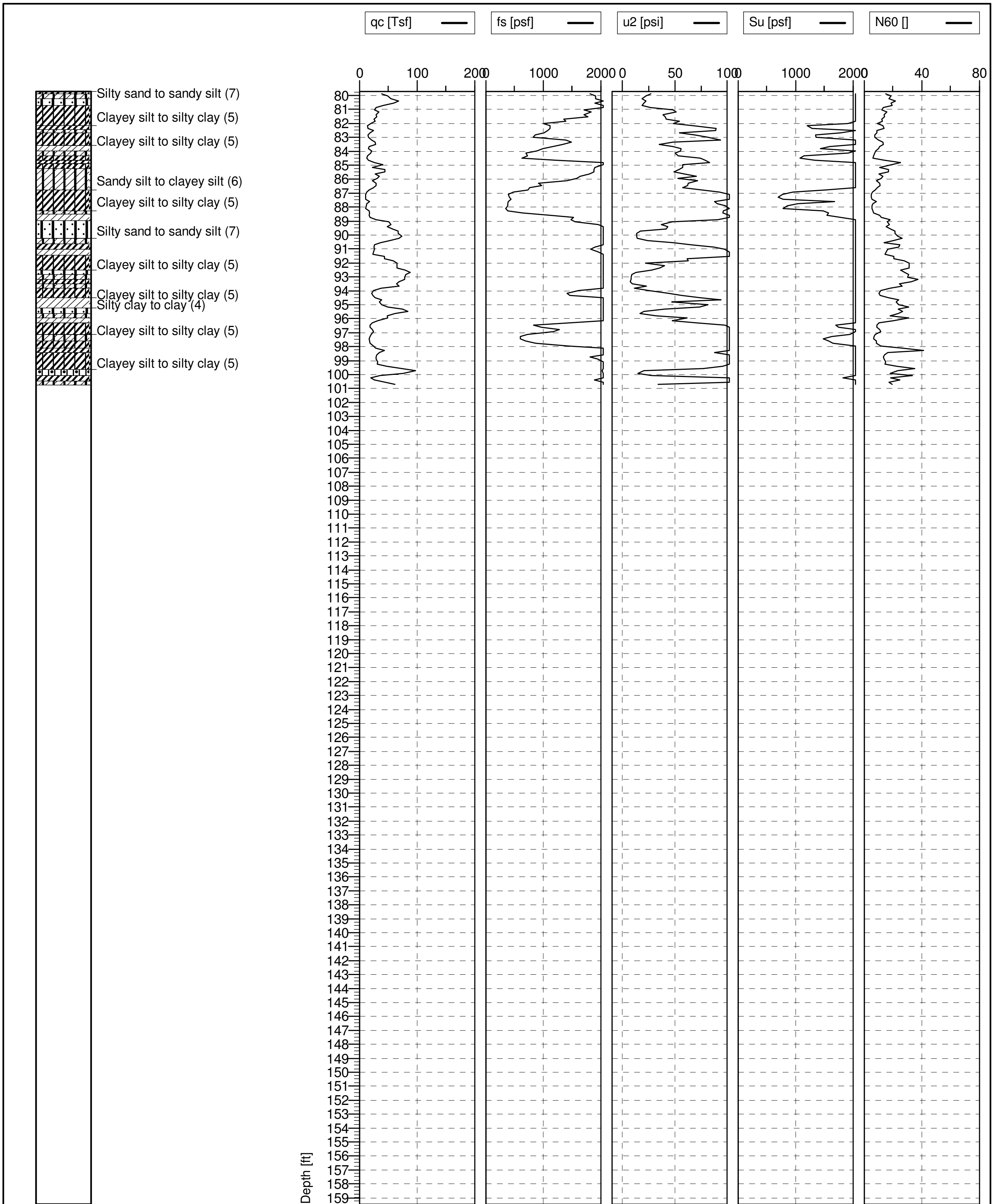
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no: CPT-6

Client:

Project:

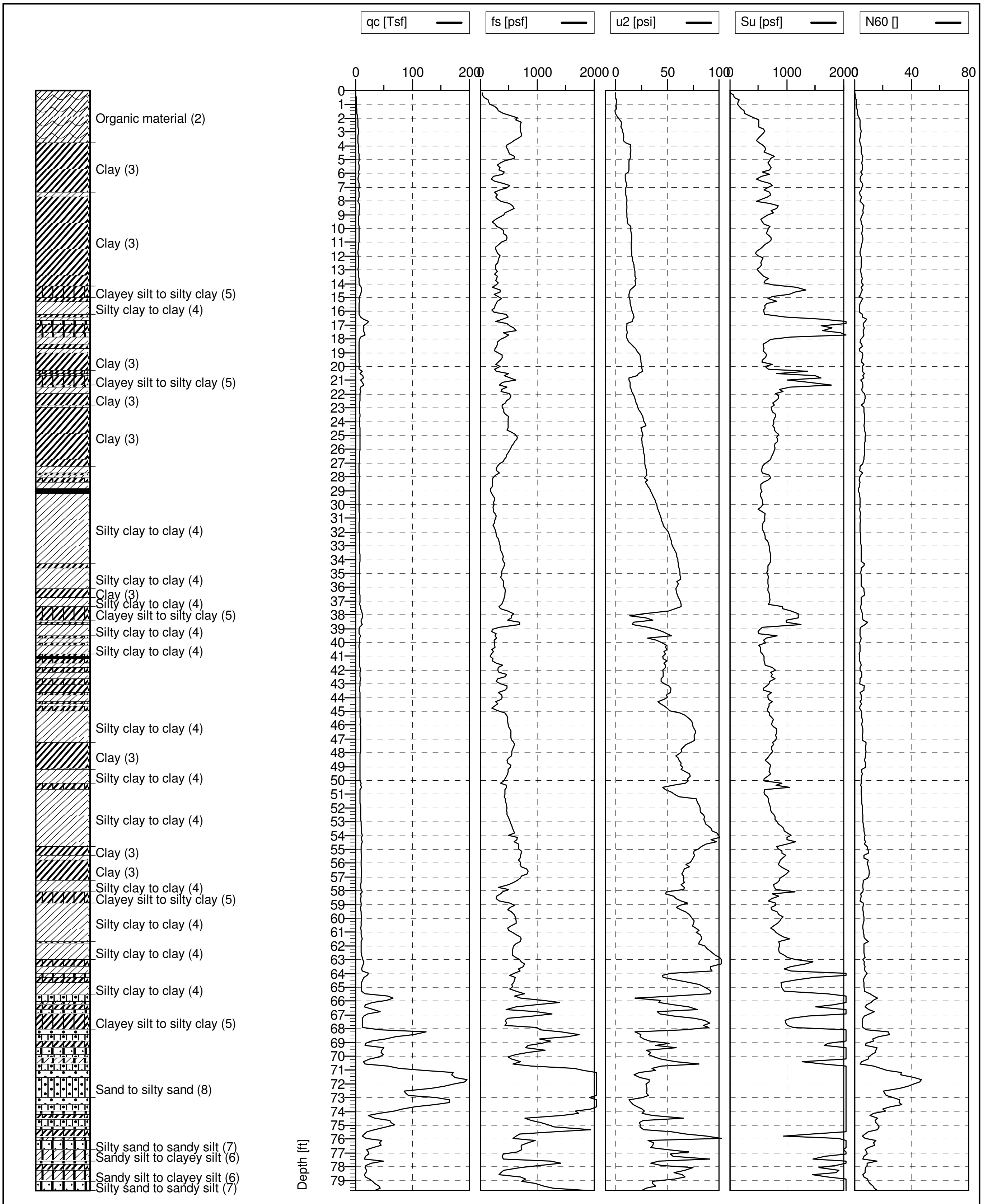


Test no:
CPT-5

Client:

Project:

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

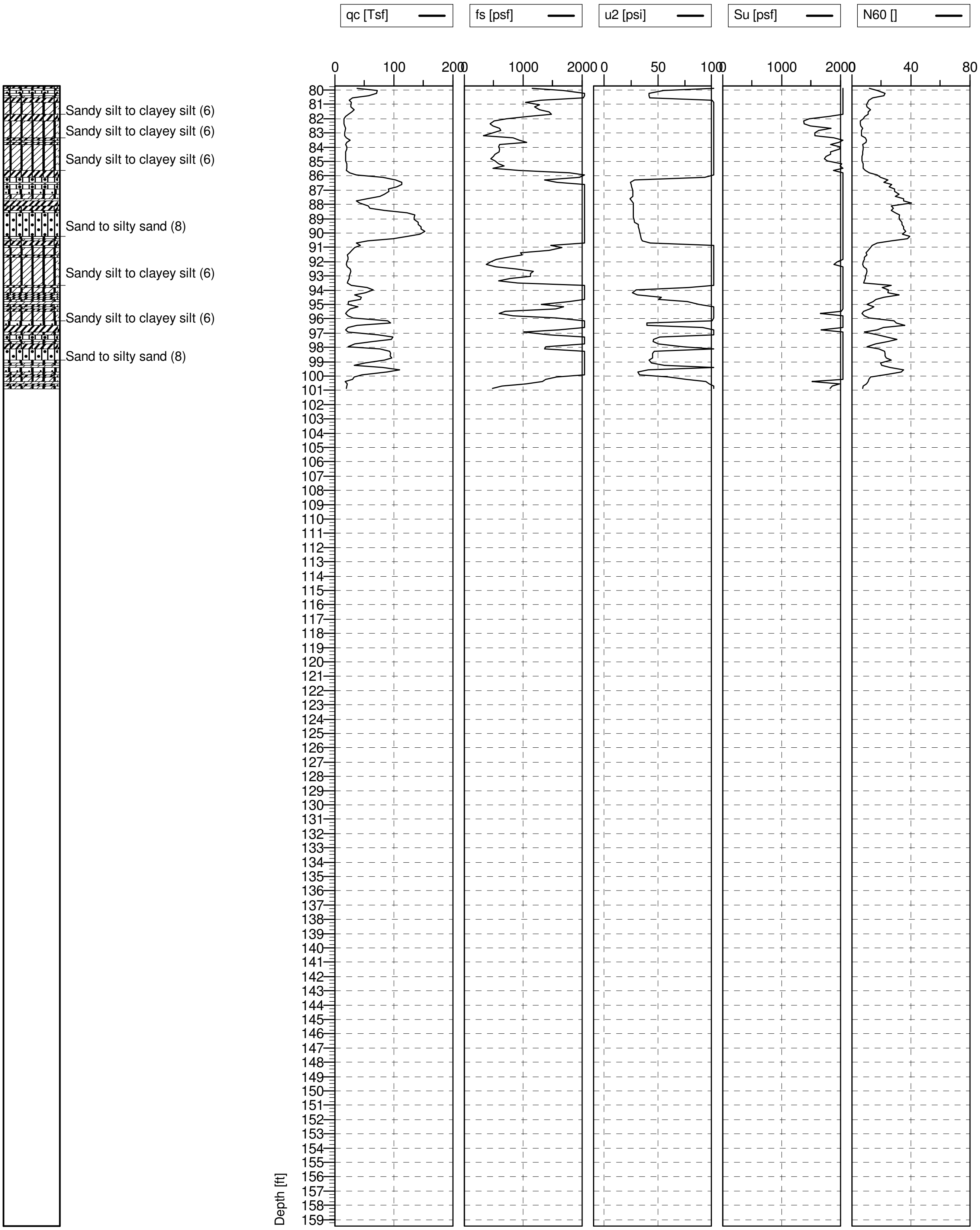


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-5

Client:

Project:



Test no: CPT-4

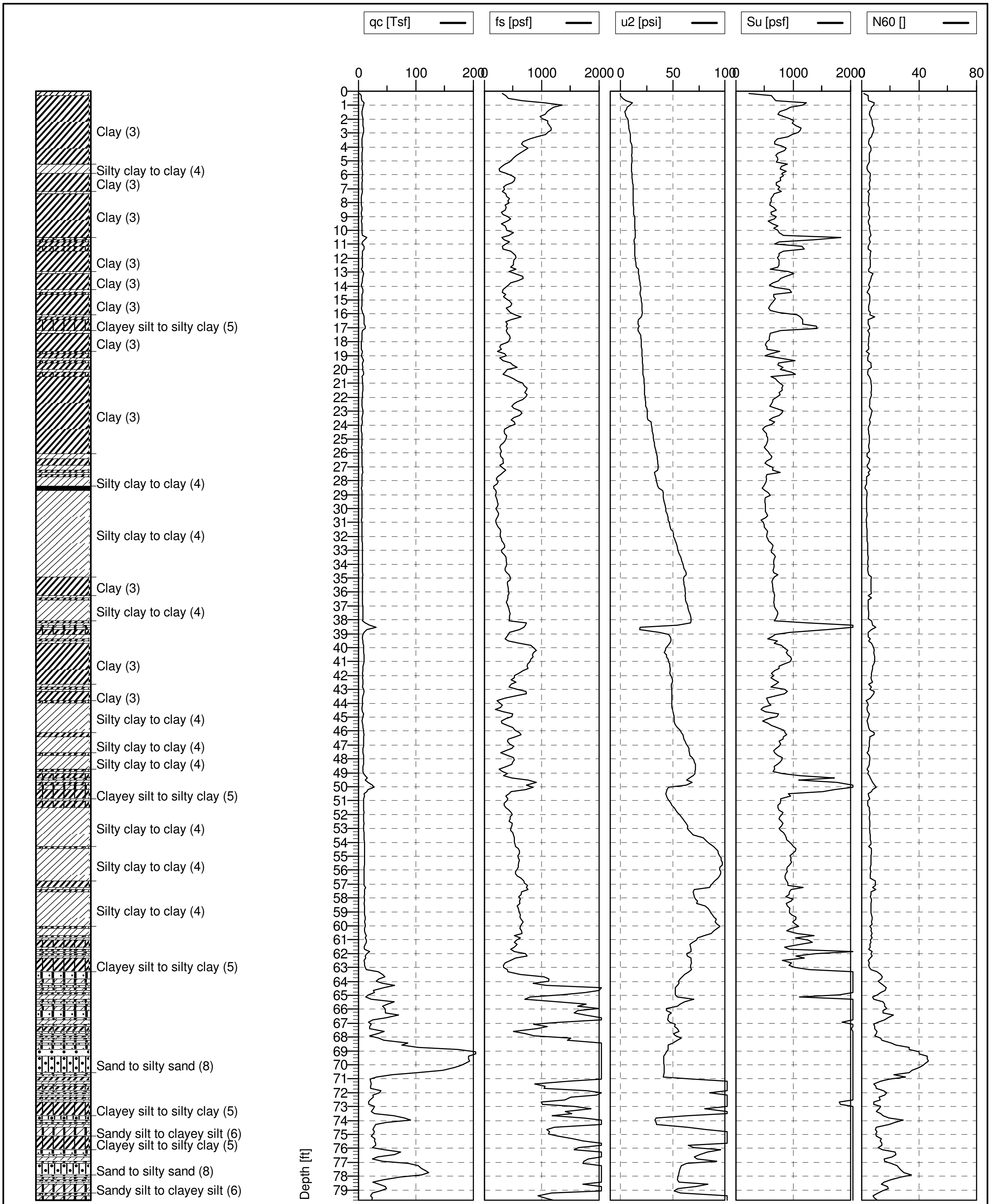
Client:

Project:

Cone No: DDG1068

Tip area [cm2]: 10

Sleeve area [cm2]: 150



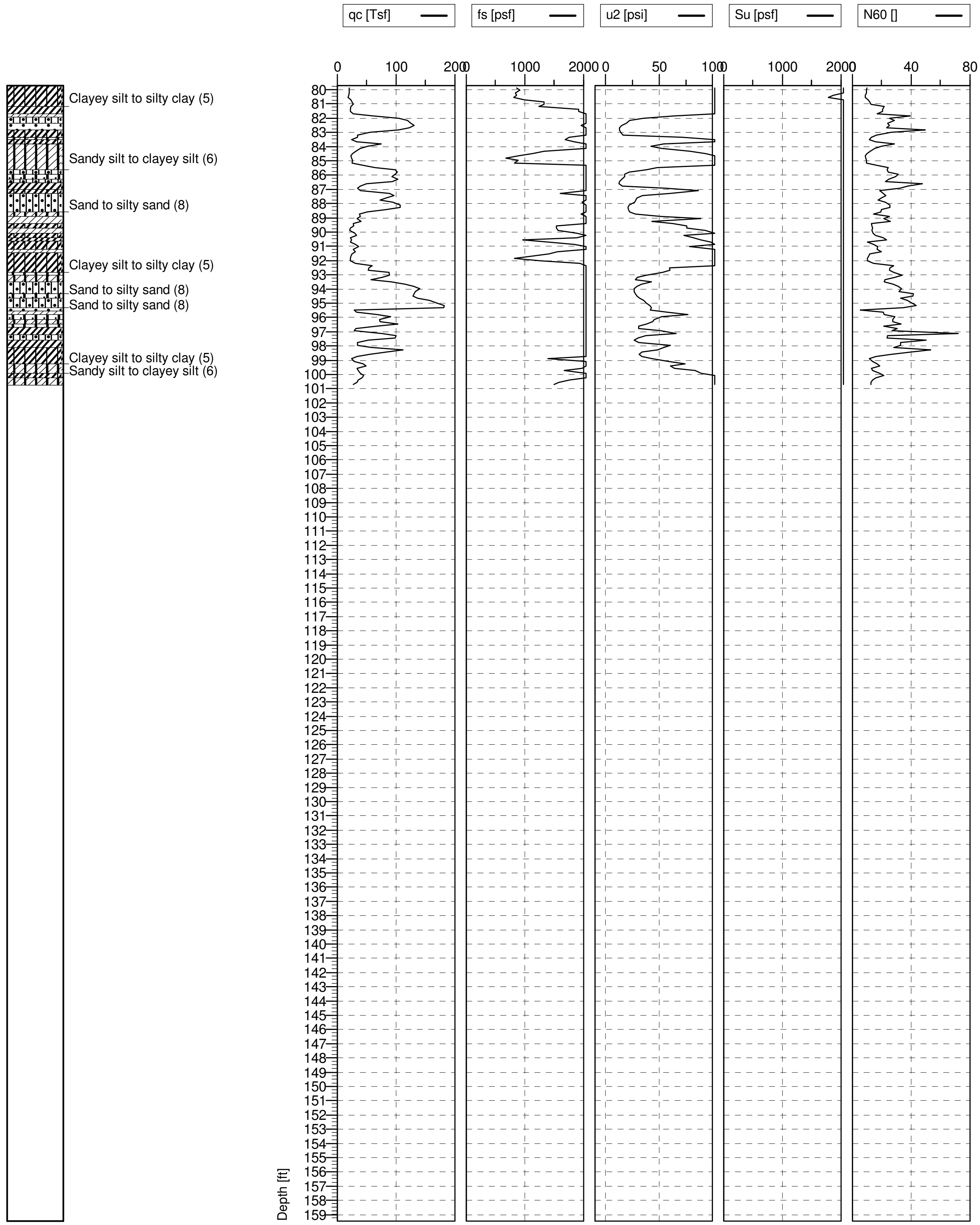
U2

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-4

Client:

Project:



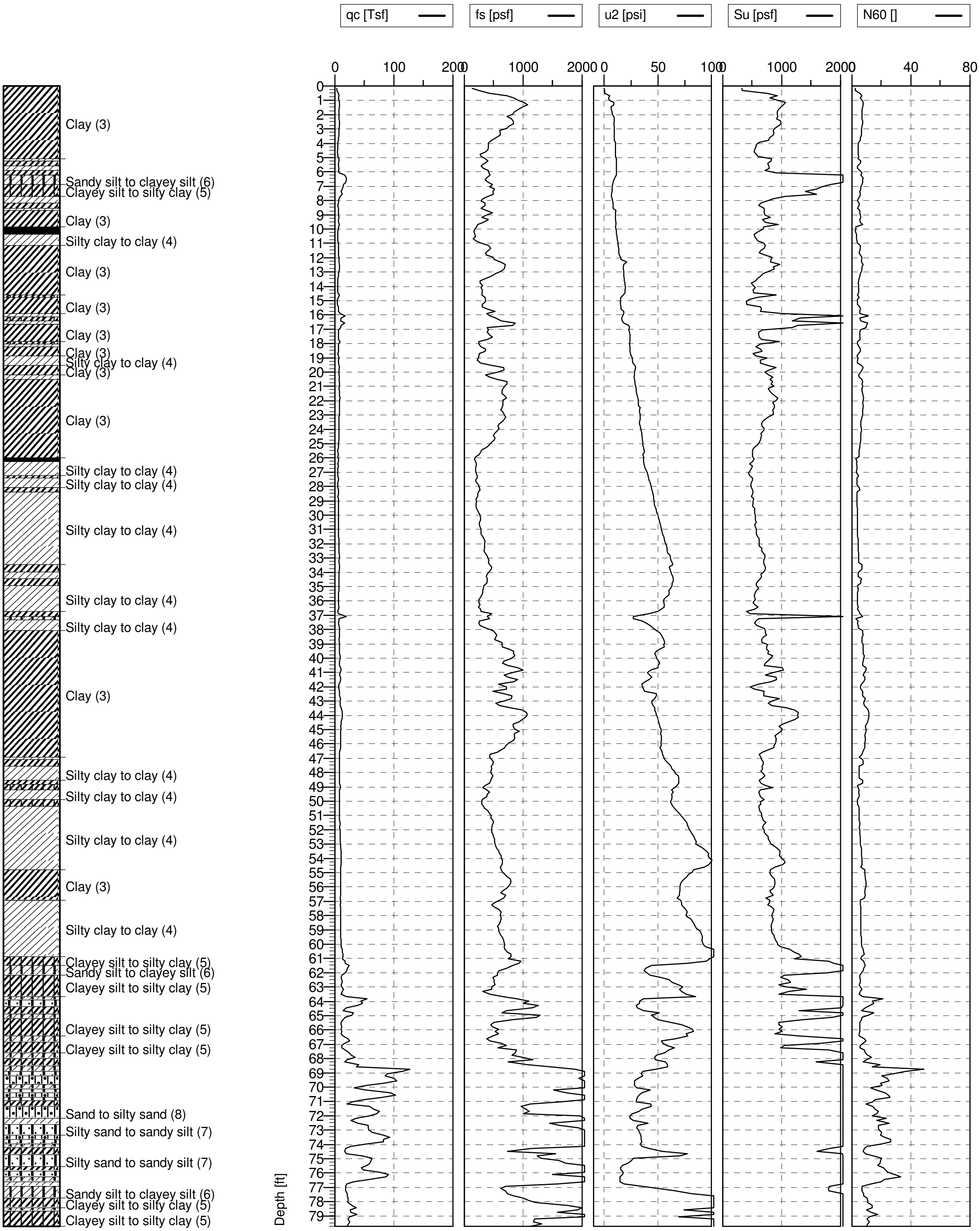
U2

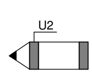
Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-3

Client:

Project:





Cone No: DDG1068

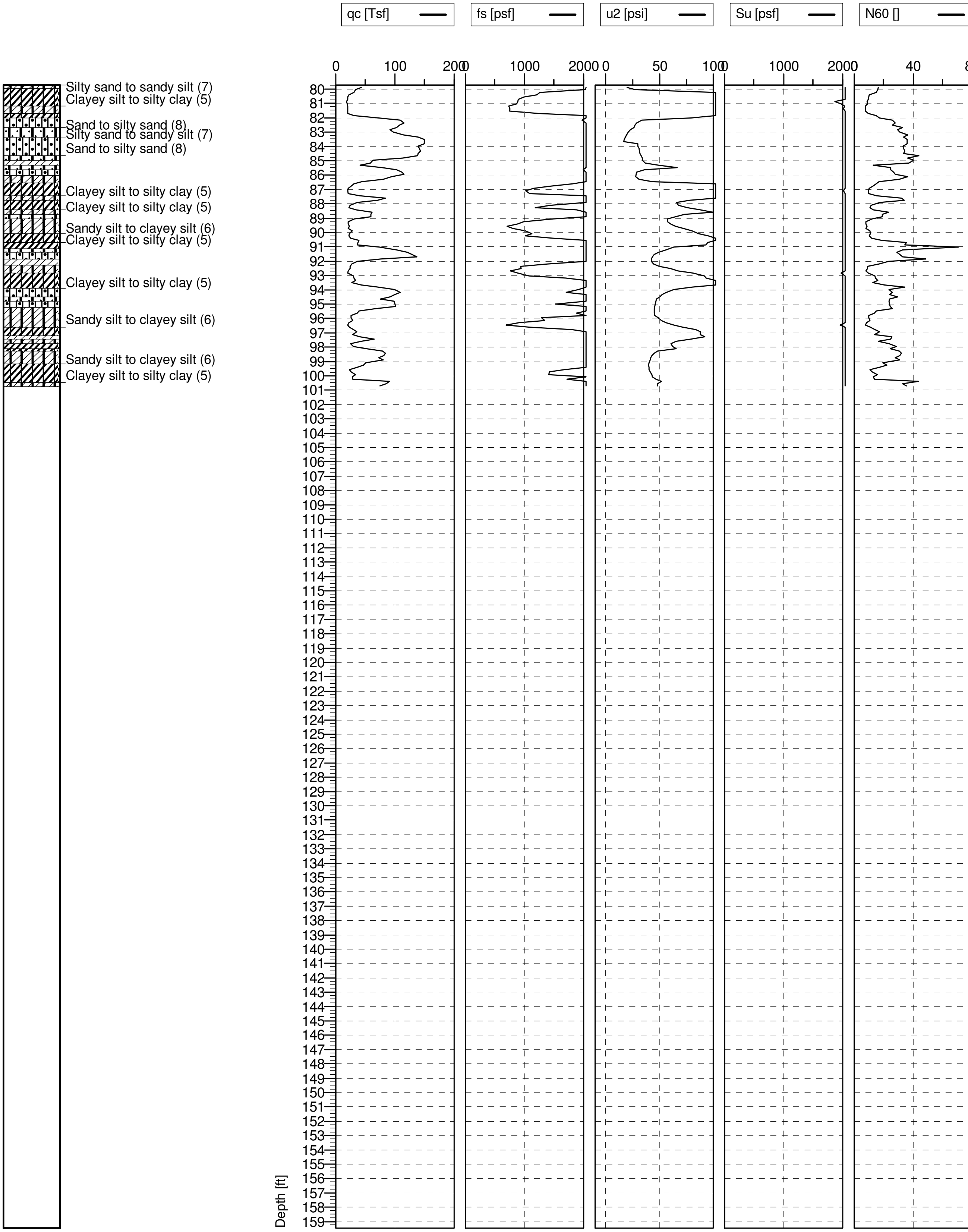
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no:
CPT-3

Client:

Project:

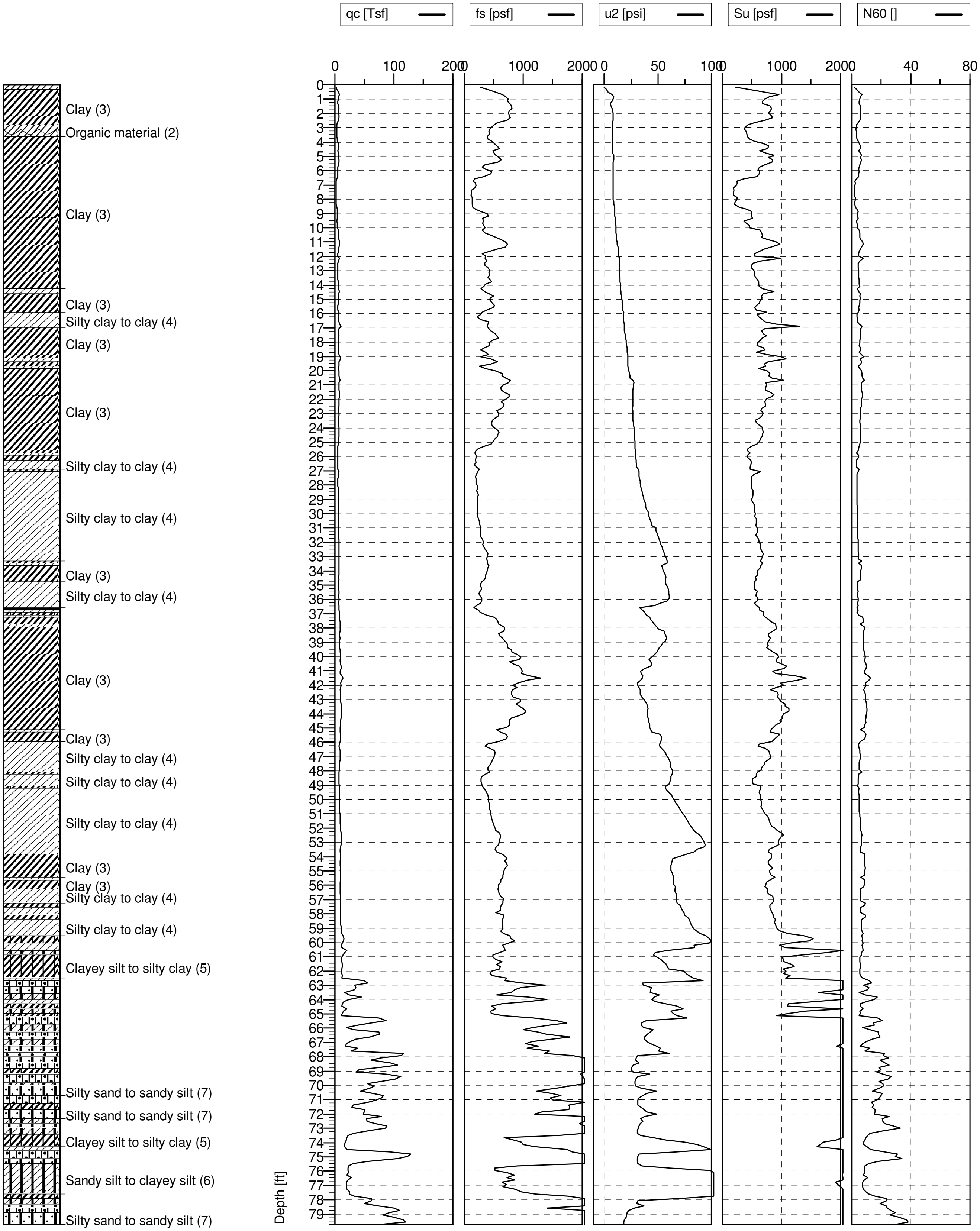


Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: CPT-2

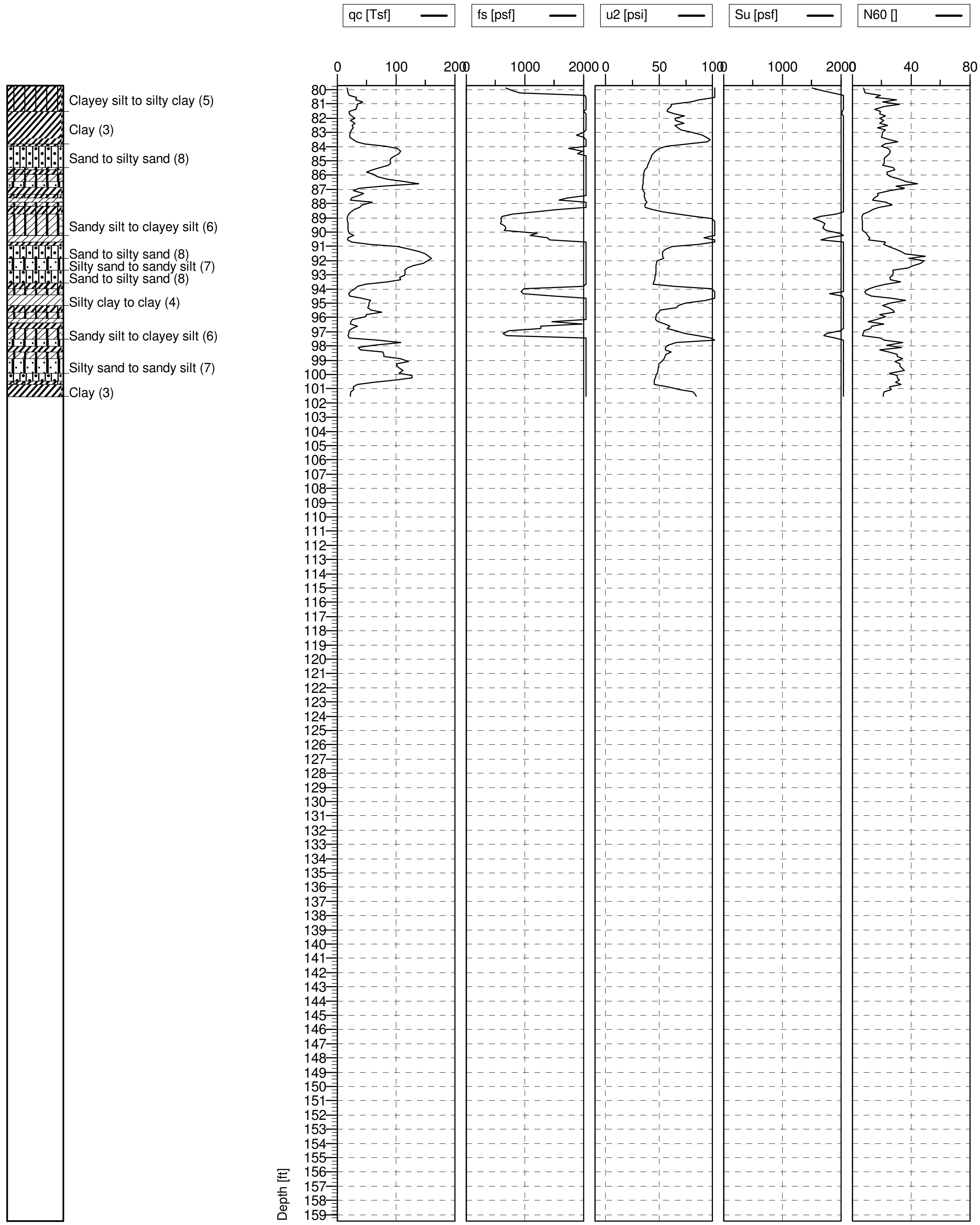
Client:

Project:



Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
CPT-2
Client:
Project:



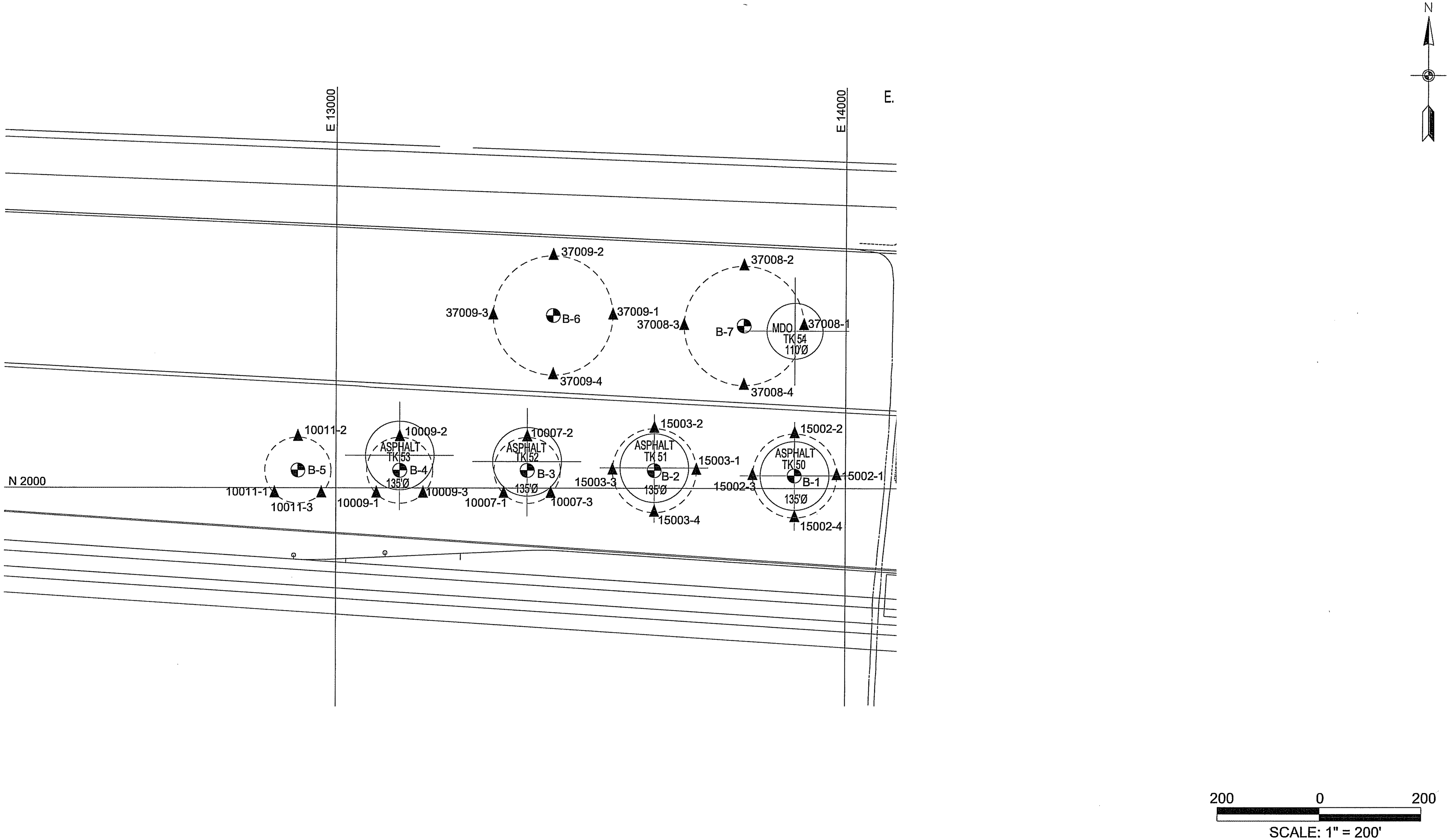
Test no:
CPT-1

Client:

Project:

Cone No: DDG1068
Tip area [cm2]: 10
Sleeve area [cm2]: 150

APPENDIX B

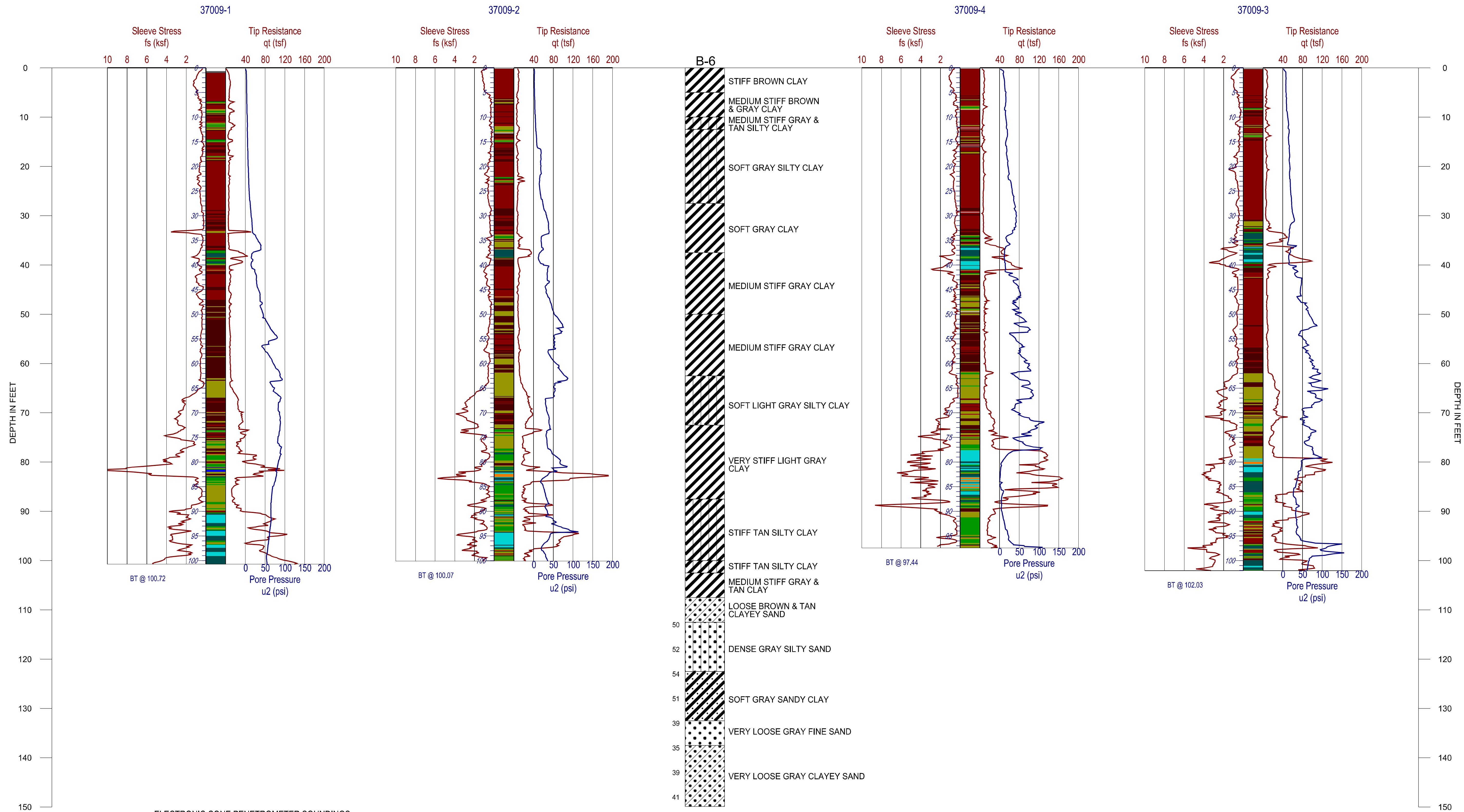


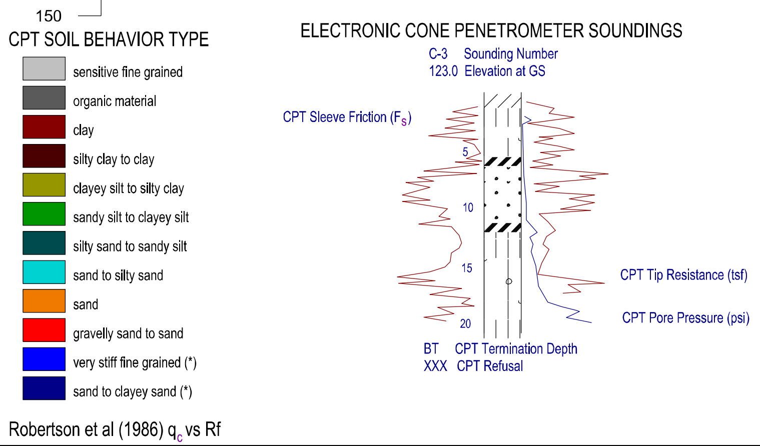
▲ DENOTES LOCATION OF CONE PENETROMETER TESTS PERFORMED: 5 TO 15 MARCH 2010

DENOTES LOCATION OF UNDISTURBED SOIL BORINGS DRILLED: 24 FEBRUARY TO 3 MARCH 2010

DENOTES LOCATION OF ORIGINALLY PROPOSED TANK; LOCATION NO LONGER PLANNED

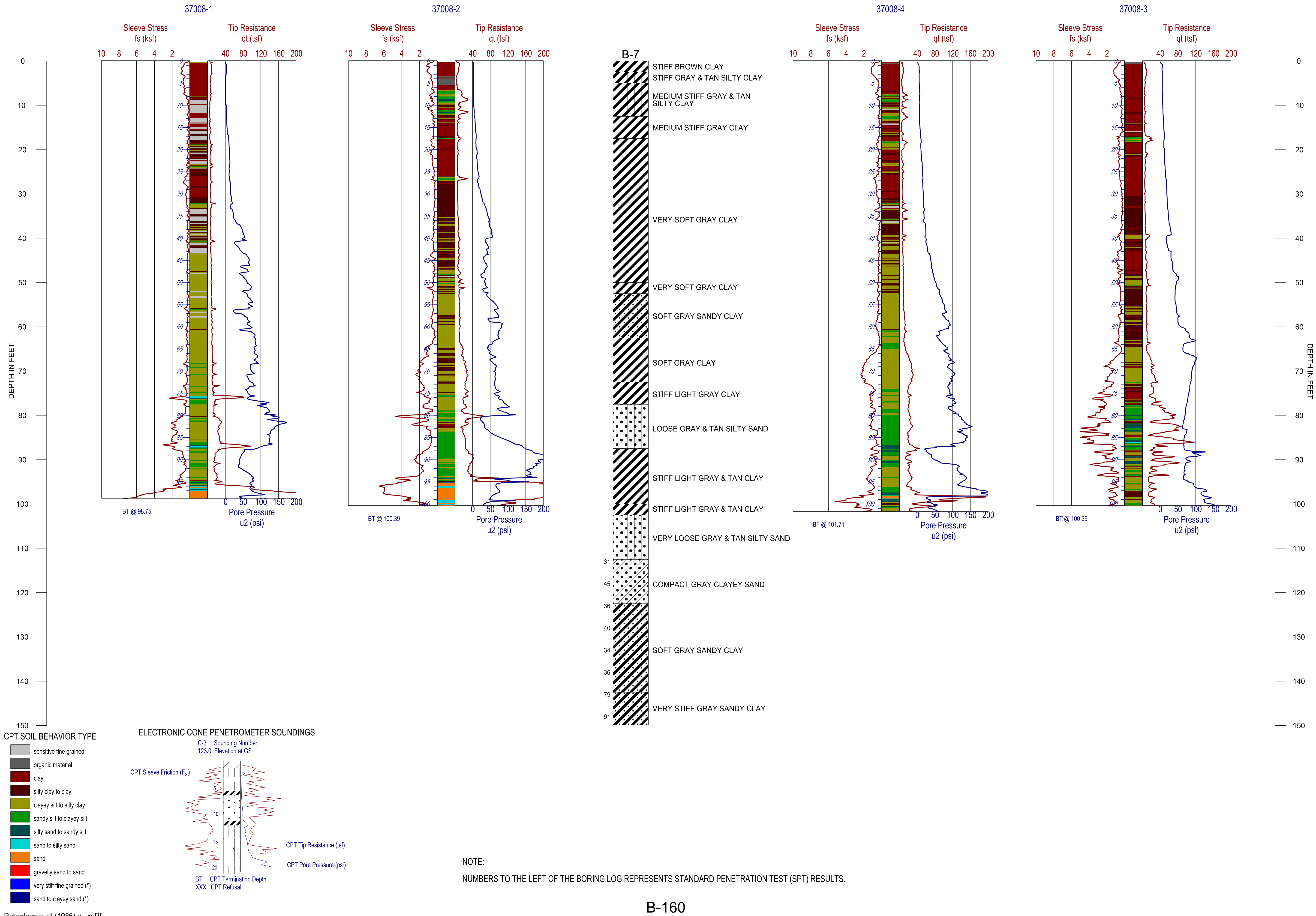
DENOTES REVISED LOCATION OF PROPOSED TANK





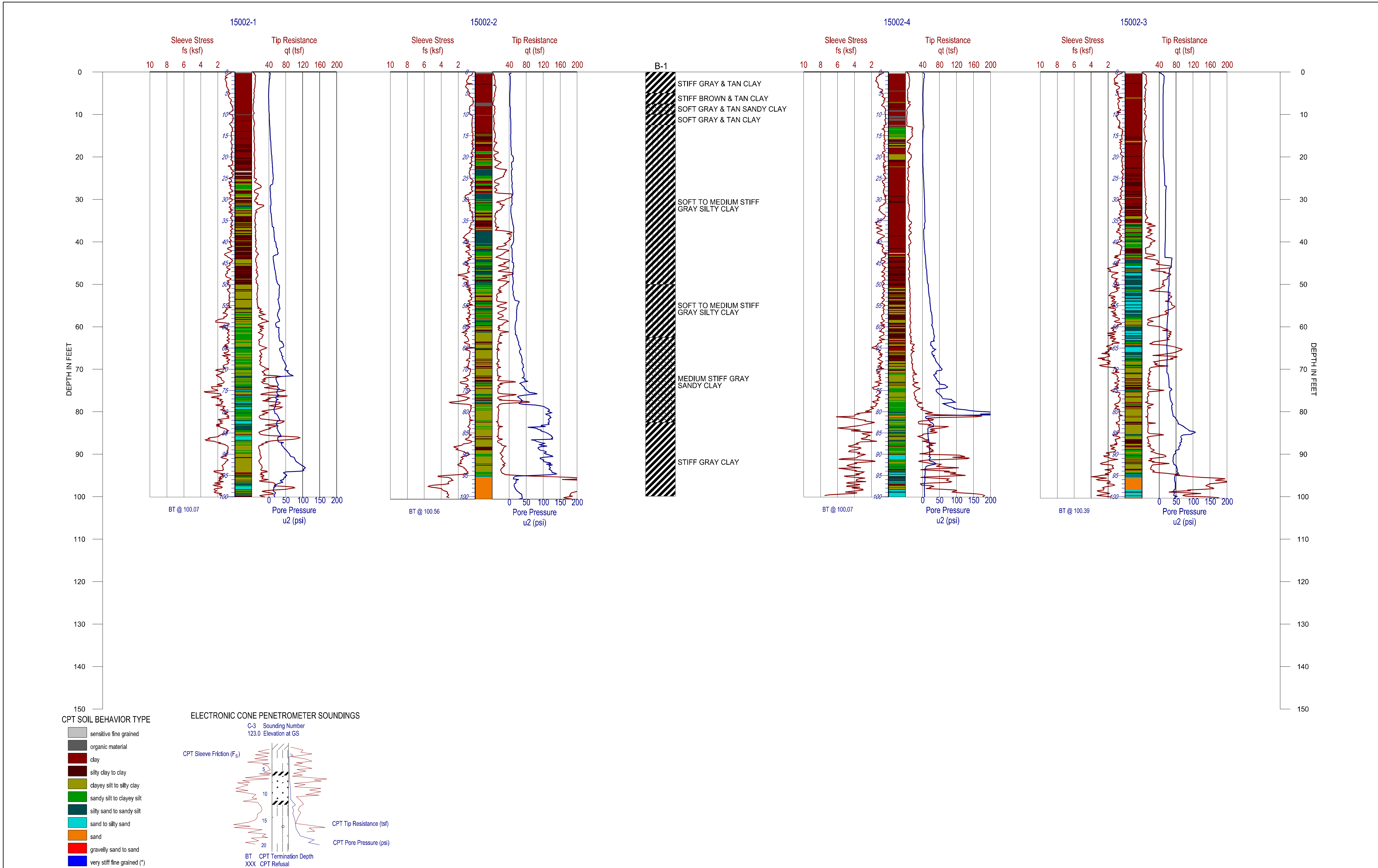
NOTE:

NUMBERS TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULTS.

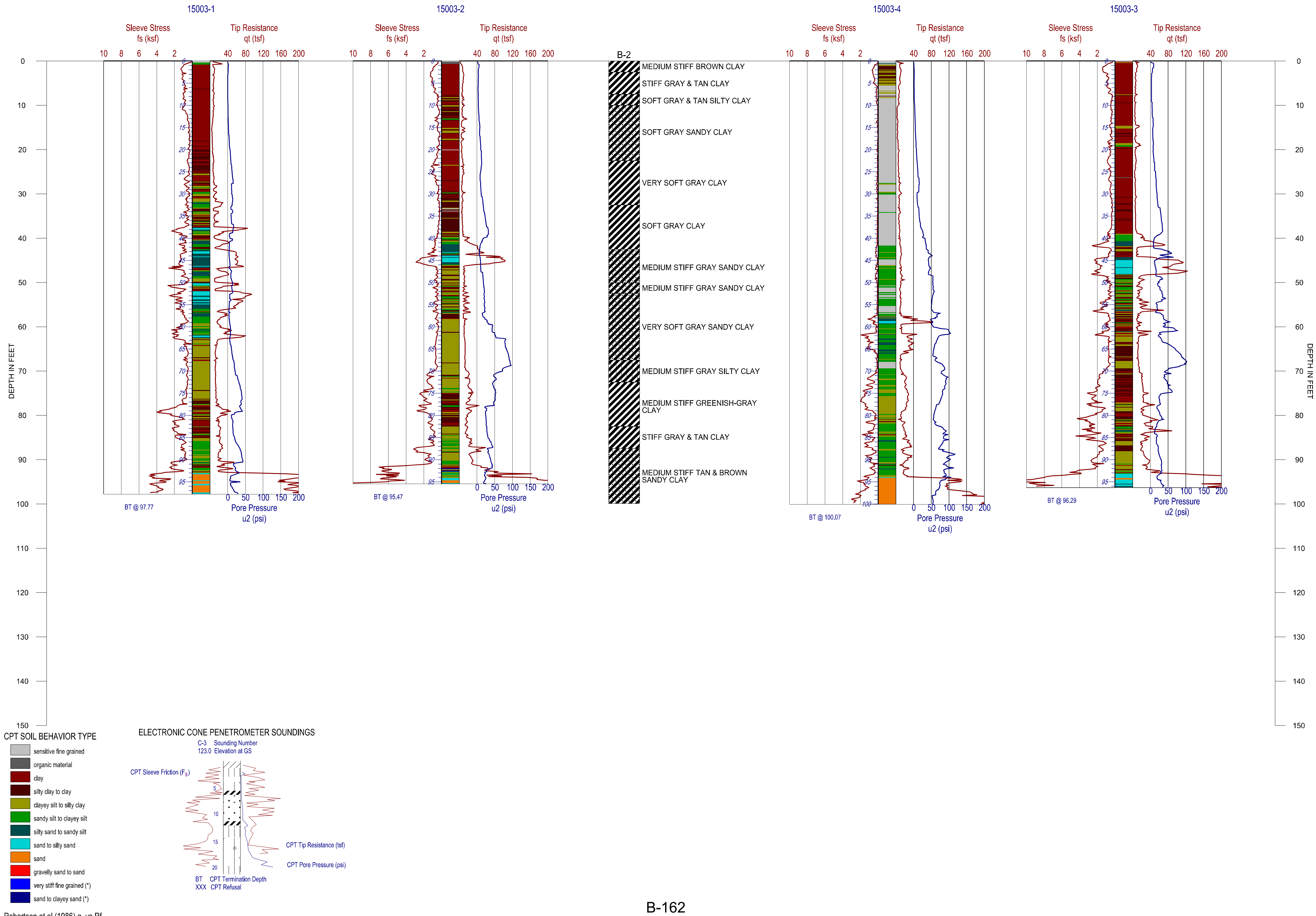


NOTE:

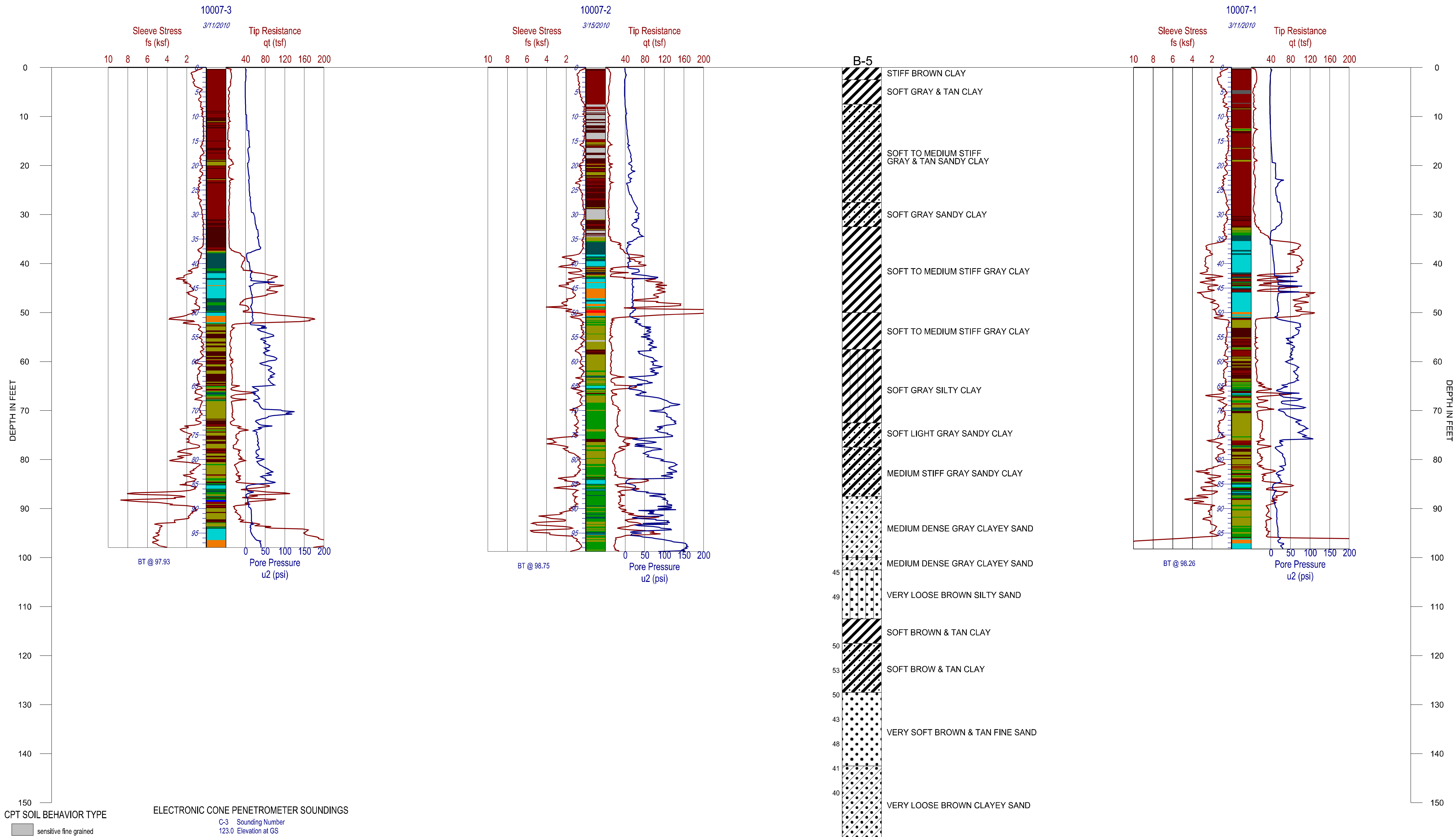
NUMBERS TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULTS.

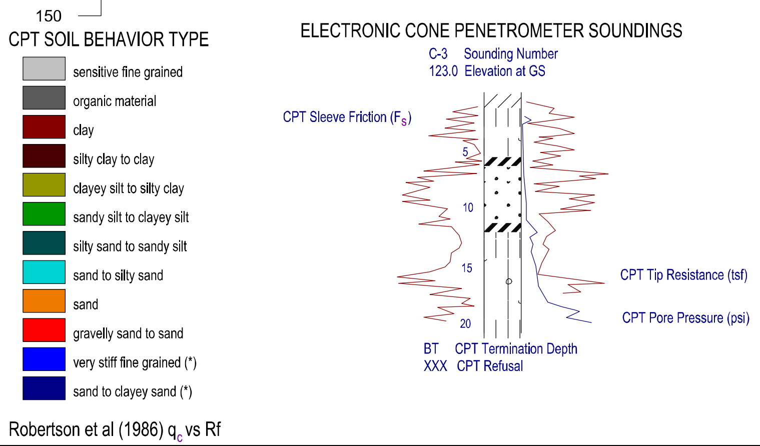


15002-1
15002-2
15002-4
15002-3
Sleeve Stress
fs (ksf)
Tip Resistance
qt (tsf)
Pore Pressure
u2 (psi)
DEPTH IN FEET
B-1
STIFF GRAY & TAN CLAY
STIFF BROWN & TAN CLAY
SOFT GRAY & TAN SANDY CLAY
SOFT GRAY & TAN CLAY
SOFT TO MEDIUM STIFF GRAY SILTY CLAY
SOFT TO MEDIUM STIFF GRAY SILTY CLAY
MEDIUM STIFF GRAY SANDY CLAY
STIFF GRAY CLAY
BT @ 100.07
BT @ 100.56
BT @ 100.07
BT @ 100.39
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) qc vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
123.0 Elevation at GS
CPT Sleeve Friction (FS)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal



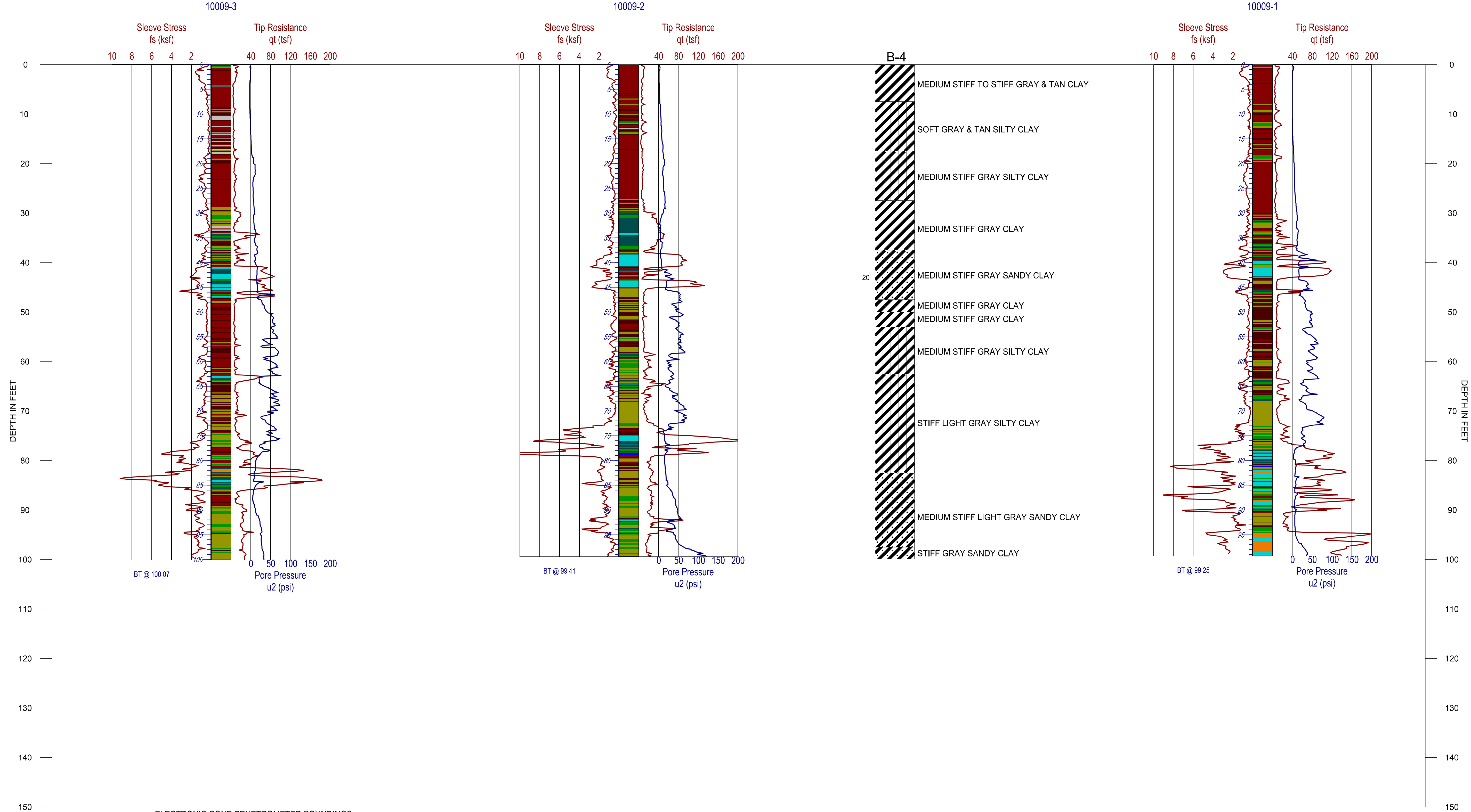
15003-1
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
BT @ 97.77
Pore Pressure u2 (psi)
15003-2
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
BT @ 95.47
Pore Pressure u2 (psi)
B-2
MEDIUM STIFF BROWN CLAY
STIFF GRAY & TAN CLAY
SOFT GRAY & TAN SILTY CLAY
SOFT GRAY SANDY CLAY
VERY SOFT GRAY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY SANDY CLAY
MEDIUM STIFF GRAY SANDY CLAY
VERY SOFT GRAY SANDY CLAY
MEDIUM STIFF GRAY SILTY CLAY
MEDIUM STIFF GREENISH-GRAY CLAY
STIFF GRAY & TAN CLAY
MEDIUM STIFF TAN & BROWN SANDY CLAY
15003-4
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
BT @ 100.07
Pore Pressure u2 (psi)
15003-3
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
BT @ 96.29
Pore Pressure u2 (psi)
DEPTH IN FEET
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
123.0 Elevation at GS
CPT Sleeve Friction (FS)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal

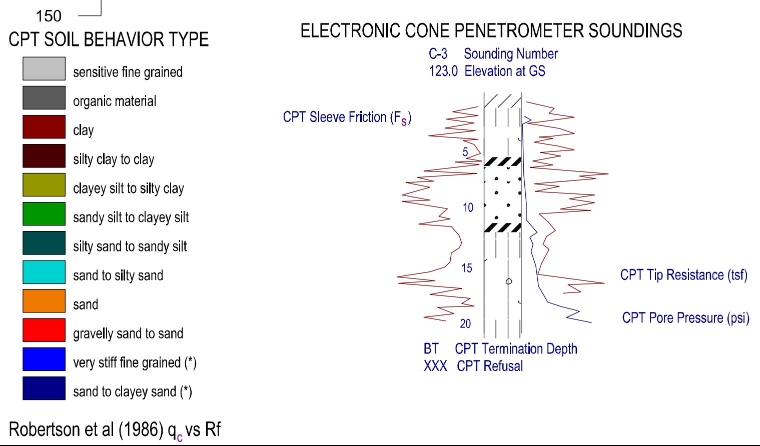




NOTE:

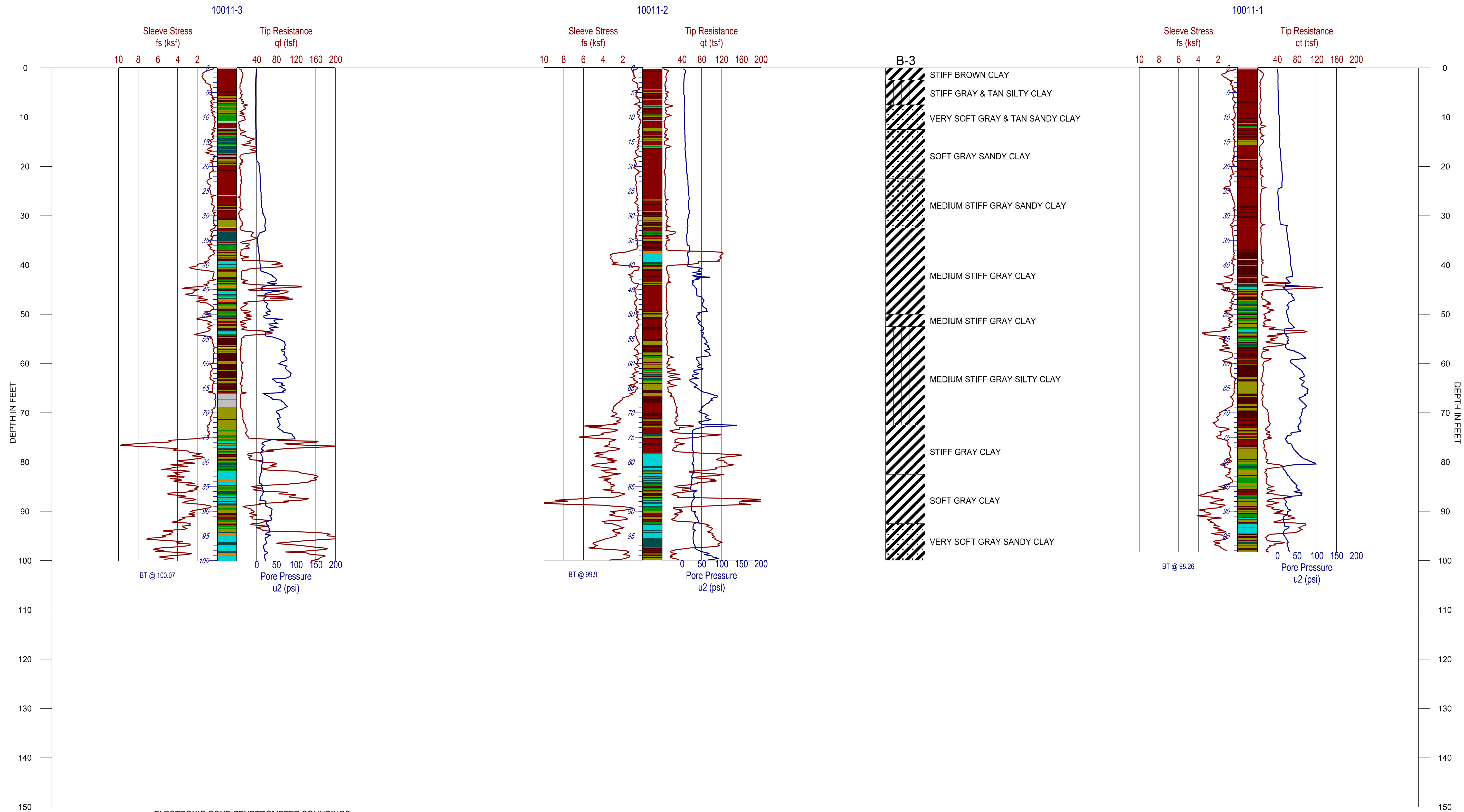
NUMBERS TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULTS.

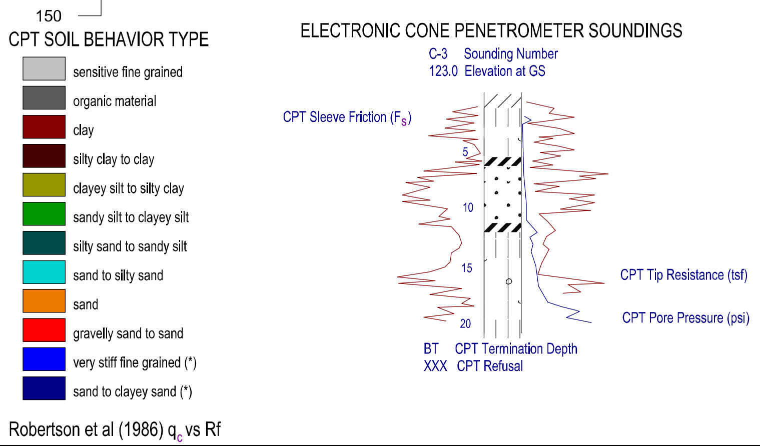


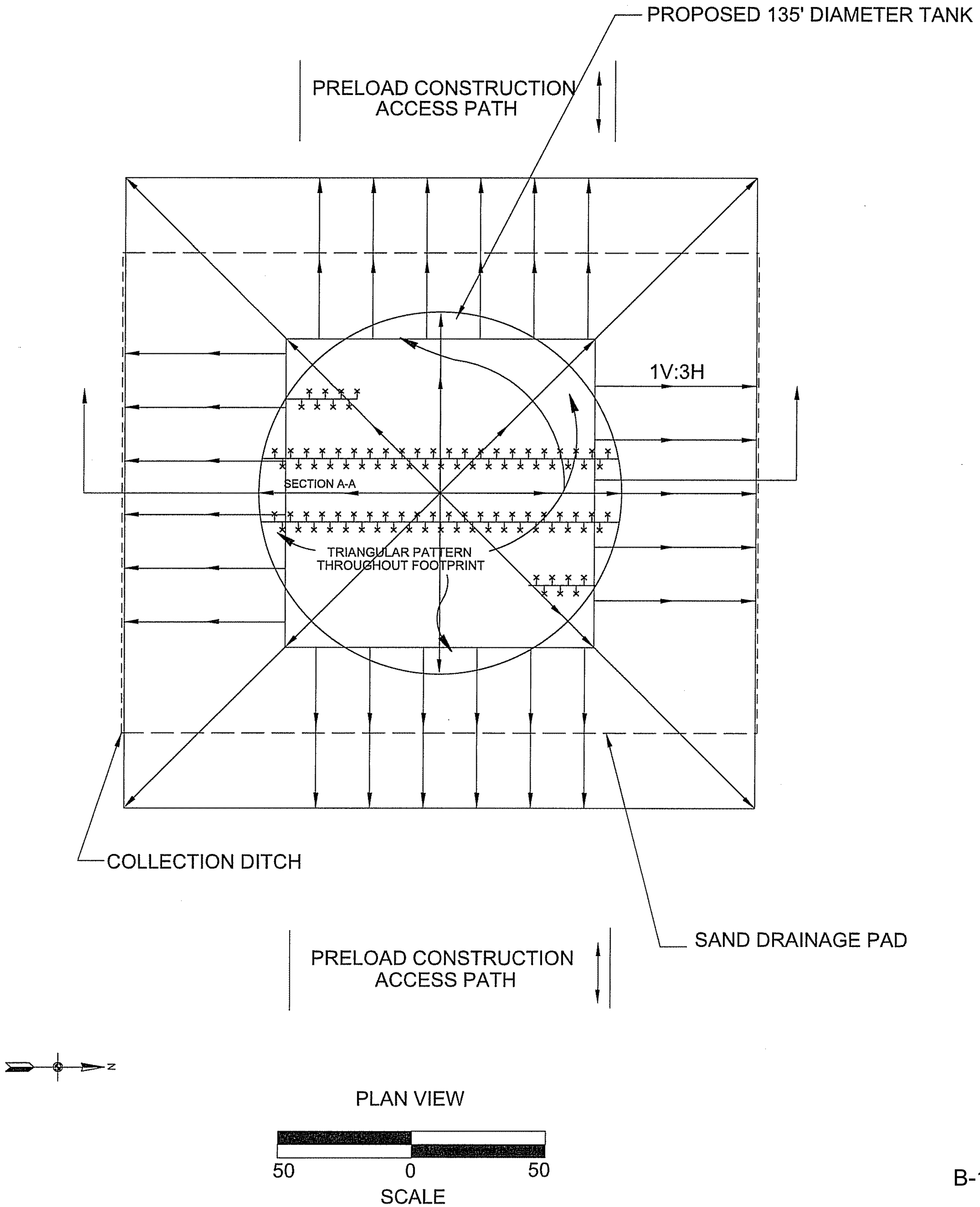


NOTE:

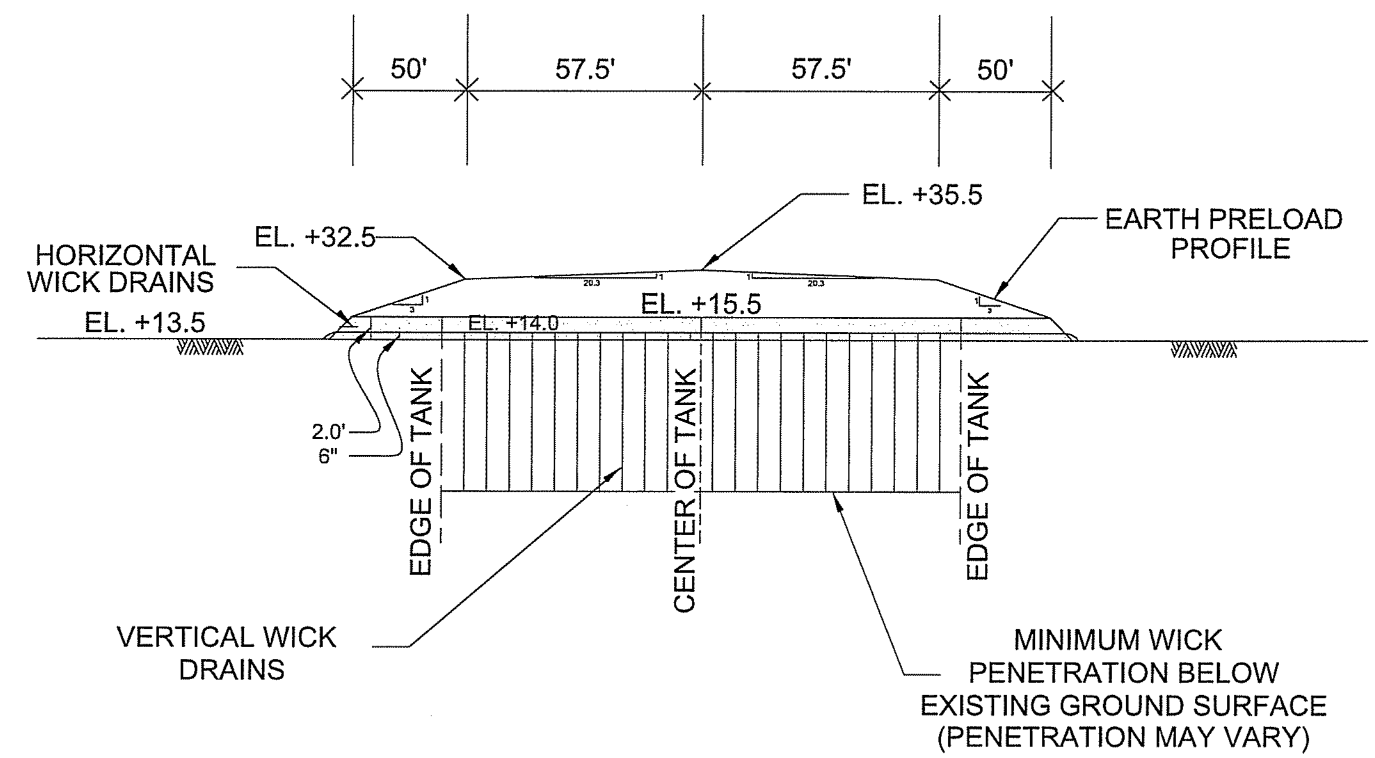
THE NUMBER TO THE LEFT OF THE BORING LOG REPRESENTS STANDARD PENETRATION TEST (SPT) RESULTS.


10011-3
Sleeve Stress
fs (ksf)
Tip Resistance
qt (tsf)
BT @ 100.07
Pore Pressure
u2 (psi)
10011-2
BT @ 99.9
B-3
STIFF BROWN CLAY
STIFF GRAY & TAN SILTY CLAY
VERY SOFT GRAY & TAN SANDY CLAY
SOFT GRAY SANDY CLAY
MEDIUM STIFF GRAY SANDY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY SILTY CLAY
STIFF GRAY CLAY
SOFT GRAY CLAY
VERY SOFT GRAY SANDY CLAY
10011-1
BT @ 98.26
DEPTH IN FEET


CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
123.0 Elevation at GS
CPT Sleeve Friction (F_s)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal



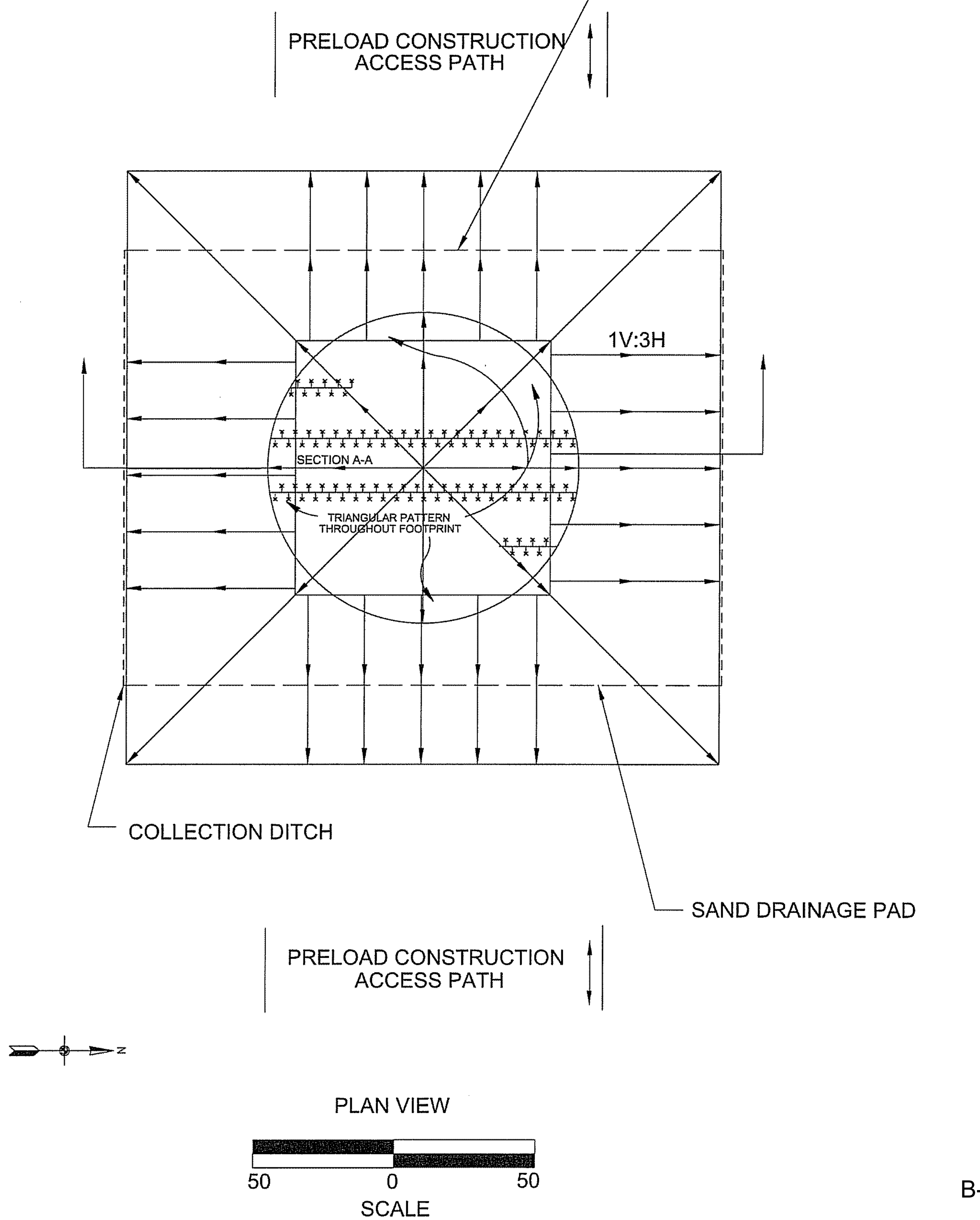
PLAN VIEW



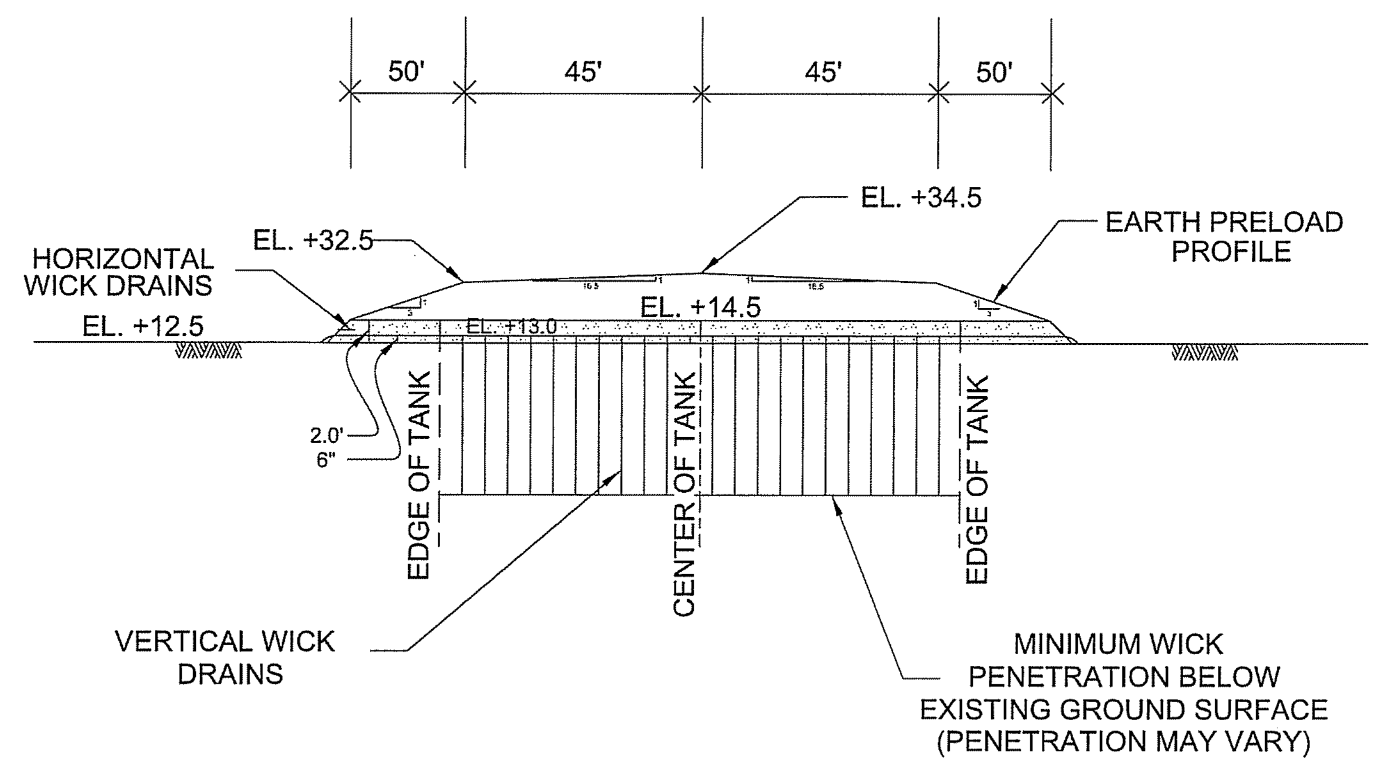
NOT TO SCALE

SECTION A-A

NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS

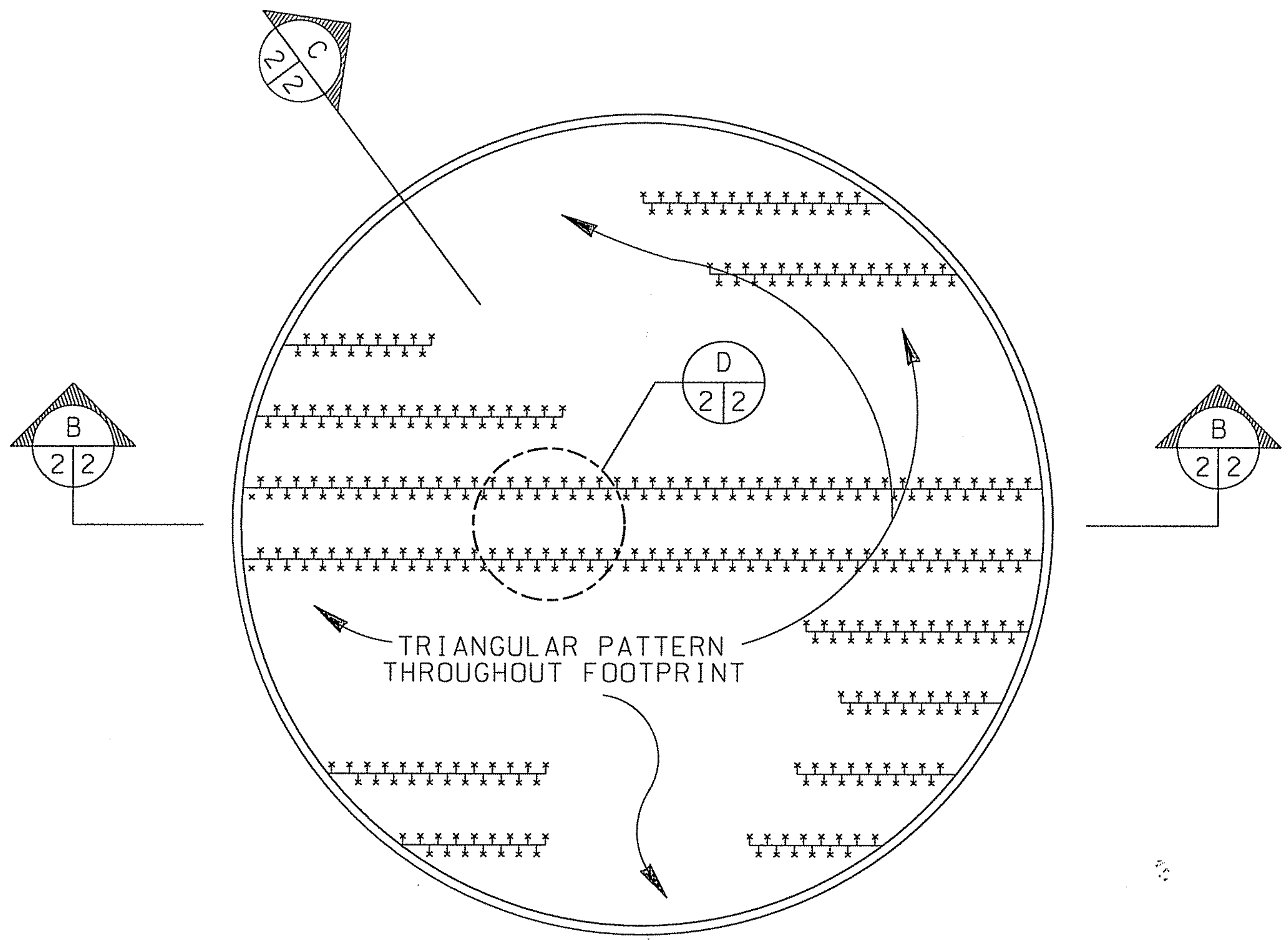


PLAN VIEW

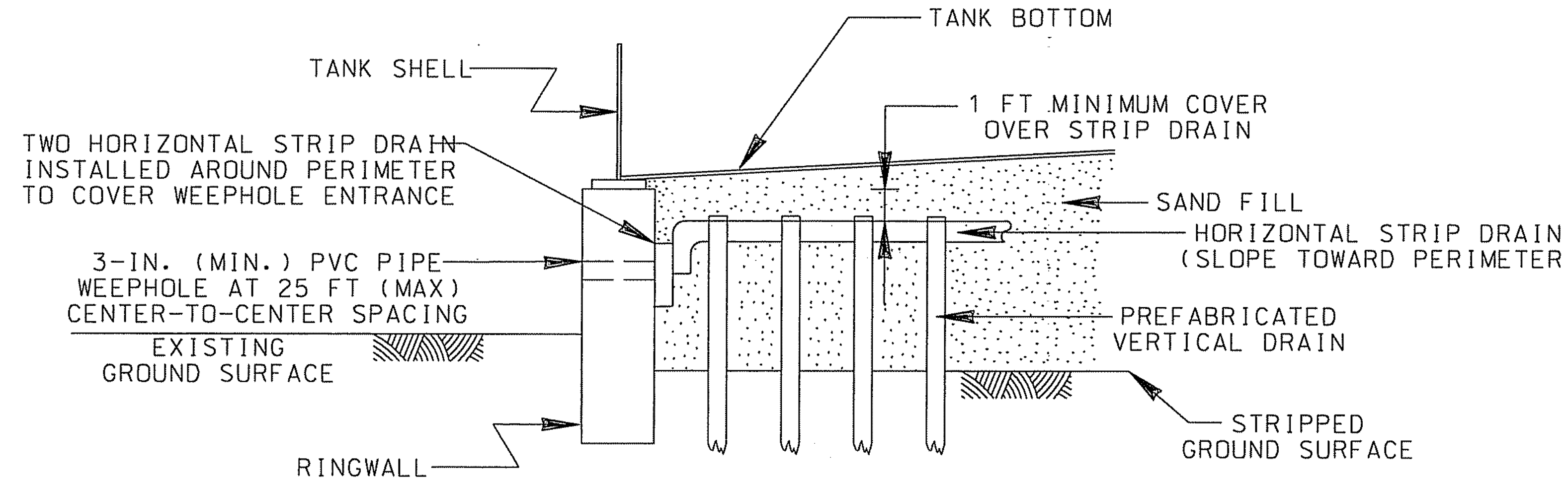


SECTION A-A

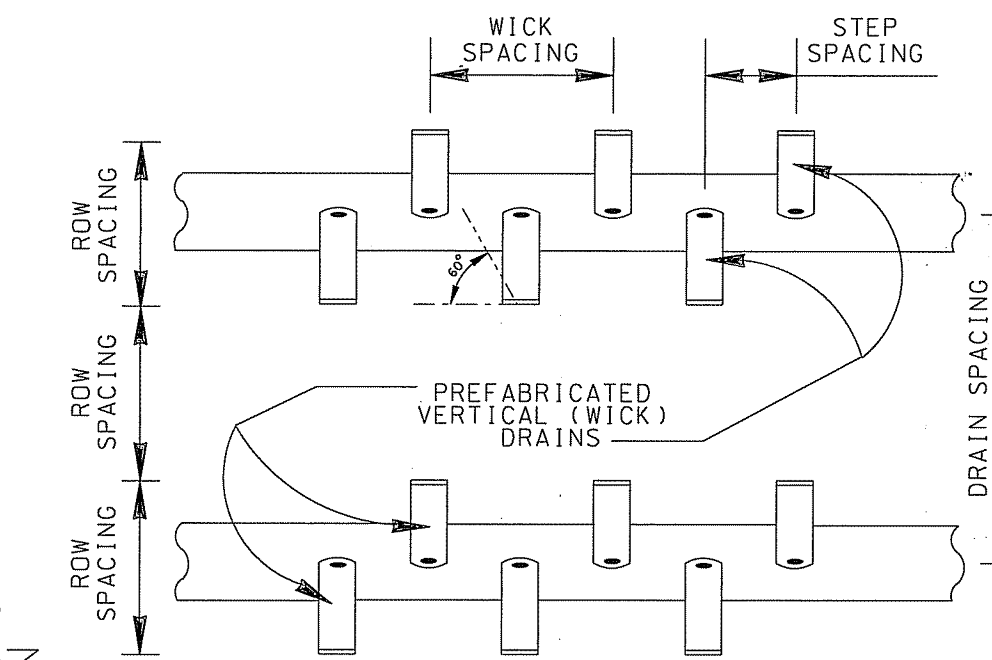
NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS



A 2|2 PLAN
NOT TO SCALE

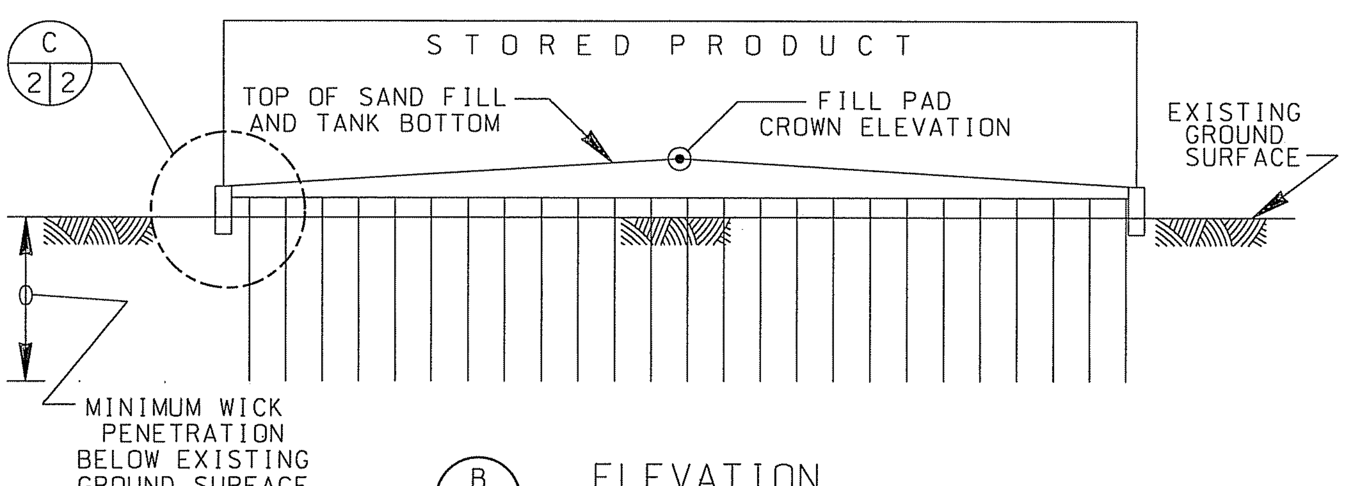


C 2|2 DETAIL AT RINGWALL
NOT TO SCALE

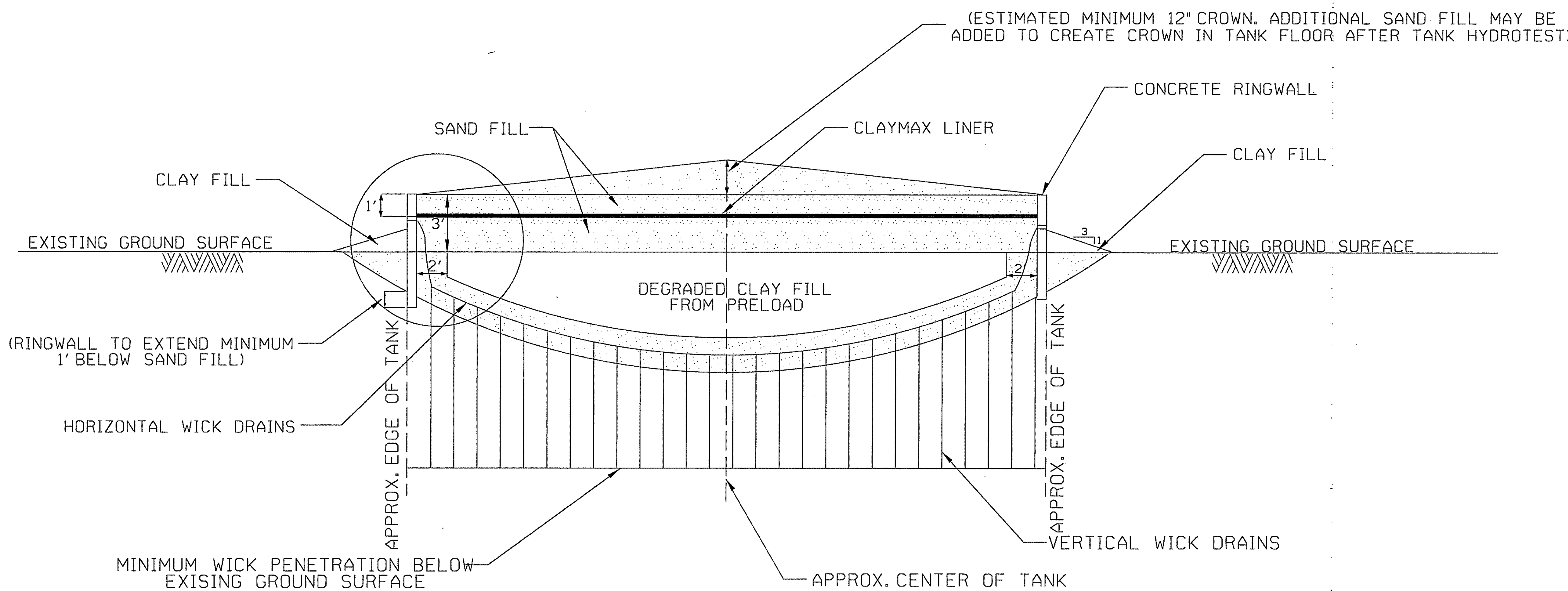


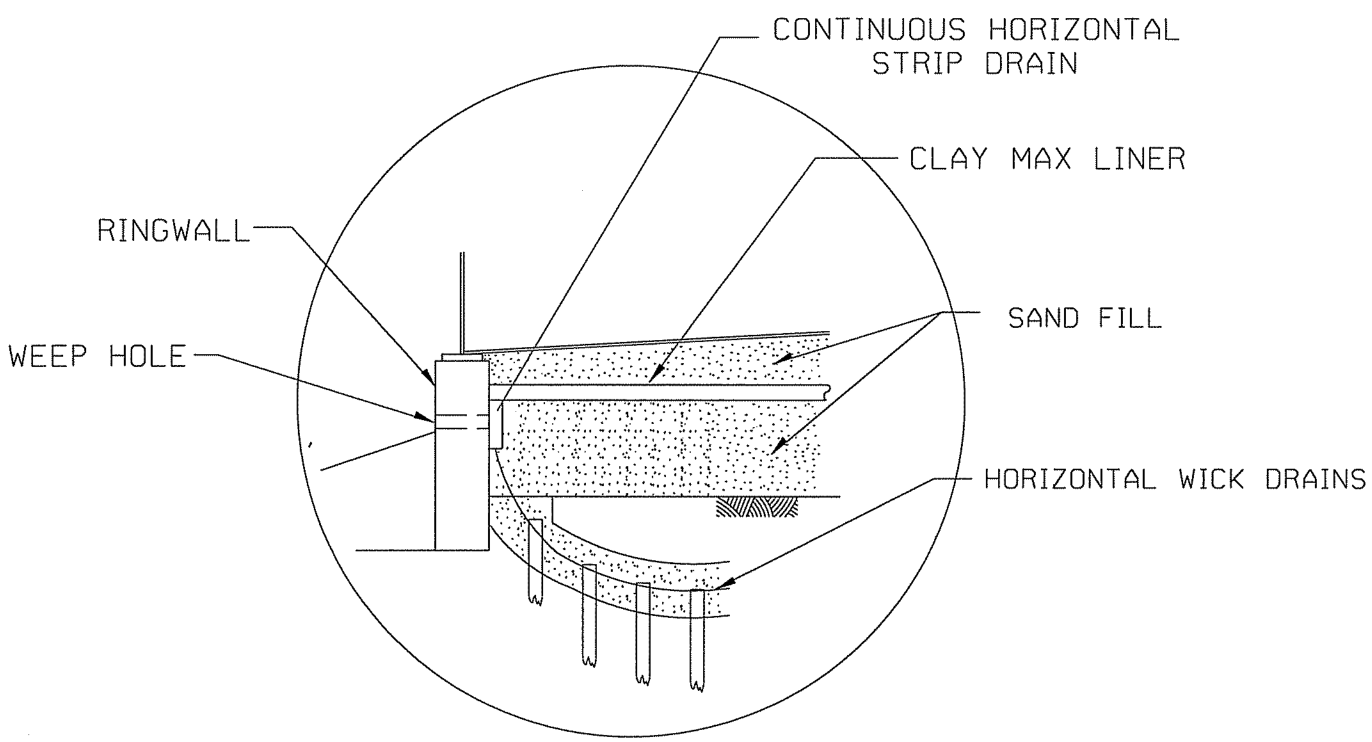
WICK SPACING (FT)	ROW SPACING (FT)	STEP SPACING (FT)	DRAIN SPACING (FT)
3	2.5	1.5	5.0
4	3.5	2	7.0
5	4.25	2.5	8.5
6	5.25	3	10.5

D 2|2 DETAIL OF WICK DRAIN PATTERN
NOT TO SCALE

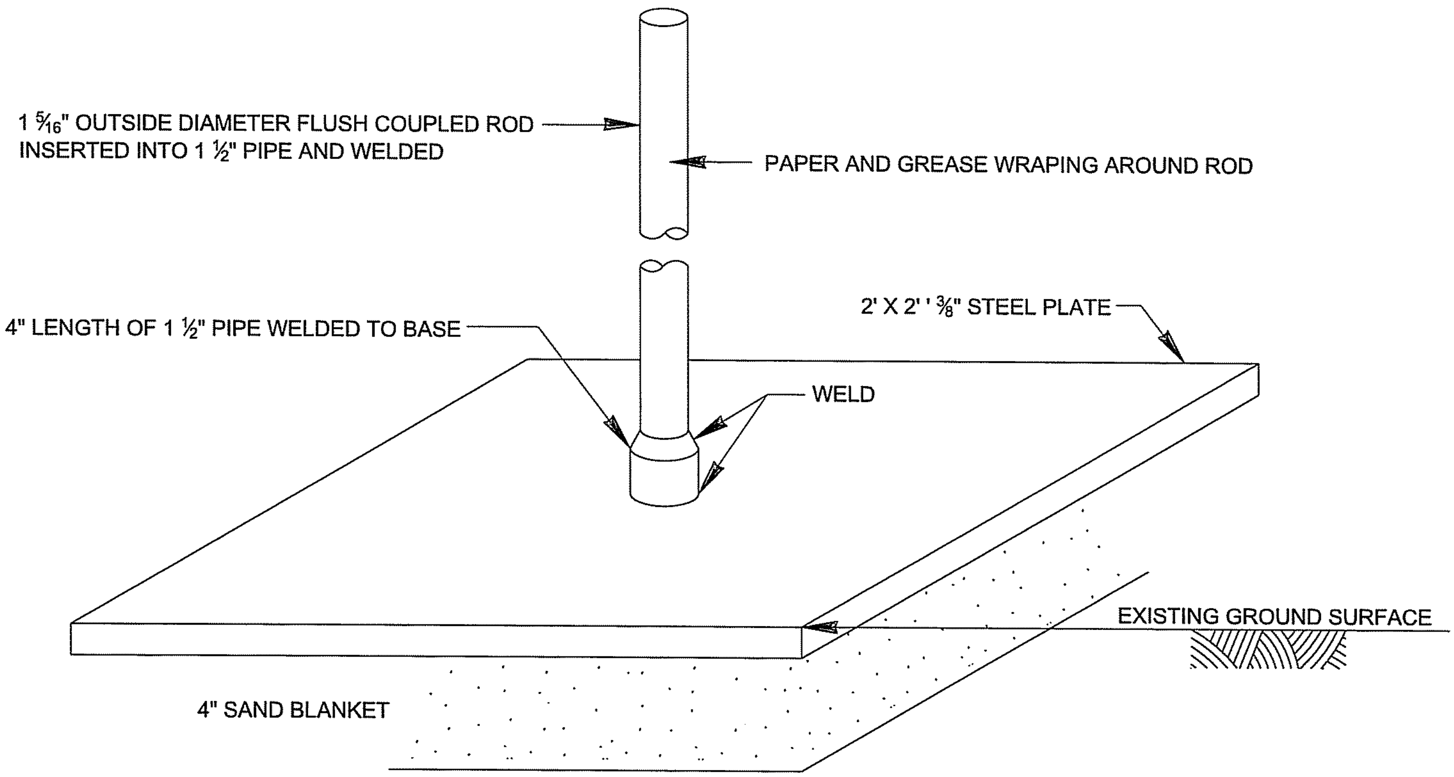


B 2|2 ELEVATION
NOT TO SCALE





NOT TO SCALE
SCHEMATIC ONLY



TYPICAL SETTLEMENT PLATE

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See T **ed:** 2/24/10 **Boring:** 1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.50				Stiff gray & tan clay w/silty sand pockets & roots	CH	1	0-2.5	29	93	120	UC	--	1268					
	1.50						2	2.5-5											
	1.00				Stiff brown & tan clay w/silty sand pockets & roots	CH	3	5-7.5	30						80	19	61		
					Soft gray & tan sandy clay	CL	4	7.5-10	32										
10					Soft gray & tan clay w/silty sand pockets	CH	5	10-12.5	41	80	113	UC	--	283					
					Soft to medium stiff gray silty clay	CL	6	12.5-15											
20							7	17.5-20	32	90	119	UC	--	487					
							8	22.5-25											
30							9	27.5-30	35	87	117	UC	--	601					
	0.50						10	32.5-35											
40	0.50						11	37.5-40	34	88	118	UC	--	736					
	0.50						12	42.5-45											
50	0.50						13	47.5-50	31	91	120	UC	--	991					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 2 of 2)

F

Ground Elev.: **Datum:** **Gr. Water Depth:** See Text : 2/24/10 **Boring:** 1 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Soft to medium stiff gray silty clay	CL													
	0.50						14	52.5-55											
60	0.50						15	57.5-60	31	92	120	UC	--	358					
	0.50				Medium stiff gray sandy clay	CL	16	62.5-65											
70	0.75						17	67.5-70	29	95	122	UC	--	691					
	0.50						18	72.5-75											
80	0.75						19	77.5-80	38	81	112	UC	--	948					
	0.50				Stiff gray clay w/silty sand pockets & lenses	CH	20	82.5-85											
90	0.50						21	87.5-90	48	74	109	UC	--	1178					
	1.00						22	92.5-95											
100	1.00						23	97.5-100	48	73	107	UC	--	1184					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **d:** 2/24-25/10 **Boring:** 2 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	0.25				Medium stiff brown clay w/silty sand pockets & vegetation	CH	1	0-2.5	33										
	1.00				Stiff gray & tan clay w/silty sand pockets, roots, & trace of organic matter	CH	2	2.5-5	35	85	115	UC	--	1013					
	1.50						3	5-7.5											
	0.50				Soft gray & tan silty clay	CL	4	7.5-10	32	90	119	UC	--	472					
10					Soft gray sandy clay	CL	5	10-12.5											
							6	12.5-15	34	88	118	UC	--	387					
	0.25						7	17.5-20											
20					Very soft gray clay w/sand pockets	CH	8	22.5-25	45						60	18	42		
							9	27.5-30											
30	0,50				Soft gray clay w/silty sand pockets & lenses	CH	10	32.5-35	51	71	108	UC	--	314					
	1.00						11	37.5-40											
40					Medium stiff gray sandy clay w/shell fragments	CL	12	42.5-45	38	83	115	UC	--	881					
50							13	47.5-50											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te: **d:** 2/24-25/10 **Boring:** 2 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Medium stiff gray sandy clay w/shell fragments	CL													
					Very soft gray sandy clay w/roots	CL	14	52.5-55											
60							15	57.5-60	39	82	114	UC	--	230					
							16	62.5-65											
70	0.50				Medium stiff gray silty clay	CL	17	67.5-70	27	97	124	UC	--	724					
	1.00				Medium stiff greenish-gray clay w/silty sand pockets & concretions	CH	18	72.5-75	23	104	128	UC	--	981					
80	2.50						19	77.5-80											
	1.50				Stiff gray & tan clay w/silty sand pockets	CH	20	82.5-85	22	101	123	UC	--	1283					
90	0.50				Medium stiff tan & brown sandy clay	CL	21	87.5-90											
	0.25						22	92.5-95											
100	1.00						23	97.5-100	23	104	128	UC	--	672					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **ed:** 2/26 & 3/01/10 **Boring:** 3 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.75				Stiff brown clay w/silt pockets & roots	CH	1	0-2.5	26										
	0.50				Stiff gray & tan silty clay w/roots	CL	2	2.5-5	25	98	122	UC	--	1514					
	0.50						3	5-7.5											
					Very soft gray & tan sandy clay	CL	4	7.5-10	32										
10							5	10-12.5											
					Soft gray sandy clay	CL	6	12.5-15	36	86	117	UC	--	298					
20							7	17.5-20											
	0.25				Medium stiff gray sandy clay w/roots	CL	8	22.5-25	38	84	115	UC	--	590					
30	0.25						9	27.5-30											
	0.75				Medium stiff gray clay	CH	10	32.5-35	48	73	108	UC	--	672					
40							11	37.5-40											
					w/silty sand layers		12	42.5-45	40	81	114	UC	--	540					
50							13	47.5-50											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te› **d:** 2/26 & 3/01/10 **Boring:** 3 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/silty sand layers	CH													
					Medium stiff gray silty clay	CL	14	52.5-55	30	93	121	UC	--	779					
60							15	57.5-60											
							16	62.5-65	31	91	120	UC	--	552					
70	2.25						17	67.5-70											
	3.00				Stiff gray clay w/trace of silty sand pockets	CH	18	72.5-75	22	105	127	UC	--	1426					
80	3.00						19	77.5-80											
					Soft gray clay w/silty sand pockets & lenses	CH	20	82.5-85	26	100	125	UC	--	297					
90	2.00						21	87.5-90											
					Very soft gray sandy clay	CL	22	92.5-95	27						27	17	10		
100							23	97.5-100											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **·d:** 2/26/10 **Boring:** 4 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.50				Medium stiff to stiff gray & tan clay w/silty sand pockets & roots	CH	1	0-2.5	27	95	120	UC	--	1594					
	1.50						2	2.5-5	28										
	0.25						3	5-7.5	29	92	118	UC	--	851					
					Soft gray & tan silty clay	CL	4	7.5-10											
10	0.25						5	10-12.5	36	85	116	UC	--	499					
							6	12.5-15											
20					Medium stiff gray silty clay w/roots	CL	7	17.5-20	40	82	114	UC	--	507					
	0.25						8	22.5-25											
30					Medium stiff gray clay w/silty sand pockets & trace of roots	CH	9	27.5-30	43	78	112	UC	--	635					
							10	32.5-35											
40					Medium stiff gray sandy clay	CL	11	37.5-40	35	87	117	OB	0	739					
		20					12	42.5-45											
50					Medium stiff gray clay w/silt pockets & concretions	CH	13	47.5-50	50	72	108	UC	--	620					

Comments:

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Tex **d:** 2/26/10 **Boring:** 4 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/silt pockets & concretions	CH													
					Medium stiff gray silty clay	CL	14 15	52.5-55 53-55	37	84	116	UC	--	577					
60							16	57.5-60											
	4.50				Stiff light gray silty clay	CL	17	62.5-65	21	107	130	UC	--	1313					
70	4.00						18	67.5-70	22	106	129	UC	--	1855					
	1.25						19	72.5-75											
80	3.00						20	77.5-80	21						31	13	18		
	0.25				Medium stiff light gray sandy clay	CL	21	82.5-85											
90	0.50						22	87.5-90	25	101	126	UC	--	575					
	3.50						23	92.5-95											
100	2.75				Stiff gray sandy clay	CL	24	97.5-100	21	107	130	UC	--	1458					

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **:d:** 2/25/10 **Boring:** 5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0	1.00				Stiff brown clay w/silty sand pockets	CH	1	0-2.5	27	97	123	UC	--	1241					
	0.50				Soft gray & tan clay w/silty sand pockets	CH	2	2.5-5											
	0.50						3	5-7.5	34	86	114	UC	--	394					
	0.50				Soft to medium stiff gray & tan sandy clay	CL	4	7.5-10											
10							5	10-12.5	30	94	122	UC	--	505					
							6	12.5-15											
20							7	17.5-20	34	88	118	UC	--	294					
	0.50						8	22.5-25											
30					Soft gray sandy clay	CL	9	27.5-30	35	87	117	UC	--	461					
					Soft to medium stiff gray clay w/silty sand lenses & pockets	CH	10	32.5-35											
40							11	37.5-40	68	60	100	UC	--	268					
							12	42.5-45											
50							13	47.5-50											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **ed:** 2/25/10 **Boring:** 5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Soft to medium stiff gray clay w/silty sand lenses & pockets	CH													
	0.25						14	52.5-55	36	85	115	UC	--	575					
	0.25				Soft gray silty clay	CL	15	57.5-60	34						44	18	26		
60																			
	0.25						16	62.5-65											
	0.25						17	67.5-70											
70																			
	2.00				Soft light gray sandy clay	CL	18	72.5-75	23	105	128	UC	--	445					
	2.00				Medium stiff gray sandy clay w/concretions	CL	19	77.5-80	22	105	129	OB	0	984					
80																			
	1.50						20	82.5-85											
	0.50				Medium dense gray clayey sand	SC	21	87.5-90	22	105	129	OB	0	871					
90																			
	0.50						22	92.5-95											
	0.50						23	97.5-100	26	99	125	OB	0	750					
100																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te ... **d:** 2/25/10 **Boring:** 5 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
100					Medium dense gray clayey sand	SC													
		45			Very loose brown silty sand	SM	24	102.5-105	26										
		49					25	107.5-110											
110																			
	0.50				Soft brown & tan clay w/silty sand lenses & layers	CH	26	112.5-115	34										
		50			Soft brown & tan sandy clay	CL	27	117.5-120											
120																			
		53					28	122.5-125	27										
		50			Very soft brown & tan fine sand	SP	29	127.5-130											
130																			
		43					30	132.5-135	24										
		48					31	137.5-140											
140																			
		41			Very loose brown clayey sand	SC	32	142.5-145	26										
		40					33	147.5-150	26										
150																			

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **:d:** 3/01-02/10 **Boring:** 6 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	2.00				Stiff brown clay w/silty sand pockets & roots	CH	1	0-2.5	27	97	123	UC	--	1328					
	1.50						2	2.5-5											
	1.25				Medium stiff brown & gray clay w/silty sand pockets & roots	CH	3	5-7.5	35	87	118	UC	--	507					
	0.25						4	7.5-10											
10	0.50				Medium stiff gray & tan silty clay	CL	5	10-12.5	30	93	120	UC	--	523					
					Soft gray silty clay	CL	6	12.5-15											
20							7	17.5-20	34	88	118	UC	--	427					
							8	22.5-25											
30					Soft gray clay w/silty sand pockets	CH	9	27.5-30	51	70	106	UC	--	373					
							10	32.5-35											
40					Medium stiff gray clay w/trace of silt pockets	CH	11	37.5-40	43	78	111	UC	--	731					
							12	42.5-45											
50	0.25						13	47.5-50											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 2 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Tex **I:** 3/01-02/10 **Boring:** 6 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/trace of silt pockets	CH													
							14	52.5-55											
60	0.25				w/silty sand pockets		15	57.5-60	38	83	114	UC	--	816					
	0.50				Soft light gray silty clay	CL	16	62.5-65											
70	1.50						17	67.5-70	22	105	127	UC	--	348					
	4.50				Very stiff light gray clay w/silty sand pockets	CH	18	72.5-75											
80	4.00						19	77.5-80	19	112	133	UC	--	3392					
							20	82.5-85											
90					Stiff tan silty clay	CL	21	87.5-90	28	96	123	UC	--	1438					
							22	92.5-95											
100							23	97.5-100											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

(Sheet 3 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **ed:** 3/01-02/10 **Boring:** 6 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
100					Stiff tan silty clay	CL													
					Medium stiff gray & tan clay w/silty sand lenses & layers	CH	24	102.5-105	33						46	14	32		
110					Loose brown & tan clayey sand	SC	25	107.5-110	28	95	123	OB	0	313					
		50			Dense gray silty sand	SM	26	112.5-115											
120		52					27	117.5-120	24										
		54			Soft gray sandy clay	CL	28	122.5-125											
130		51					29	127.5-130	32										
		39			Very loose gray fine sand	SP	30	132.5-135	26										
140		35			Very loose gray clayey sand	SC	31	137.5-140											
		39					32	142.5-145	24										
150		41					33	147.5-150											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te) **d:** 3/02-03/10 **Boring:** 7 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0	1.25				Stiff brown clay w/silt pockets & roots	CH	1	0-2.5	28	96	123	UC	--	1055					
	1.25				Stiff gray & tan silty clay w/silty sand pockets	CL	2	2.5-5	31	92	120	UC	--	1160					
	1.00				Medium stiff gray & tan silty clay	CL	3	5-7.5											
	0.25						4	7.5-10	32	90	119	UC	--	991					
10							5	10-12.5											
					Medium stiff gray clay w/silt pockets	CH	6	12.5-15	37	85	116	UC	--	668					
					Very soft gray clay w/silty sand pockets & lenses	CH	7	17.5-20											
20							8	22.5-25	37	85	116	UC	--	209					
							9	27.5-30											
30							10	32.5-35	42	80	113	UC	--	167					
							11	37.5-40											
40	0.25						12	42.5-45	50	72	107	UC	--	250					
50							13	47.5-50											

Comments:

EUSTIS ENGINEERING

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **ed:** 3/02-03/10 **Boring:** 7 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	ø	C	Atterberg Limits LL	PL	PI		Other Tests
50					Very soft gray clay w/silty sand pockets & lenses	CH													
					Soft gray sandy clay	CL	14	52.5-55	34	88	118	UC	--	325					
60							15	57.5-60											
					Soft gray clay w/silty sand pockets & decayed wood	CH	16	62.5-65	69	58	98	UC	--	354	107	24	83		
70							17	67.5-70											
	2.00				Stiff light gray clay w/silt pockets	CH	18	72.5-75	20	109	132	UC	--	1981					
80					Loose gray & tan silty sand w/clay layers	SM	19	77.5-80											
							20	82.5-85	23										
90	1.75				Stiff light gray & tan clay w/silt pockets	CH	21	87.5-90											
	2.50						22	92.5-95	22	106	129	UC	--	1155					
100	1.00						23	97.5-100											

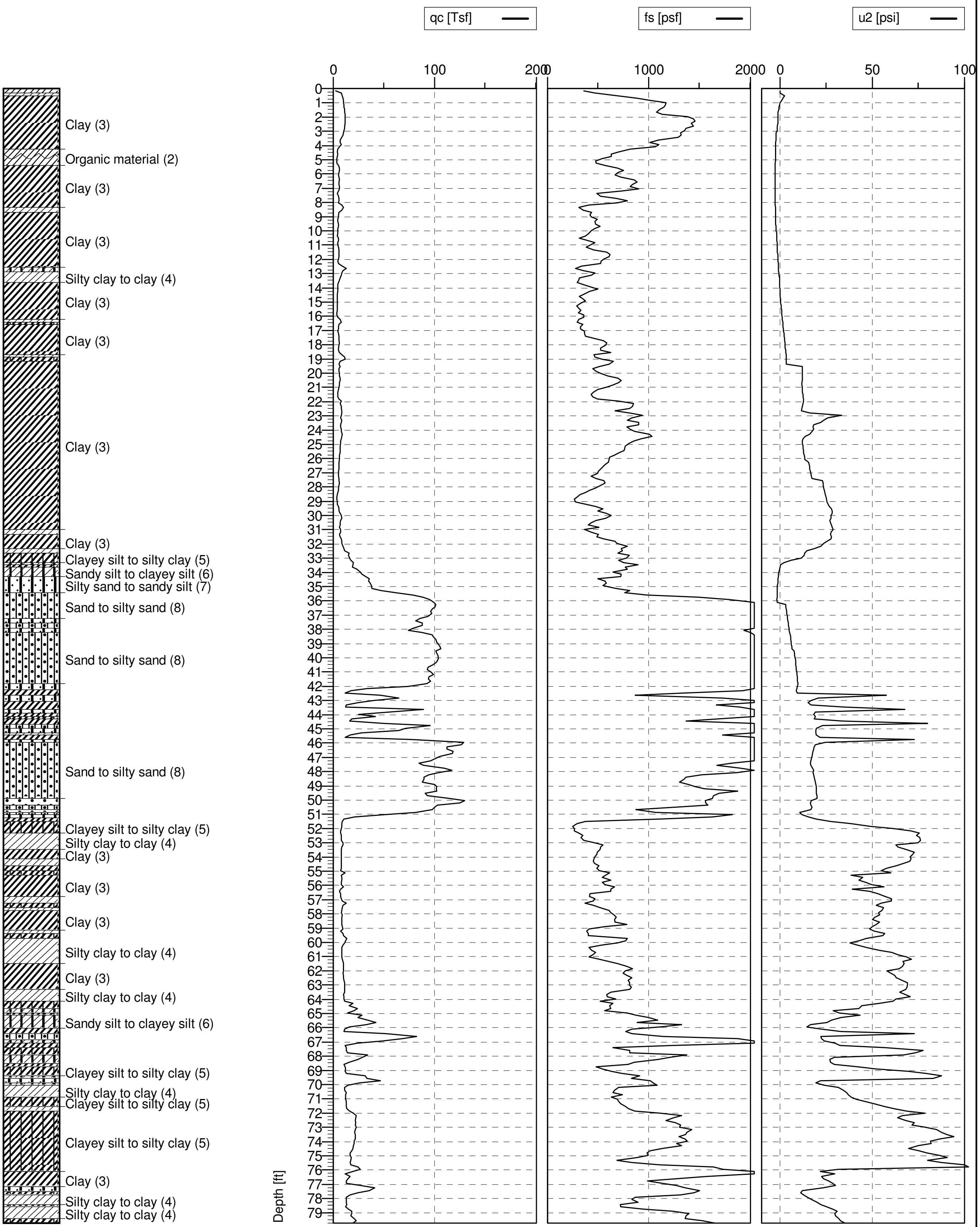
Comments:

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** See Te **d:** 3/02-03/10 **Boring:** 7 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
100					Stiff light gray & tan clay w/silt pockets	CH													
					Very loose gray & tan silty sand	SM	24	102.5-105	21										
110	1.00						25	107.5-110											
		31			Compact gray clayey sand	SC	26	112.5-115	23										
		45					27	117.5-120											
120		36			Soft gray sandy clay	CL	28	122.5-125	29										
		40					29	127.5-130											
130		34					30	132,5-135	22										
		36					31	137.5-140											
140		79			Very stiff gray sandy clay	CL	32	142.5-145	27										
		91					33	147.5-150											
150																			

Comments:



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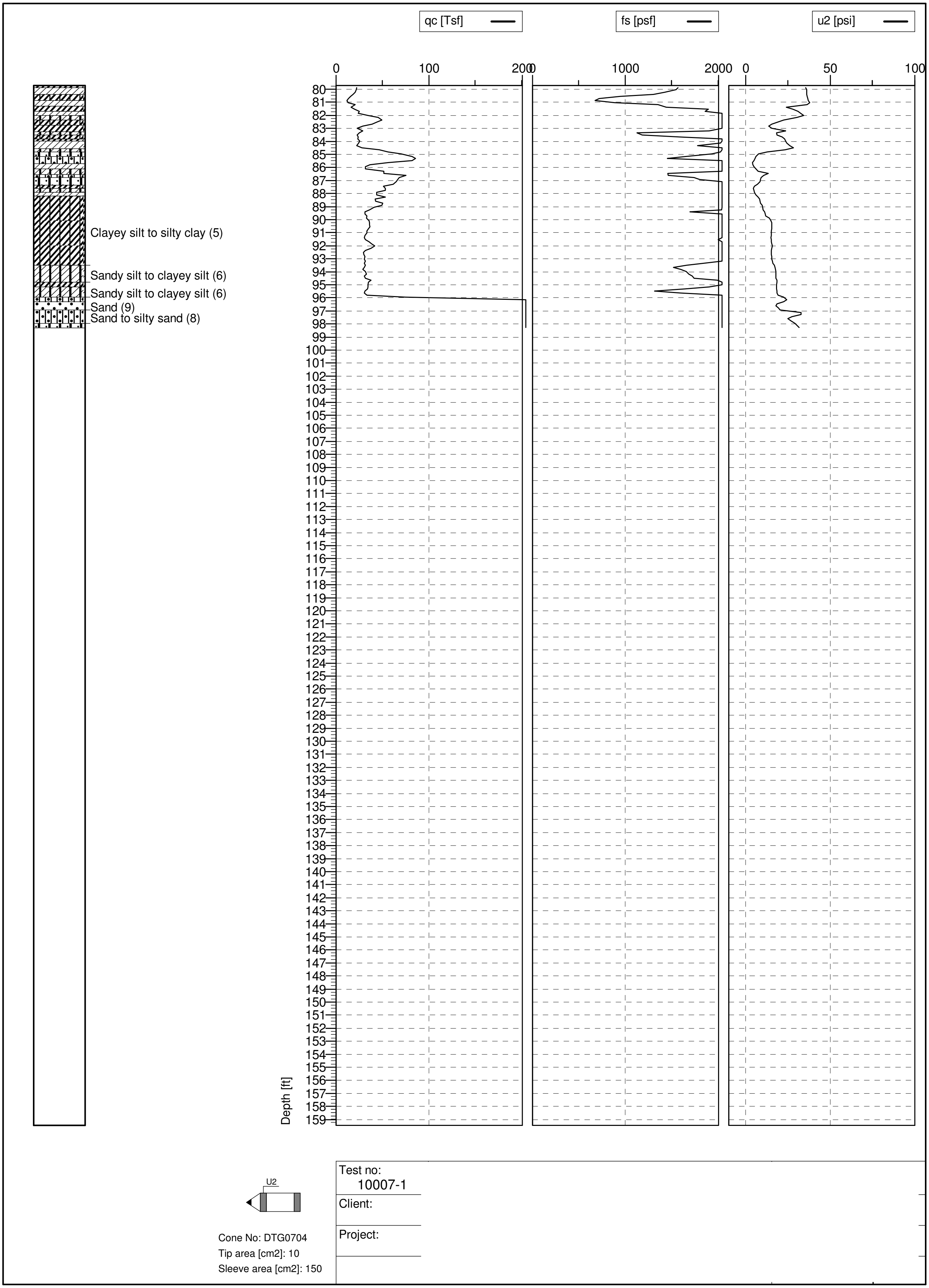
Sleeve area [cm2]: 150

Test no: 10007-1

Client:

Project: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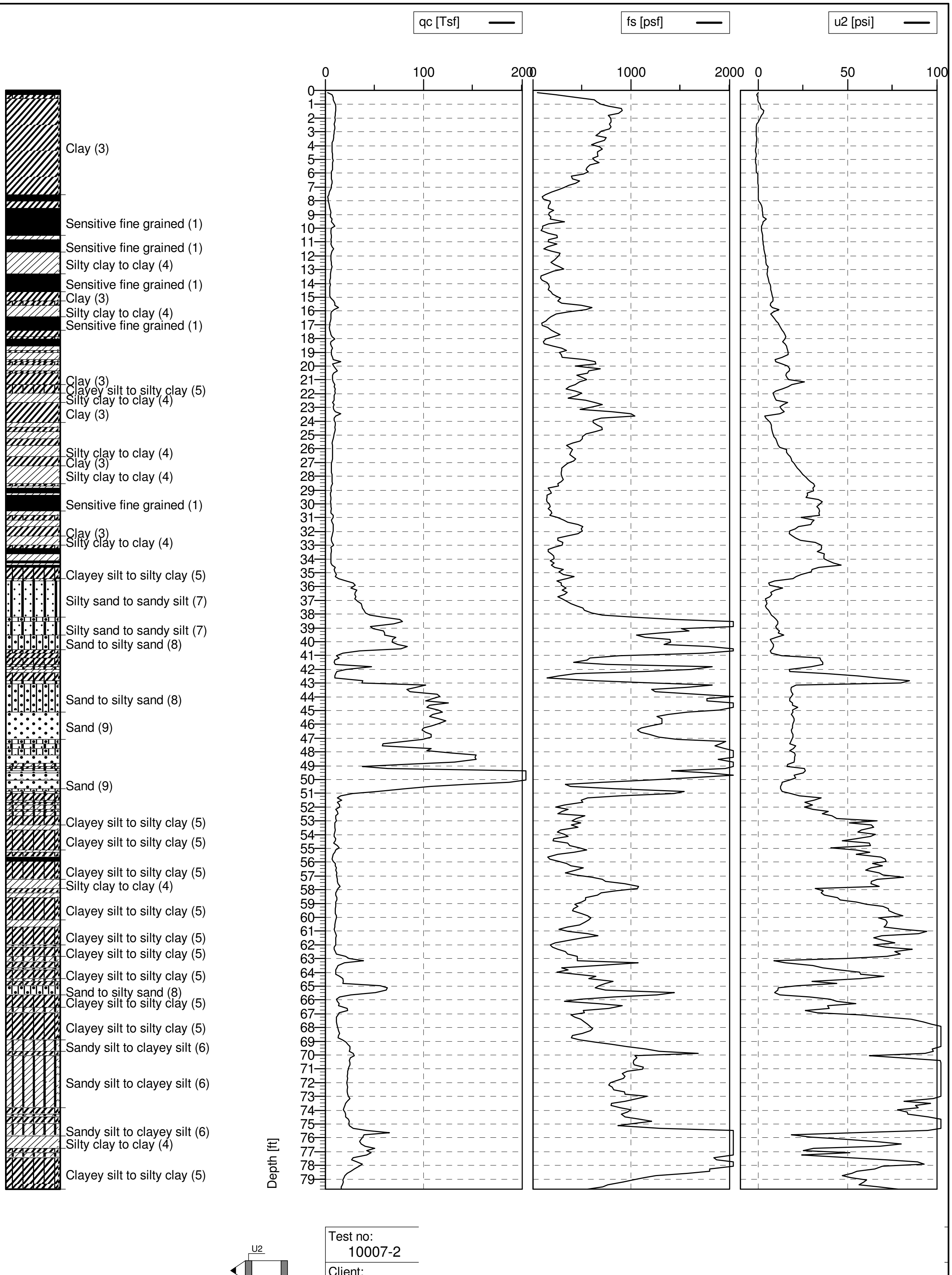
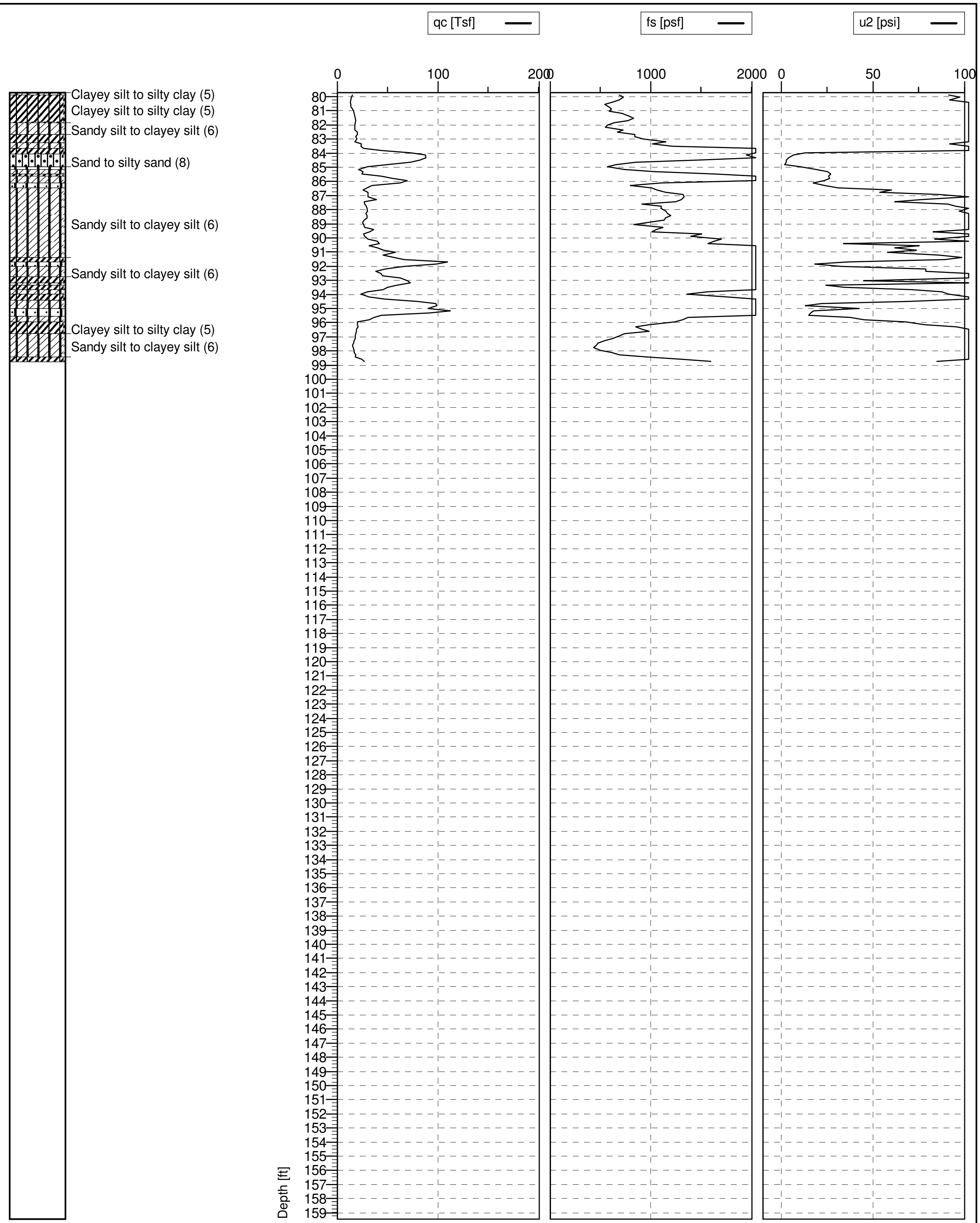
fs [psf]
u2 [psi]
Clayey silt to silty clay (5)
Sandy silt to clayey silt (6)
Sandy silt to clayey silt (6)
Sand (9)
Sand to silty sand (8)
Depth [ft]
U2
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150
Test no:
10007-1
Client:
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10007-2
Client:
Project:

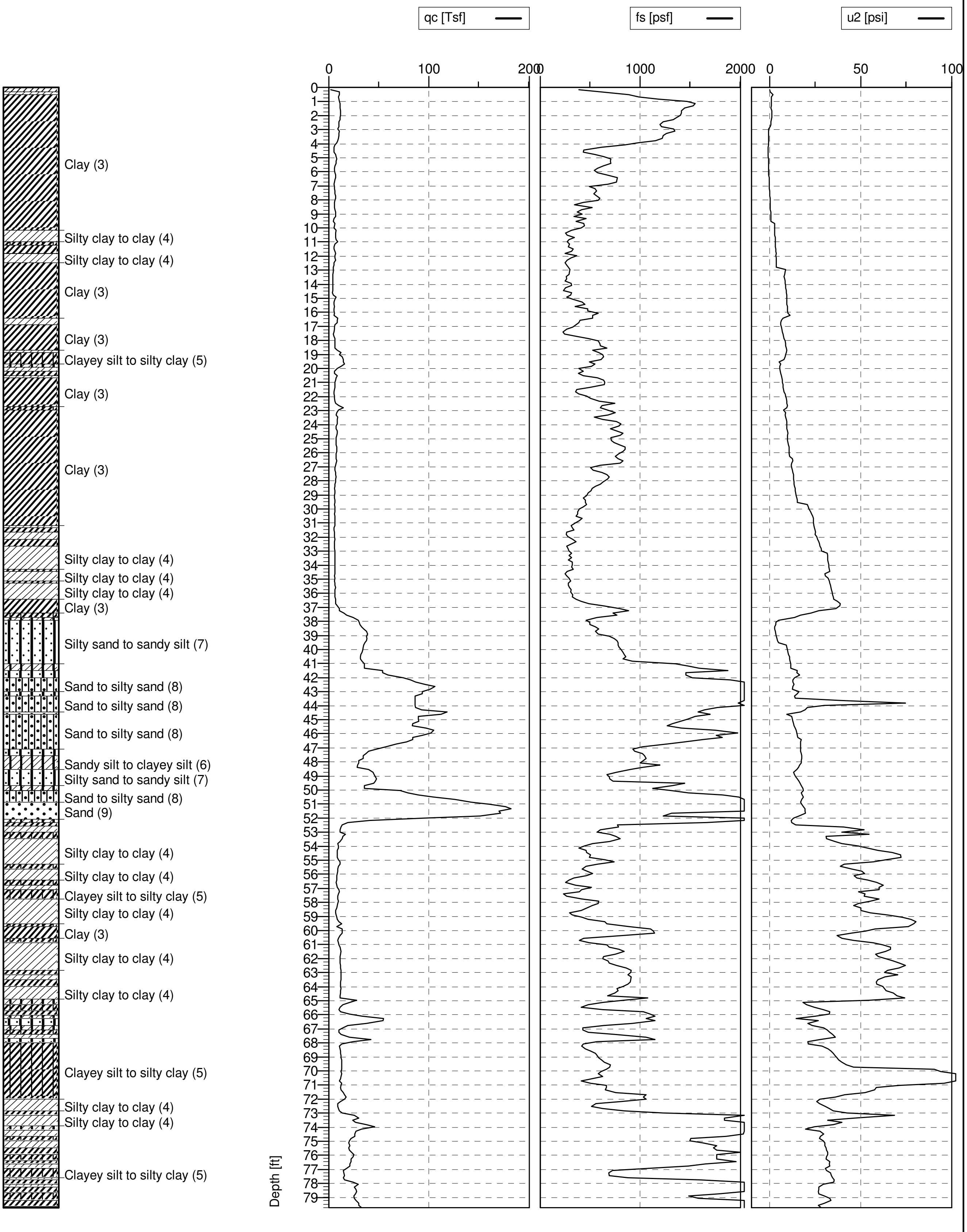


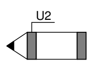
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10007-2

Client:

Project:



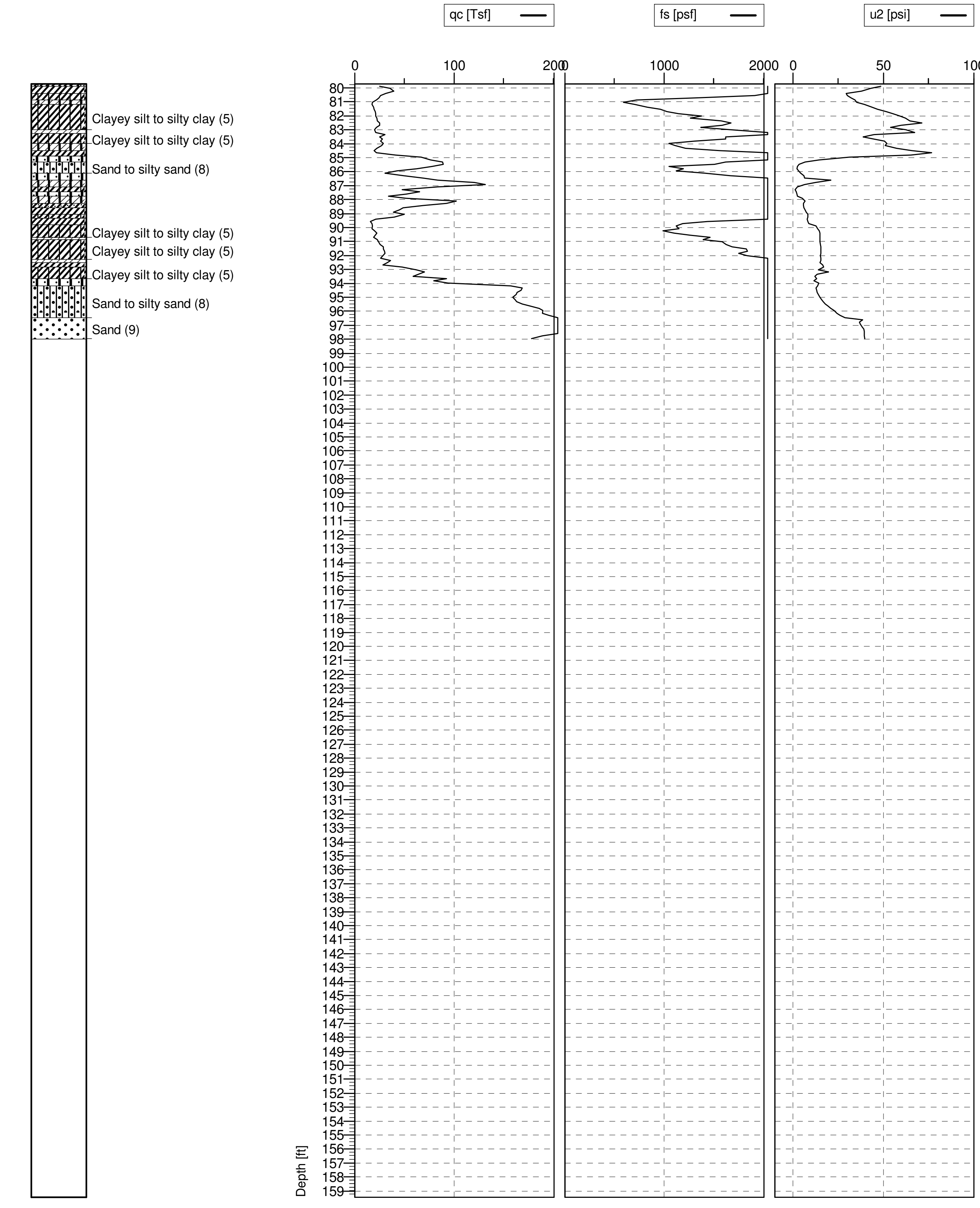


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 10007-3

Client:

Project:



Test no: 10007-3

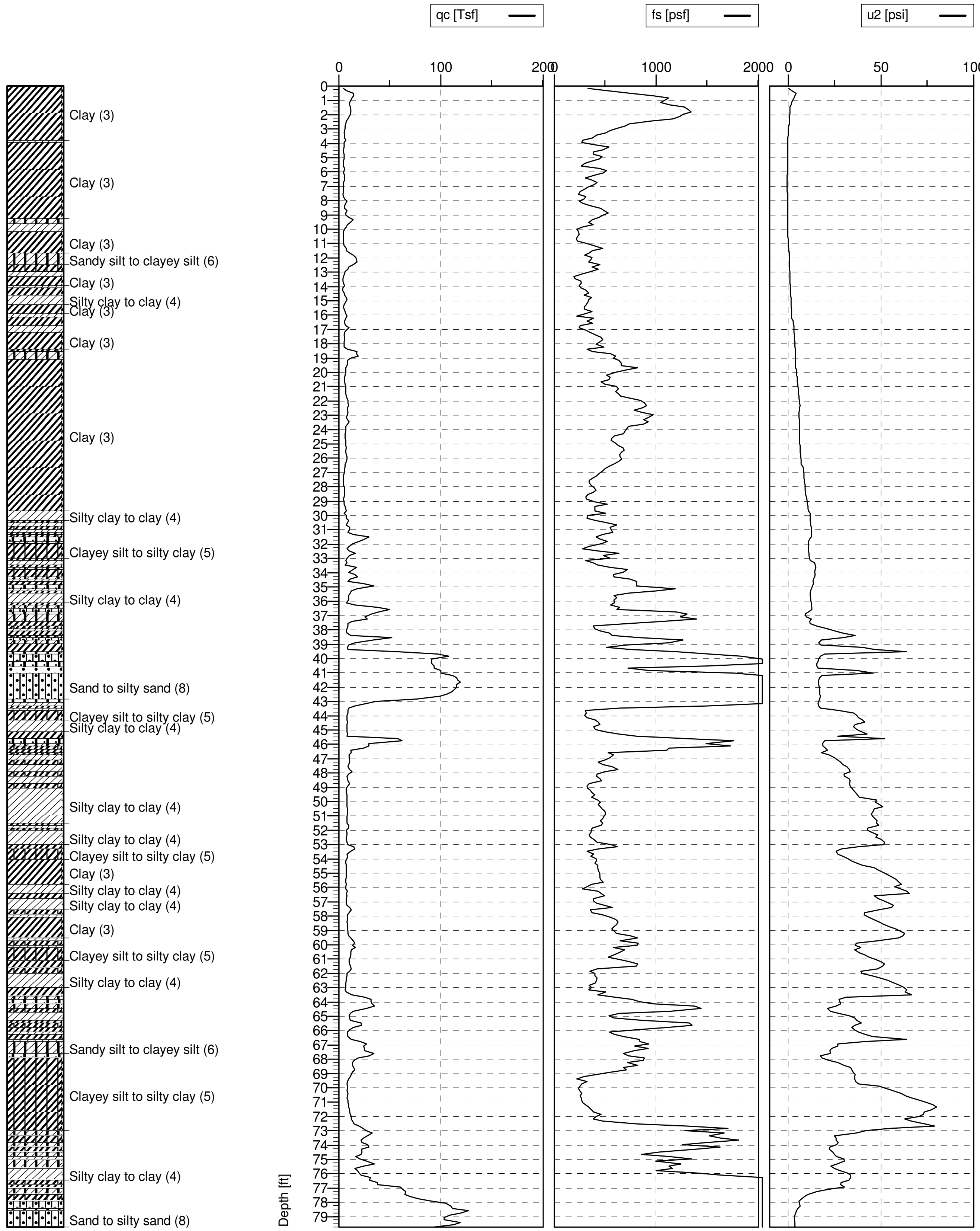
Client:

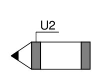
Project:

Cone No: DTG0704

Tip area [cm2]: 10

Sleeve area [cm2]: 150



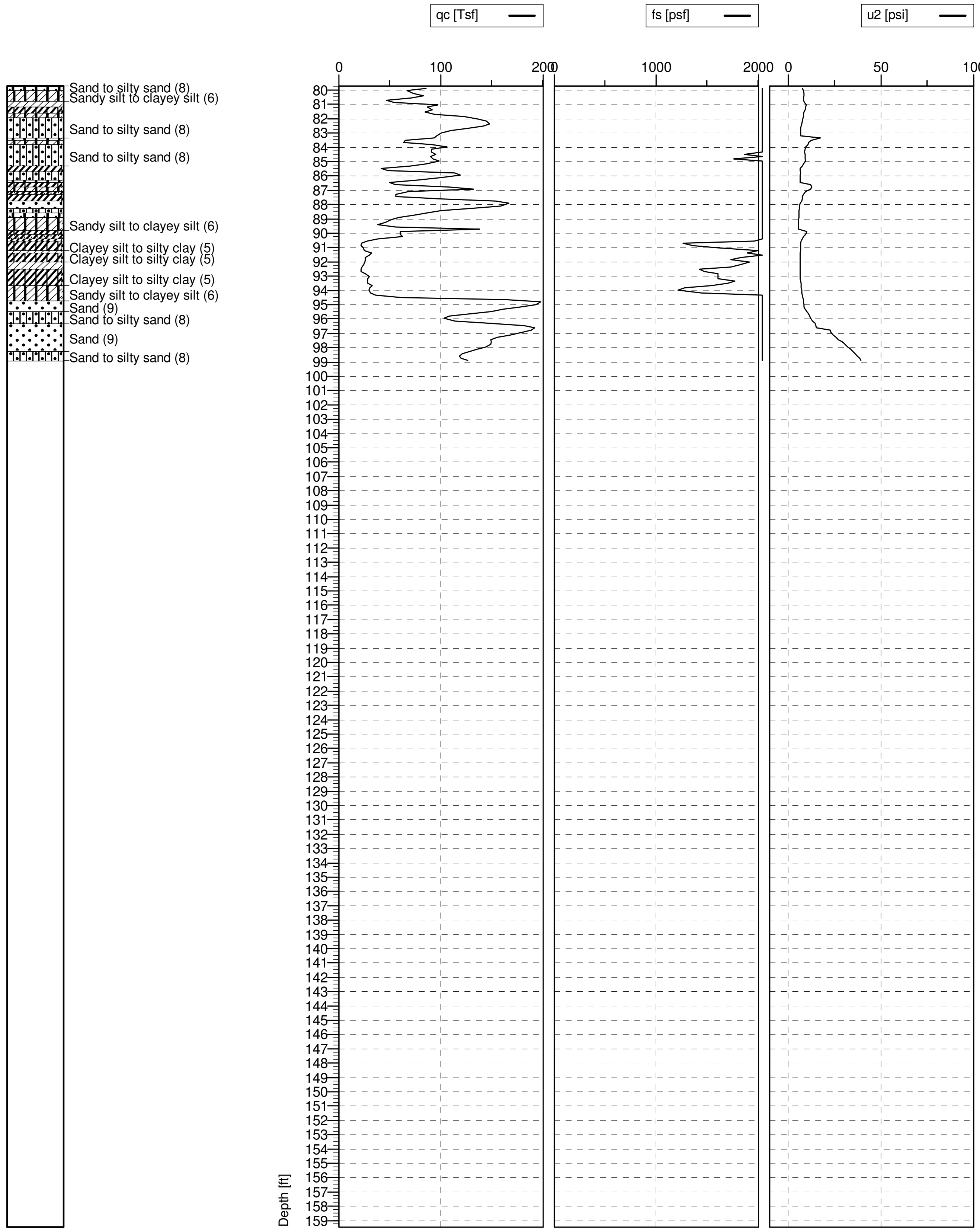


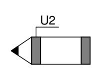
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 10009-1

Client:

Project:



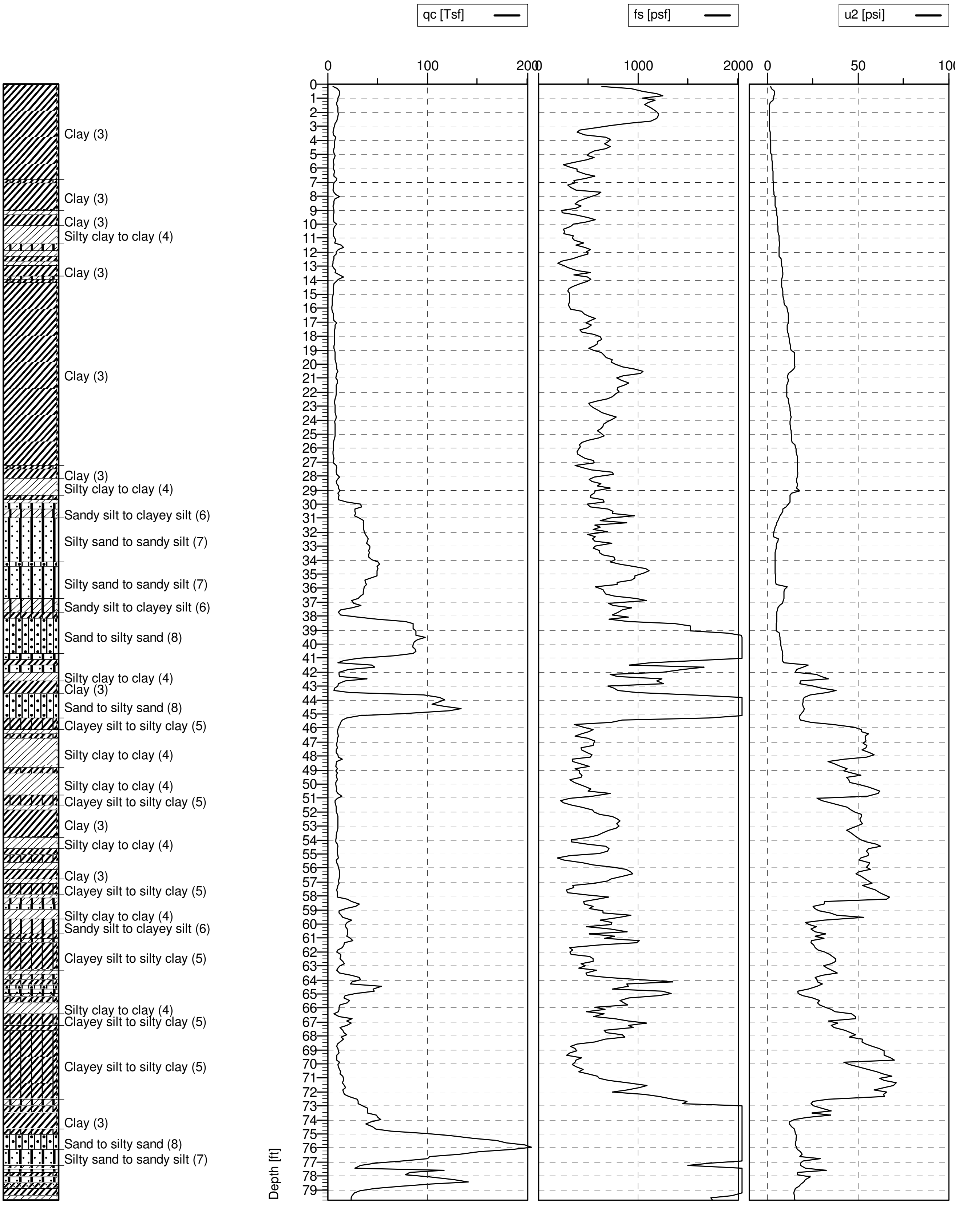


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10009-1

Client:

Project:

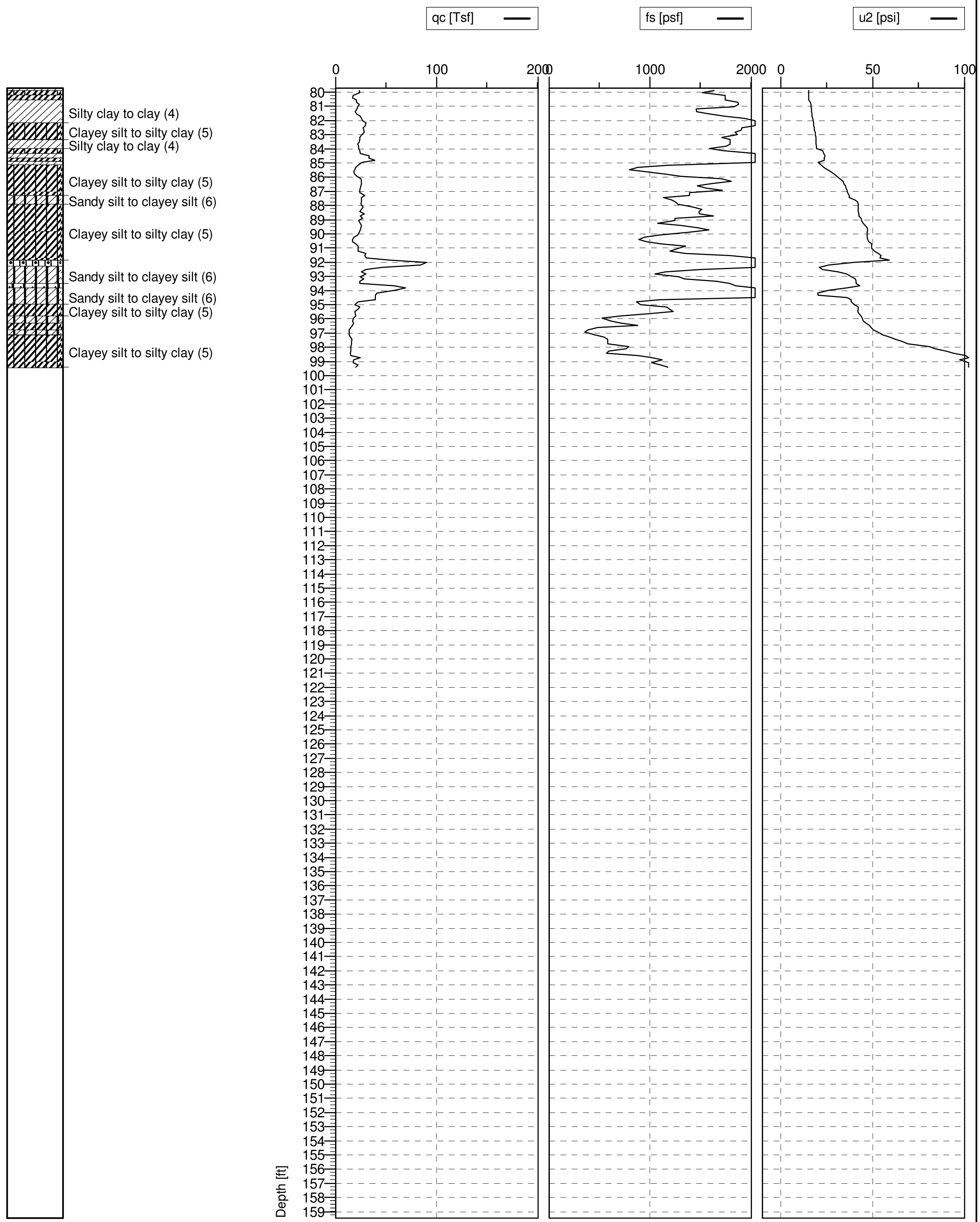


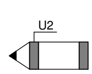
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 10009-2

Client:

Project:



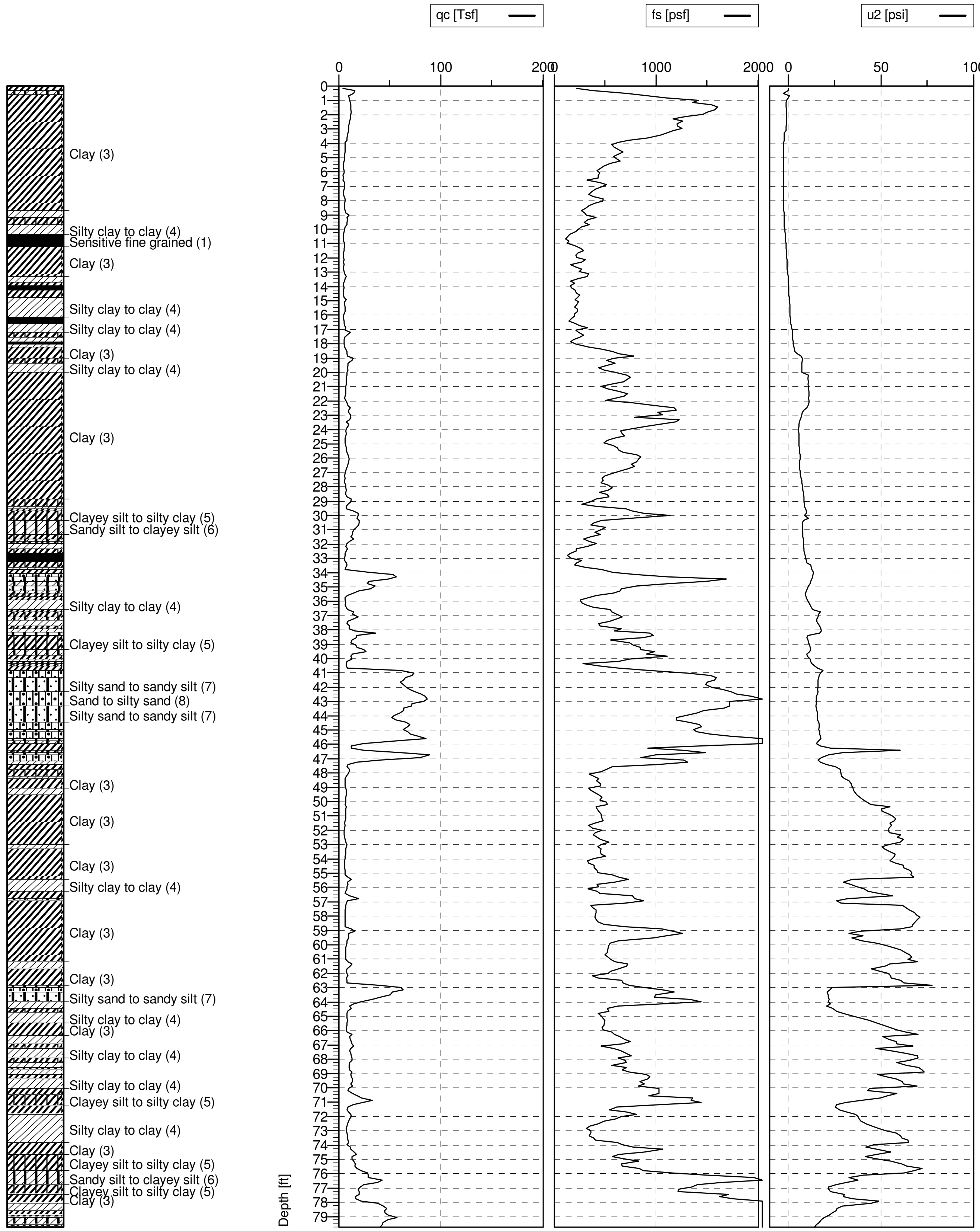


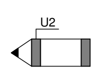
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10009-2

Client:

Project:



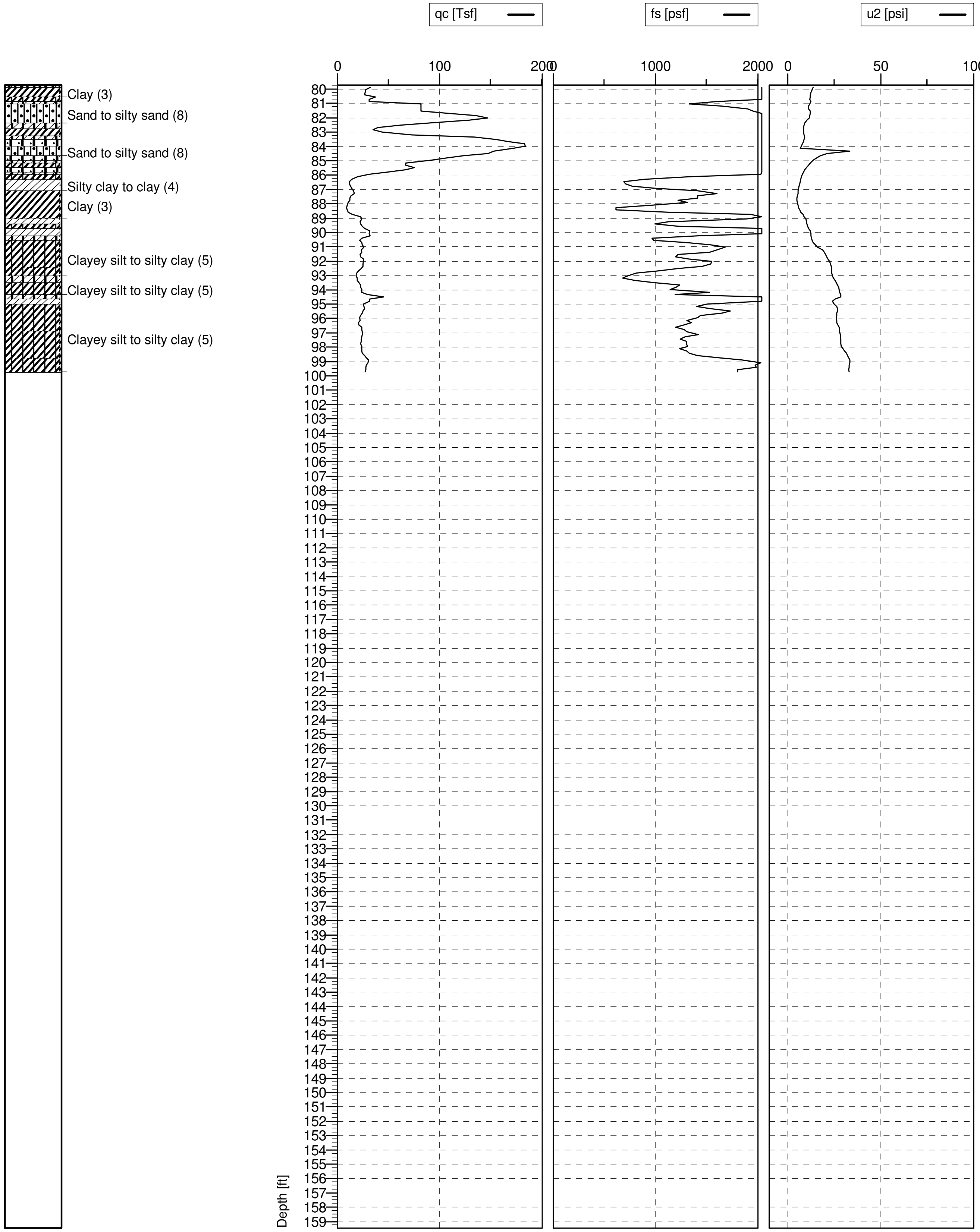


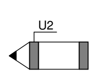
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10009-3

Client:

Project:



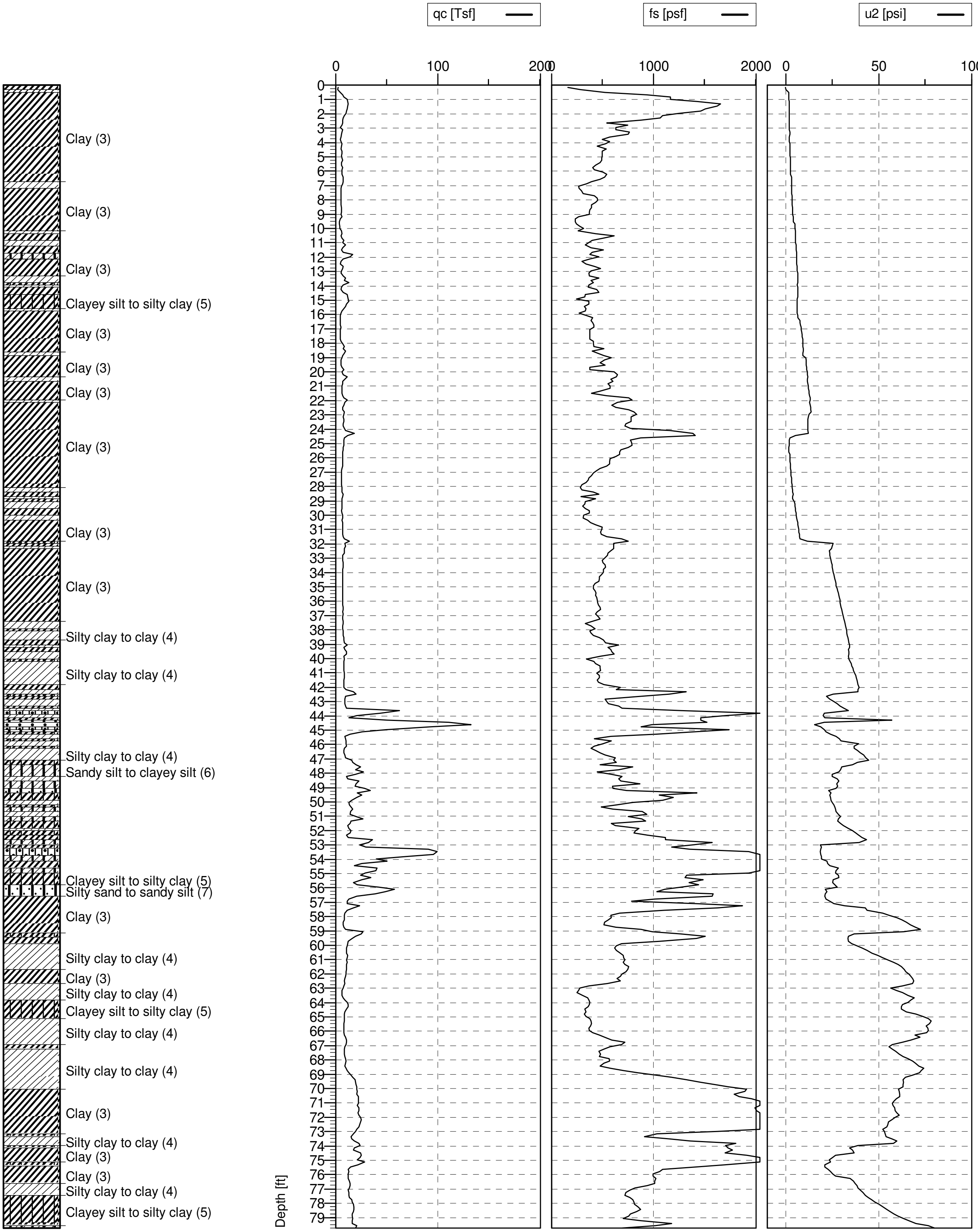


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10009-3

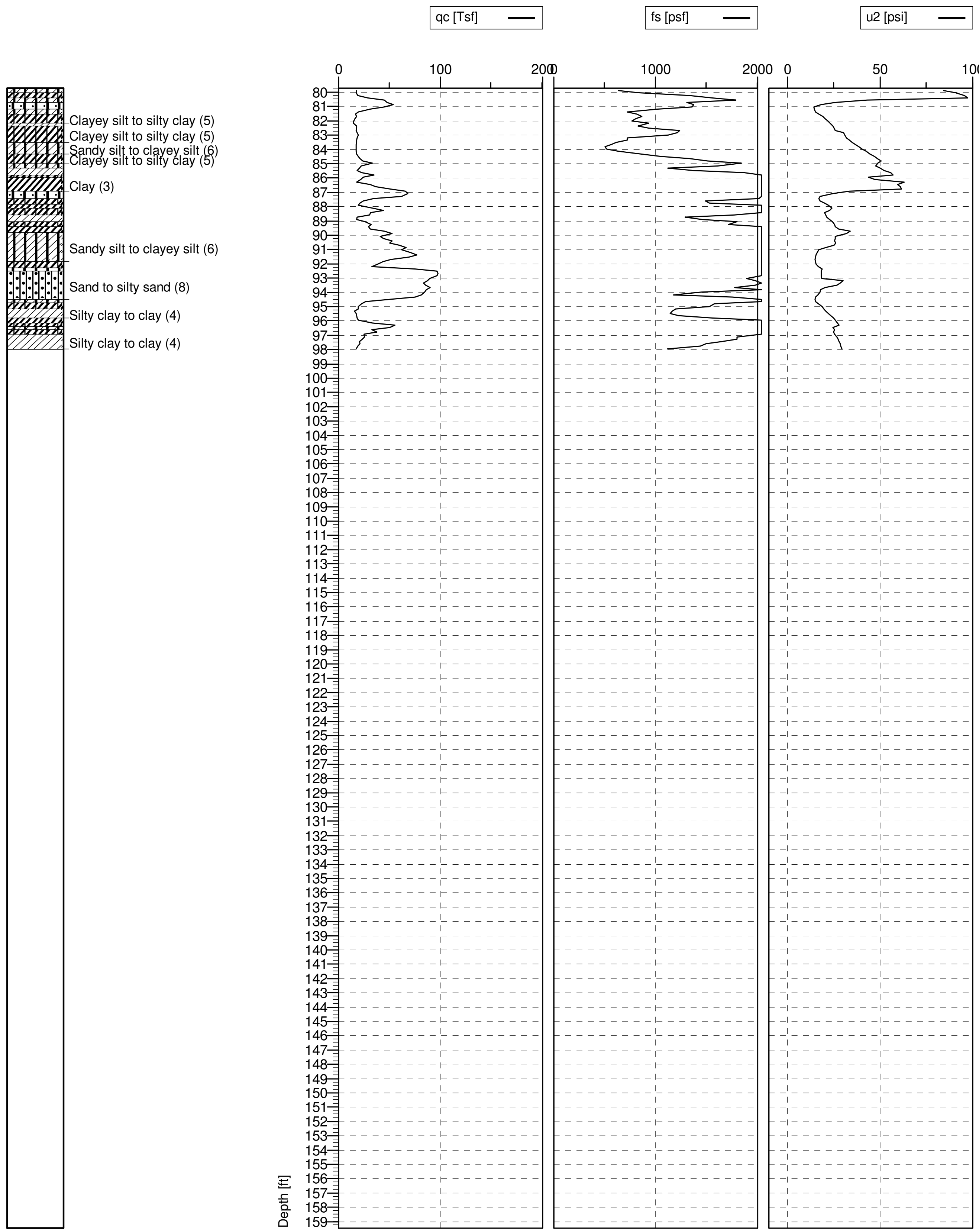
Client:

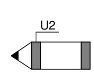
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10011-1
Client:
Project:



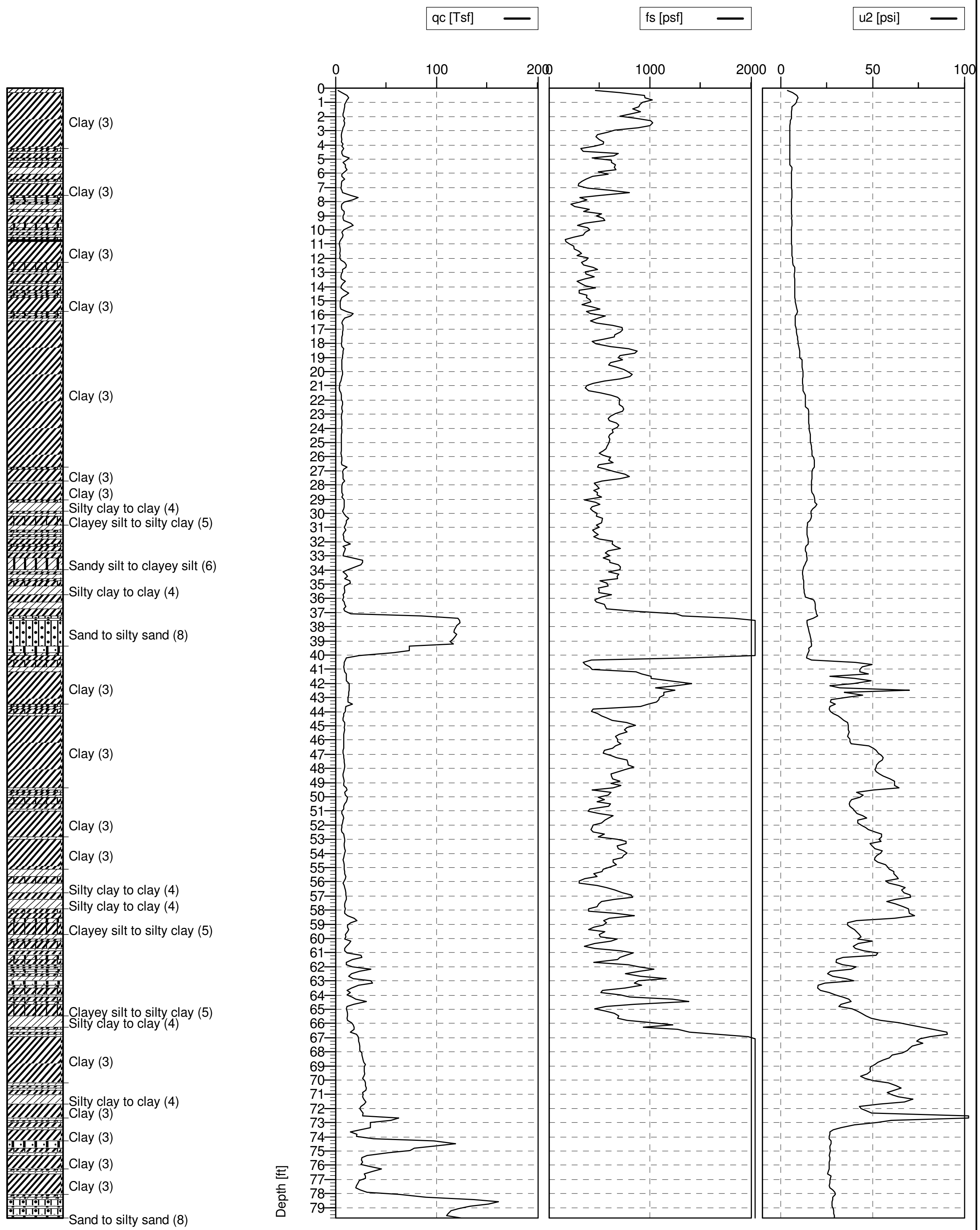


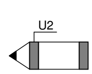
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10011-1

Client:

Project:



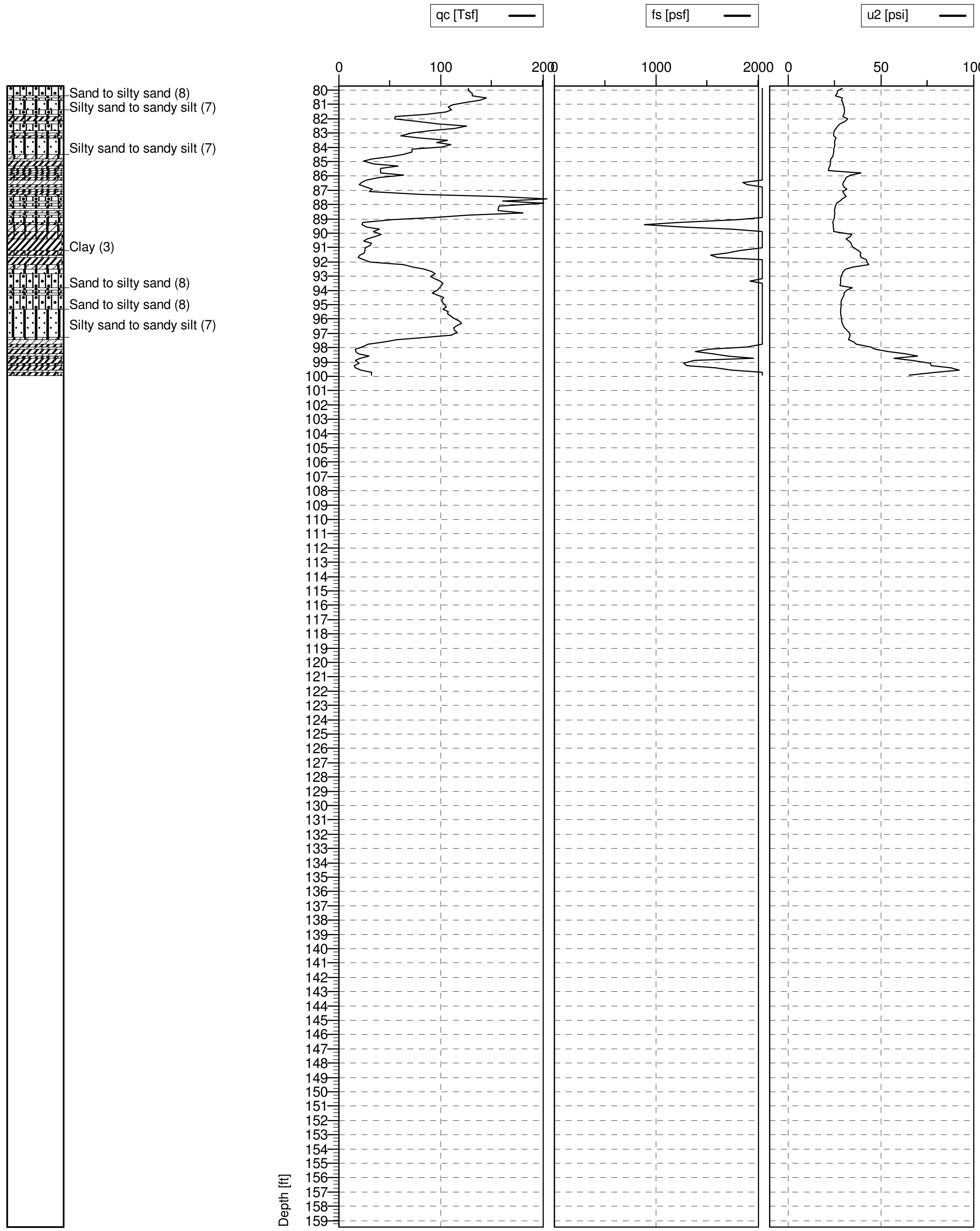


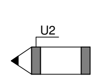
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
10011-2

Client:

Project:



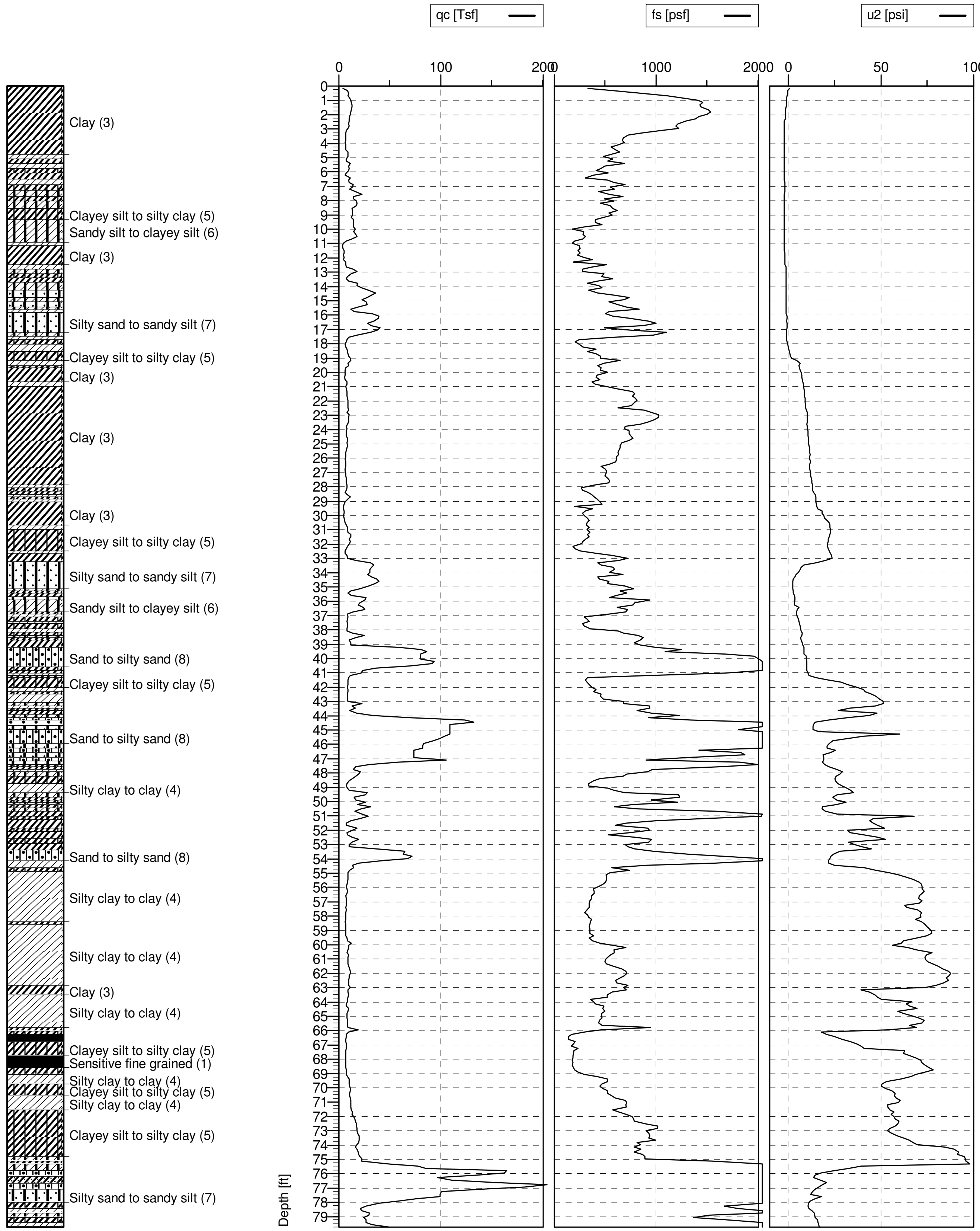


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 10011-2

Client:

Project:

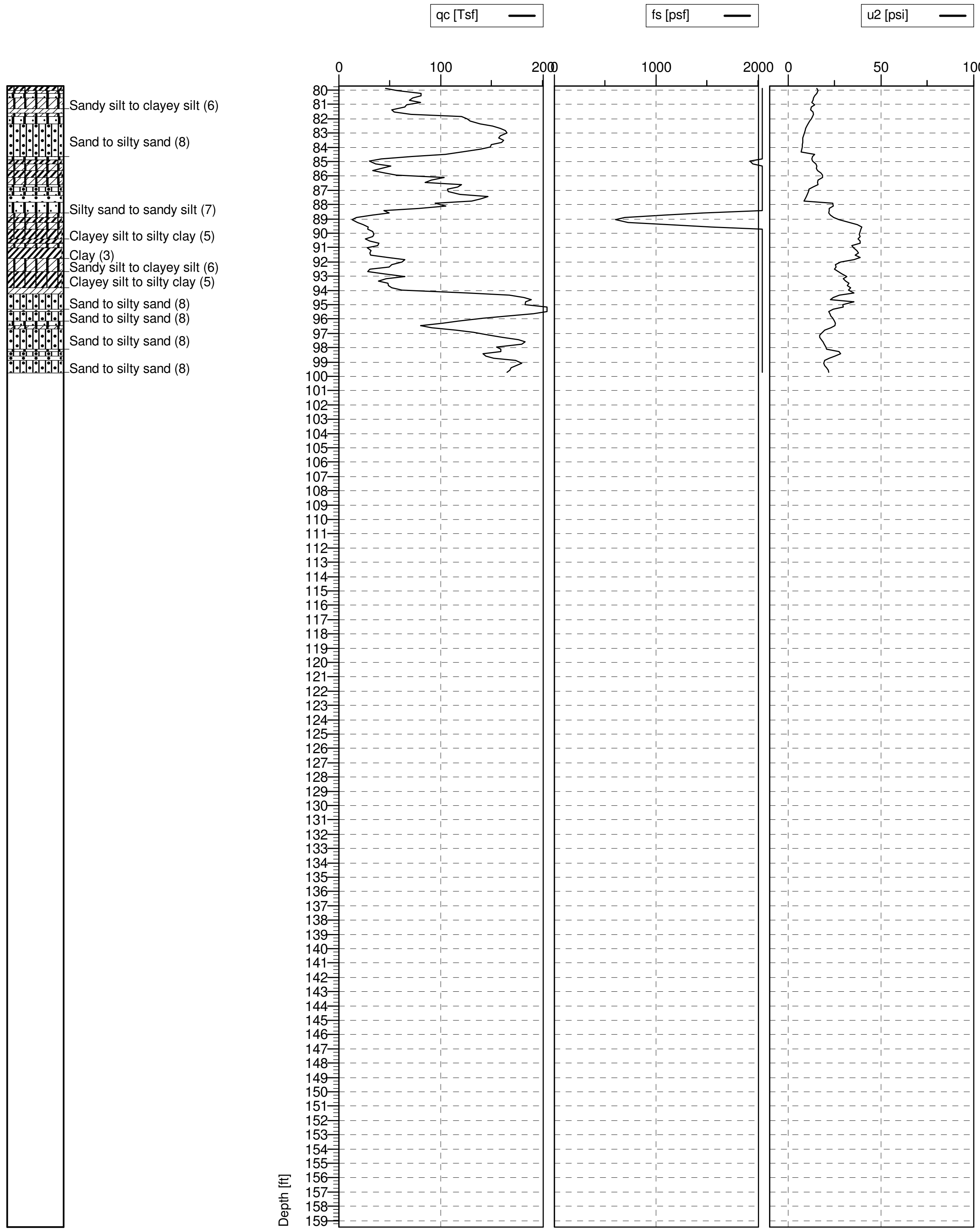


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 10011-3

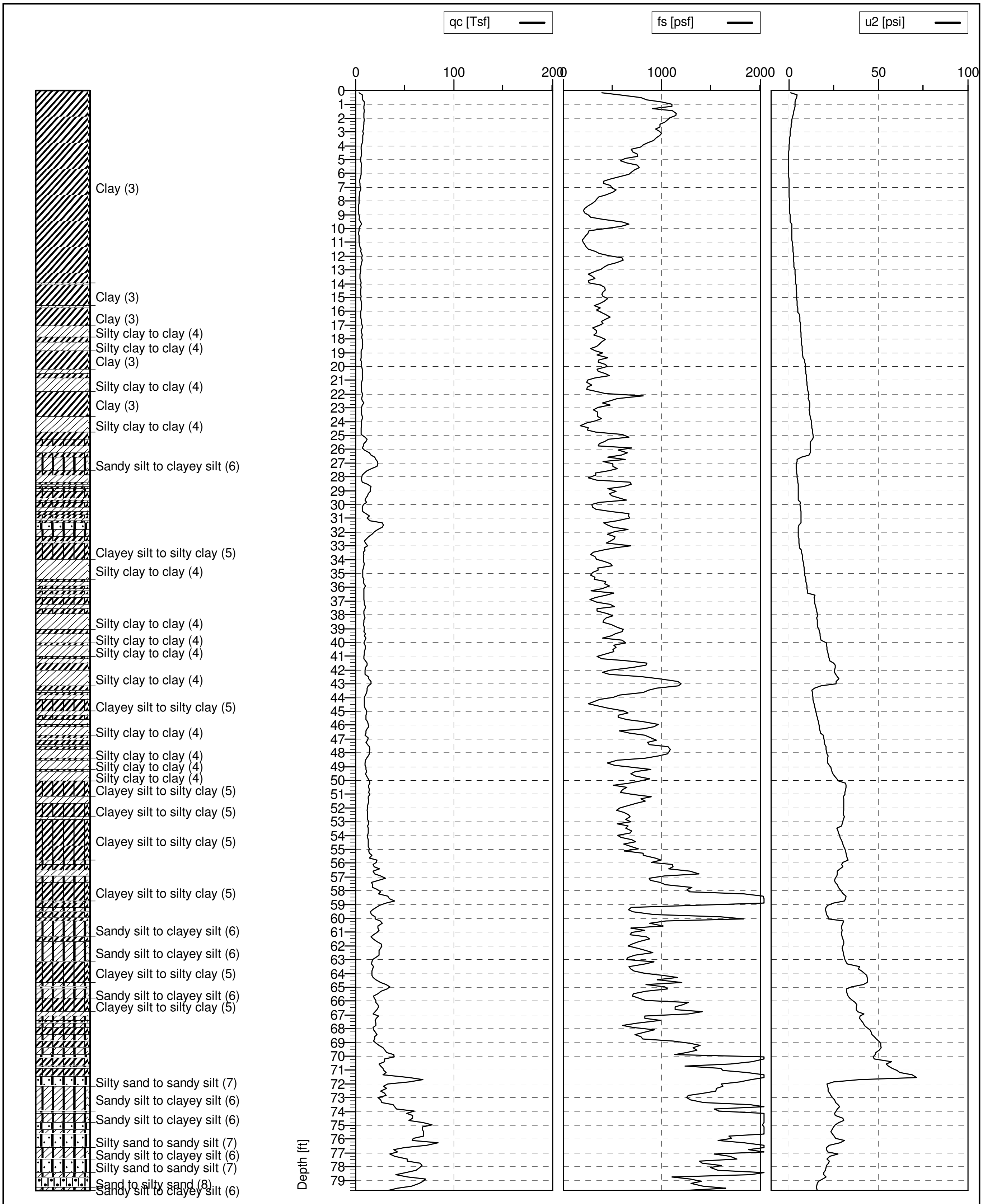
Client:

Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

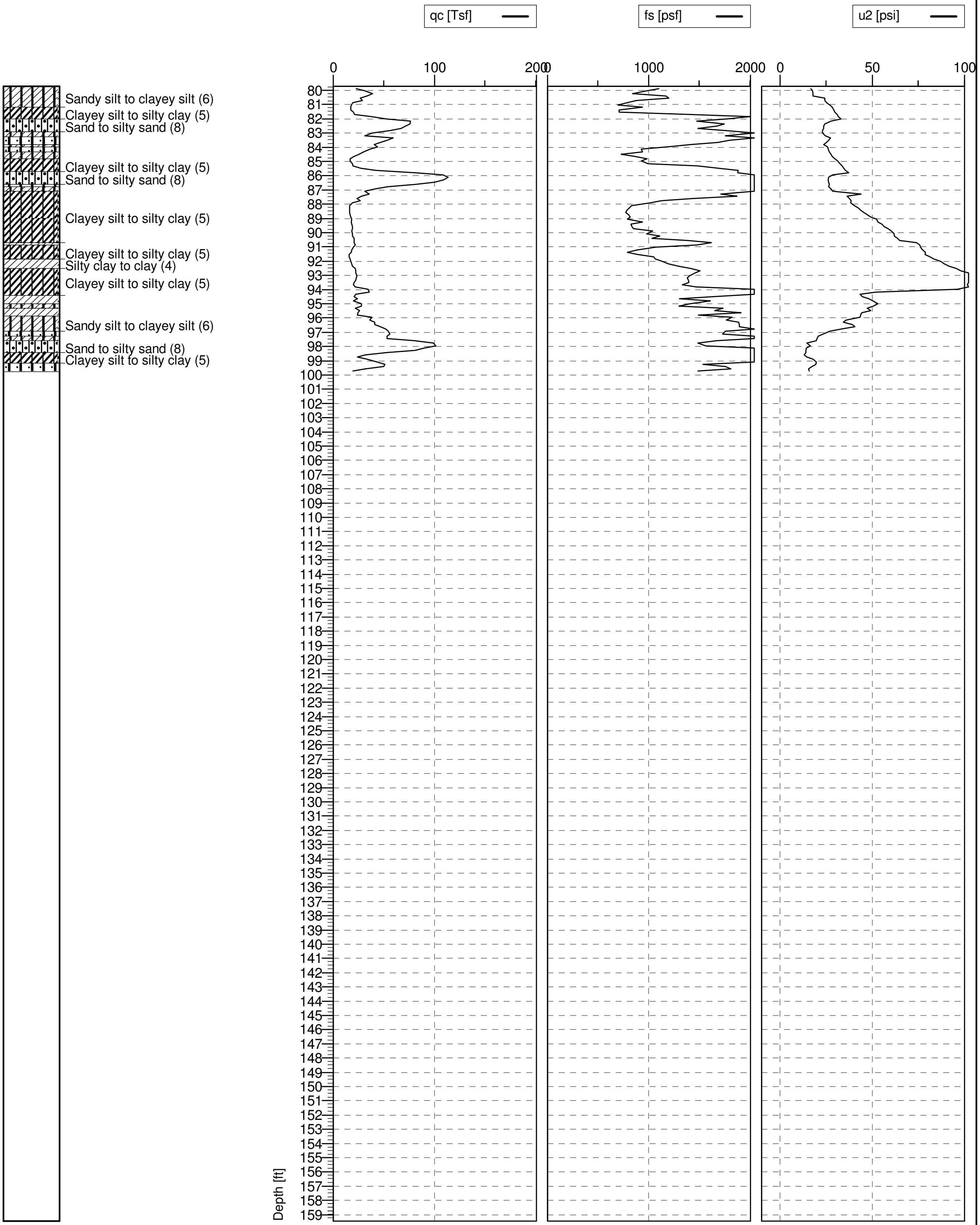
Test no:
10011-3
Client:
Project:



Test no:
15002-1

Client:

Project:

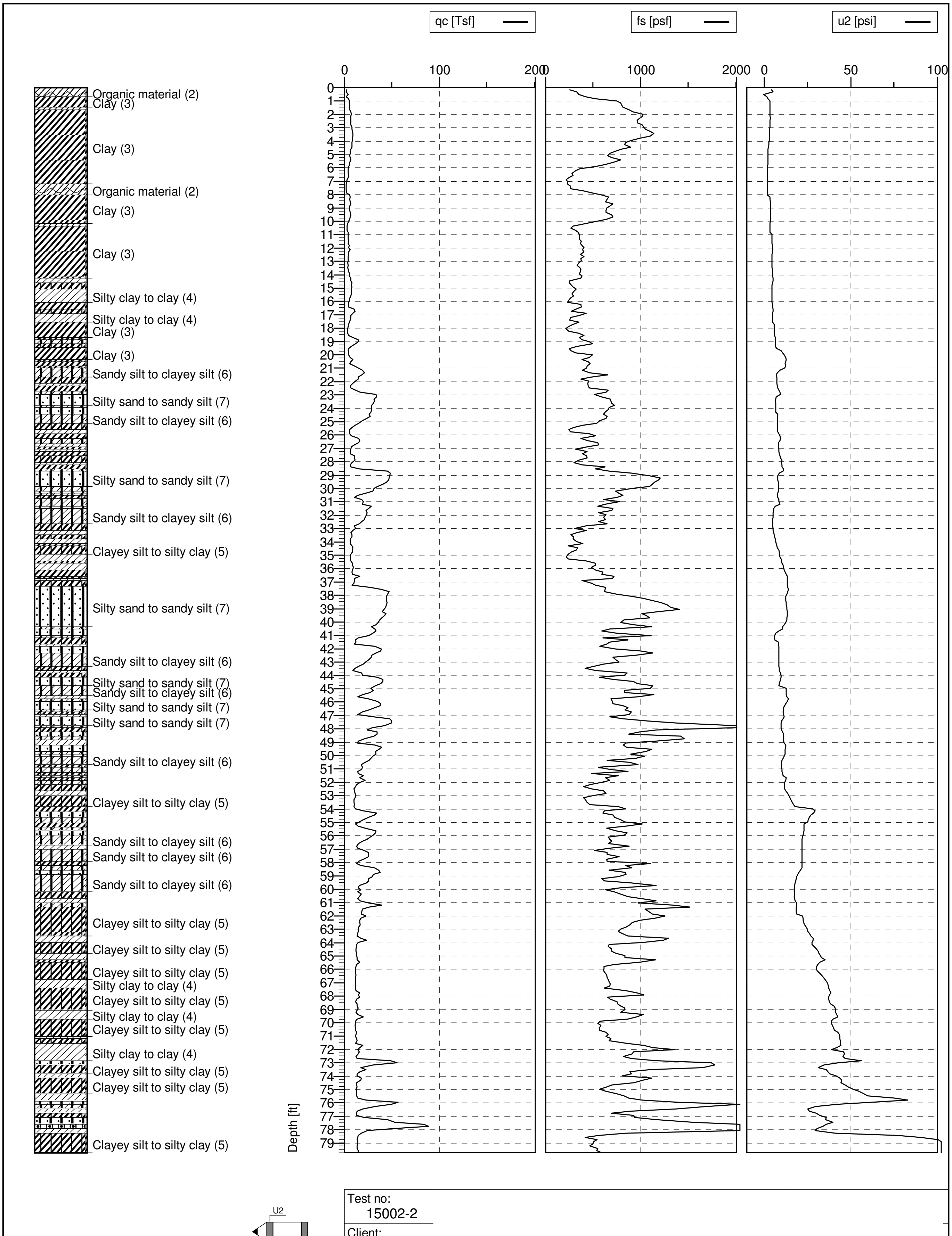


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 15002-1

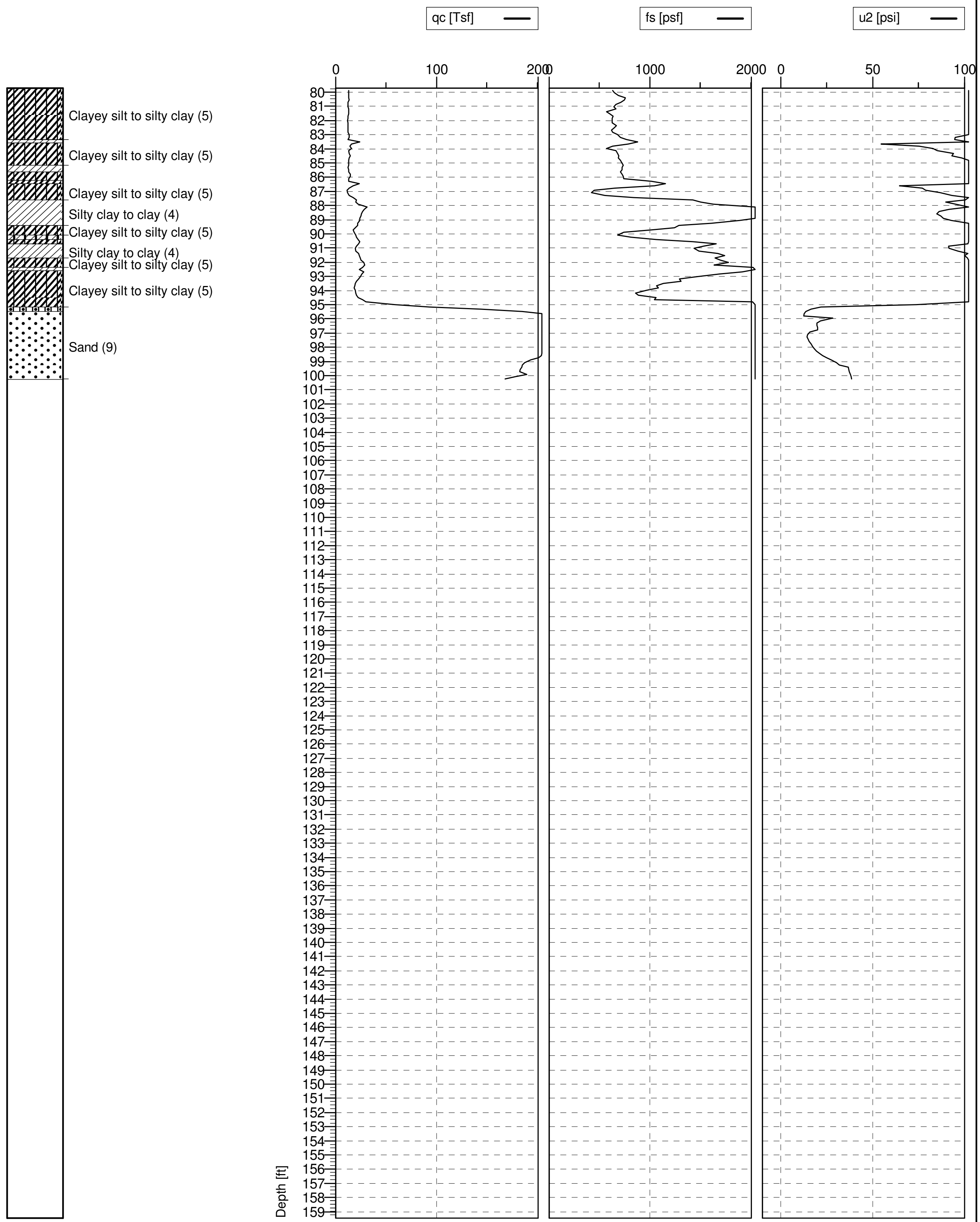
Client:

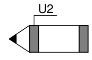
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

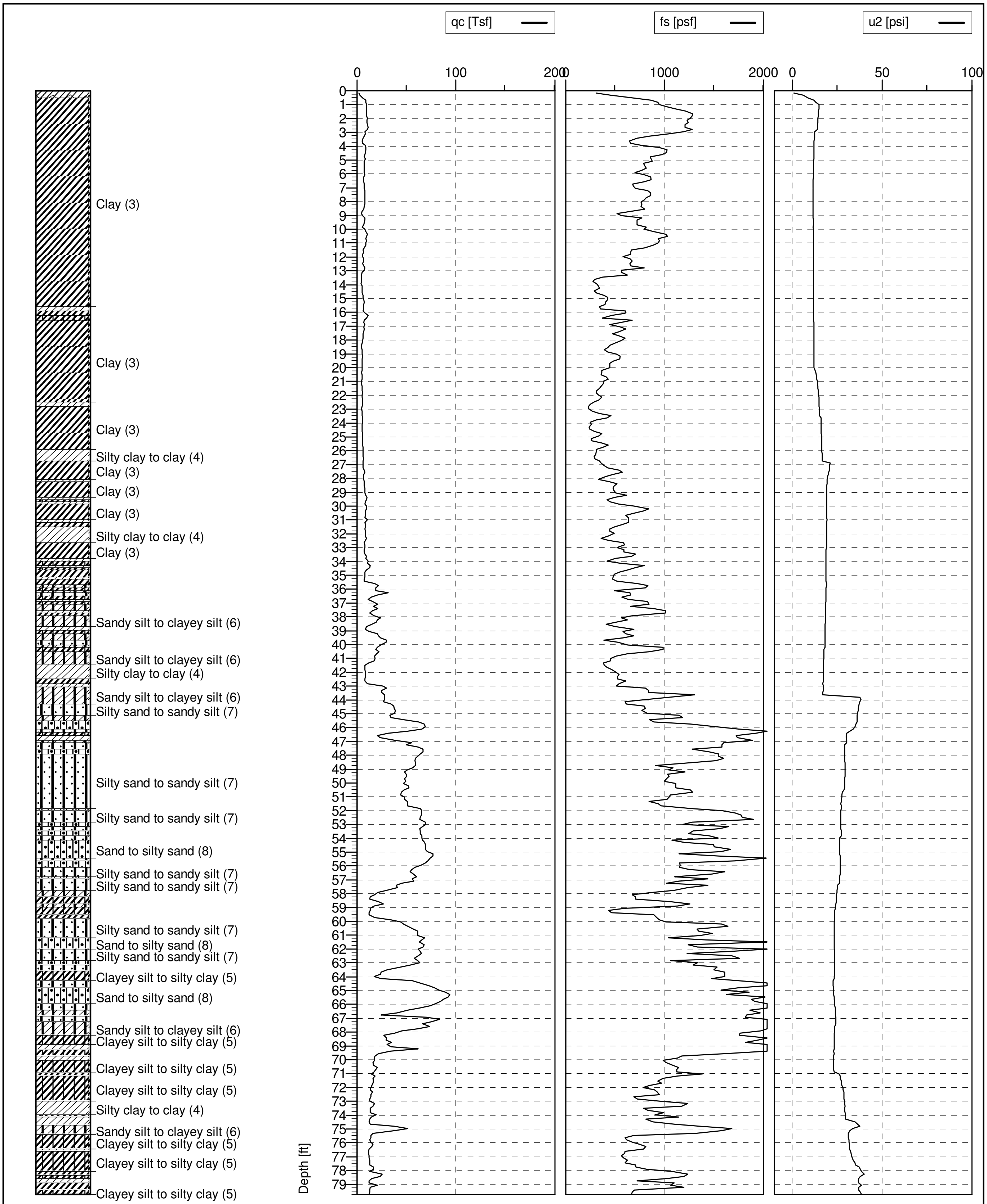
Test no: 15002-2
Client:
Project:

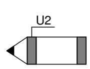




Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
15002-2
Client:
Project:





Cone No: DTG0704

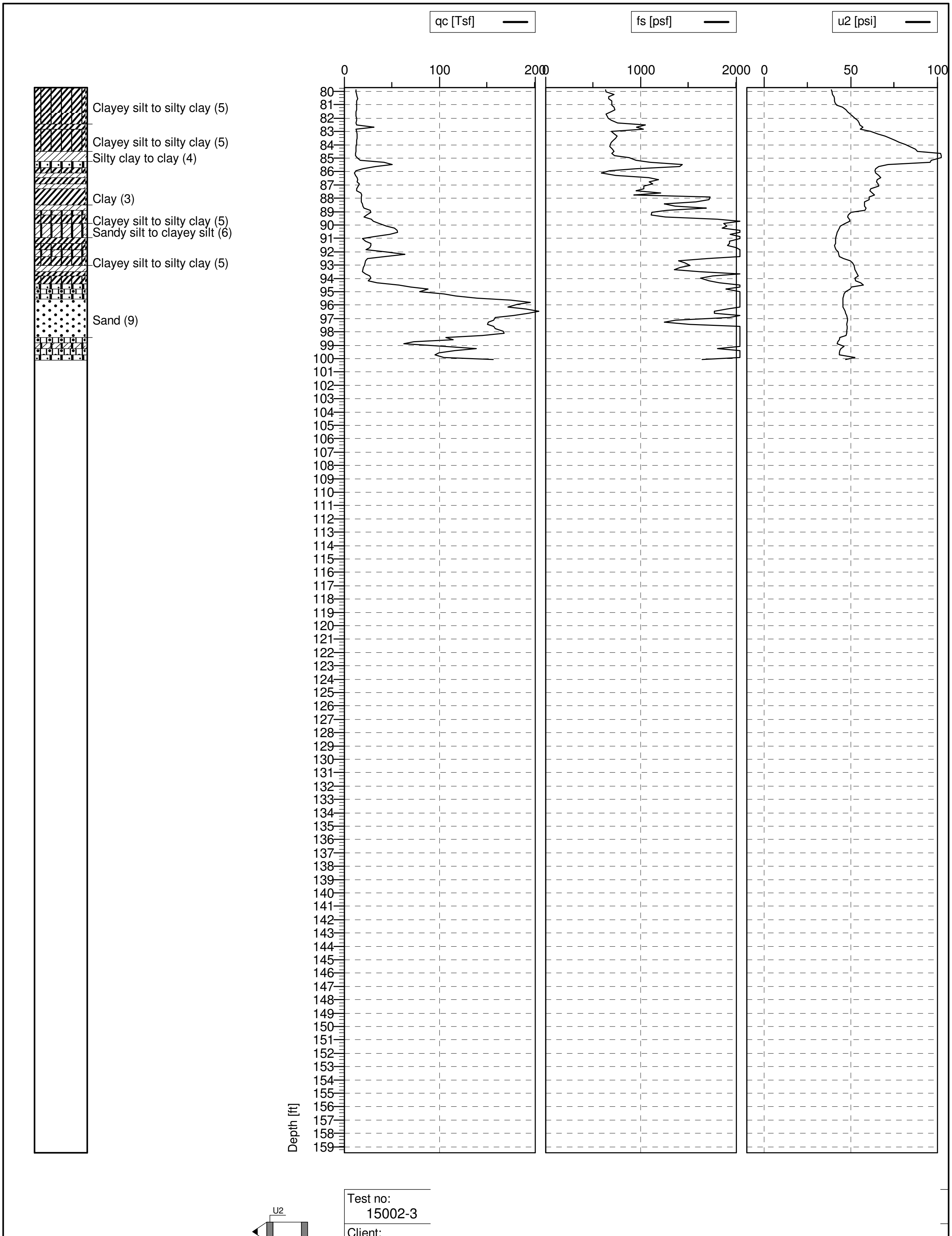
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no:
15002-3

Client:

Project:

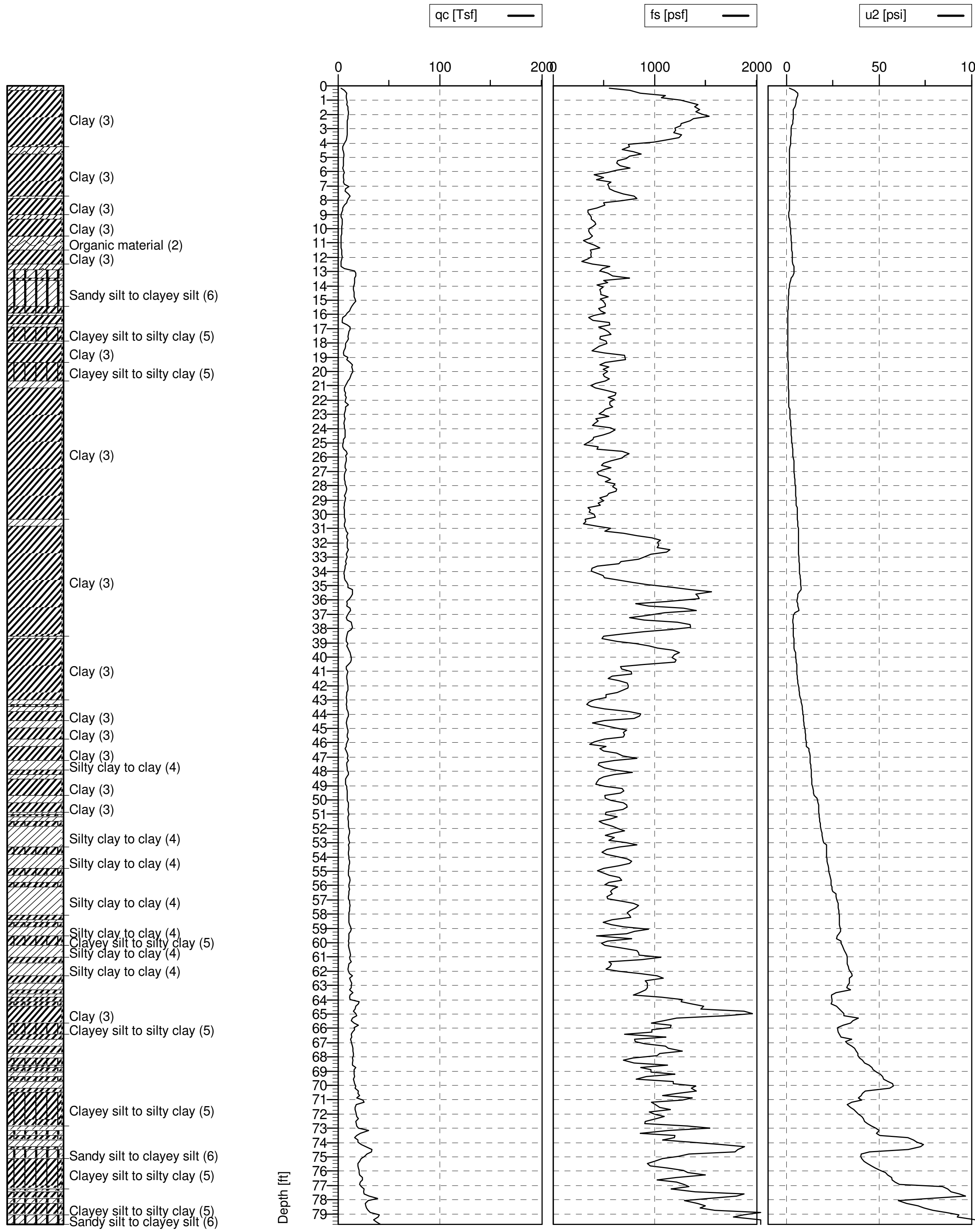


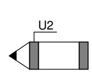
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 15002-3

Client:

Project:



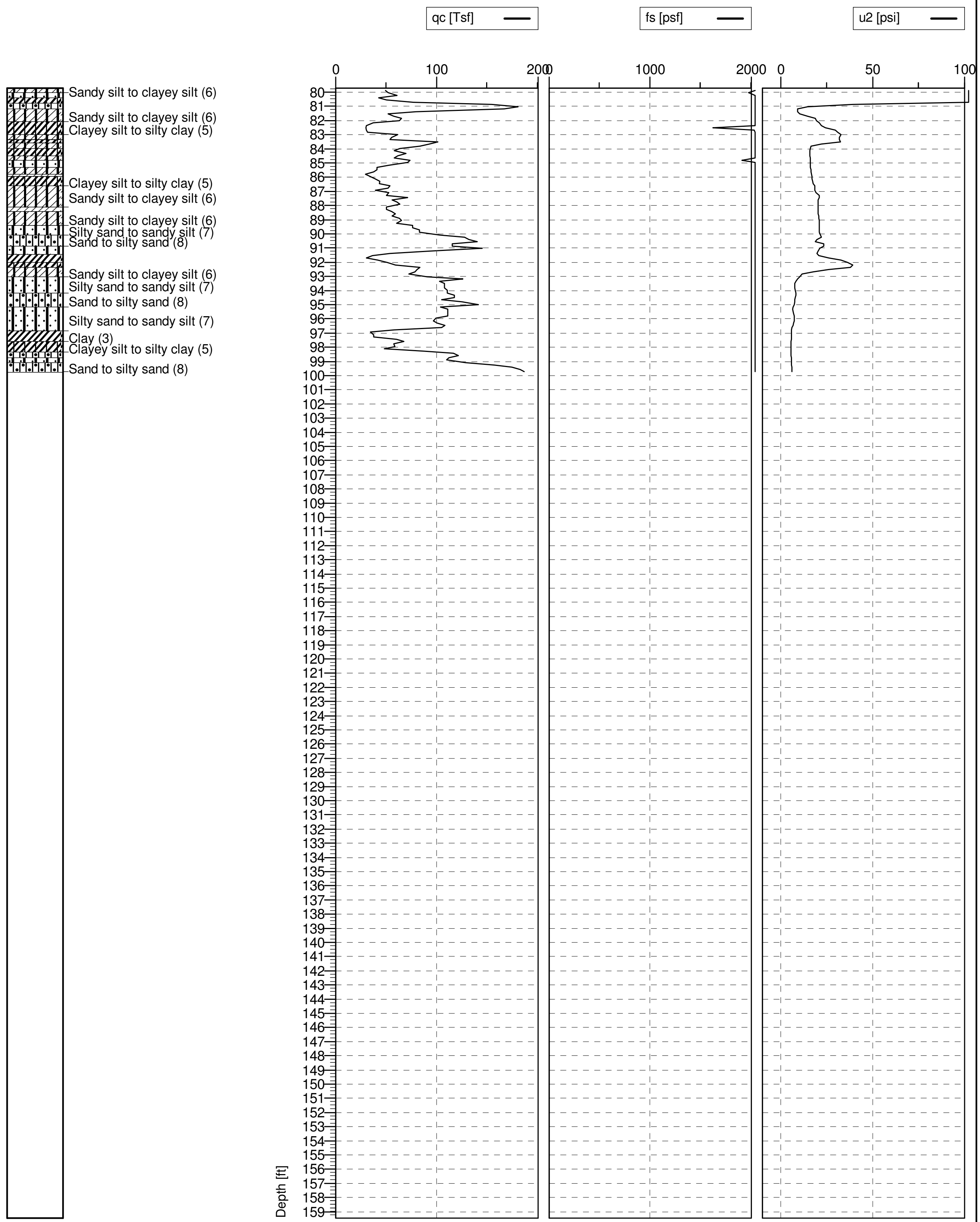


Cone No: DTG0704

Tip area [cm2]: 10

Sleeve area [cm2]: 150

Test no: 15002-4	
Client:	
Project:	

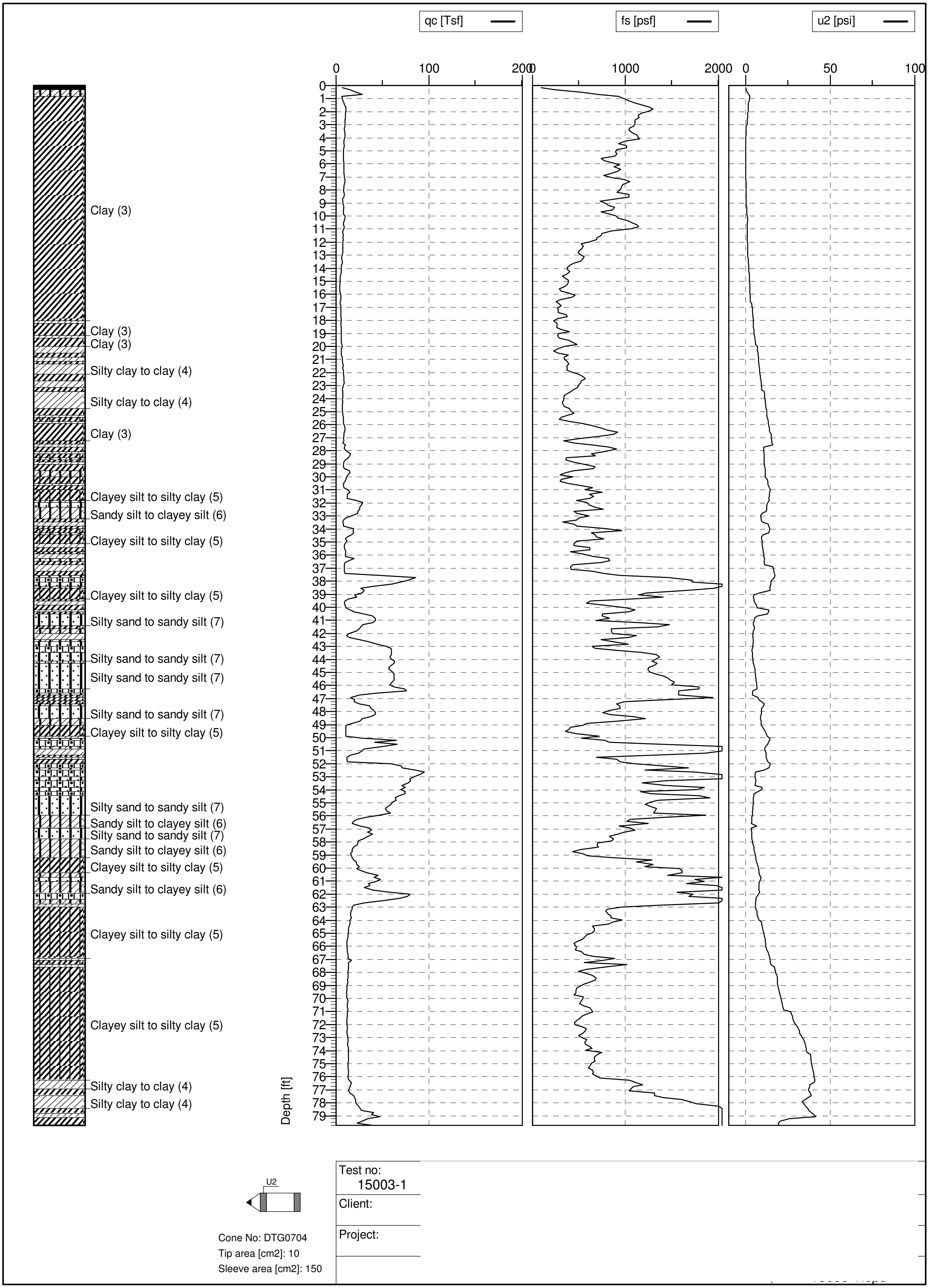


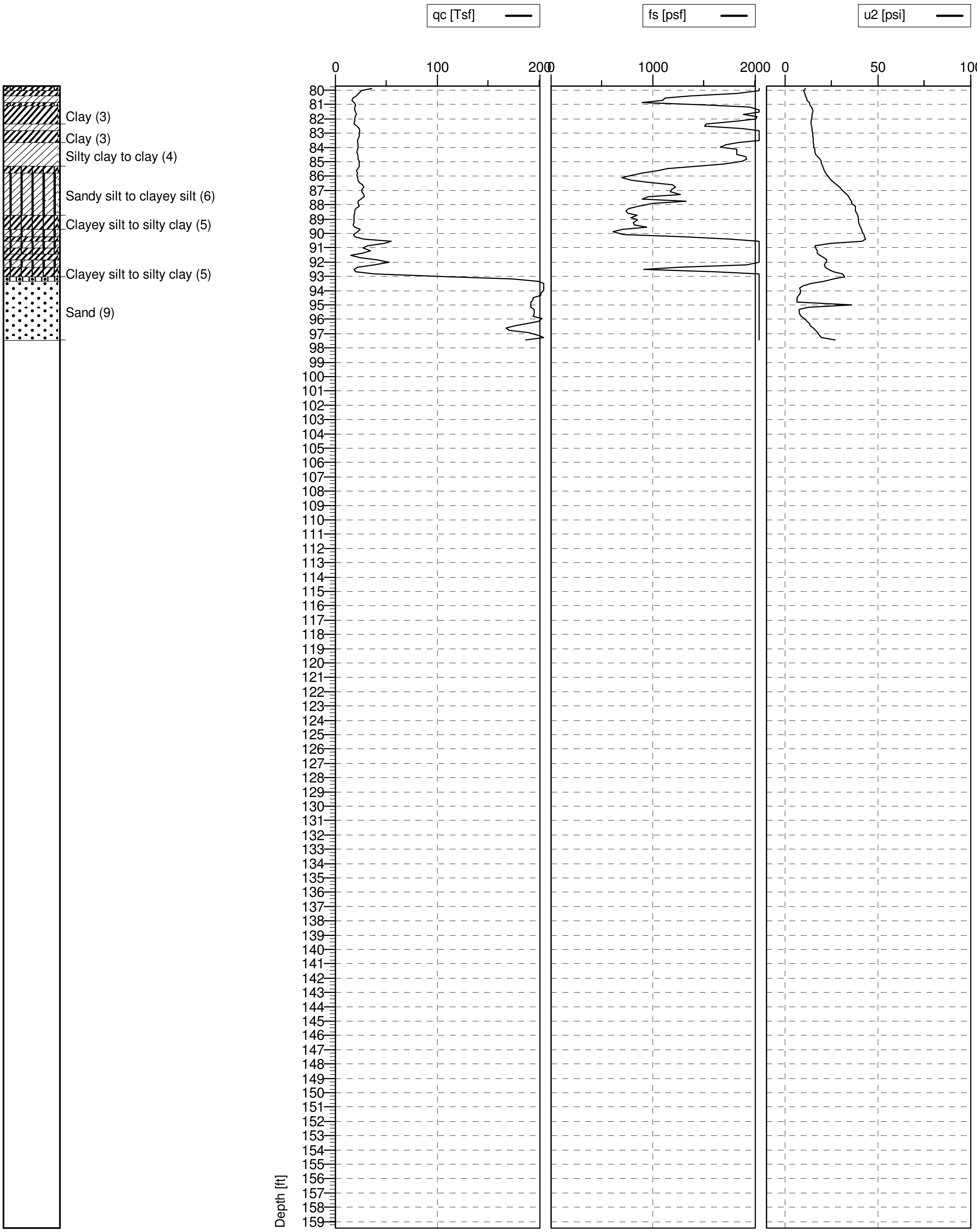
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 15002-4

Client:

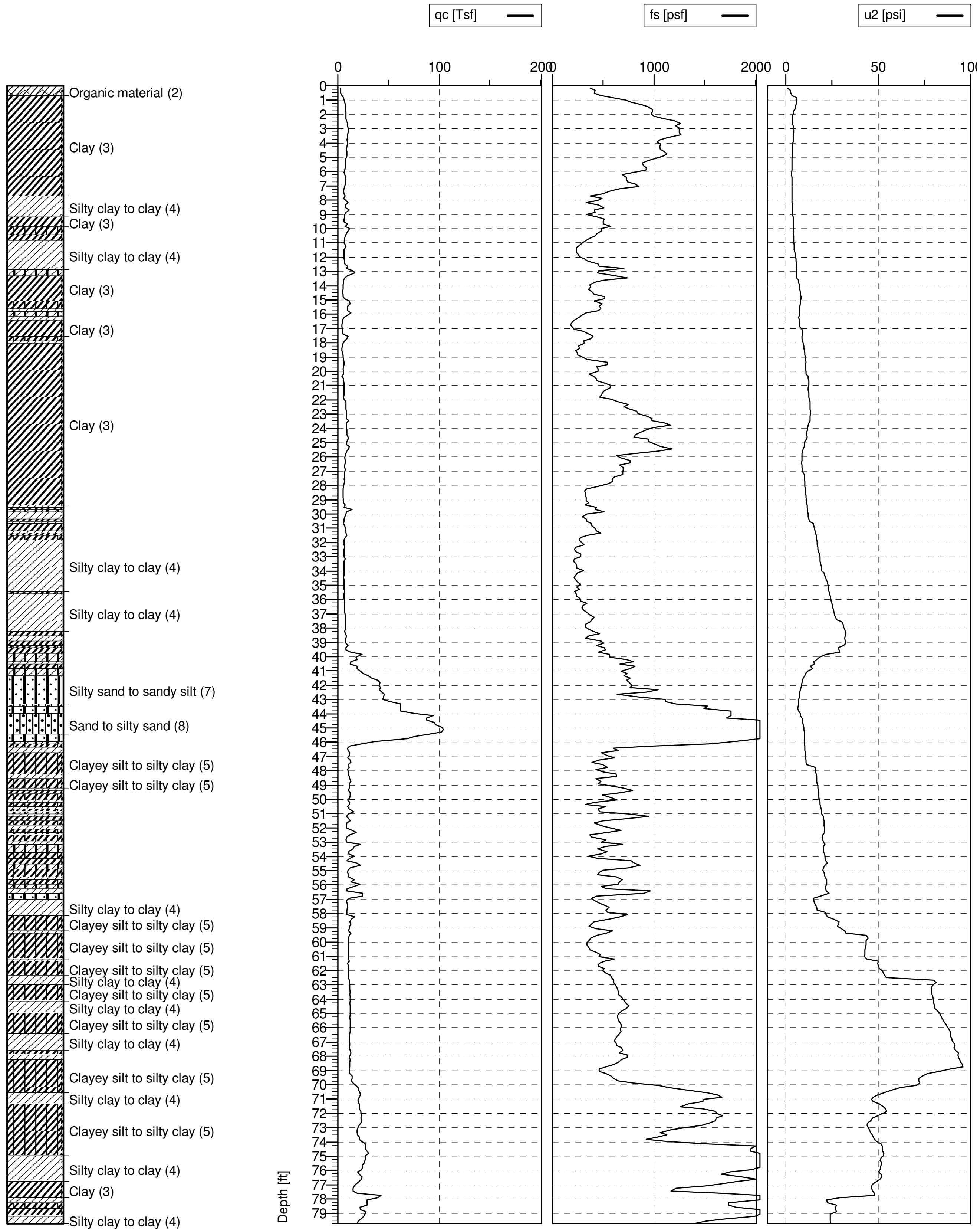
Project:

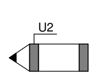

qc [Tsf]
fs [psf]
u2 [psi]
0
100
200
0
1000
2000
0
50
100
Depth [ft]
Clay (3)
Clay (3)
Clay (3)
Silty clay to clay (4)
Silty clay to clay (4)
Clay (3)
Clayey silt to silty clay (5)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
Silty sand to sandy silt (7)
Silty sand to sandy silt (7)
Silty sand to sandy silt (7)
Silty sand to sandy silt (7)
Clayey silt to silty clay (5)
Silty sand to sandy silt (7)
Sandy silt to clayey silt (6)
Silty sand to sandy silt (7)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Silty clay to clay (4)
U2
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150
Test no:
15003-1
Client:
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

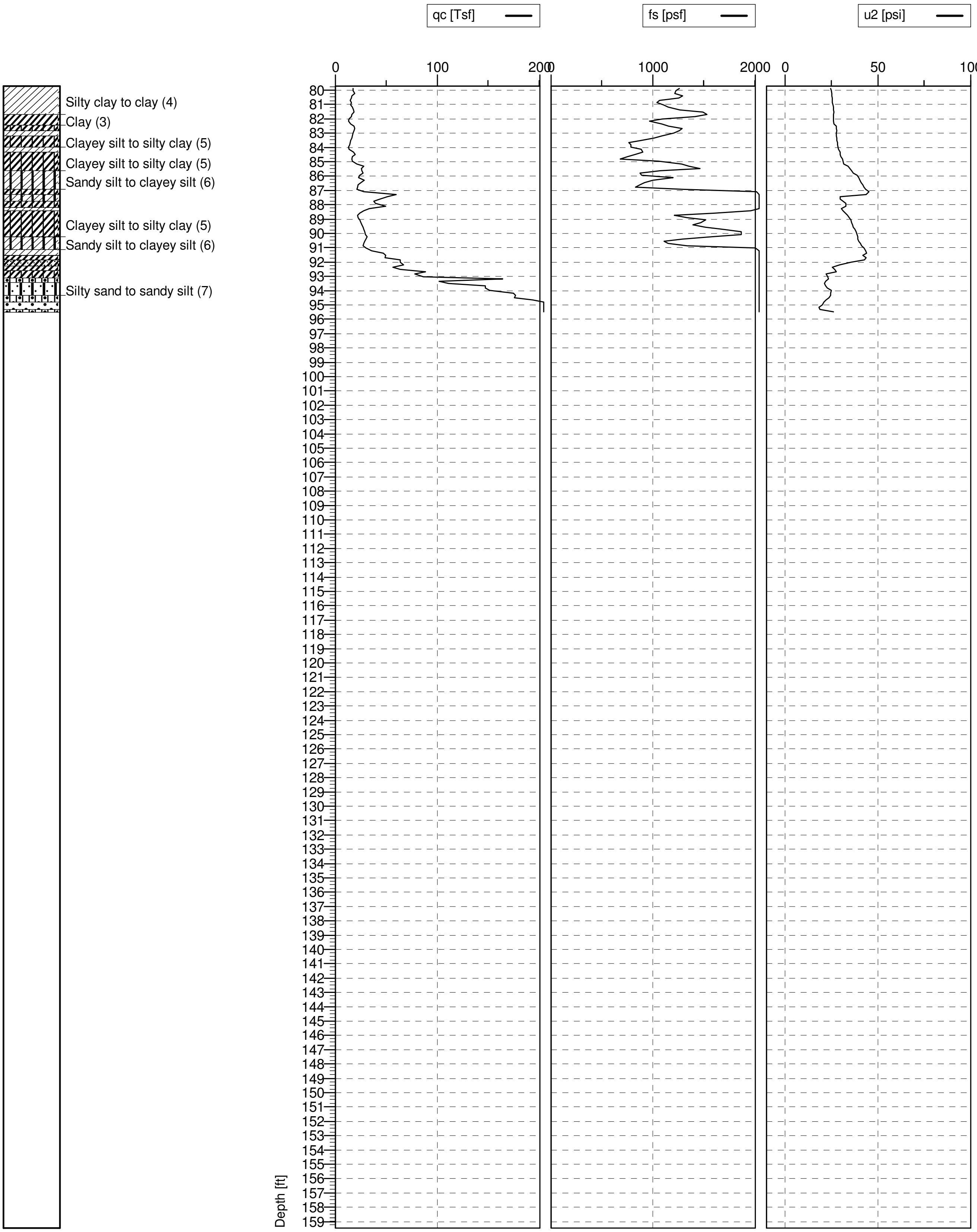
Test no:
15003-1
Client:
Project:





Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

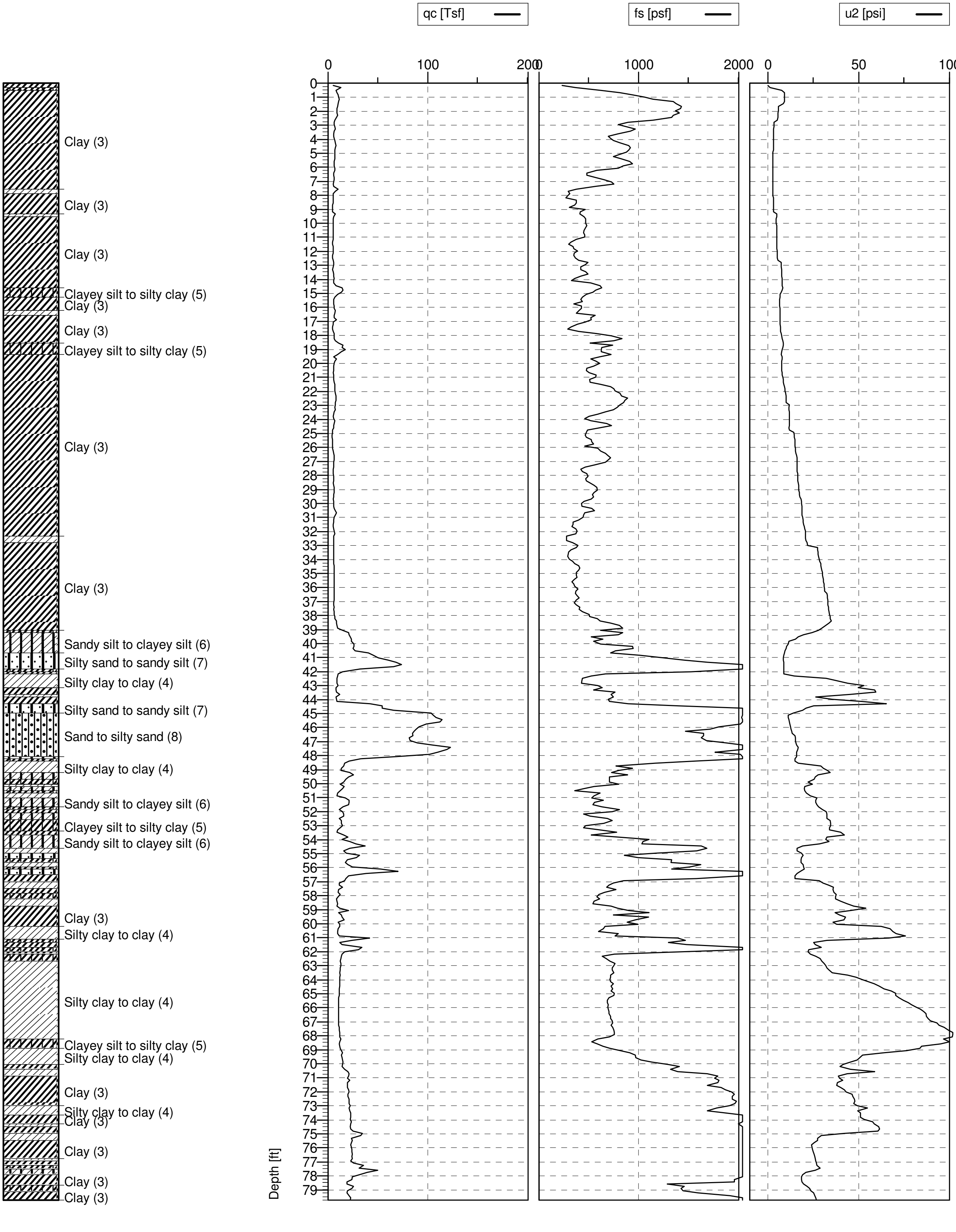
Test no:
15002-2
Client:
Project:



U2

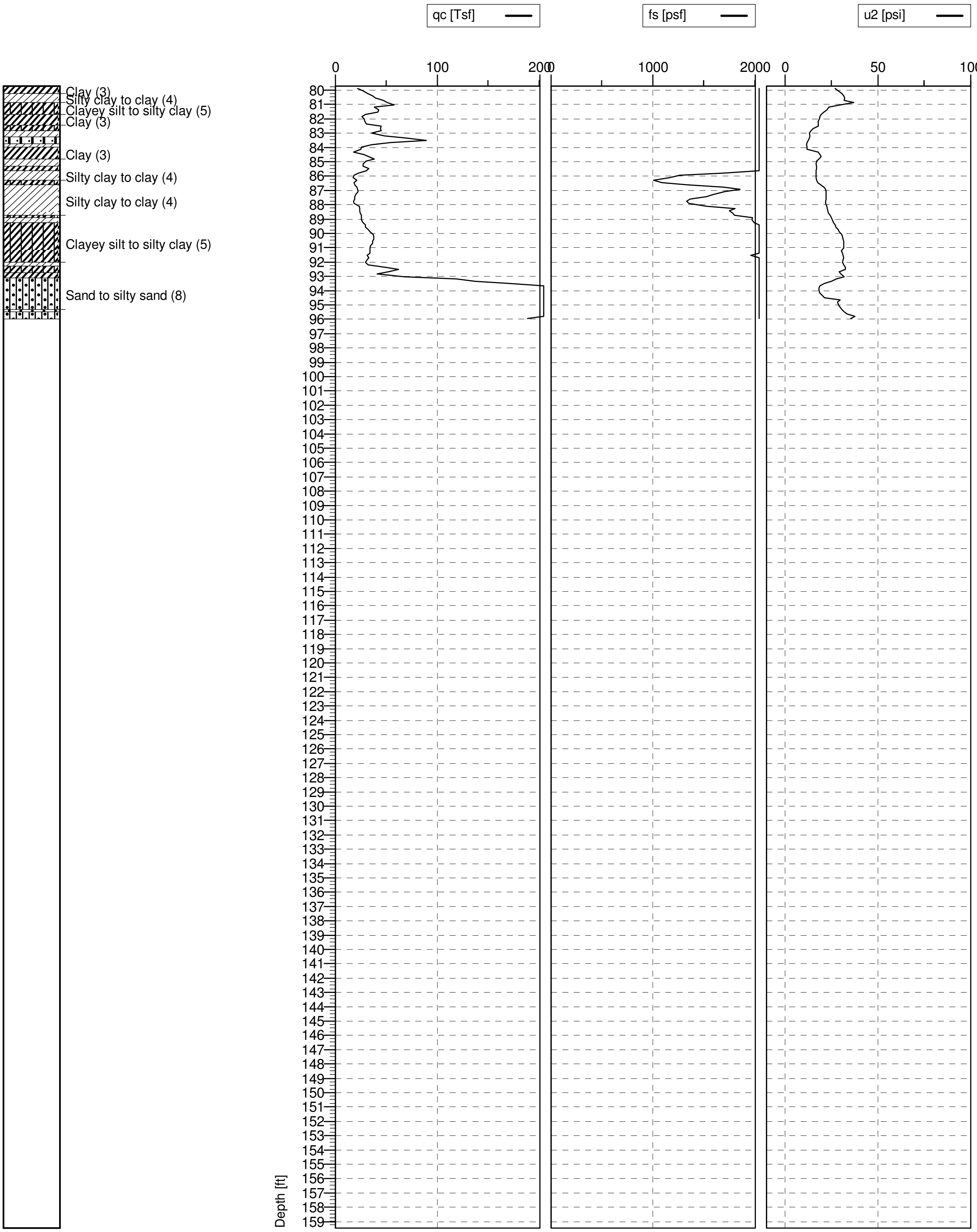
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
15002-2
Client:
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 15003-3
Client:
Project:

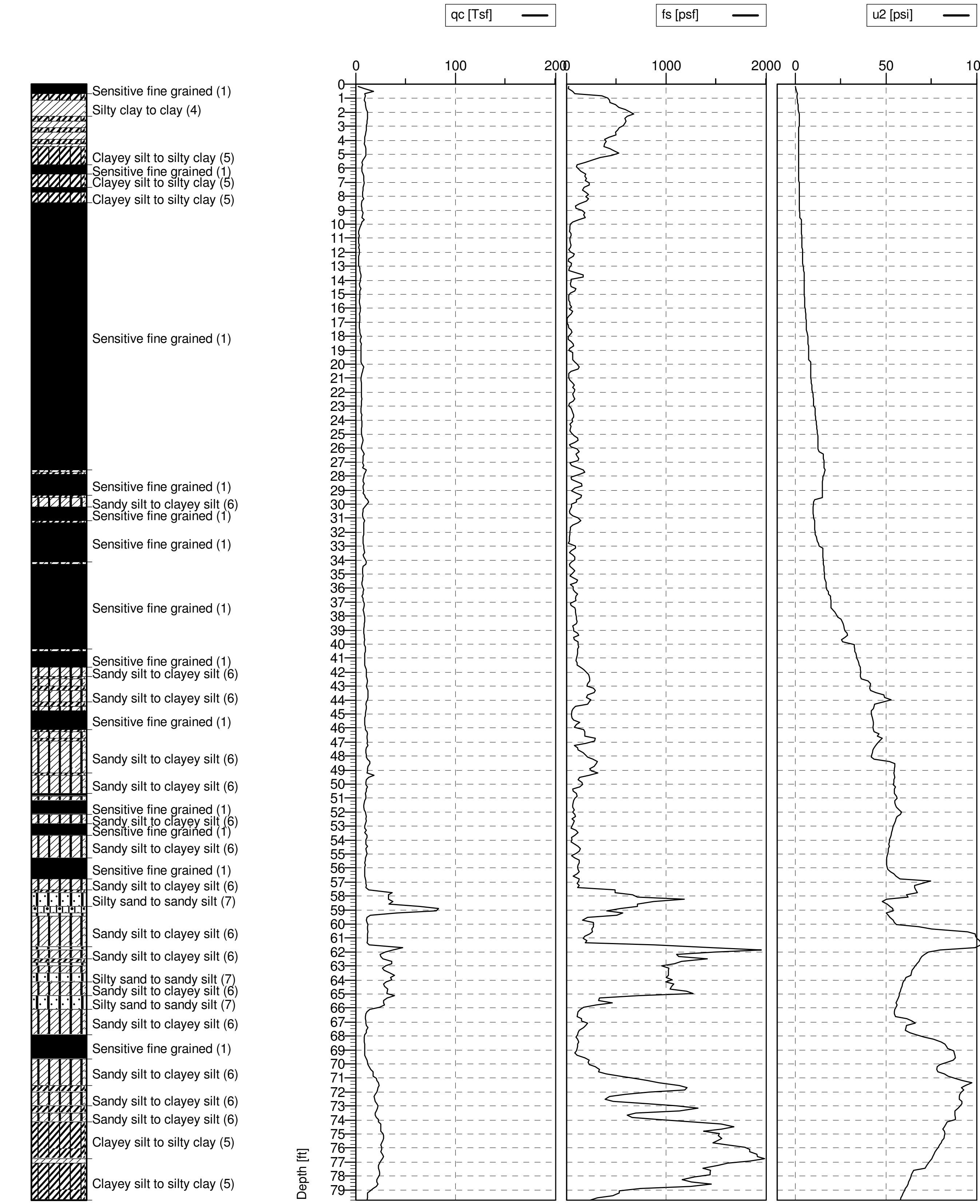


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 15003-3

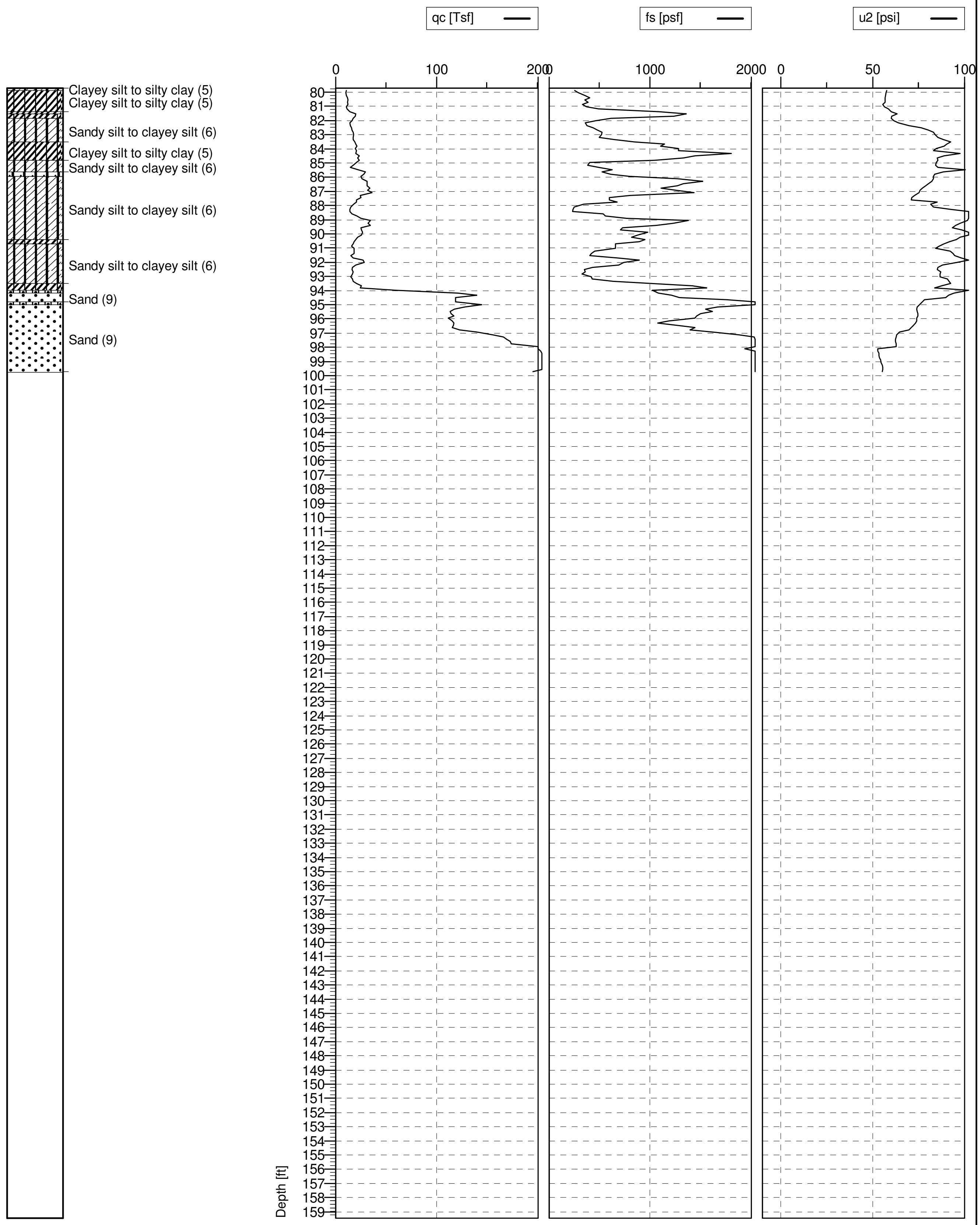
Client:

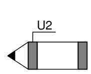
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

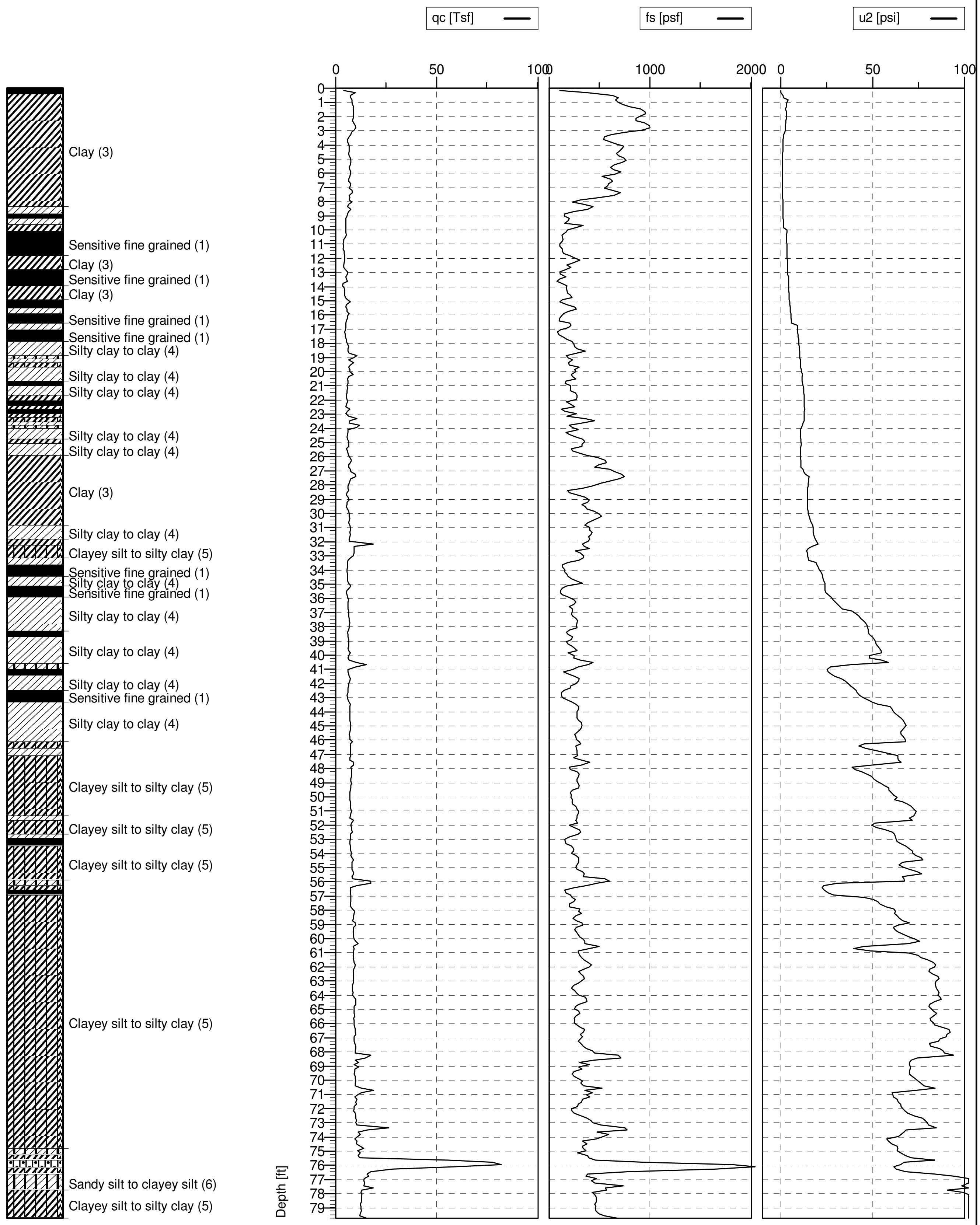
Test no: 15003-4
Client:
Project:





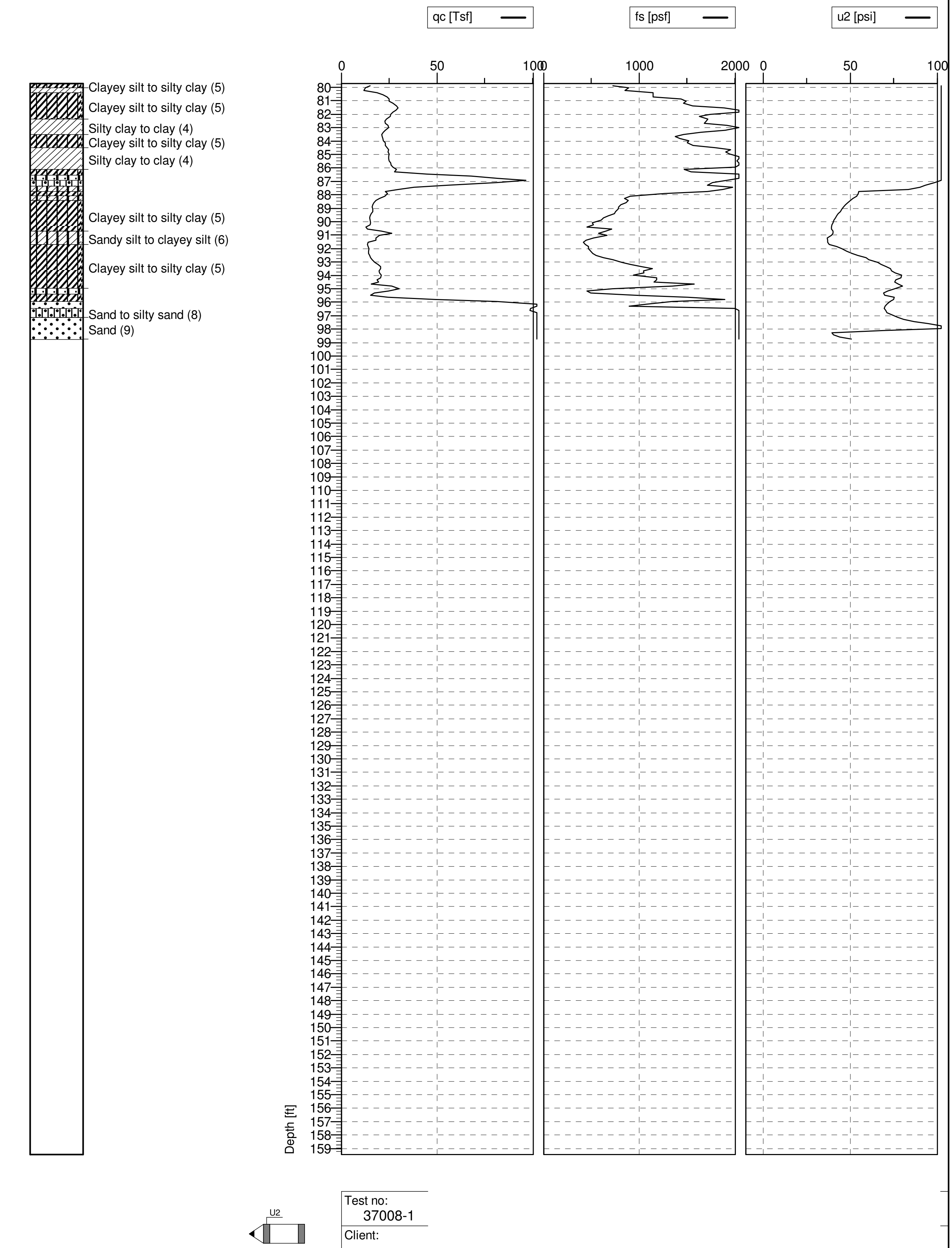
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
15003-4
Client:
Project:



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-1	
Client:	
Project: PROPOSE	

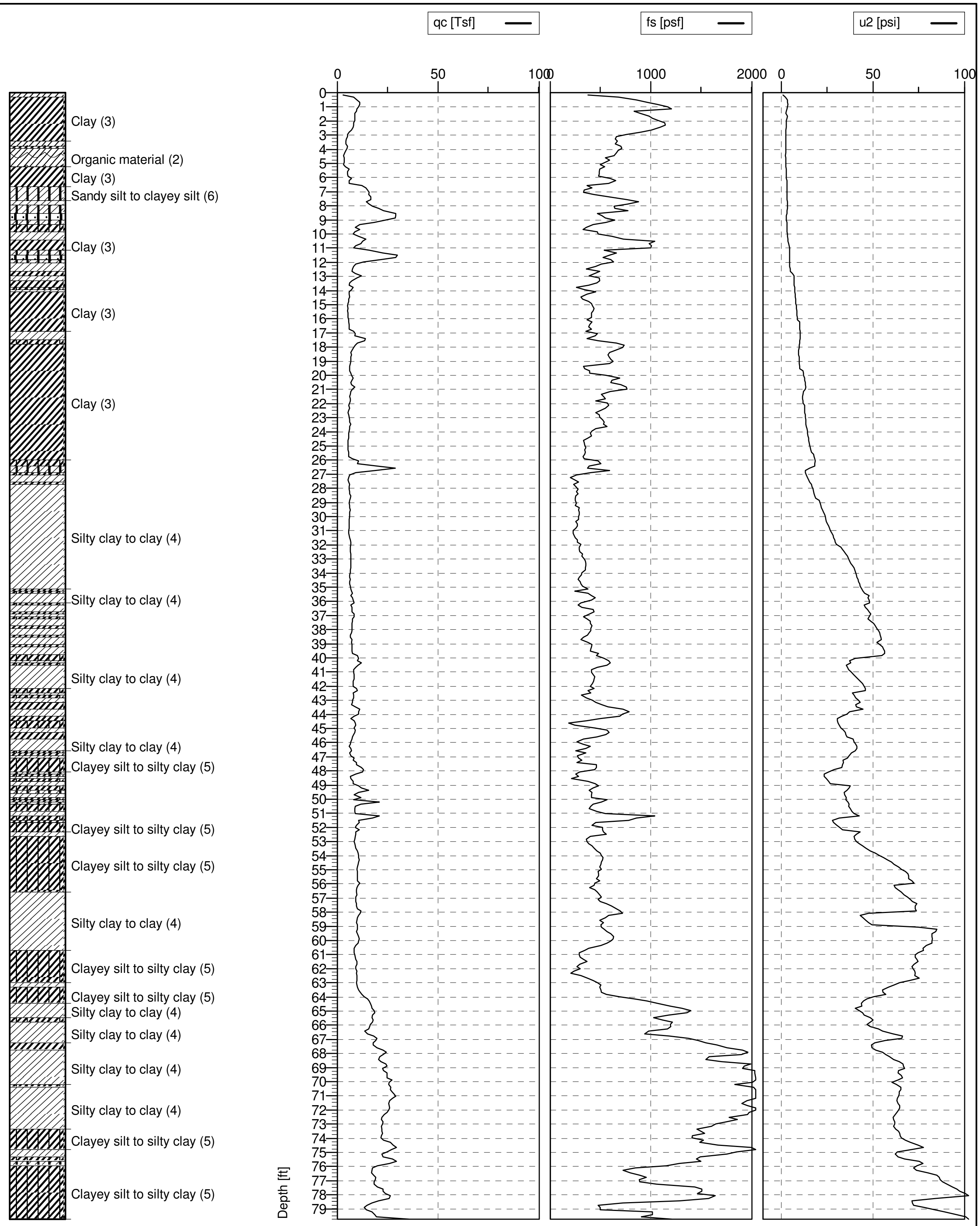


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-1

Client:

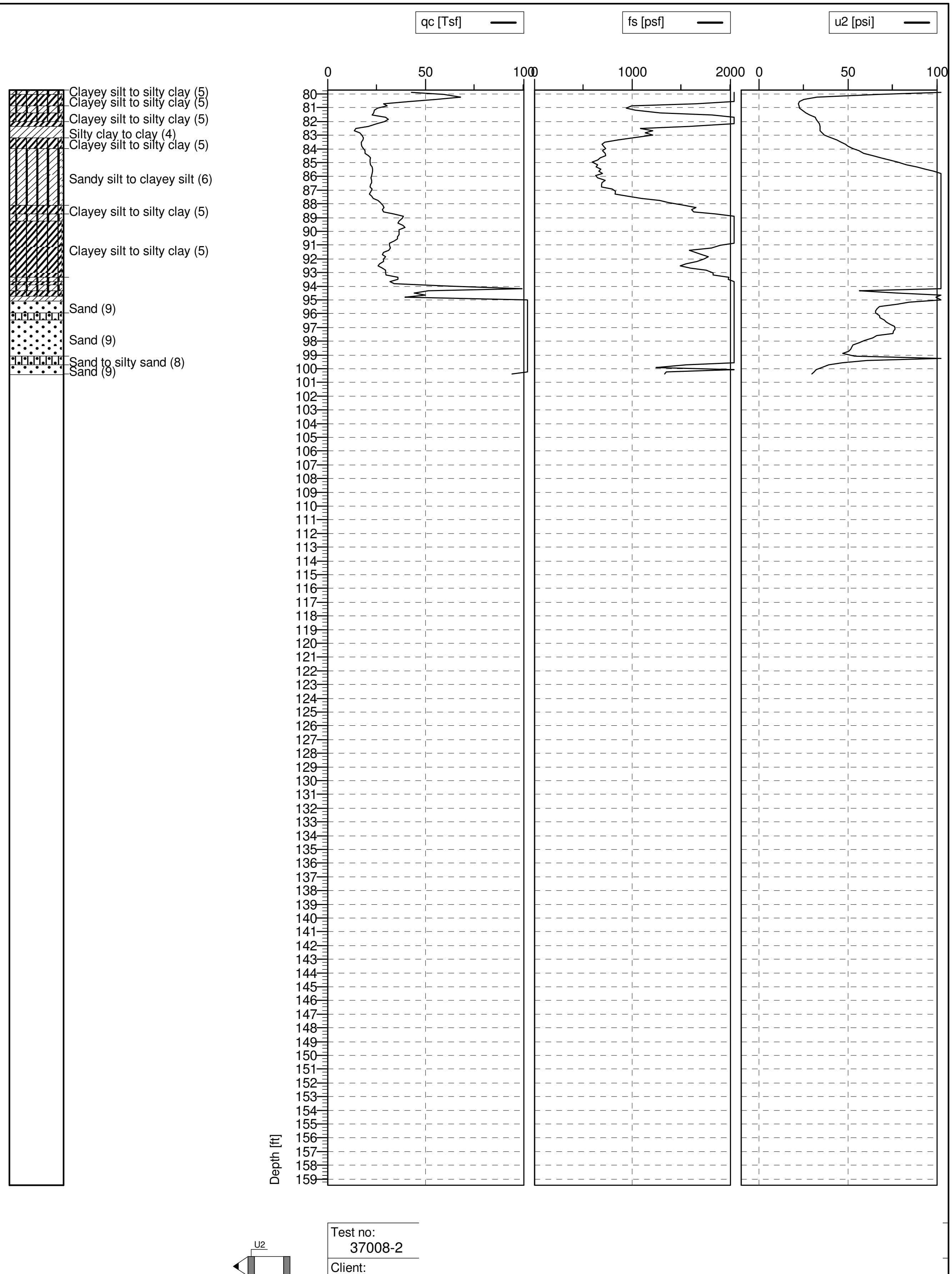
Project: PROPOS



U2

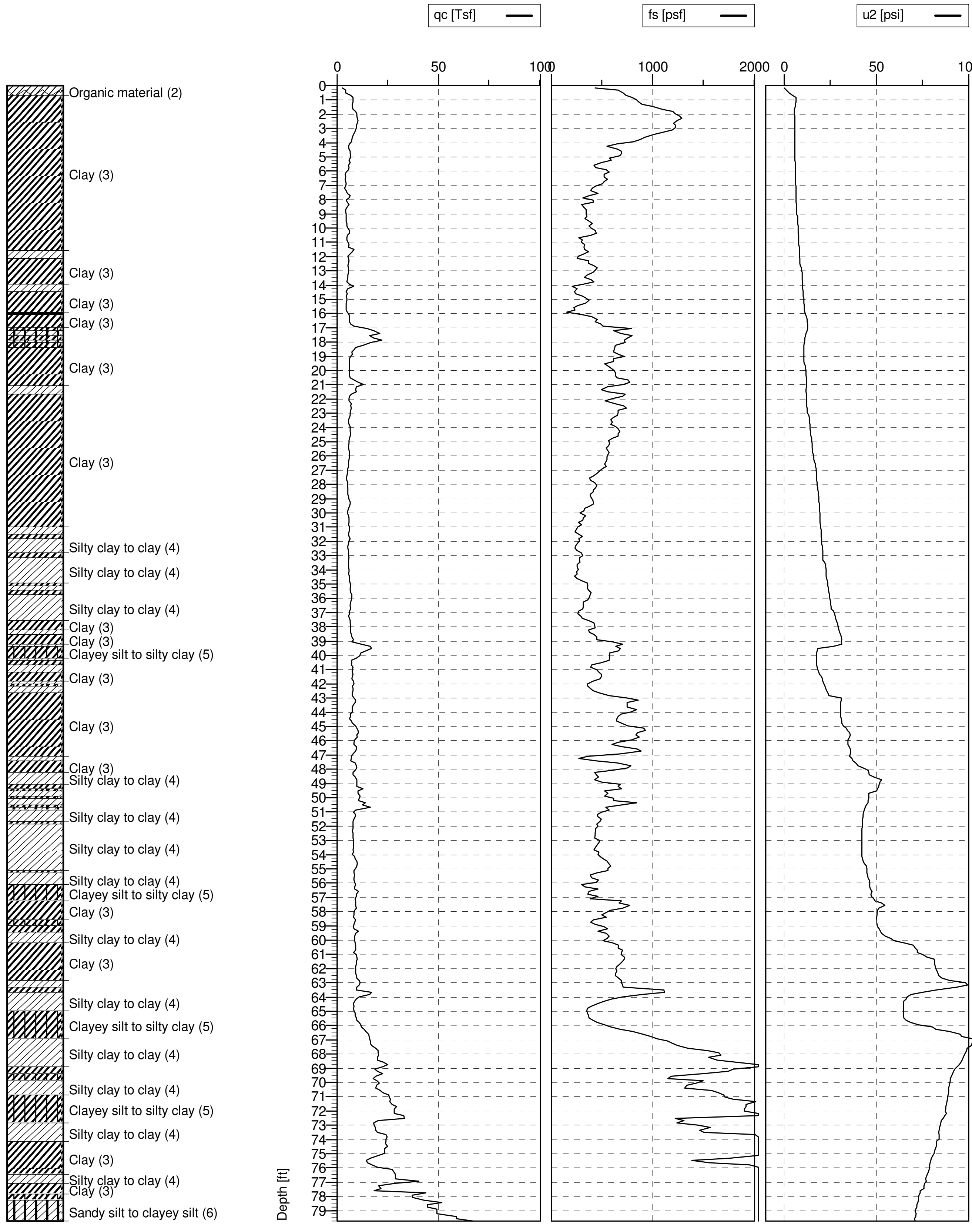
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-2
Client:
Project: PROPOS



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-2
Client:
Project: PROPOSI



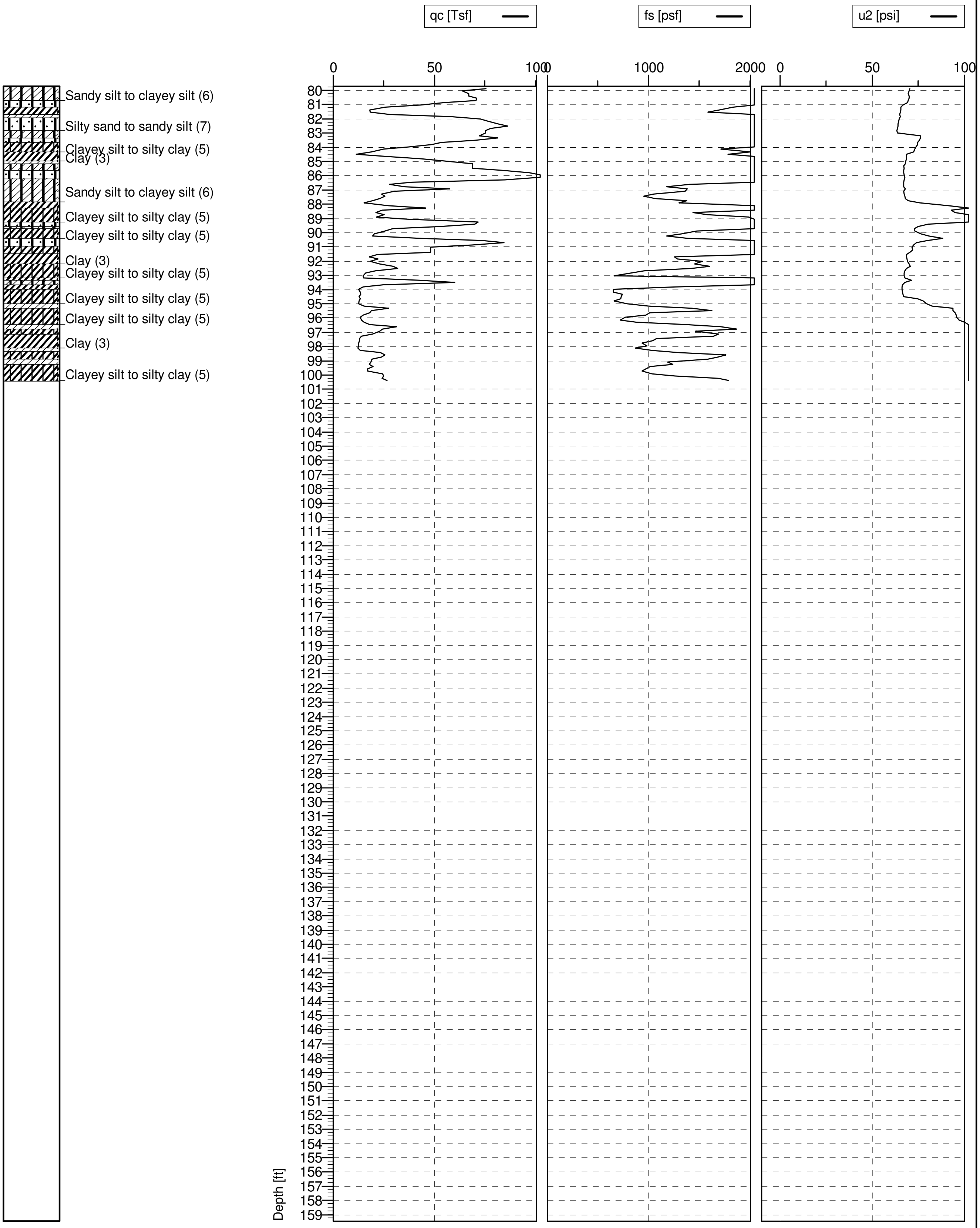
U2

Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
37008-3

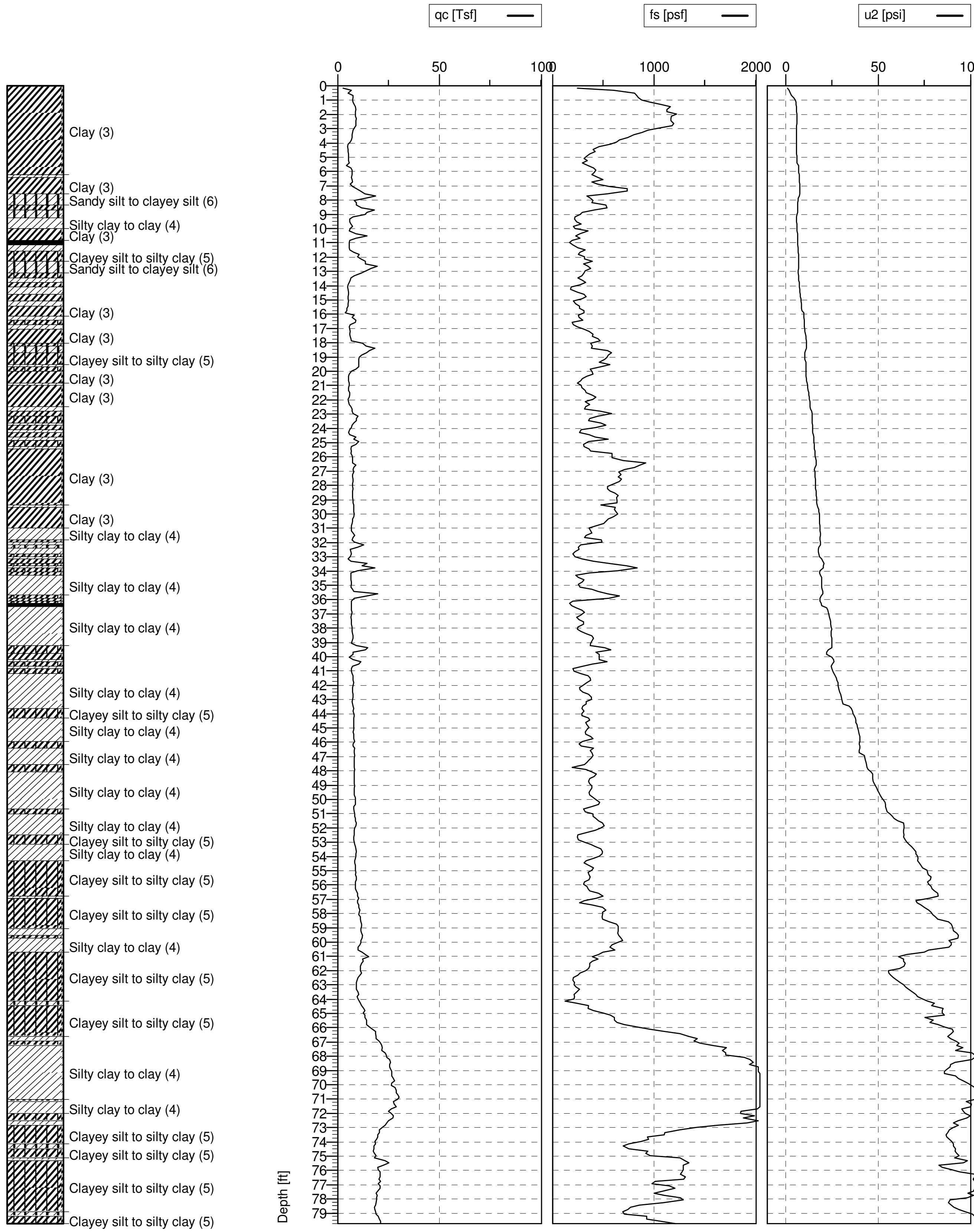
Client:

Project: PROPOS



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-3
Client:
Project: PROPOSE

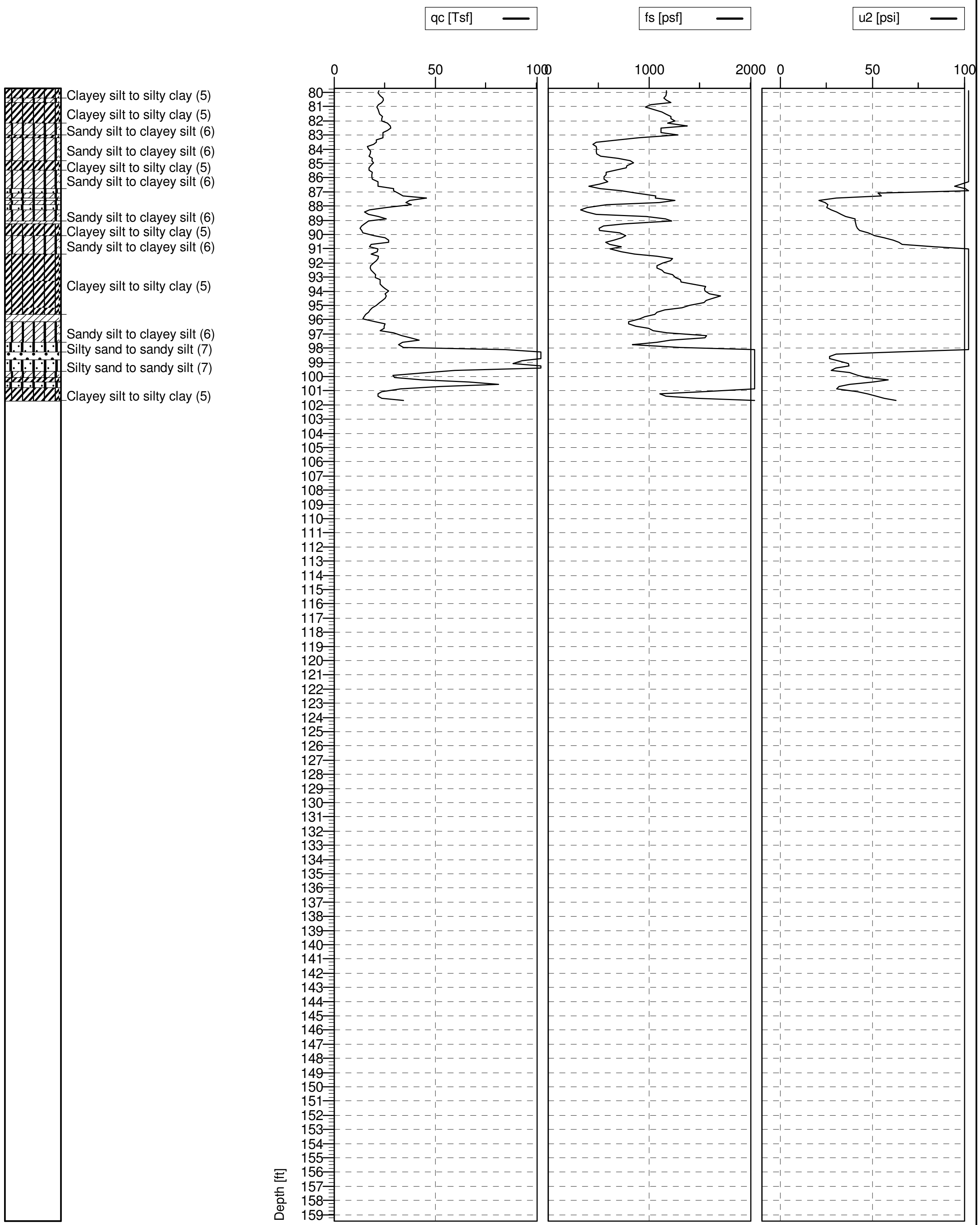


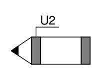
Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37008-4

Client:

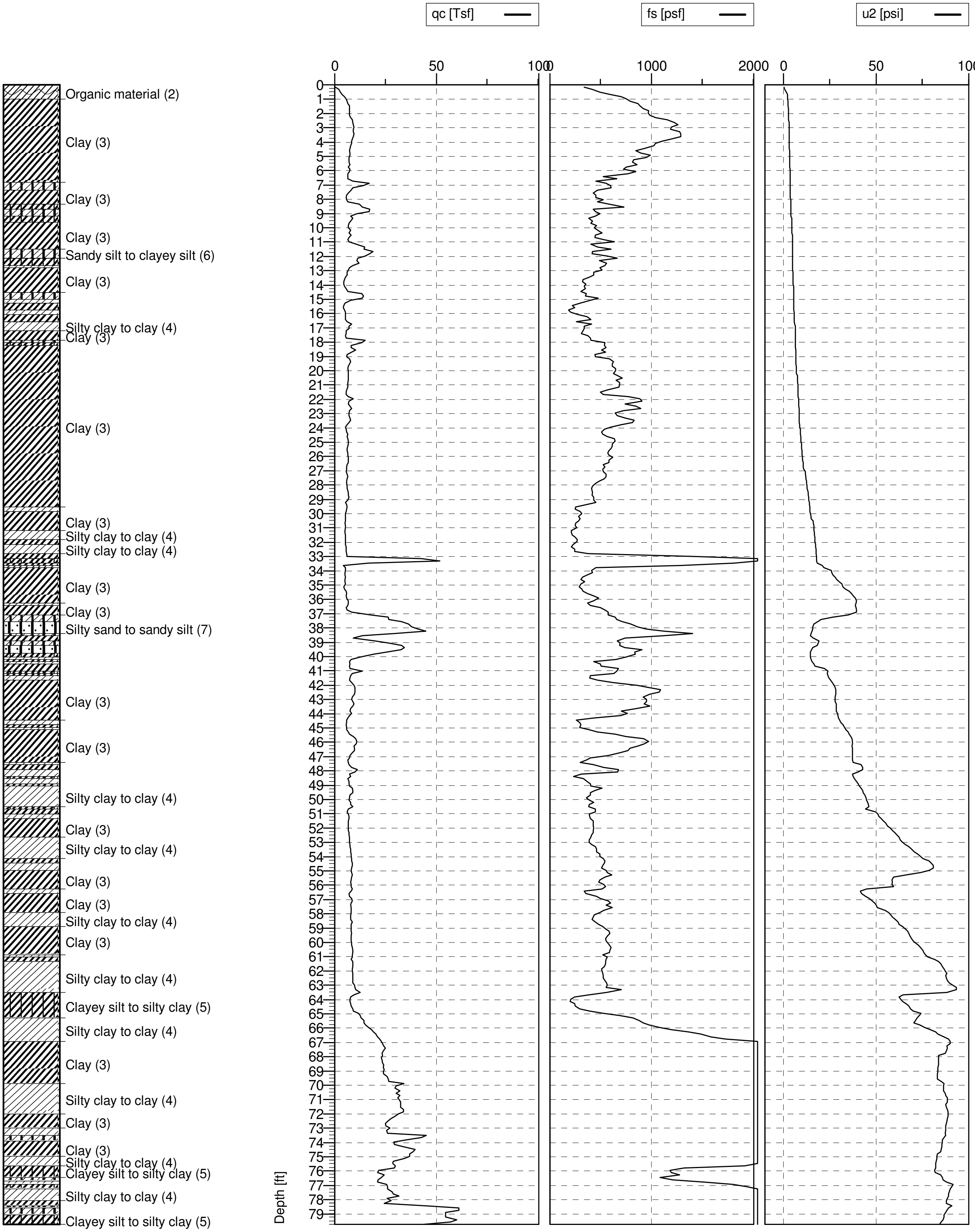
Project: PROPO

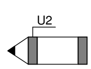




Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
37008-4
Client:
Project:
PROPOS



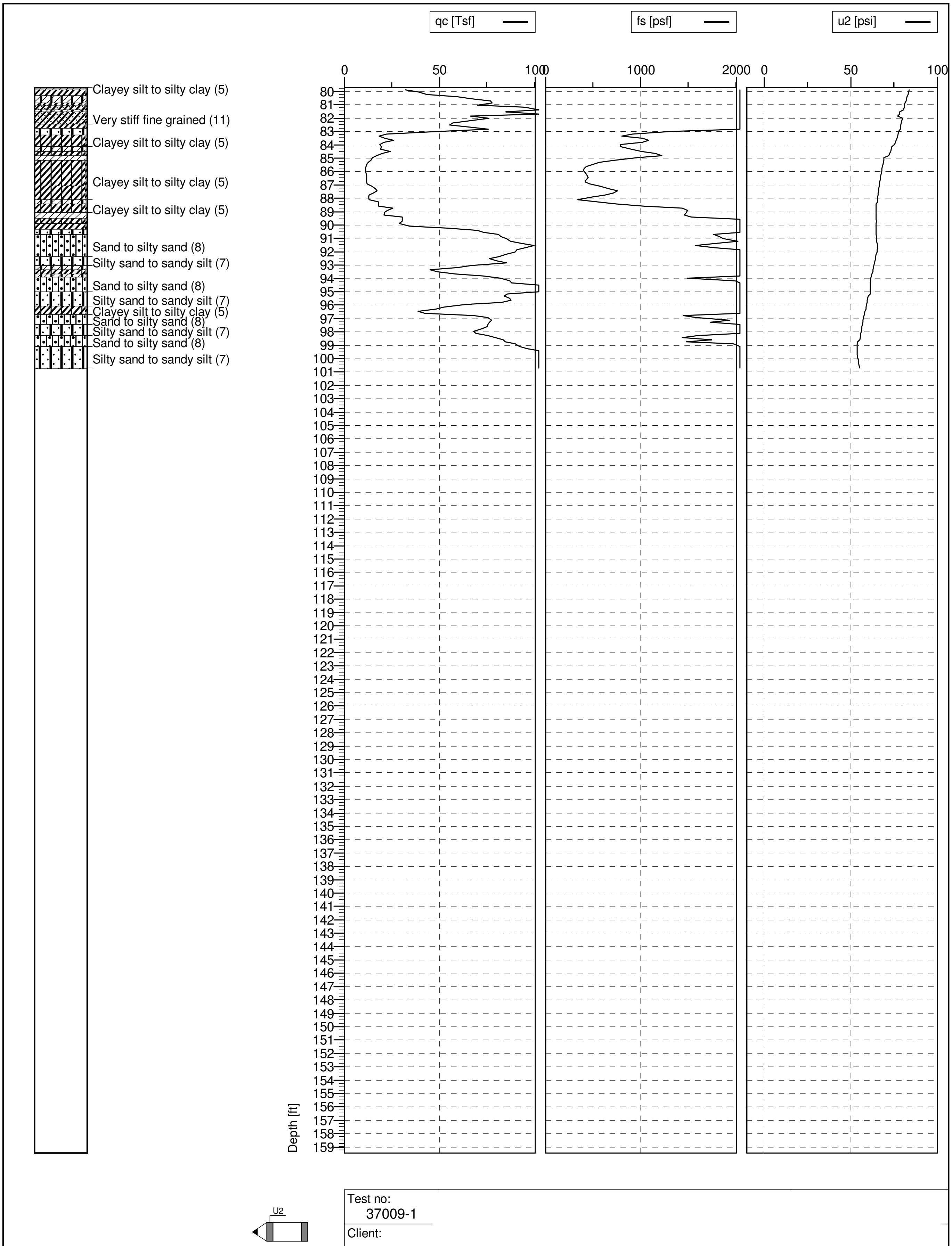


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
37009-1

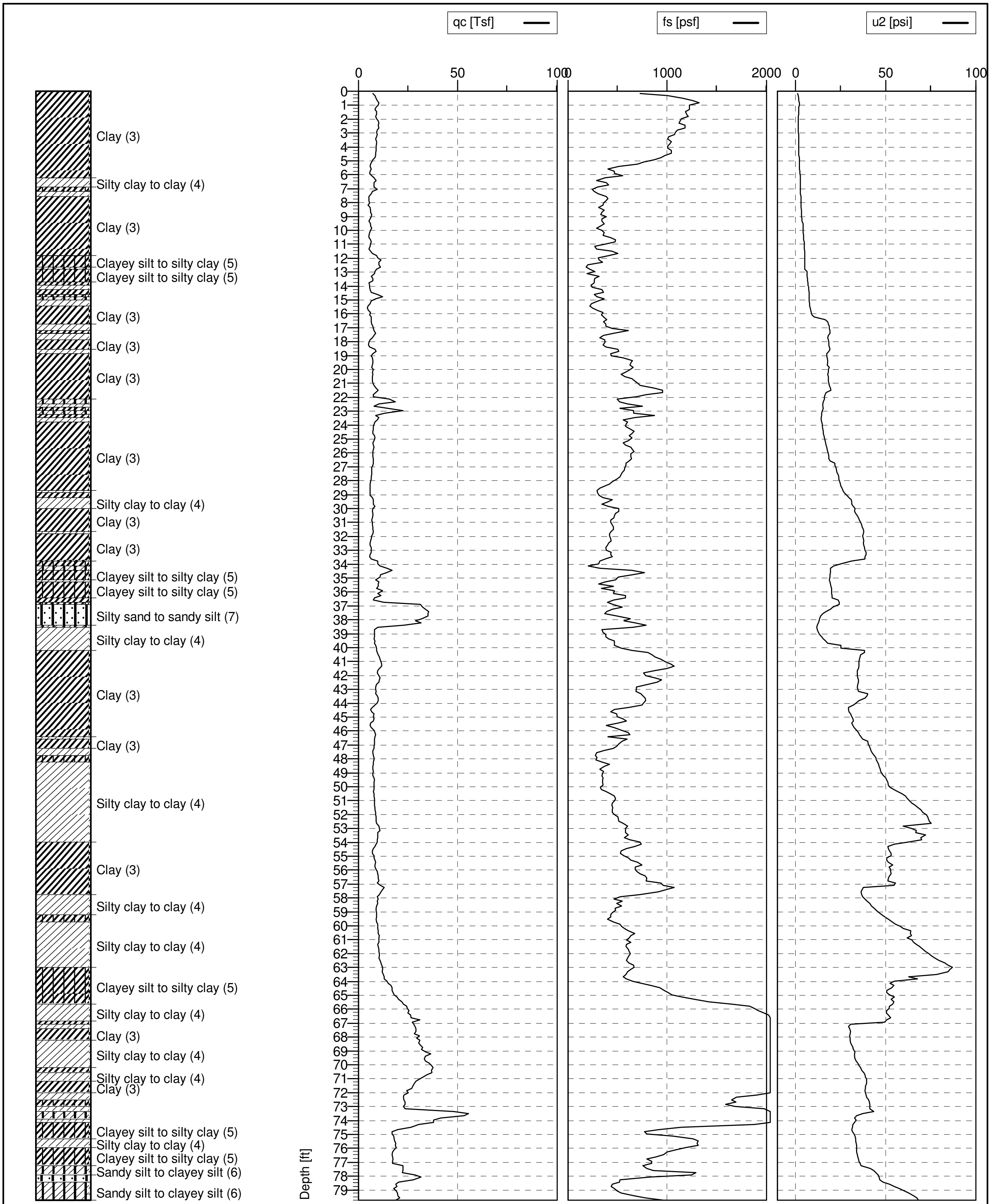
Client:

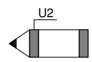
Project:
PROPOS



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
37009-1
Client:
Project:
PROPOS



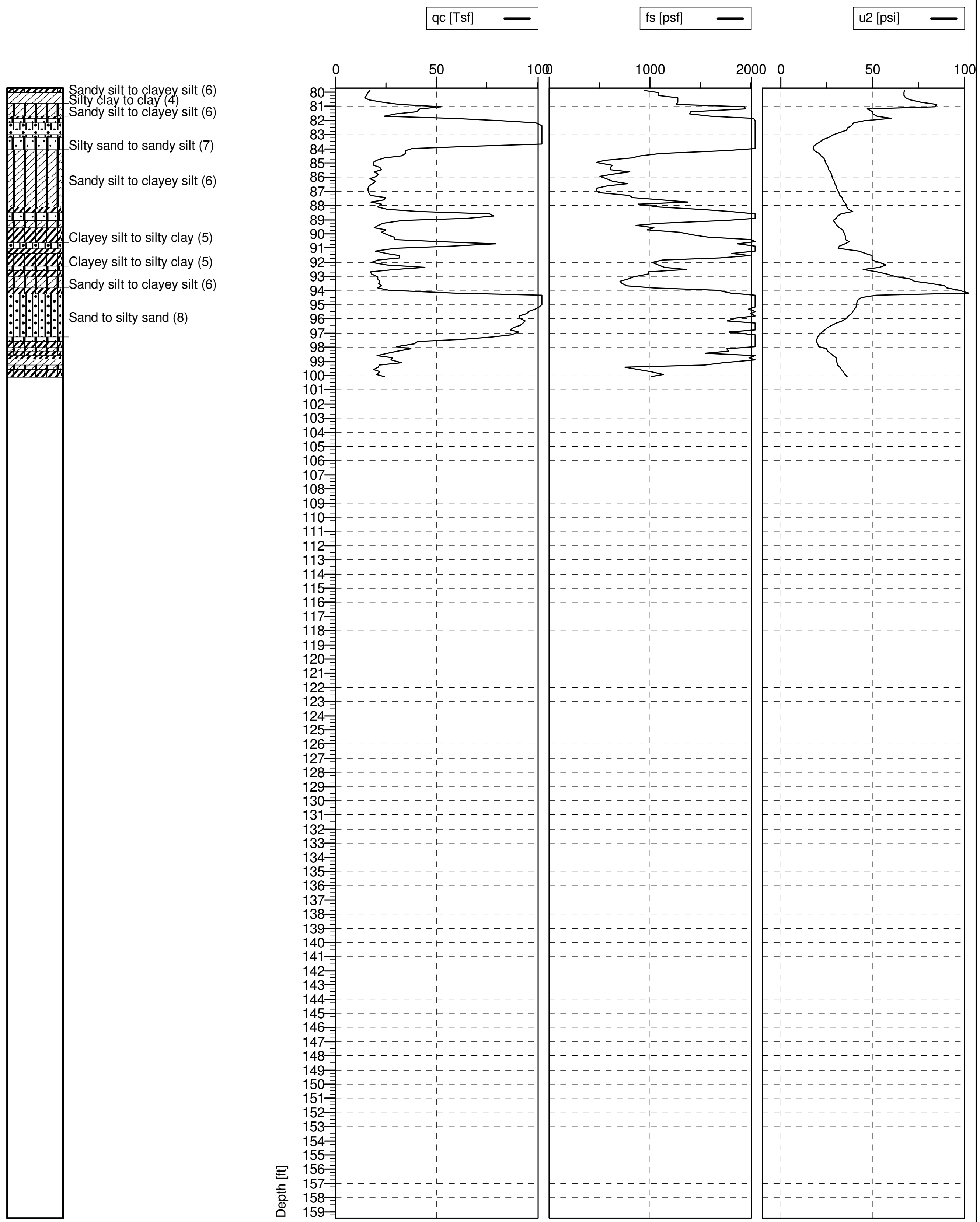


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37009-2

Client:

Project: PROPOS



Test no: 37009-2

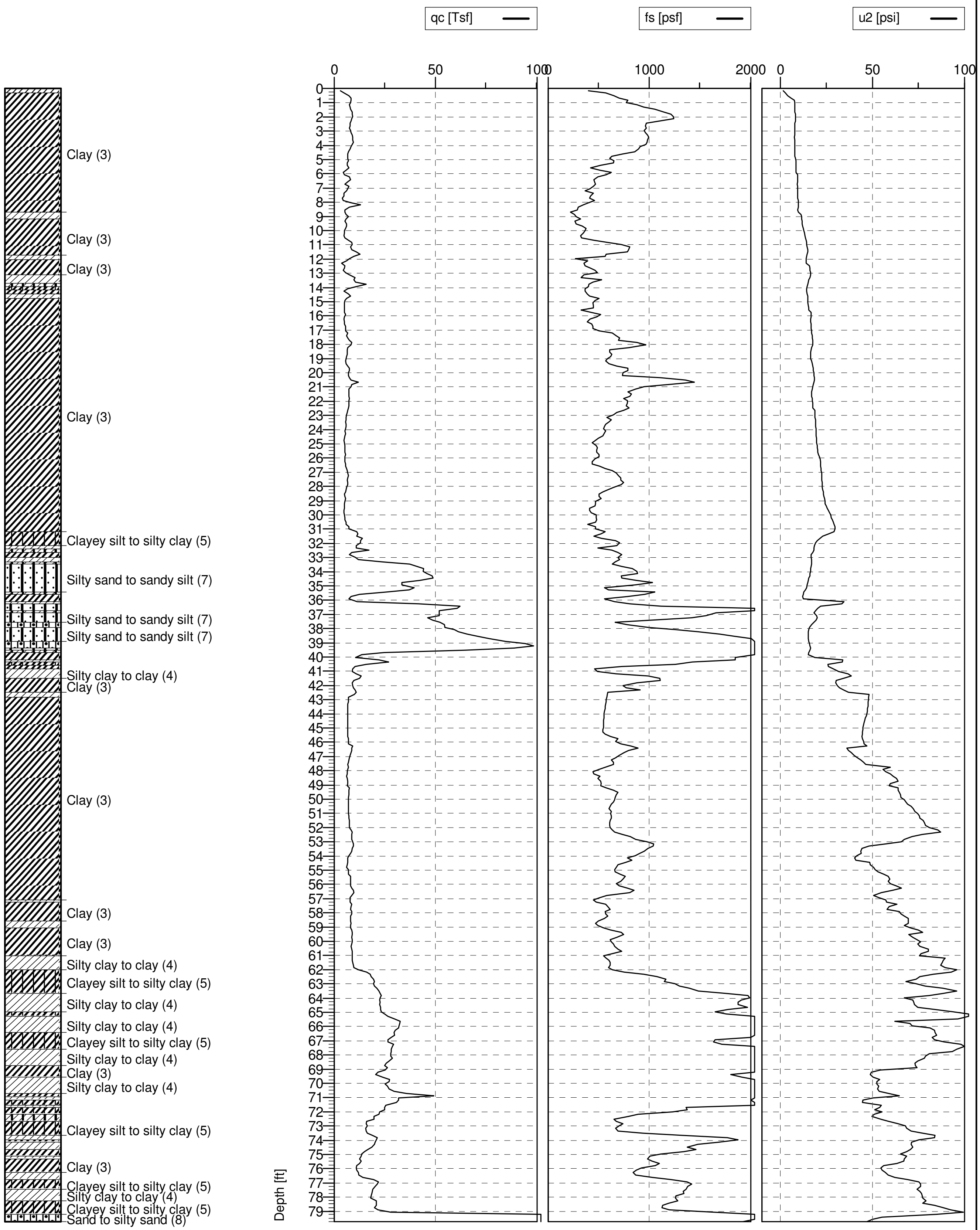
Client:

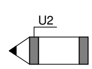
Project: PROPOS

Cone No: DTG0704

Tip area [cm2]: 10

Sleeve area [cm2]: 150



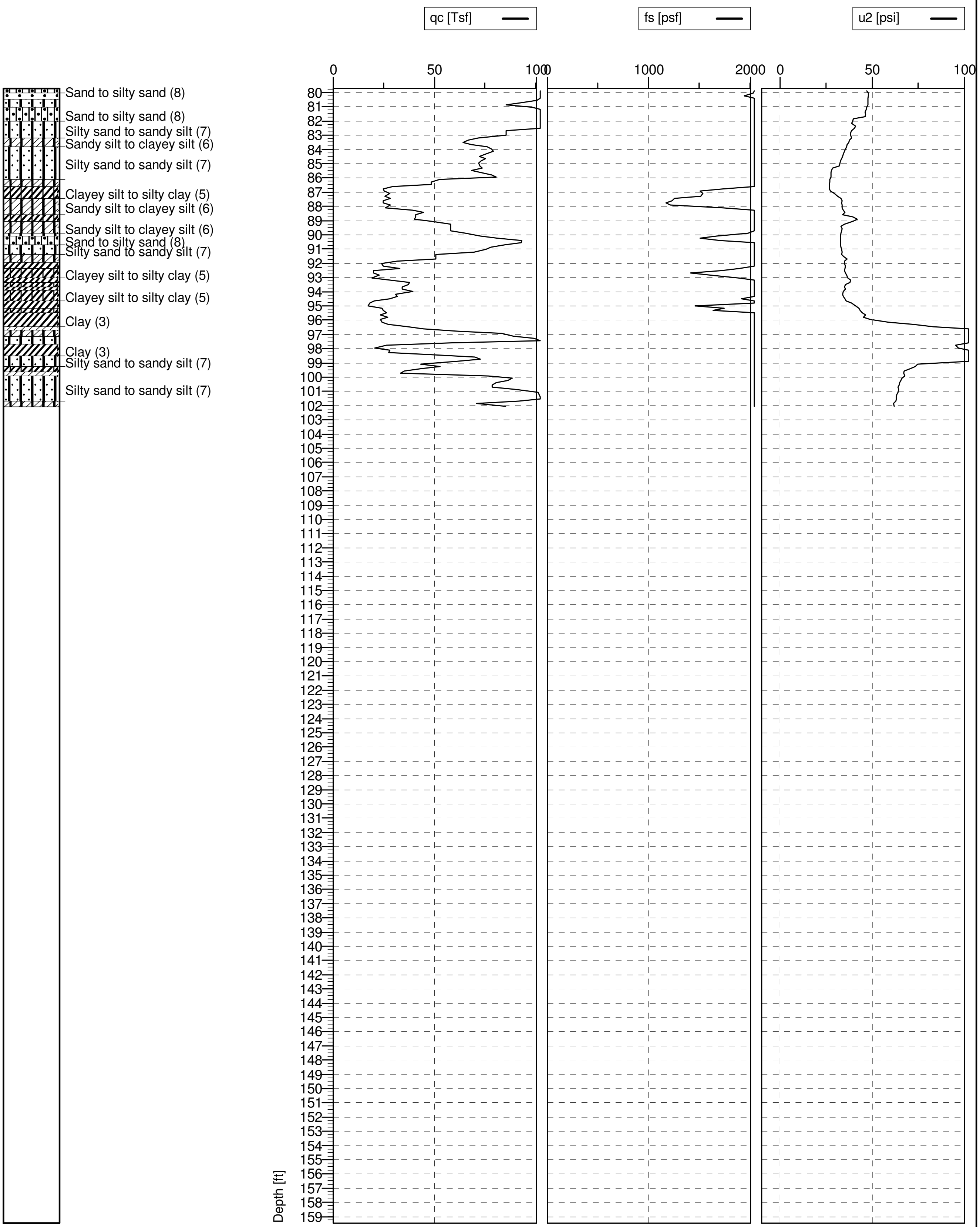


Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37009-3

Client:

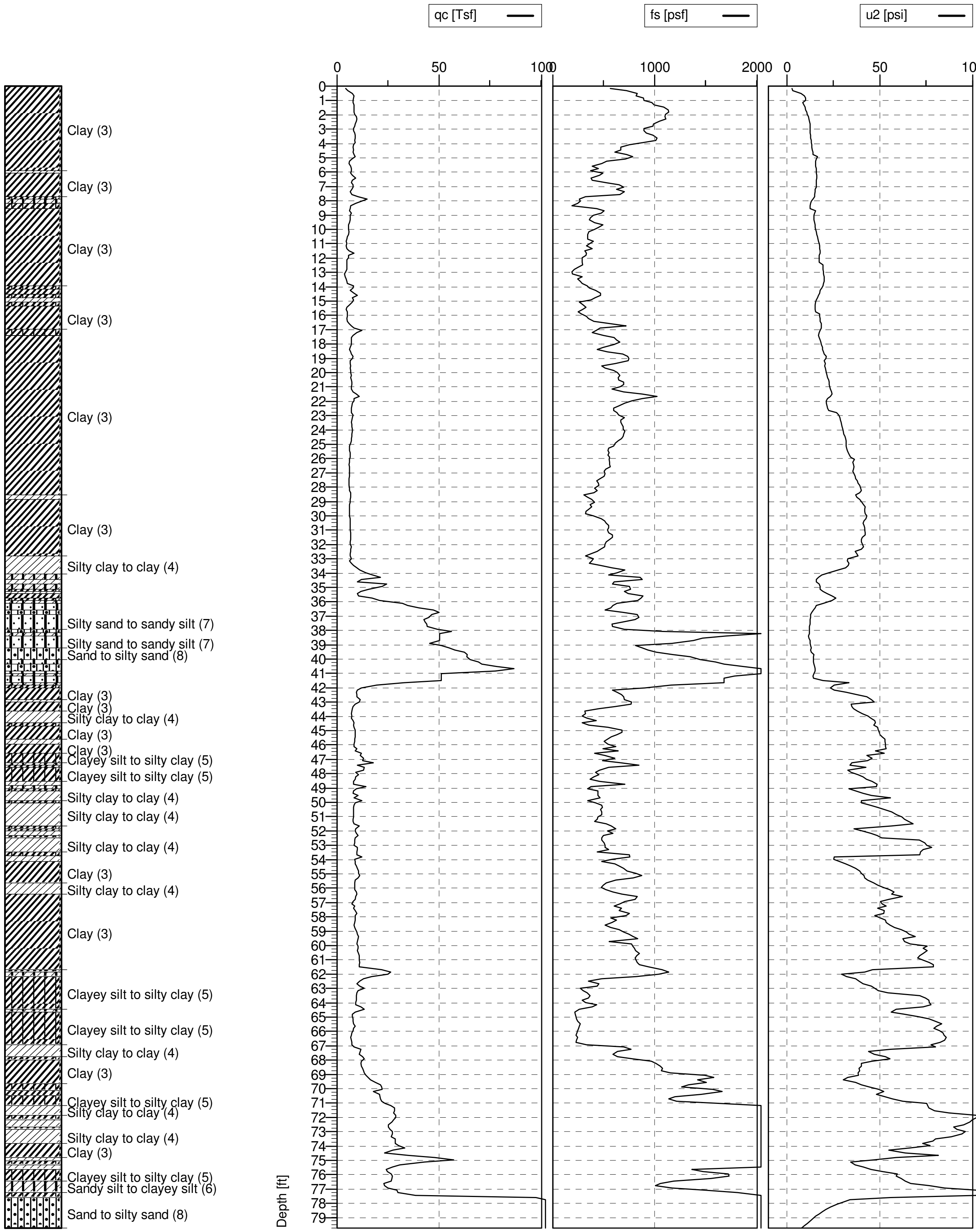
Project: PROPOS

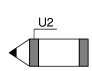


U2

Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

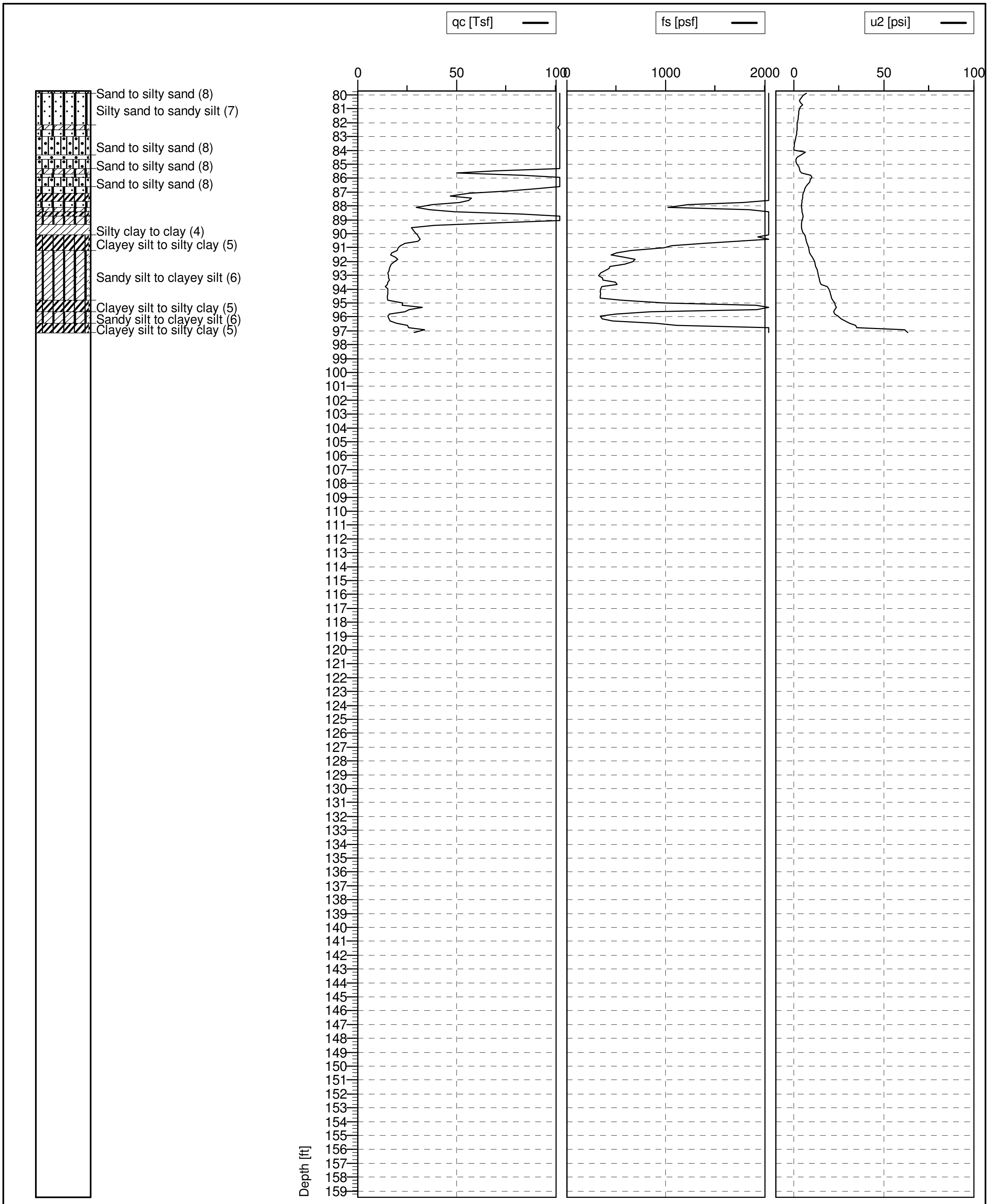
Test no:
37009-3
Client:
Project:
PROPOS





Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

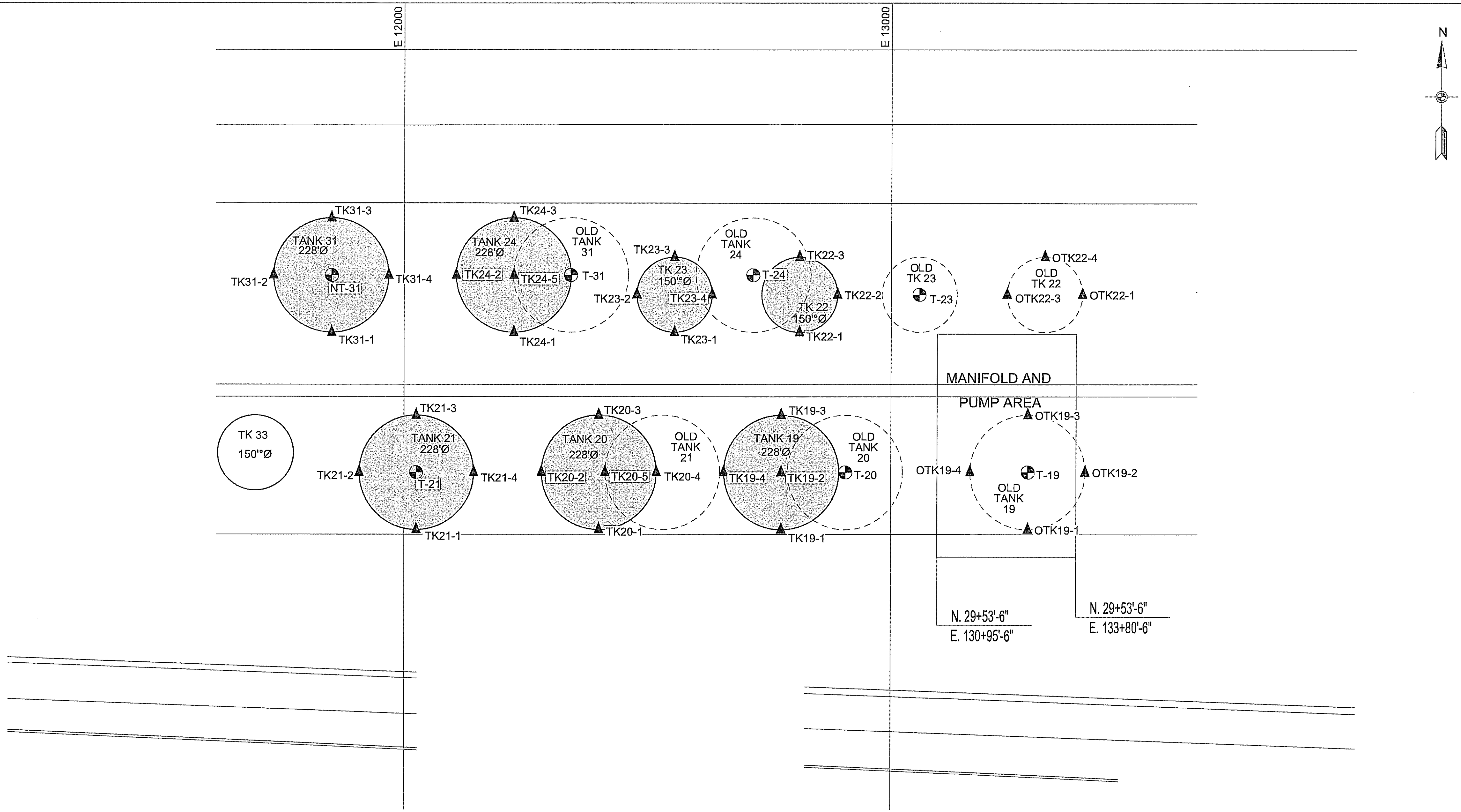
Test no:
37009-4
Client:
Project:
PROPO



Cone No: DTG0704
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: 37009-4
Client:
Project: PROPOS

APPENDIX C

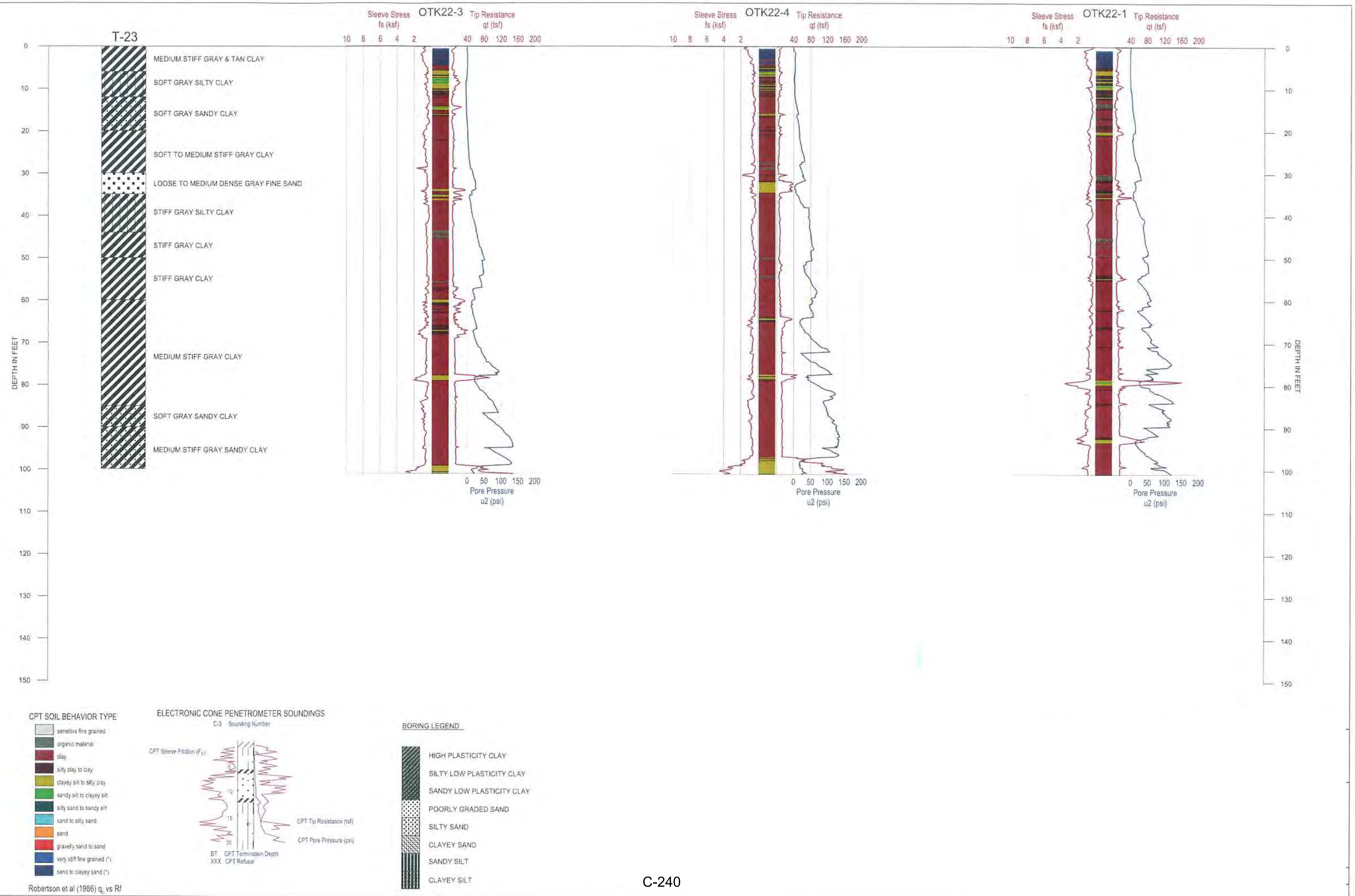


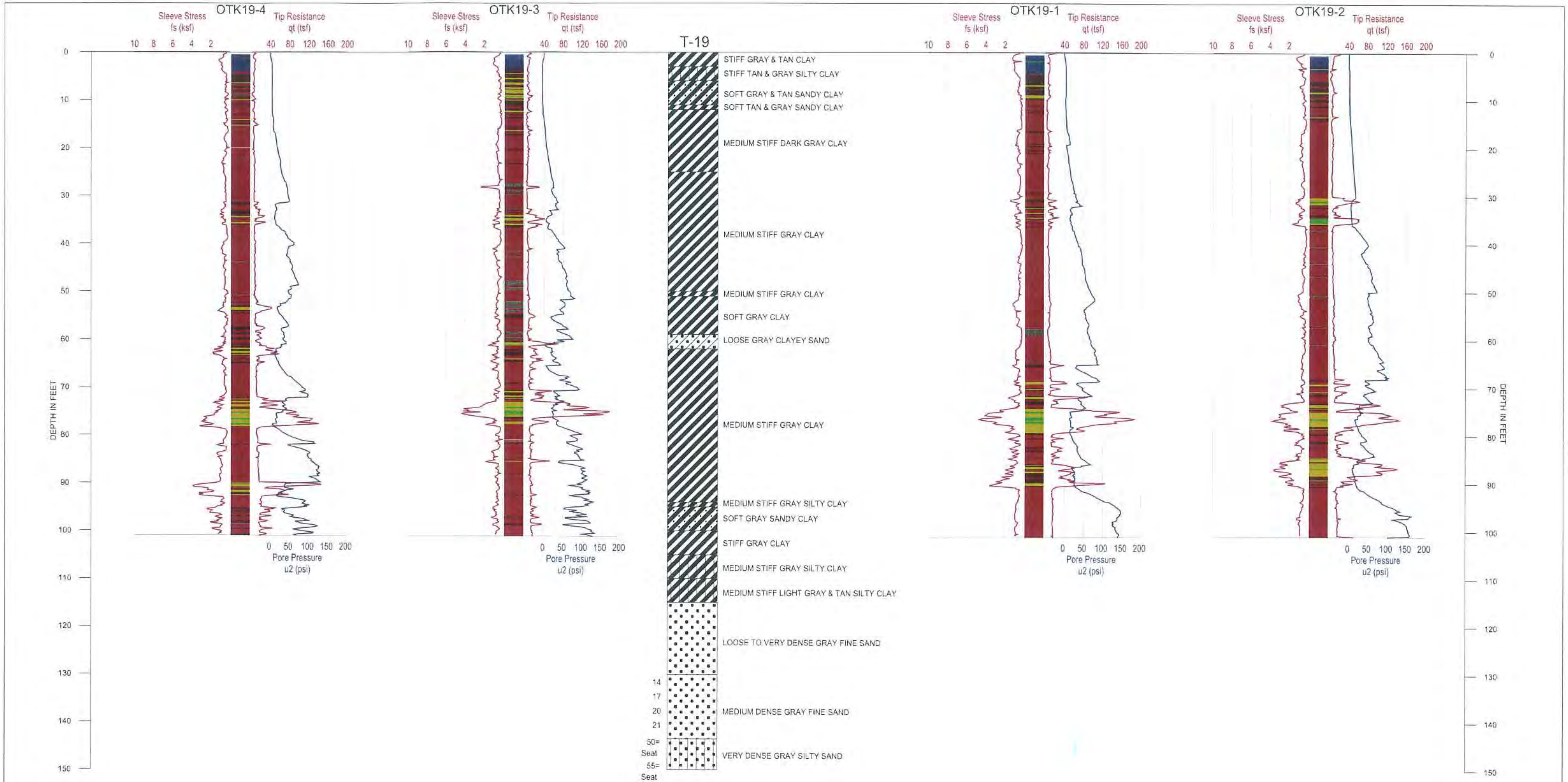
▲ DENOTES LOCATION OF CONE PENETROMETER TESTS PERFORMED: 12 APRIL THROUGH 21 MAY 2010

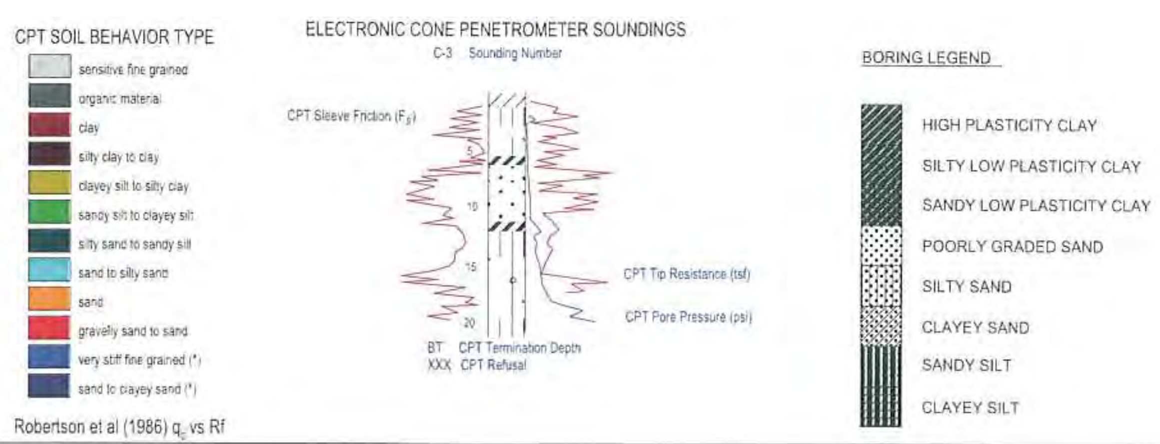
DENOTES LOCATION OF UNDISTURBED SOIL BORINGS DRILLED: 6 APRIL THROUGH 10 MAY 2010

DENOTES LOCATION OF ORIGINALLY PROPOSED TANK; LOCATION NO LONGER PLANNED

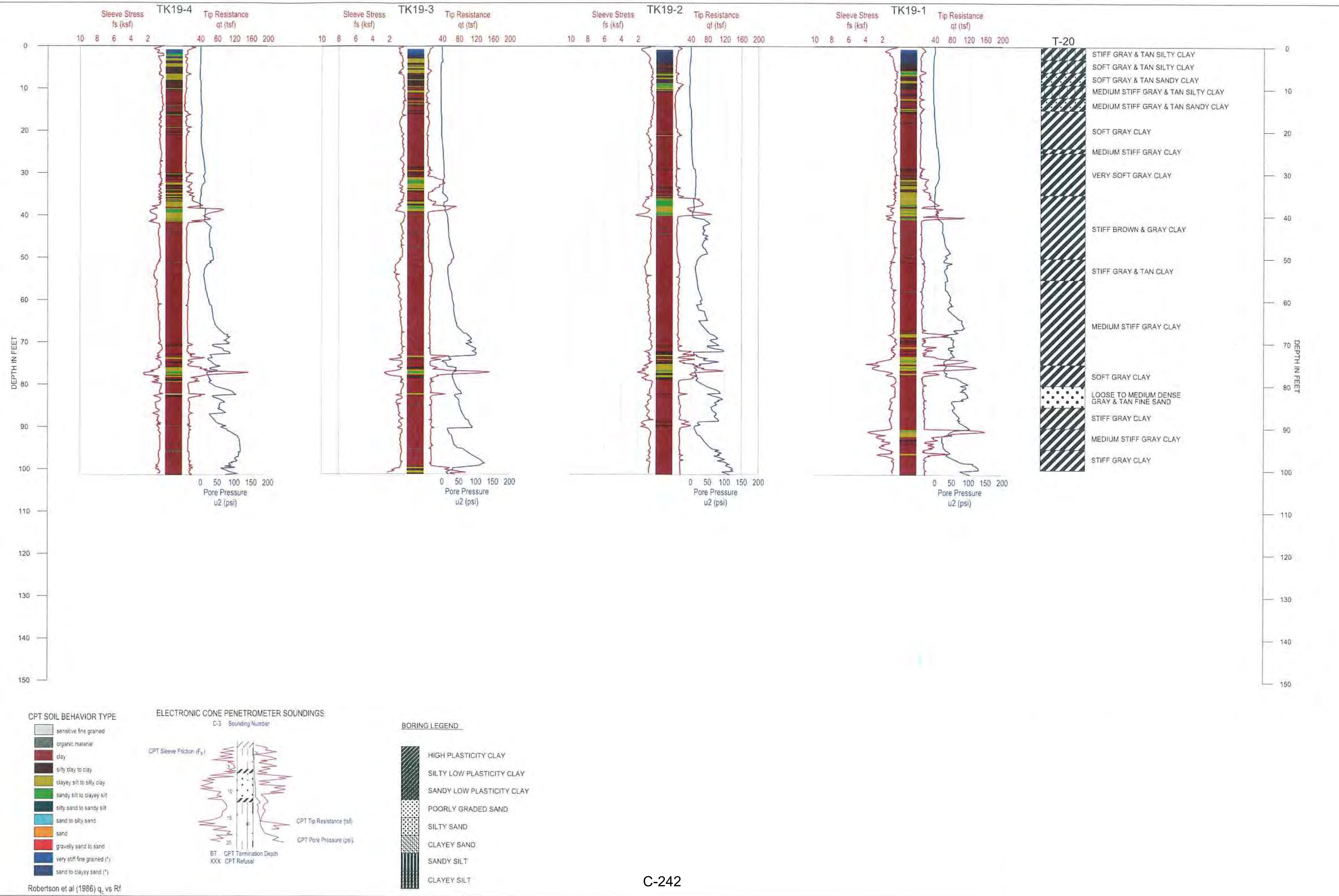
DENOTES REVISED LOCATION OF PROPOSED TANK

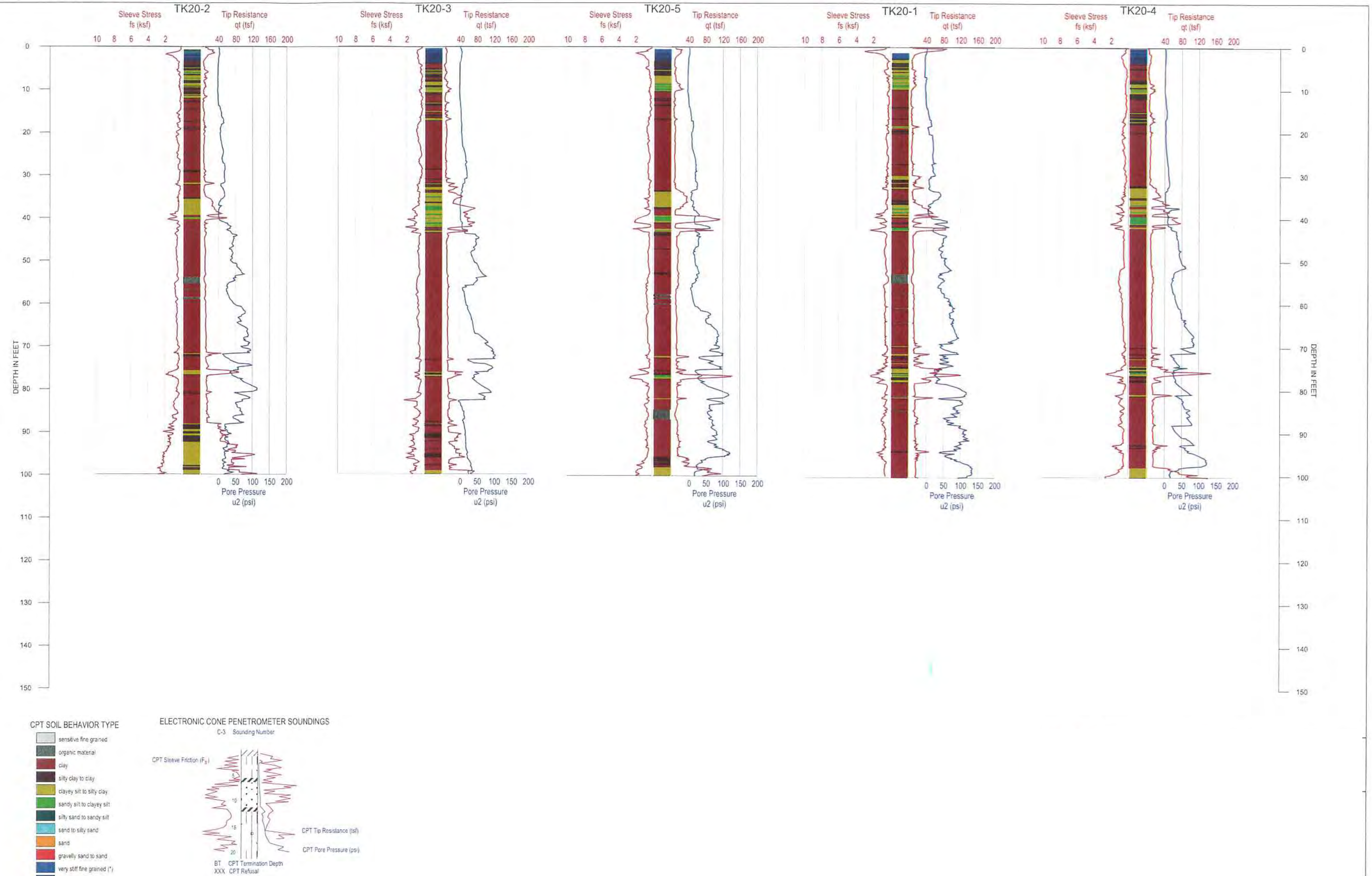

T-23
OTK22-3
OTK22-4
OTK22-1
Sleeve Stress
fs (ksf)
Tip Resistance
qt (tsf)
10 8 6 4 2
40 80 120 160 200
0 50 100 150 200
Pore Pressure
u2 (psi)
DEPTH IN FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
MEDIUM STIFF GRAY & TAN CLAY
SOFT GRAY SILTY CLAY
SOFT GRAY SANDY CLAY
SOFT TO MEDIUM STIFF GRAY CLAY
LOOSE TO MEDIUM DENSE GRAY FINE SAND
STIFF GRAY SILTY CLAY
STIFF GRAY CLAY
STIFF GRAY CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY SANDY CLAY
MEDIUM STIFF GRAY SANDY CLAY
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (F_s)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal
BORING LEGEND
HIGH PLASTICITY CLAY
SILTY LOW PLASTICITY CLAY
SANDY LOW PLASTICITY CLAY
POORLY GRADED SAND
SILTY SAND
CLAYEY SAND
SANDY SILT
CLAYEY SILT

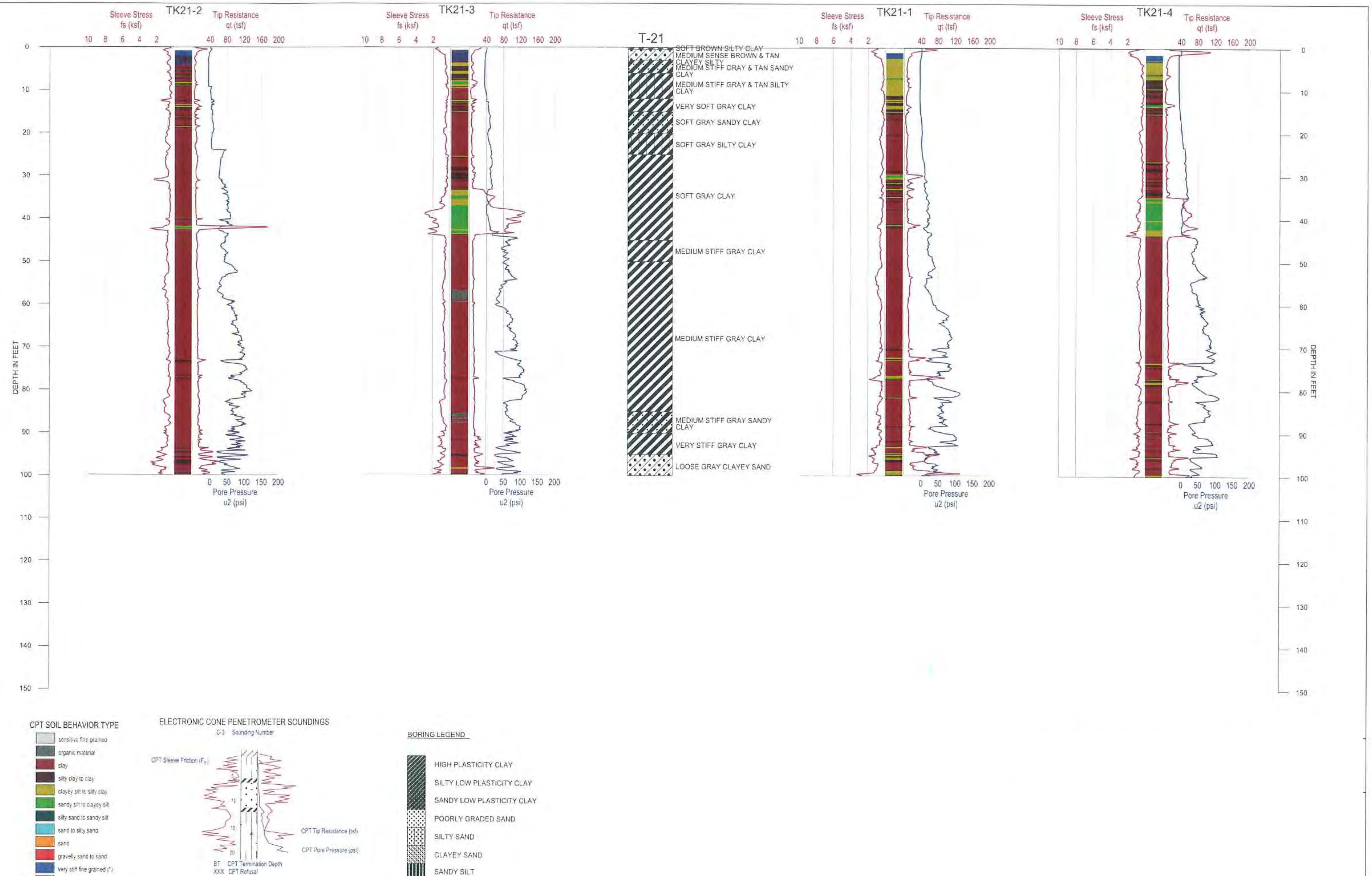


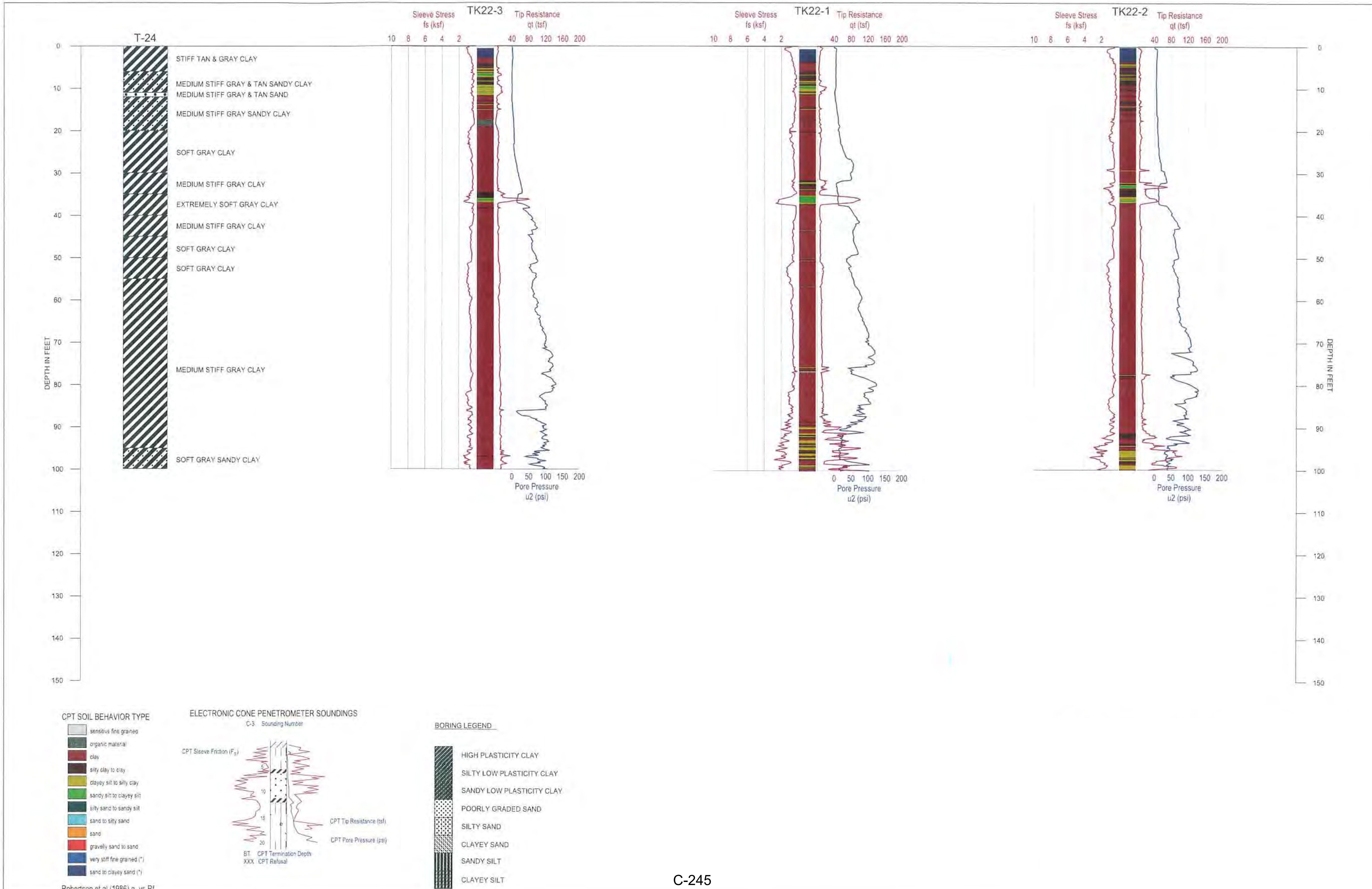


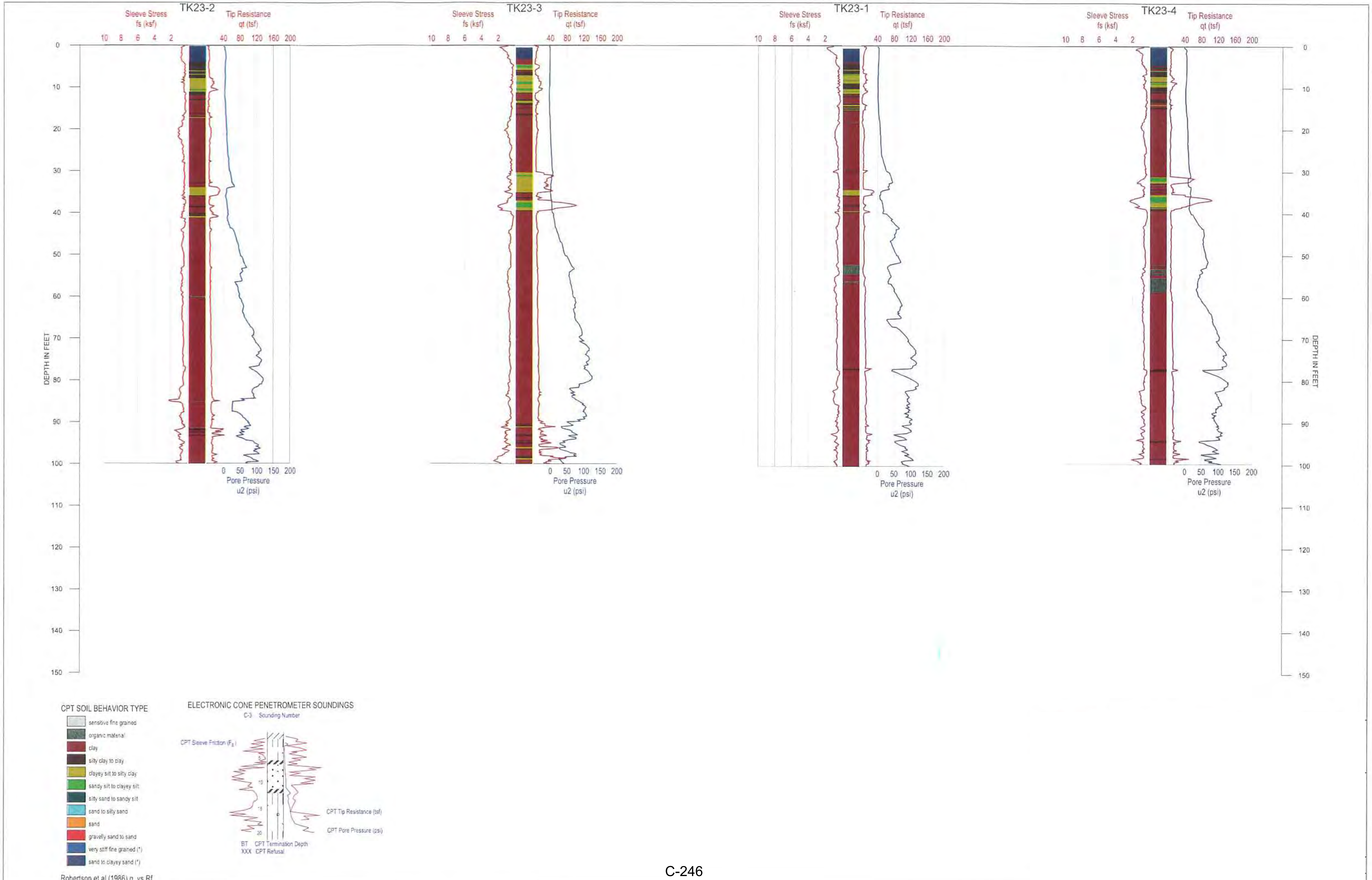
NOTE: NUMBERS TO THE LEFT OF THE LOG ARE STANDARD PENETRATION TEST RESULTS.


TK19-4
TK19-3
TK19-2
TK19-1
Sleeve Stress
fs (ksf)
10 8 6 4 2
Tip Resistance
qt (tsf)
40 80 120 160 200
0 50 100 150 200
Pore Pressure
u2 (psi)
DEPTH IN FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
T-20
STIFF GRAY & TAN SILTY CLAY
SOFT GRAY & TAN SILTY CLAY
SOFT GRAY & TAN SANDY CLAY
MEDIUM STIFF GRAY & TAN SILTY CLAY
MEDIUM STIFF GRAY & TAN SANDY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
VERY SOFT GRAY CLAY
STIFF BROWN & GRAY CLAY
STIFF GRAY & TAN CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY CLAY
LOOSE TO MEDIUM DENSE
GRAY & TAN FINE SAND
STIFF GRAY CLAY
MEDIUM STIFF GRAY CLAY
STIFF GRAY CLAY
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) qc vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (Fs)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal
BORING LEGEND
HIGH PLASTICITY CLAY
SILTY LOW PLASTICITY CLAY
SANDY LOW PLASTICITY CLAY
POORLY GRADED SAND
SILTY SAND
CLAYEY SAND
SANDY SILT
CLAYEY SILT

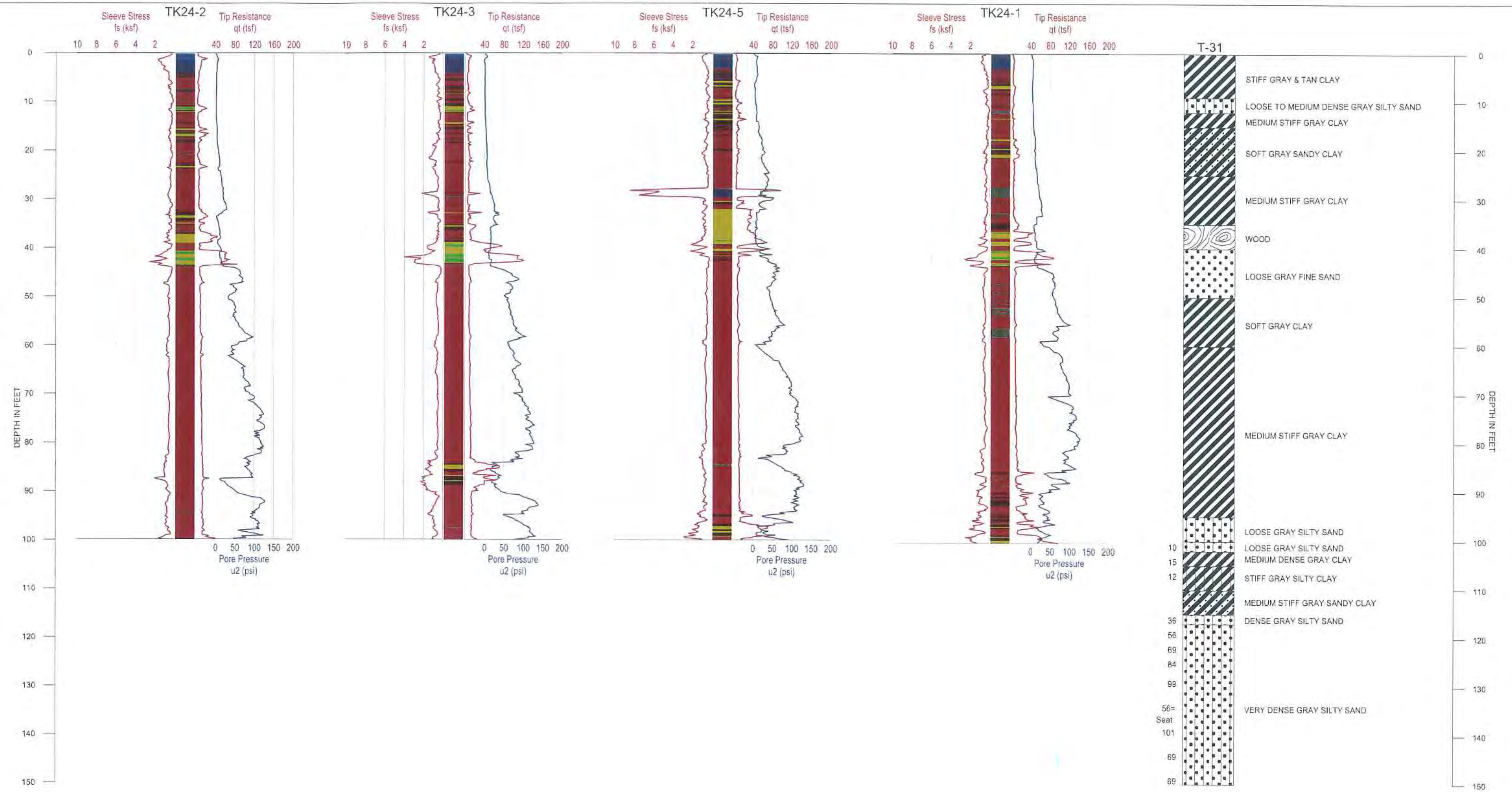

TK20-2
TK20-3
TK20-5
TK20-1
TK20-4
Sleeve Stress
fs (ksf)
10 8 6 4 2
Tip Resistance
qt (tsf)
40 80 120 160 200
Pore Pressure
u2 (psi)
0 50 100 150 200
DEPTH IN FEET
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (F_s)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal


TK21-2
TK21-3
T-21
TK21-1
TK21-4
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
Pore Pressure u2 (psi)
DEPTH IN FEET
SOFT BROWN SILTY CLAY
MEDIUM SENSE BROWN & TAN CLAYEY SILTY
MEDIUM STIFF GRAY & TAN SANDY CLAY
MEDIUM STIFF GRAY & TAN SILTY CLAY
VERY SOFT GRAY CLAY
SOFT GRAY SANDY CLAY
SOFT GRAY SILTY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY CLAY
MEDIUM STIFF GRAY SANDY CLAY
VERY STIFF GRAY CLAY
LOOSE GRAY CLAYEY SAND
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) qc vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (Fs)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal
BORING LEGEND
HIGH PLASTICITY CLAY
SILTY LOW PLASTICITY CLAY
SANDY LOW PLASTICITY CLAY
POORLY GRADED SAND
SILTY SAND
CLAYEY SAND
SANDY SILT
CLAYEY SILT


T-24
TK22-3
TK22-1
TK22-2
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
Pore Pressure u2 (psi)
DEPTH IN FEET
STIFF TAN & GRAY CLAY
MEDIUM STIFF GRAY & TAN SANDY CLAY
MEDIUM STIFF GRAY & TAN SAND
MEDIUM STIFF GRAY SANDY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
EXTREMELY SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY CLAY
SOFT GRAY CLAY
MEDIUM STIFF GRAY CLAY
SOFT GRAY SANDY CLAY
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) qc vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (Fs)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal
BORING LEGEND
HIGH PLASTICITY CLAY
SILTY LOW PLASTICITY CLAY
SANDY LOW PLASTICITY CLAY
POORLY GRADED SAND
SILTY SAND
CLAYEY SAND
SANDY SILT
CLAYEY SILT



TK23-2
TK23-3
TK23-1
TK23-4
Sleeve Stress fs (ksf)
Tip Resistance qt (tsf)
Pore Pressure u2 (psi)
DEPTH IN FEET
CPT SOIL BEHAVIOR TYPE
sensitive fine grained
organic material
clay
silty clay to clay
clayey silt to silty clay
sandy silt to clayey silt
silty sand to sandy silt
sand to silty sand
sand
gravelly sand to sand
very stiff fine grained (*)
sand to clayey sand (*)
Robertson et al (1986) q_c vs Rf
ELECTRONIC CONE PENETROMETER SOUNDINGS
C-3 Sounding Number
CPT Sleeve Friction (Fs)
CPT Tip Resistance (tsf)
CPT Pore Pressure (psi)
BT CPT Termination Depth
XXX CPT Refusal

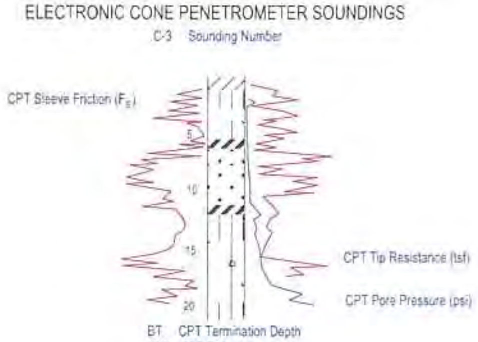


CPT SOIL BEHAVIOR TYPE

- sensitive fine grained
- organic material
- clay
- silty clay to clay
- clayey silt to silty clay
- sandy silt to clayey silt
- silty sand to sandy silt
- sand to silty sand
- sand
- gravelly sand to sand
- very stiff fine grained (*)
- sand to clayey sand (*)

Robertson et al (1986) q_c vs Rf

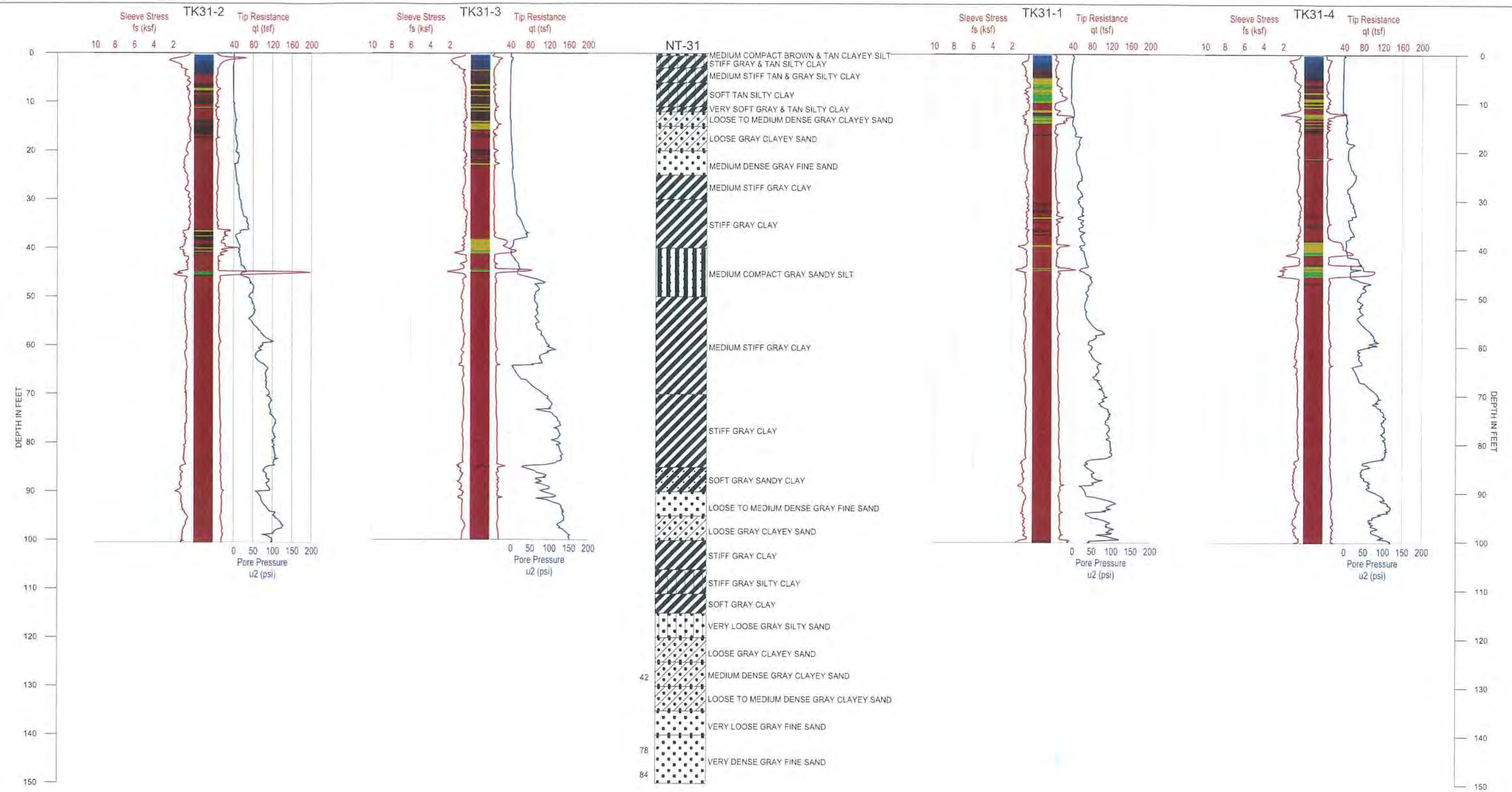
ELECTRONIC CONE PENETROMETER SOUNDINGS

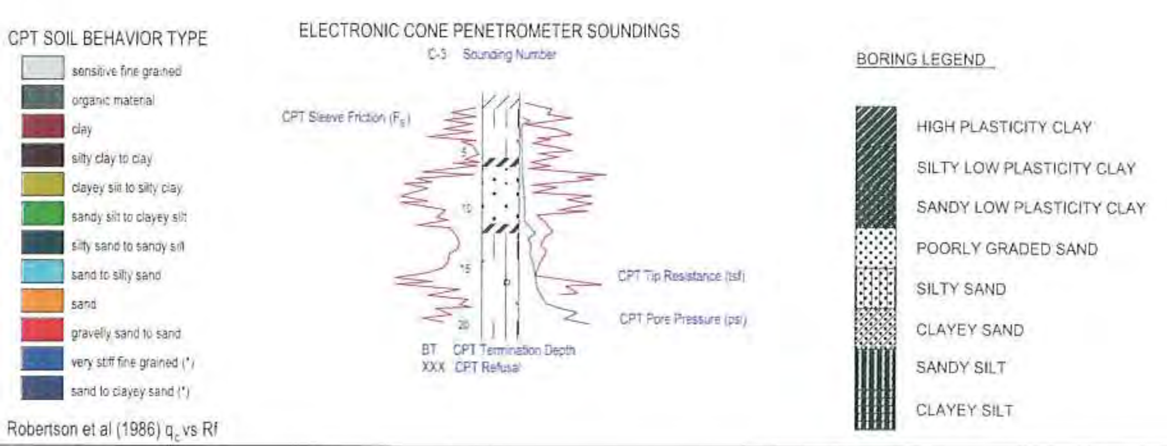


BORING LEGEND

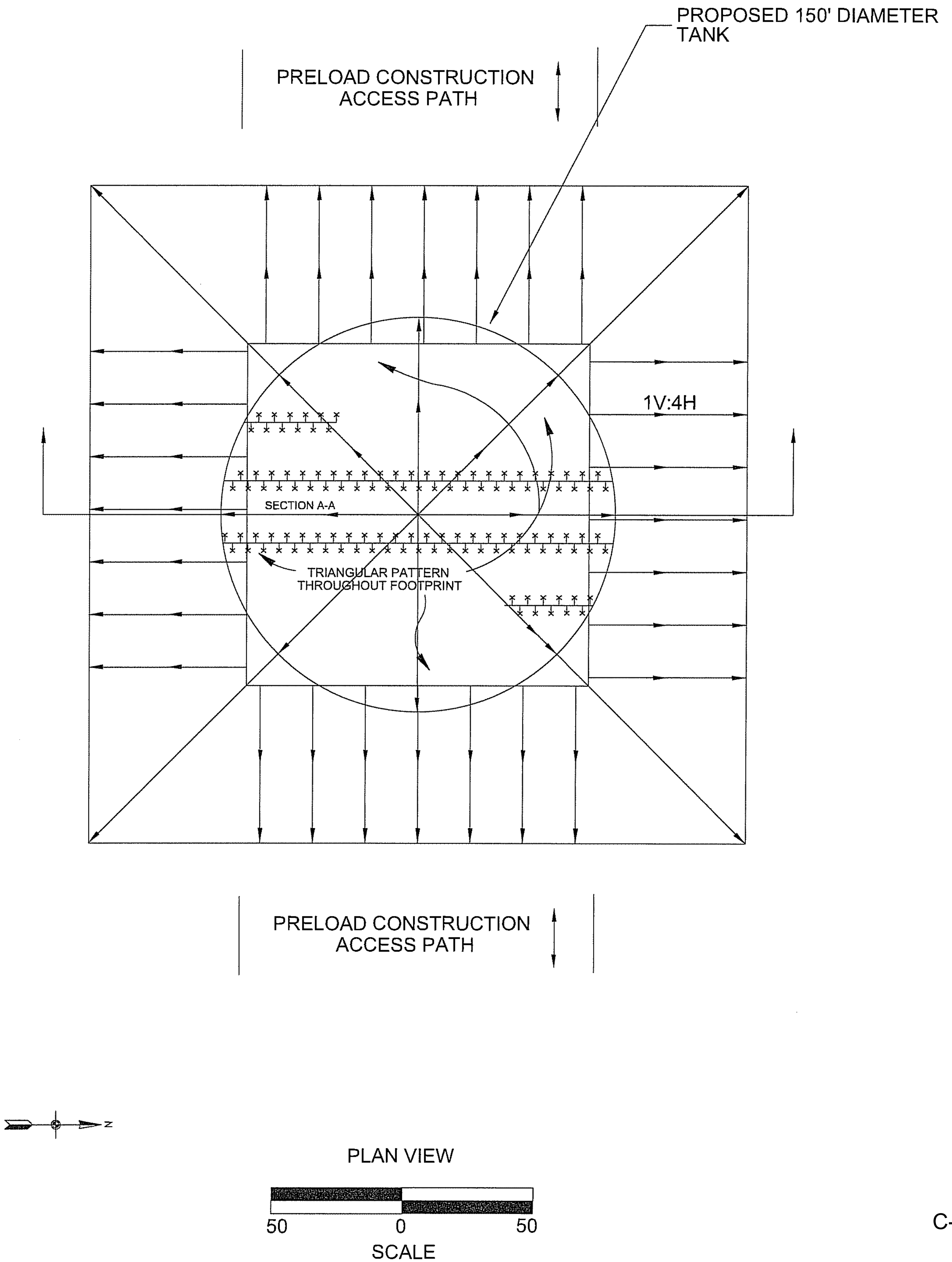
- HIGH PLASTICITY CLAY
- SILTY LOW PLASTICITY CLAY
- SANDY LOW PLASTICITY CLAY
- POORLY GRADED SAND
- SILTY SAND
- CLAYEY SAND
- SANDY SILT
- CLAYEY SILT

NOTE: NUMBERS TO THE LEFT OF THE LOG ARE STANDARD PENETRATION TEST RESULTS.

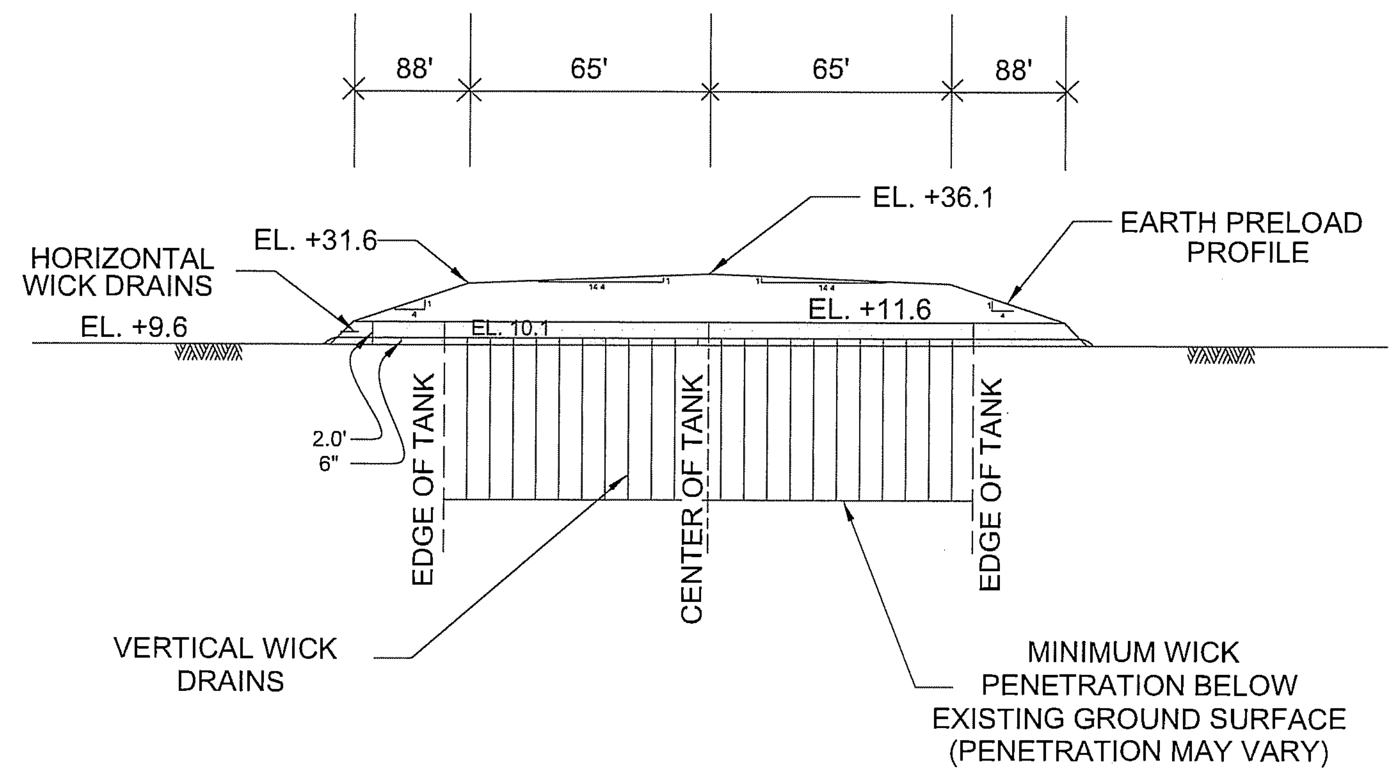




NOTE: NUMBERS TO THE LEFT OF THE LOG ARE STANDARD PENETRATION TEST RESULTS.



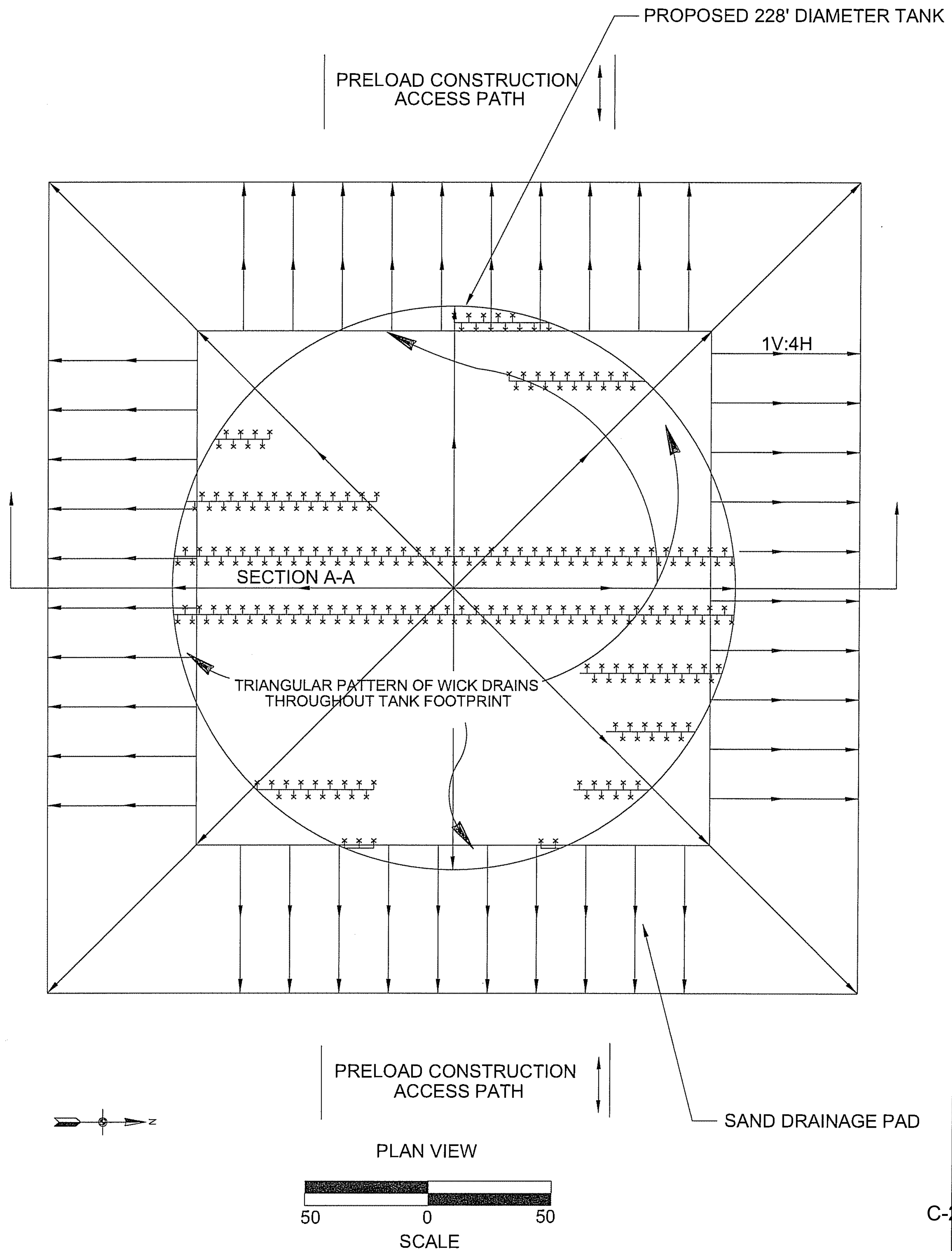
PLAN VIEW



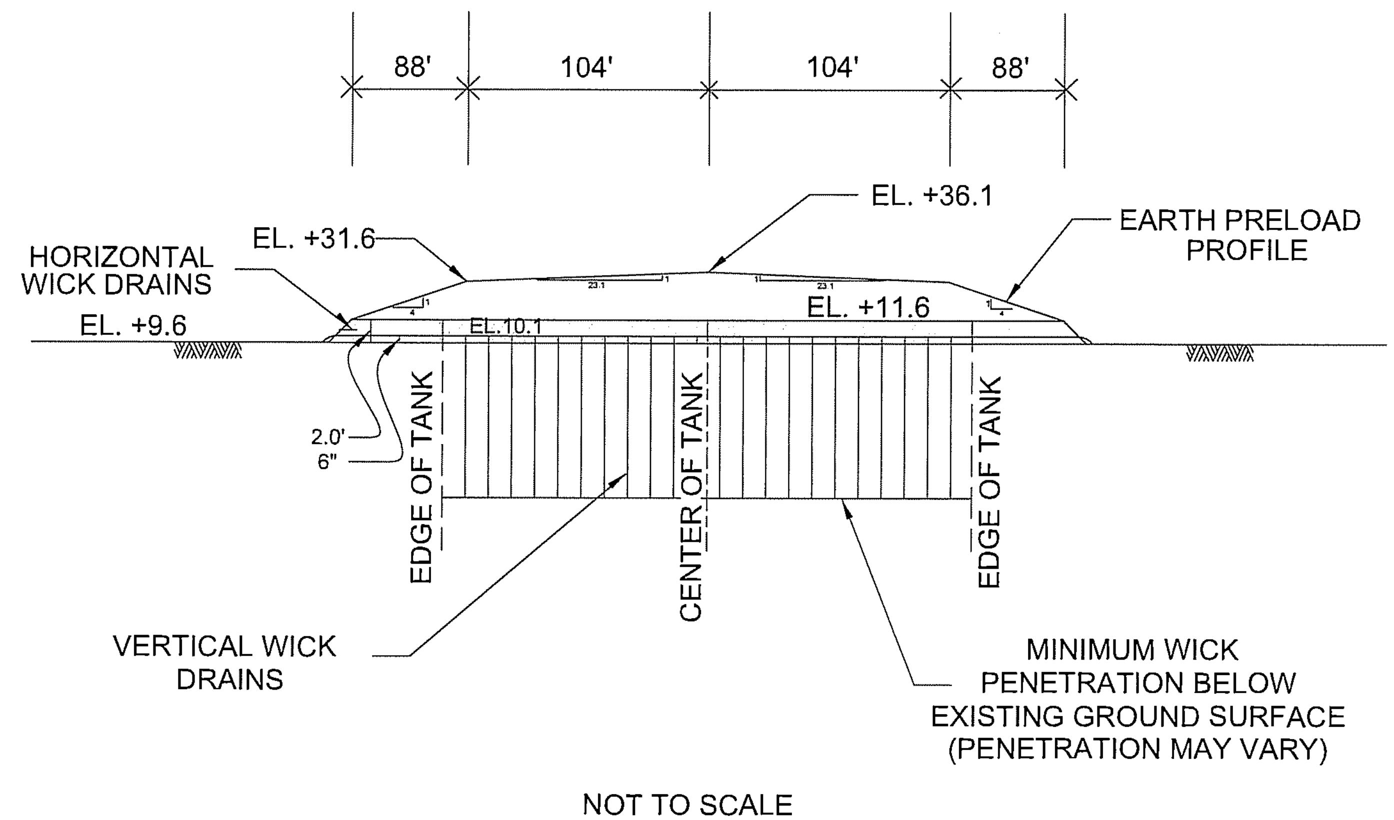
NOT TO SCALE

SECTION A-A

NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS

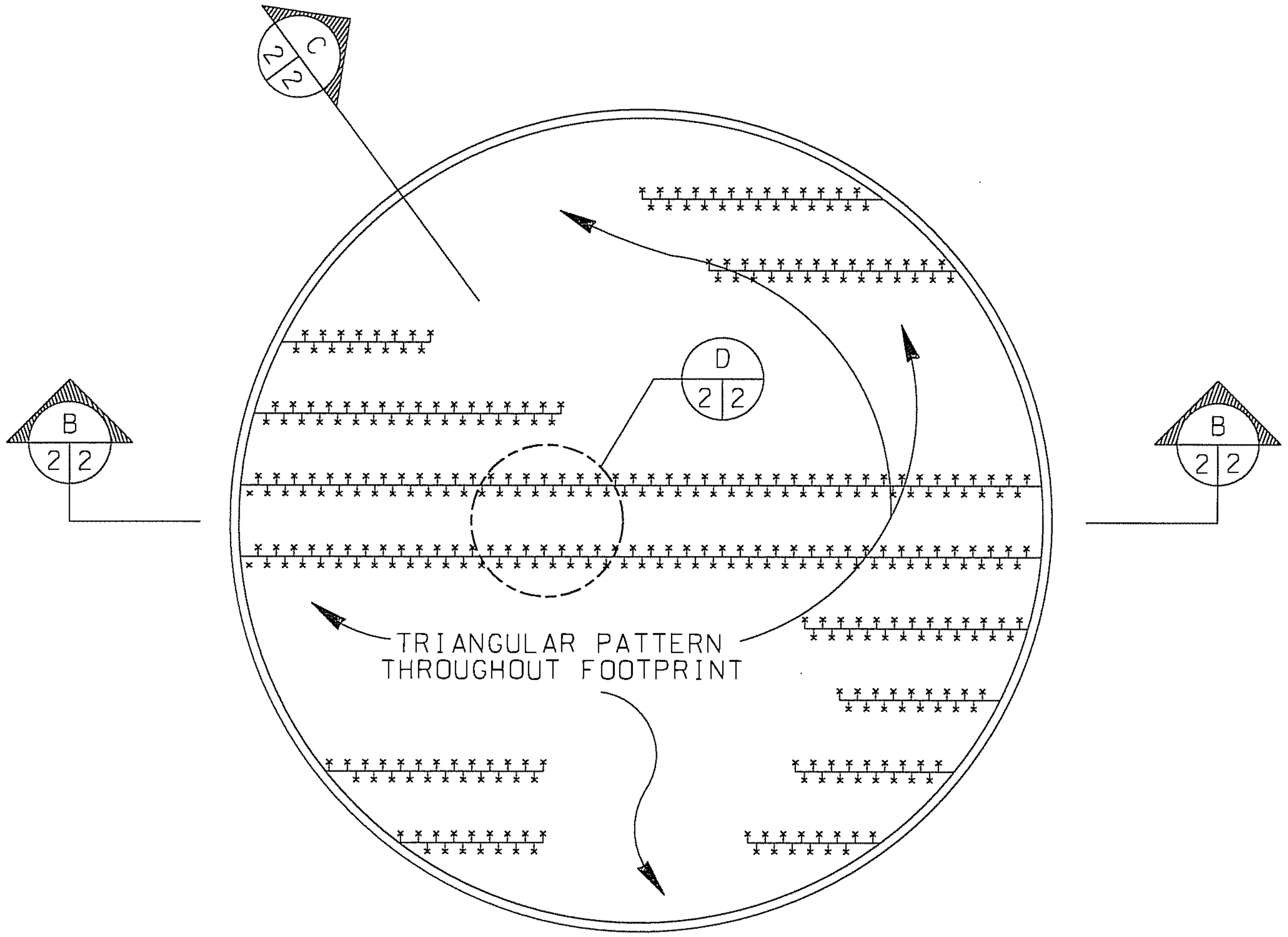


PLAN VIEW

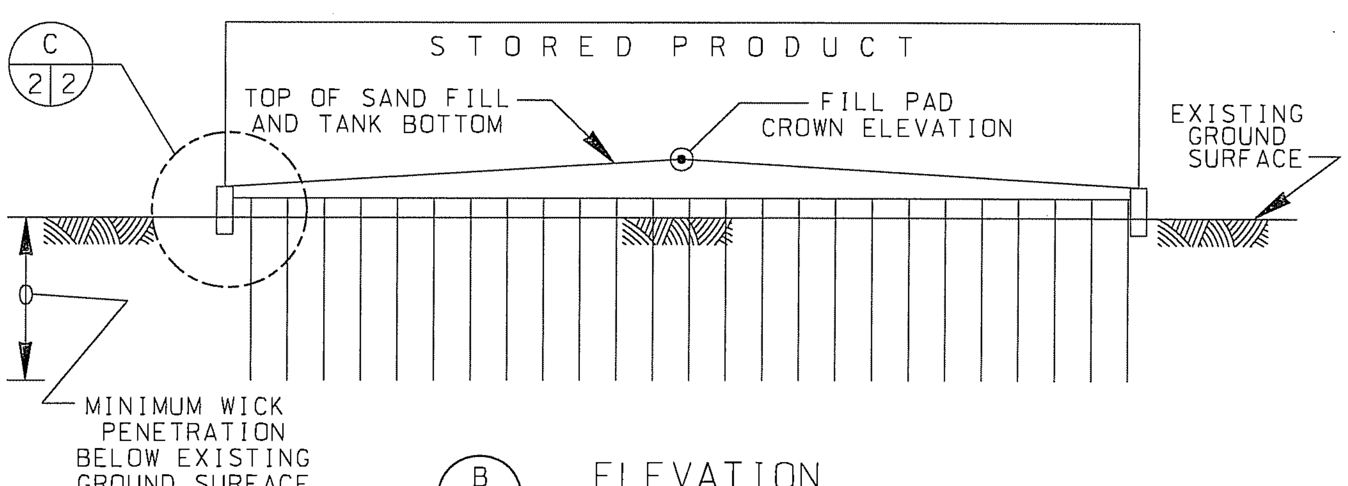


SECTION A-A

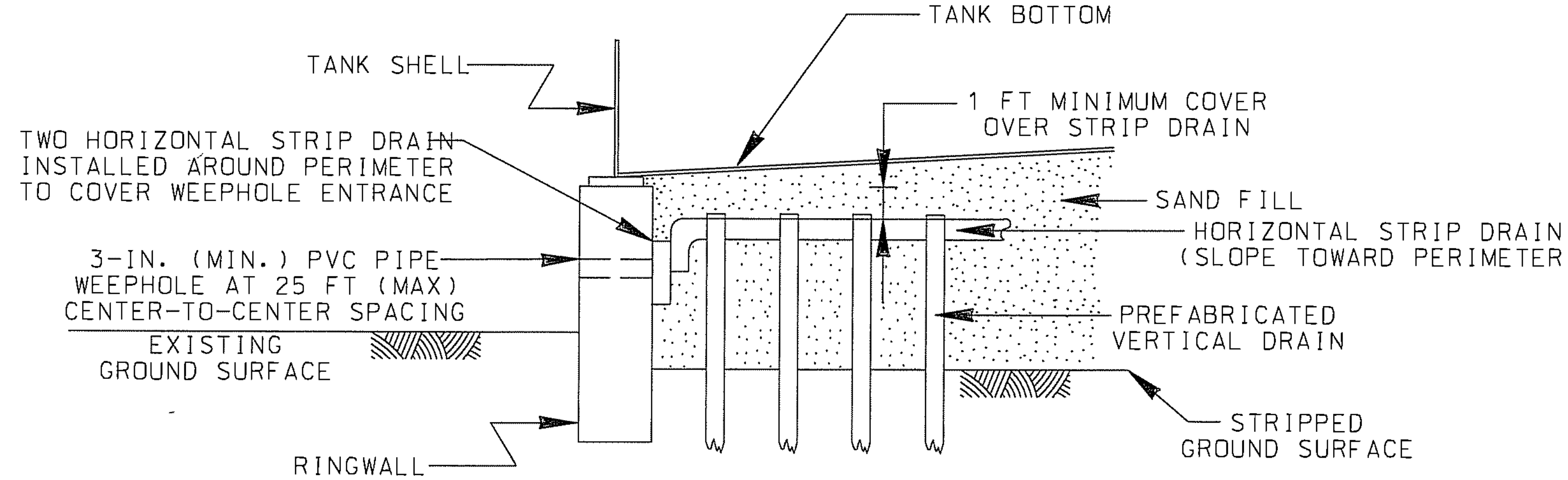
NOTE: DRAWING INDICATES SCHEMATIC OF PROPOSED RECOMMENDATIONS. THE LIMITS OF THE EARTH PRELOAD MAY PROPORTIONED ACCORDING TO ALTERNATE TANK DIAMETERS



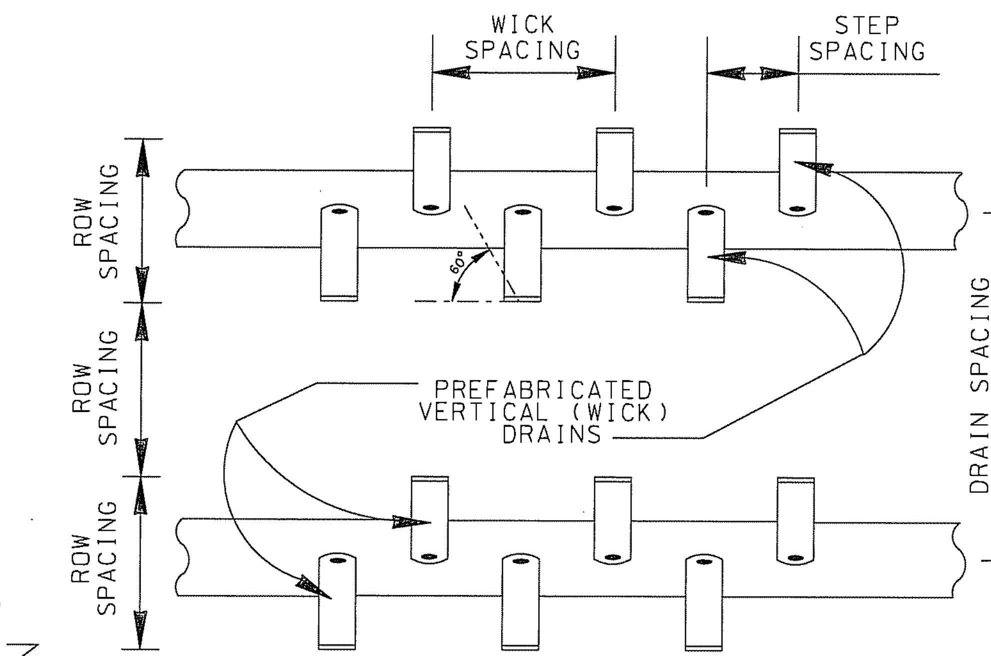
A 2|2 PLAN
NOT TO SCALE



B 2|2 ELEVATION
NOT TO SCALE

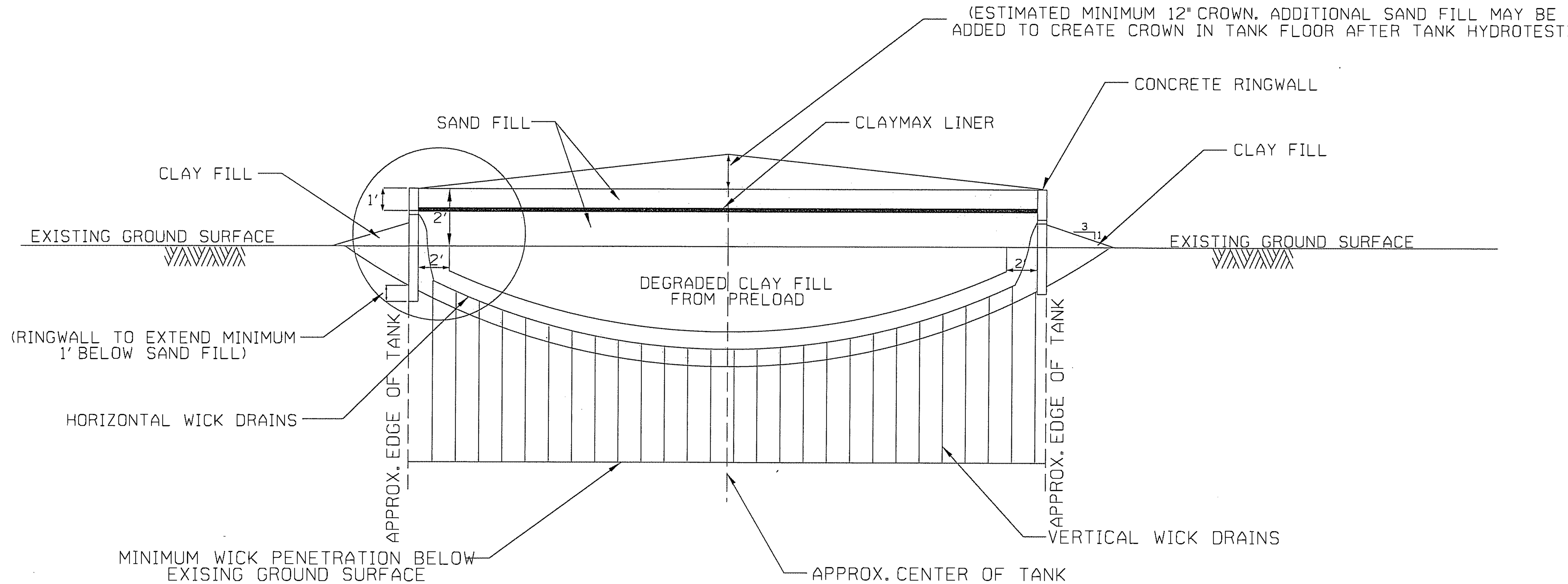


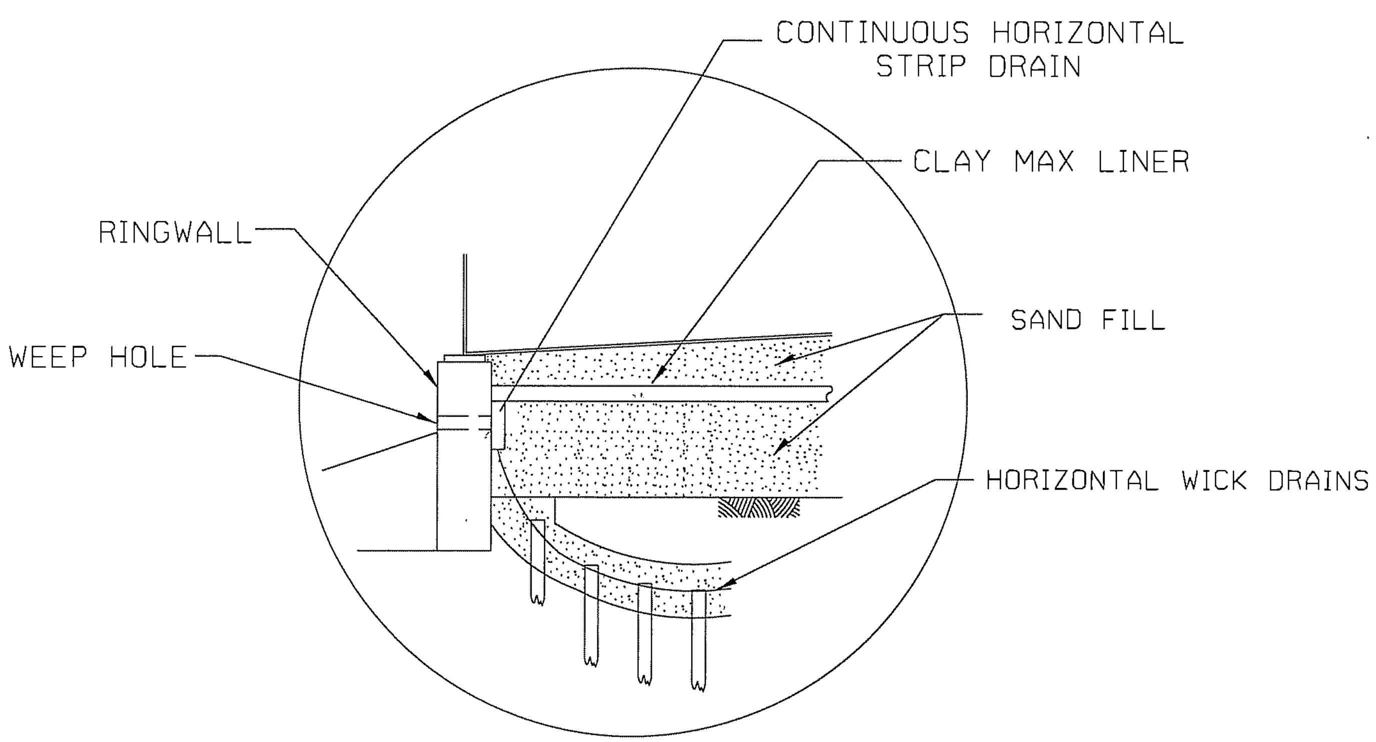
C 2|2 DETAIL AT RINGWALL
NOT TO SCALE



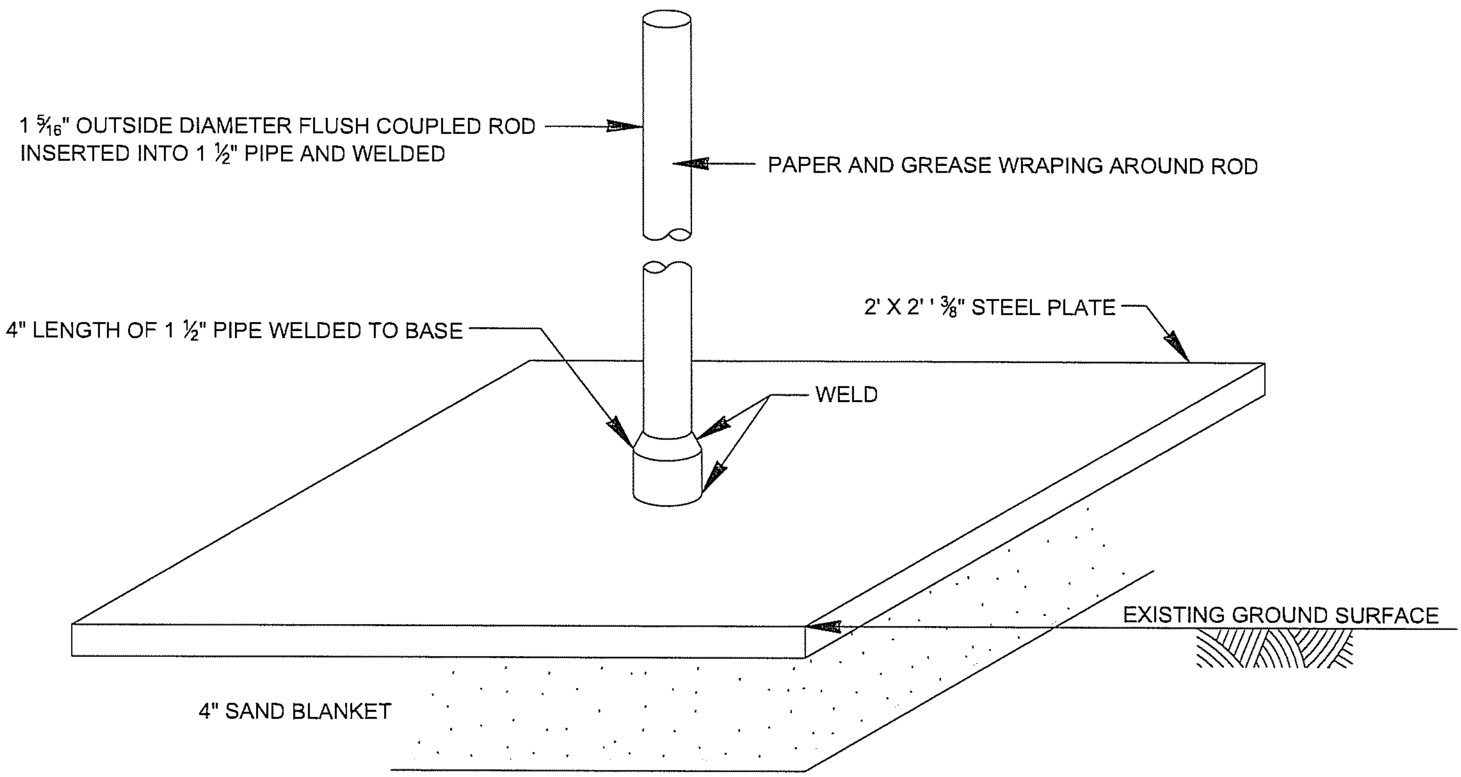
WICK SPACING (FT)	ROW SPACING (FT)	STEP SPACING (FT)	DRAIN SPACING (FT)
3	2.5	1.5	5.0
4	3.5	2	7.0
5	4.25	2.5	8.5
6	5.25	3	10.5

D 2|2 DETAIL OF WICK DRAIN PATTERN
NOT TO SCALE





NOT TO SCALE
SCHEMATIC ONLY



TYPICAL SETTLEMENT PLATE

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** S **d:** 4/13-14/10 **Boring:** T-19 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Stiff gray & tan clay w/roots & silt pockets	CH													
	1.50						1	2-3	27	97	123	UC	–	1357					
					Stiff tan & gray silty clay w/roots	CL													
	0.75						2	5-6	28	94	121	UC	–	1222					
					Soft gray & tan sandy clay	CL													
	0.50						3	8-9	34	89	119	UC	–	306					
10																			
	0.50				Soft tan & gray sandy clay	CL	4	11-12	31	92	121	UC	–	372					
					Medium stiff dark gray clay w/trace of silt & decayed wood	CH													
	0.50						5	14-15	40	80	113	UC	–	309					
20	0.50				w/silt lenses		6	19-20											
	0.75				w/trace of humus & decayed wood		7	24-25	81	52	94	UC	–	527					
					Medium stiff gray clay	CH													
30	0.75						8	29-30											
	0.75						9	34-35	62	63	103	UC	–	441					
40	0.75				w/trace of silt		10	39-40											
	1.00				w/silty sand pockets & lenses		11	44-45	48	72	107	UC	–	249					
50	1.00				w/wood & trace of silt		12	49-50											

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See 4/13-14/10 **Boring:** T-19 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/wood & trace of silt	CH													
					Soft gray clay w/trace of silt	CH													
	0.50						13	54-55											
60	0.50				Loose gray clayey sand	SC	14	59-60											
					Medium stiff gray clay	CH													
	1.00						15	64-65											
70	1.00				w/silty sand pockets & shell fragments		16	69-70	65	60	99	UC	--	471					
	1.00				w/silt pockets & lenses		17	74-75											
80	1.00				w/silty sand pockets & lenses, & shell fragments		18	79-80	36	84	114	UC	--	732					
	1.00				w/trace of silt		19	84-85											
90	1.00						20	89-90											
	1.00				Medium stiff gray silty clay w/shell fragments	CL	21	94-95	32	86	114	UC	--	287					
					Soft gray sandy clay	CL													
100	0.50						22	99-100	37	84	114	UC	--	172					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See [illegible] 4/13-14/10 **Boring:** T-19 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	S P L R	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
100					Stiff gray clay w/shell fragments, silty sand pockets, & decayed wood	CH	-												
	1.50						23	104-105	44	74	106	UC	--	1215					
					Medium stiff gray silty clay w/shell fragments & decayed wood	CL													
110	1.50						24	109-110	35	83	112	UC	--	875					
					Medium stiff light gray & tan silty clay w/decayed wood	CL													
	1.75						25	114-115	29	94	119	UC	--	993					
					Loose to very dense gray fine sand w/clay pockets	SP													
120	2.25						26	119-120	24										
	2.00				Loose to very dense gray fine sand		27	124-125											
130	2.00						28	129-130	21										
					Medium dense gray fine sand	SP													
		14					29	131-132.5	27										
		17					30	134-135.5											
		20					31	137-138.5	28										
140		21					32	140-141.5	26										
		50=Seat			Very dense gray silty sand	SM	33	143.5-145											
150		55=Seat					34	148.5-150	24										

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 4/08-09/10 **Boring:** T-20 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Stiff gray & tan silty clay	CL													
	1.50						1	2-3	30	92	119	UC	--	1408					
					Soft gray & tan silty clay	CL													
	1.50						2	5-6	36	84	115	UC	--	477					
					Soft gray & tan sandy clay	CL													
	1.00						3	8-9	33	86	115	UC	--	337					
10					Medium stiff gray & tan silty clay	CL													
	1.50						4	11-12	34	87	116	UC	--	662					
					Medium stiff gray & tan sandy clay	CL													
	1.50						5	14-15	29	93	121	UC	--	529					
					Soft gray clay w/fine sand pockets & roots	CH													
20	1.00						6	19-20	52	69	105	UC	--	254					
	1.00				Medium stiff gray clay w/roots	CH	7	24-25											
					Very soft gray clay w/silty sand lenses & layers	CH													
30	0.50						8	29-30	48	74	110	UC	--	213					
	0.50						9	34-35											
					Stiff brown & gray clay w/decayed wood, silt pockets, & trace of organic matter	CH													
40	0.50						10	39-40	75	54	94	UC	--	1237					
	0.50				Stiff brown & gray clay		11	44-45											
50	2.50						12	49-50											

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 2 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 4/08-09/10 **Boring:** T-20 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Stiff gray & tan clay	CH													
	2.50				w/silty sand pockets, decayed wood, roots, & shell fragmnents		13	54-55	33	86	114	UC	--	1000					
					Medium stiff gray clay	CH													
60	1.00						14	59-60											
	1.50				w/silt pockets, decayed wood, roots, & shell fragments		15	64-65	51	70	105	UC	--	673					
70	0.50				w/silt pockets		16	69-70											
	1.00				w/silty sand pockets, shell fragments, & decayed wood		17	74-75	43	78	112	UC	--	583					
					Soft gray clay	CH													
80	0.50						18	79-80											
					Loose to medium dense gray & tan fine sand w/clay layers	SP													
							19	84-85	25										
					Stiff gray clay	CH													
90	2.00						20	89-90											
					Medium stiff gray clay w/silty sand pockets	CH													
	1.50						21	94-95	40	79	110	UC	--	958					
					Stiff gray clay w/decayed wood & roots	CH													
100	1.50						22	99-100	64	60	98	UC	--	132					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 5/07 & 10/10 **Boring:** T-21 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0	1.00				Soft brown silty clay w/roots & wood	CL	1	0-0.5	24										
	0.75				Medium dense brown & tan clayey silt w/roots & wood	SC	2	2-3	14										
					Medium stiff gray & tan sandy clay	CL	3	5-6	29	92	119	UC	--	667					
	0.05				Medium stiff gray & tan silty clay w/trace of organic matter	CL	4	8-9											
10	0.25						5	11-12	34	87	117	UC	--	567					
					Very soft gray clay w/silty sand pockets & roots	CH	6	14-15	43	77	110	UC	--	191					
					Soft gray sandy clay w/trace of wood	CL	7	18-19	33	89	118	UC	--	251					
20					Soft gray silty clay w/trace of roots & decayed wood	CL	8	23-24	49	71	105	UC	--	387					
					Soft gray clay w/silty sand pockets	CH	9	28-29											
30							10	33-34	56	67	104	UC	--	332					
					w/silt														
40							11	38-39											
					w/silty sand lenses & layers		12	43-44	50	72	108	UC	--	250					
					Medium stiff gray clay	CH	13	48-49											
50																			

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C.

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** Se **d:** 5/07 & 10/10 **Boring:** T-21 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Medium stiff gray clay w/silt pockets	CH													
	0.50						14	53-54											
	0.75				Medium stiff gray clay		15	58-59	37	83	114	UC	--	779					
60																			
	0.75				w/silt pockets		16	63-64											
	0.75						17	68-69											
70																			
	0.75				w/silt pockets, decayed wood, & concretions		18	73-74	51	70	106	UC	--	460					
	0.50				w/silt lenses & silt pockets		19	78-79											
80																			
	0.50				w/silt pockets		20	83-84											
					Medium stiff gray sandy clay	CL													
	0.75						21	88-89	35	85	115	UC	--	161					
90					Very stiff gray clay w/silty sand pockets	CH													
	0.75						22	93-94	39										
					Loose gray clayey sand	SC													
							23	98-99	33										
100																			

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 4/06/10 **Boring:** T-23 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0					Medium stiff gray & tan clay w/roots & silt pockets	CH													
	1.75						1	2-3	36	86	116	UC	--	900					
	1.25				w/sit pockets		2	5-6											
					Soft gray silty clay	CL													
	0.50						3	8-9	30	93	121	UC	--	427					
10	0.50						4	11-12											
					Soft gray sandy clay w/wood & roots	CL													
	0.50						5	14-15	43	78	112	UC	--	197					
20	0.50						6	19-20											
					Soft to medium stiff gray clay w/roots & decayed wood (fissured)	CH													
	0.75						7	24-25	69	58	98	UC	--	393					
30	0.75						8	29-30											
					Loose to medium dense gray fine sand w/clay layers & shell fragments	SP													
	0.50						9	34-35	23										
					Stiff gray silty clay w/decayed wood & roots	CL													
40	1.25						10	39-40	78	53	94	UC	--	1043					
	1.50				Stiff gray clay w/silt pockets	CH	11	44-45											
50	1.25				w/silt pockets & shell fragments		12	49-50	62	63	102	UC	--	498					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See 4/06/10 **Boring:** T-23 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Stiff gray clay	CH													
	2.00						13	54-55											
60	1.25						14	59-60											
					Medium stiff gray clay w/silt pockets & concretions	CH													
	1.50						15	64-65	43	77	110	UC	–	707					
70	1.50				Medium stiff gray clay		16	69-70											
	1.25				w/silt pockets & decayed wood		17	74-75	51	71	107	UC	–	617					
80	1.25				w/silt pockets		18	79-80	43	77	110	UC	–	994					
	1.25				Medium stiff gray clay		19	84-85											
					Soft gray sandy clay	CL													
90	0.75						20	89-90	37	81	111	UC	–	381					
					Medium stiff gray sandy clay w/silt pockets & lenses	CL													
	0.75						21	94-95											
100	1.00				w/decayed wood, roots, & sh frag		22	99-100	43	77	109	UC	–	686					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 2)

Ground Elev.: **Datum:** **Gr. Water Depth:** See [illegible]: 4/21-22 & 24/10 **Boring:** T-24 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Stiff tan & gray clay w/roots & silt pockets	CH													
	2.50						1	2-3											
	2.00				w/silt pockets		2	5-6	30	93	120	UC	--	1013					
					Medium stiff gray & tan sandy clay	CL													
	1.25						3	8-9											
10																			
	1.25				Medium stiff gray & tan sand	SP	4	11-12	31	91	119	UC	--	480					
					Medium stiff gray sandy clay	CL													
	0.50						5	14-15											
20	0.50						6	19-20	30	94	123	UC	--	706					
					Soft gray clay w/silt pockets	CH													
	0.50						7	24-25											
30	0.50				Soft gray clay		8	29-30	54	67	103	UC	--	427					
					Medium stiff gray clay w/decayed wood, roots, & trace of organic matter	CH													
	1.00						9	34-35	90	48	92	UC	--	683					
					Extremely soft gray clay w/silty sand pockets & shell fragments	CH													
40	0.25						10	39-40	51	72	109	UC	--	75					
					Medium stiff gray clay w/silt pockets & trace of decayed wood	CH													
	0.25						11	44-45	56	66	103	UC	--	588					
					Soft gray clay w/silt pockets, decayed wood, & trace of organic matter	CH													
50	0.50						12	49-50	77	54	96	UC	--	414					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 4/21-22 & 24/10 **Boring:** T-24 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Soft gray clay w/silt pockets, decayed wood, & trace of organic matter	CH													
	0.50				w/trace of decayed wood		13	54-55	66	61	101	UC	–	268					
					Medium stiff gray clay w/silt pockets & trace of decayed wood	CH													
60	1.00						14	59-60	43	77	111	UC	–	681					
	1.00				Medium stiff gray clay		15	64-65											
70	1.25						16	69-70											
	1.25						17	74-75	64	62	101	UC	–	762					
80	1.50				w/shell fragments		18	79-80											
	1.25				Medium stiff gray clay		19	84-85	45	75	109	UC	–	663					
90	1.25				w/shell fragments & silt pockets		20	89-90	56	68	105	UC	–	846					
	1.75				w/silt pockets		21	94-95	47	73	107	UC	–	644					
					Soft gray sandy clay	CL													
100	0.25						22	99-100	33	88	117	UC	–	334					

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See 4/19-20/10 **Boring:** T-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Stiff gray & tan clay w/roots	CH													
	1.75						1	2-3											
	1.50				w/roots, silty sand pockets, & trace of decayed wood		2	5-6	32	90	118	UC	–	939					
	1.00				w/silt pockets		3	8-9											
10					Loose to medium dense gray silty sand w/clay layers & decayed wood	SM													
	0.75						4	11-12	32										
					Medium stiff gray clay w/silt pockets, concretions, & roots	CH													
	0.75						5	14-15	46	76	111	UC	–	603					
					Soft gray sandy clay	CL													
20	0.75						6	19-20	34	91	121	UC	–	302					
	0.75						7	24-25	37	84	115	UC	–	345					
					Medium stiff gray clay	CH													
30	0.75						8	29-30											
	0.75				w/decayed wood, roots, & trace of organic matter		9	34-35	145										
					Wood	Wd													
40							10	39-40	588										
					Loose gray fine sand w/clay layers	SP													
	0.75						11	44-45											
50							12	49-50	27										

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 4/19-20/10 **Boring:** T-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
50					Soft gray clay w/silt pockets	CH													
	0.50						13	54-55											
60	1.25				w/decayed wood & roots		14	59-60	53	69	106	UC	--	398					
					Medium stiff gray clay	CH													
	1.50						15	64-65											
70	1.50				w/roots, shell fragments, concretions, & silt pockets		16	69-70	57	66	103	UC	--	879					
	1.50				Medium stiff gray clay		17	74-75											
80	1.50						18	79-80	56	66	103	UC	--	861					
	1.25						19	84-85											
90	1.00				w/silty sand pockets, decayed wood, & shell fragments		20	89-90	42	79	111	UC	--	941					
	1.00				w/silt lenses, layers, & pockets		21	94-95											
					Loose gray silty sand w/clay lenses & trace of organic matter	SM													
100	1.25						22	99-100	31										

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C.

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** Se **1:** 4/19-20/10 **Boring:** T-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
100		10			Loose gray silty sand w/clay pockets	SM	23	100.5-102	31										
		15			Medium dense gray clay w/silt pockets	CH	24	103.5-105	29										
		12			Stiff gray silty clay	CL	25	106.5-108	30										
110							26	109-110											
					Medium stiff gray sandy clay w/roots	CL													
	1.25						27	114-115	27	99	126	UC	--	547					
		36			Dense gray silty sand	SM	28	115.5-117	24										
		56			Very dense gray silty sand	SM	29	118.5-120											
120		69					30	121.5-123											
		84					31	124-125.5	28										
130		99					32	128.5-130											
		56=Seat					33	133.5-135											
140		101					34	138.5-140	27										
		69					35	143.5-145											
150		69					36	148.5-150	23										

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 1 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** See [illegible]: 5/05-07/10 **Boring:** NT-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	ø	C	LL	PL	PI		
0					Medium compact brown & tan clayey silt w/roots	ML	1	0-1	14										
	1.50				Stiff gray & tan silty clay	CL	2	2-3	24	100	124	UC	--	1167					
	0.25				Medium stiff tan & gray silty clay w/roots	CL	3	5-6	27	96	122	UC	--	845					
	0.25				Soft tan silty clay	CL	4	8-9											
10																			
	0.25				Very soft gray & tan silty clay w/trace of decayed wood	CL	5	11-12	40	42	59	UC	--	233					
	0.25				Loose to medium dense gray clayey sand	SC	6	14-15	25										
					Loose gray clayey sand	SC	7	18-19											
20					Medium dense gray fine sand w/clay pockets	SP													
	0.50						8	23-24	25										
					Medium stiff gray clay w/silty sand pockets & concretions	CH													
	0.50						9	28-29	48	72	107	UC	--	433					
30					Stiff gray clay w/silt layers	CH													
	1.00						10	33-34											
	1.00				w/silt pockets & decayed wood		11	38-39	36	86	117	UC	--	644					
40					Medium compact gray sandy silt	ML													
	0.25						12	43-44											
	0.25						13	48-49	32										
50																			

Comments:

EUSTIS ENGINEERING SERVICES, L.L.C. **LOG OF BORING AND TEST RESULTS**

(Sheet 2 of 3)

Ground Elev.: **Datum:** **Gr. Water Depth:** See : 5/05-07/10 **Boring:** NT-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
50					Medium stiff gray clay w/shell fragments	CH													
	1.00						14	53-54											
	0.75				w/roots & decayed wood		15	58-59	52	70	106	UC	--	460					
60																			
	0.75				w/silt pockets		16	63-64											
	0.75				w/decayed wood, roots, & concretions		17	68-69	56	66	102	UC	--	741					
70					Stiff gray clay w/silt pockets	CH													
	0.75						18	73-74											
	0.75				w/shell fragments		19	78-79	59	63	100	UC	--	1040					
80																			
	0.75				w/silt pockets		20	83-84											
					Soft gray sandy clay	CL													
							21	88-89	36										
90					Loose to medium dense gray fine sand w/clay lenses	SP													
							22	93-94	28										
					Loose gray clayey sand	SC													
							23	98-99	31										
100																			

Comments:

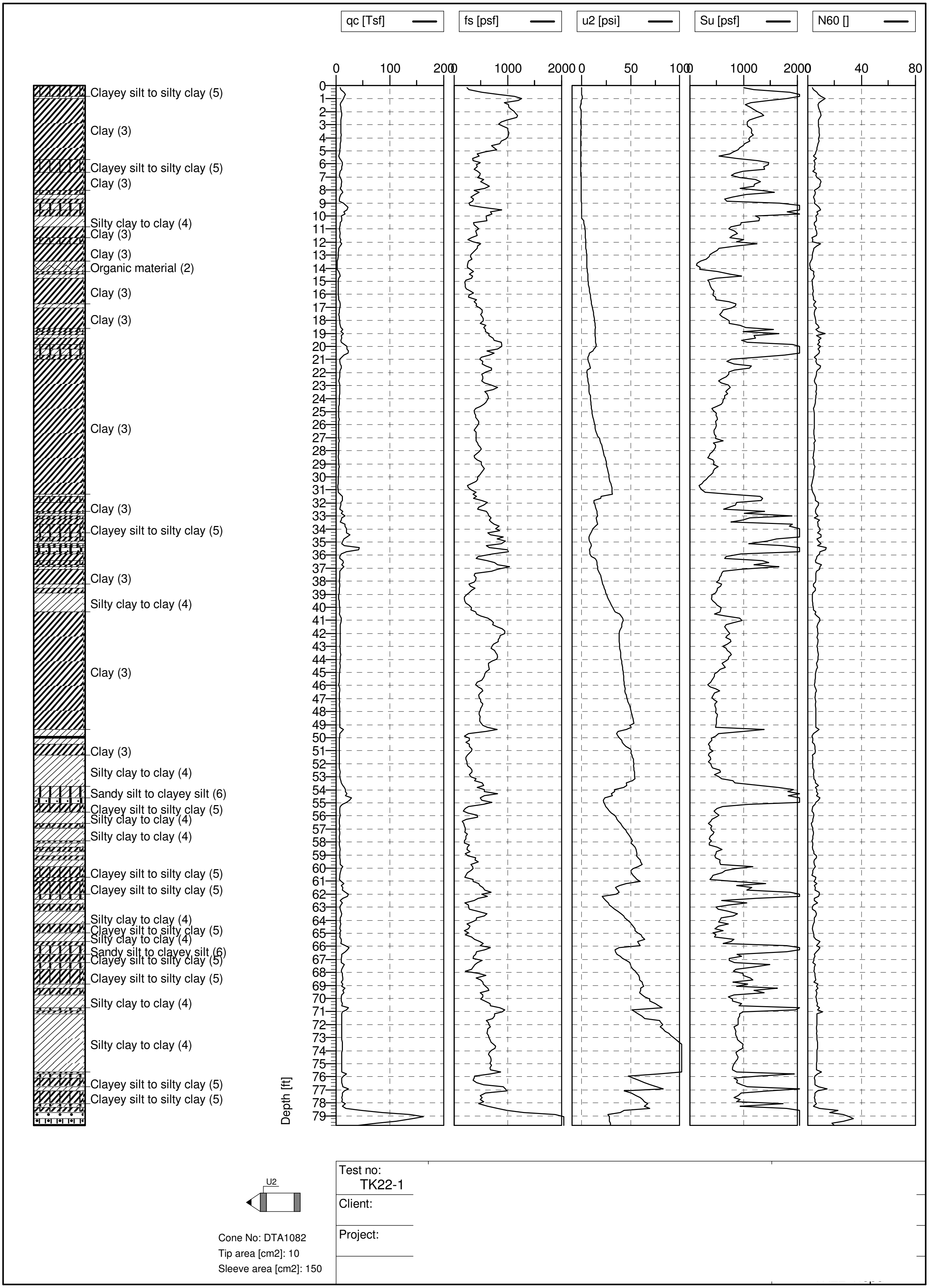
EUSTIS ENGINEERING SERVICES, L.L.C.

LOG OF BORING AND TEST RESULTS

Ground Elev.: **Datum:** **Gr. Water Depth:** Se(**l:** 5/05-07/10 **Boring:** NT-31 **Refer to "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
100	1.00				Stiff gray clay w/trace of sand	CH	24	103-104											
110	0.25				Stiff gray silty clay w/organic matter, decayed wood, concretions, & shell fragments	CL	25	108-109	40	78	110	UC	--	1320					
	0.25				Soft gray clay w/organic matter	CH	26	113-114											
120					Very loose gray silty sand	SM	27	118-119	30										
	0.50				Loose gray clayey sand w/concretions	SC	28	123-124	27										
130		42			Medium dense gray clayey sand	SC	29	128-129	22										
	0.25				Loose to medium dense gray clayey sand	SC	30	133-134	24										
140					Very loose gray fine sand	SP	31	138-139											
		78			Very dense gray fine sand	SP	32	143-144	30										
150		84					33	148-149											

Comments: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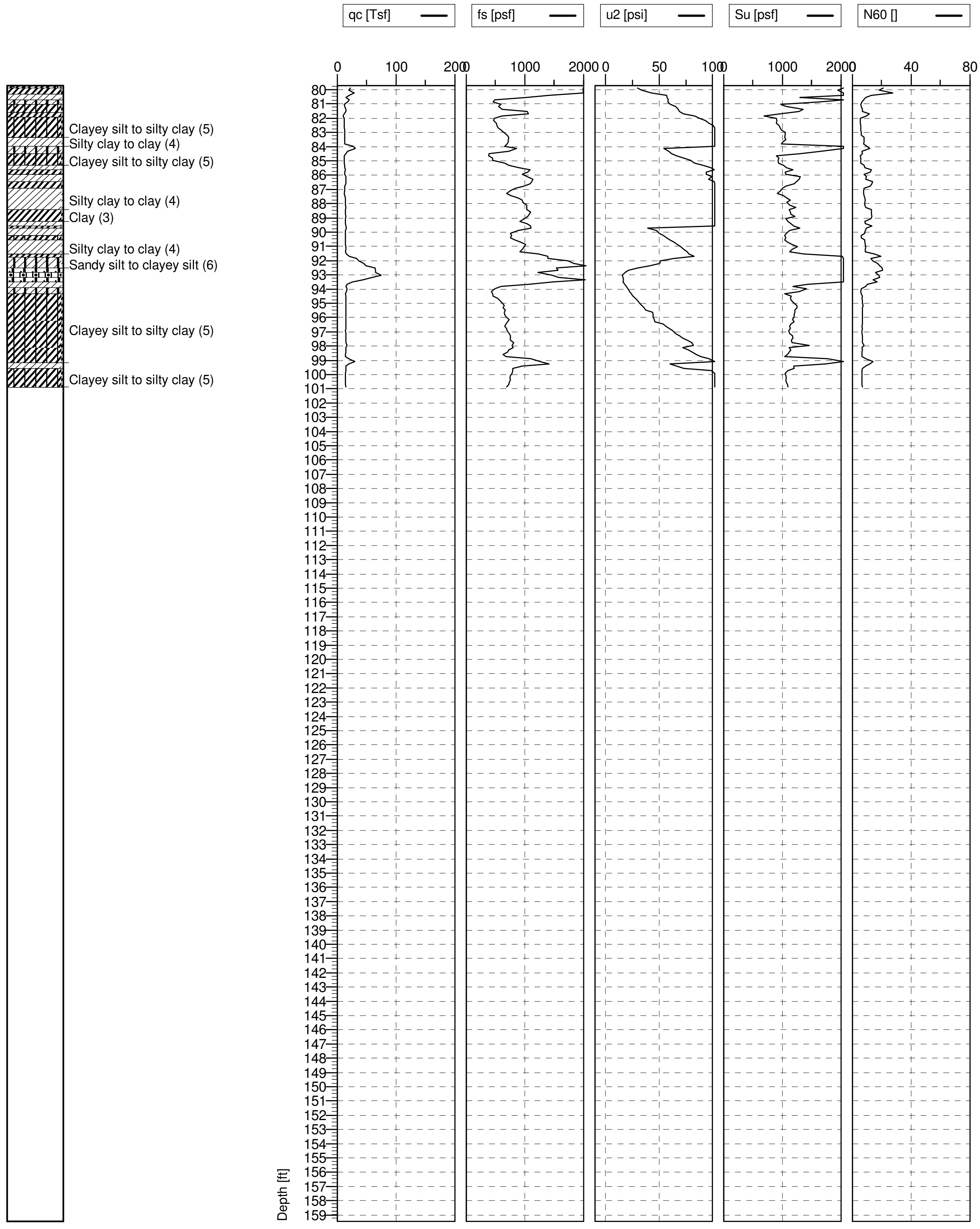
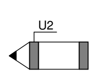
fs [psf]
u2 [psi]
Su [psf]
N60 []
Depth [ft]
Clayey silt to silty clay (5)
Clay (3)
Clayey silt to silty clay (5)
Clay (3)
Silty clay to clay (4)
Clay (3)
Clay (3)
Organic material (2)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clayey silt to silty clay (5)
Clay (3)
Silty clay to clay (4)
Clay (3)
Clay (3)
Silty clay to clay (4)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
U2
Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150
Test no:
TK22-1
Client:
Project:



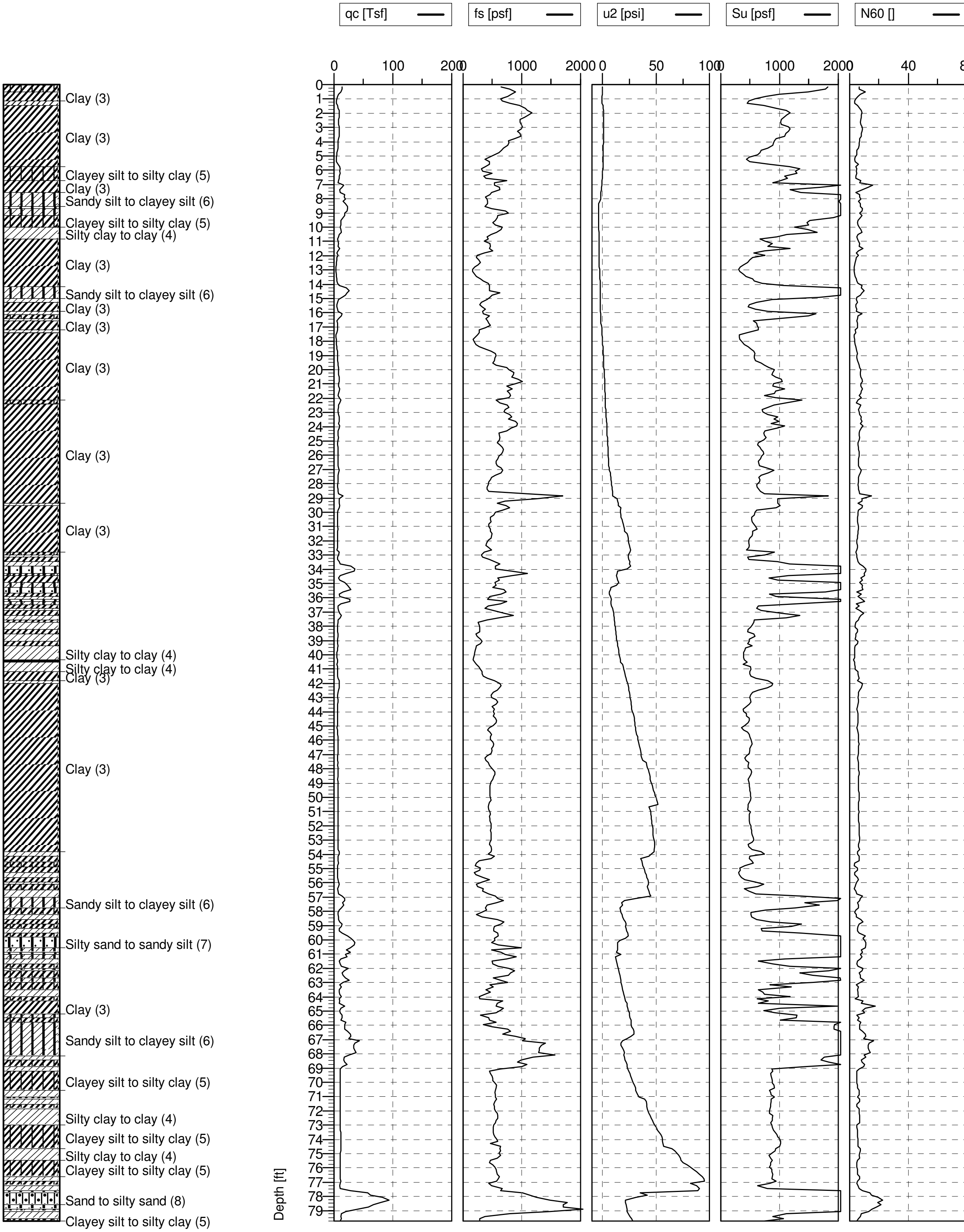


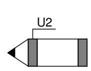
Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no: TK22-1

Client:

Project:



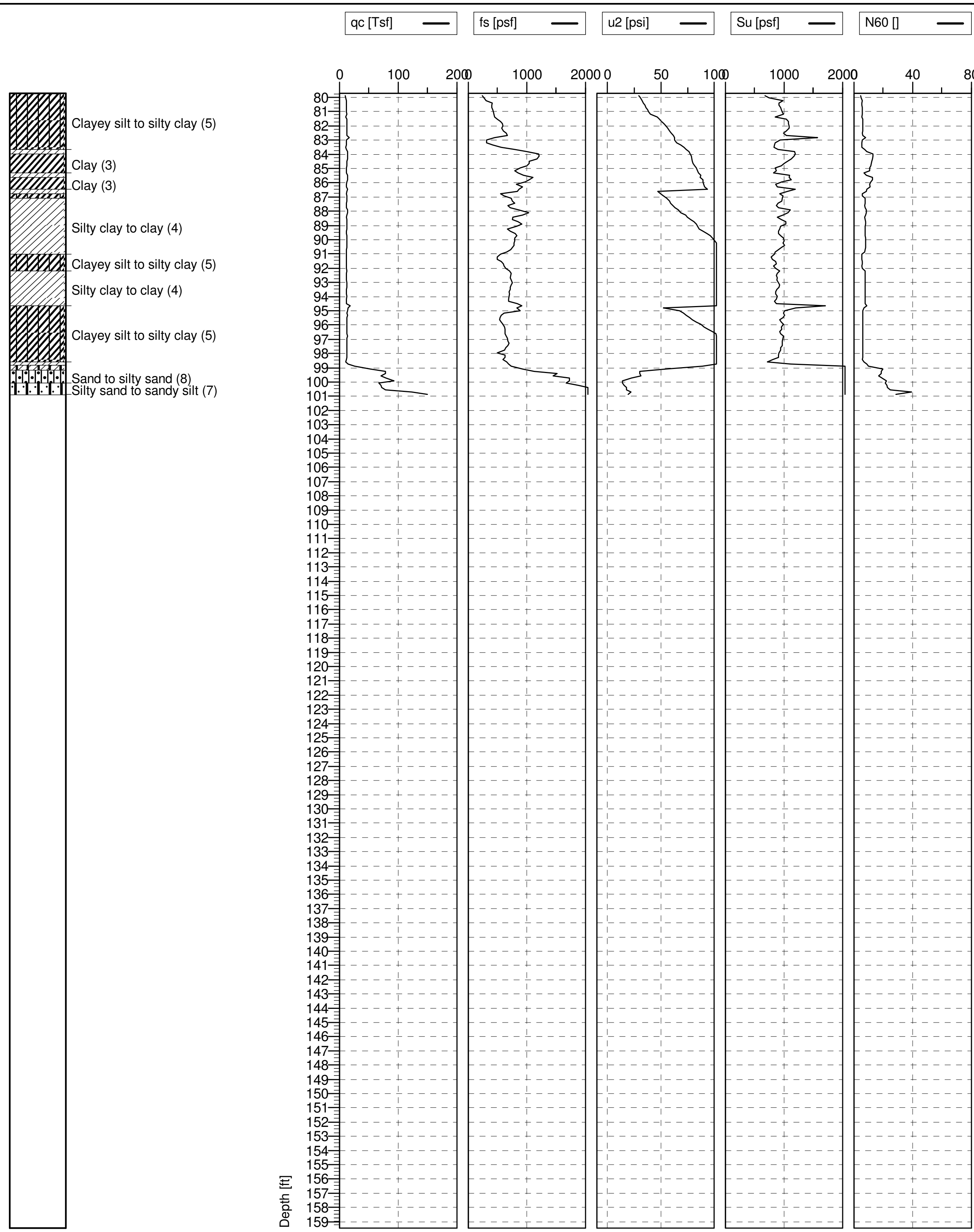


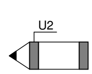
Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
TK22-3

Client:

Project:



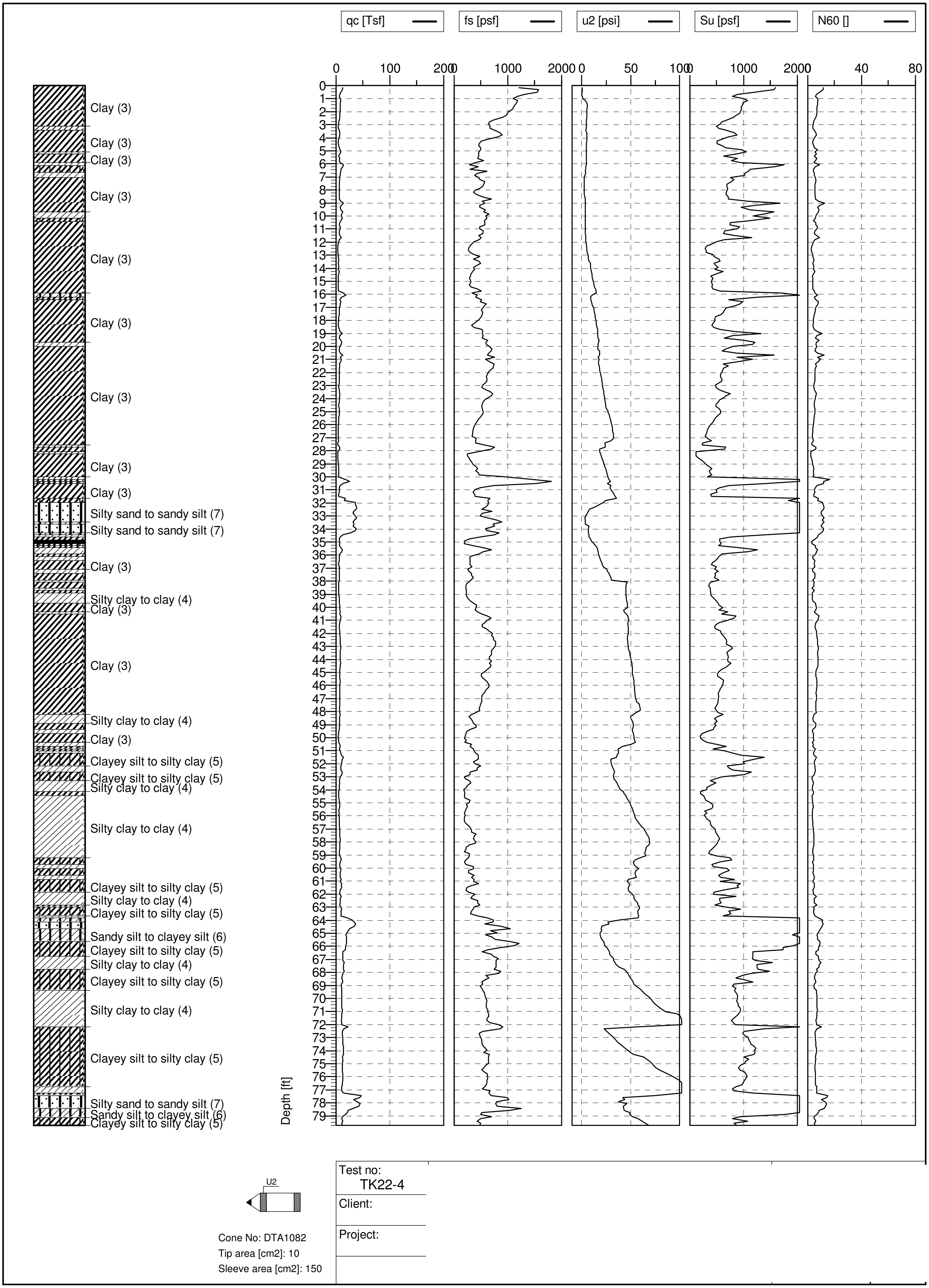


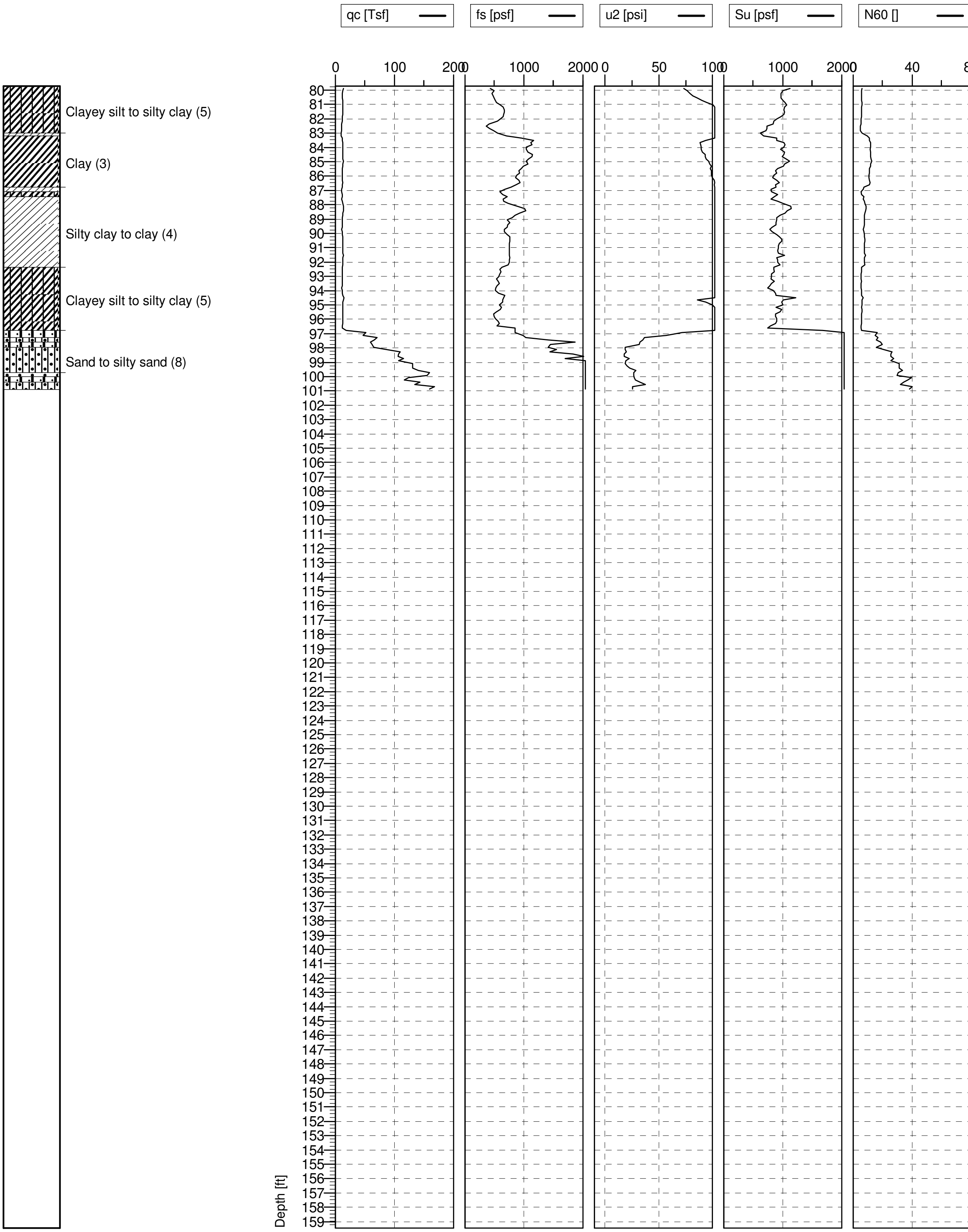
Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150

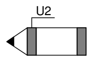
Test no: TK22-3

Client:

Project:


qc [Tsf]
fs [psf]
u2 [psi]
Su [psf]
N60 []
0 100 200
0 1000 2000
0 50 100
0 1000 2000
0 40 80
Depth [ft]
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Clay (3)
Silty sand to sandy silt (7)
Silty sand to sandy silt (7)
Clay (3)
Silty clay to clay (4)
Clay (3)
Clay (3)
Silty clay to clay (4)
Clay (3)
Clayey silt to silty clay (5)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Silty clay to clay (4)
Clayey silt to silty clay (5)
Silty sand to sandy silt (7)
Sandy silt to clayey silt (6)
Clayey silt to silty clay (5)
U2
Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150
Test no:
TK22-4
Client:
Project:





Cone No: DTA1082
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Test no:
TK22-4

Client:

Project:

APPENDIX D

Settle3D Analysis Information

Project Settings

Document Name: 20878-228ft-dia.s3z
Date Created: 3/29/2011, 6:26:57 AM
Stress Computation Method: Westergaard
Time-dependent Consolidation Analysis
Time Units: months
Permeability Units: feet/year
Use average properties to calculate layered stresses
Groundwater method: Water Table
Water Unit Weight: 0.0624 kips/ft^3
Depth to water table: 0 [ft]

Stage Settings

Stage #	Name	Time [months]
1	Stage 1	0
2	preload 2mo	2
3	preload removal	2.01
4	tank installation	3
5	50 yrs	603

Results

Time taken to compute: 0 seconds

Stage: Stage 1 = 0 mon

Data Type	Minimum	Maximum
Total Settlement [in]	0	0
Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress [ksf]	0.00174414	2.61365
Effective Stress [ksf]	0	5.166
Total Stress [ksf]	0.00174414	12.7727
Total Strain	0	0
Pore Water Pressure [ksf]	0.00174414	7.60669
Excess Pore Water Pressure [ksf]	0.00174414	2.61365
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.83	5.1387
Over-consolidation Ratio	1	99.5204
Void Ratio	1.1	1.1
Permeability [ft/y]	0.0385413	45.1198
Coefficient of Consolidation [ft^2/y]	36.5	730
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0

Stage: preload 2mo = 2 mon

Data Type	Minimum	Maximum
Total Settlement [in]	0	25.4943
Consolidation Settlement [in]	0	25.4943
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress [ksf]	0.00174414	2.61365
Effective Stress [ksf]	0.00174414	6.53269
Total Stress [ksf]	0.00174414	12.7727
Total Strain	-0.00044728	0.100348
Pore Water Pressure [ksf]	0	7.03861
Excess Pore Water Pressure [ksf]	0	2.31738
Degree of Consolidation [%]	0	92.3077
Pre-consolidation Stress [ksf]	0.83	6.39282
Over-consolidation Ratio	1	79.8373
Void Ratio	0.889269	1.10094

Permeability [ft/y]	0.0385413	45.1198
Coefficient of Consolidation [ft^2/y]	36.5	730
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0

Stage: preload removal = 2.01 mon

Data Type	Minimum	Maximum
Total Settlement [in]	0	25.5711
Consolidation Settlement [in]	0	25.5711
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress [ksf]	0	0.241619
Effective Stress [ksf]	0.00174414	6.53269
Total Stress [ksf]	0	11.5545
Total Strain	-0.000448939	0.100348
Pore Water Pressure [ksf]	-2.37365	6.09142
Excess Pore Water Pressure [ksf]	-2.37365	0.246115
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	0.83	6.39311
Over-consolidation Ratio	1	79.8373
Void Ratio	0.889269	1.10094
Permeability [ft/y]	0.0578119	45.1198
Coefficient of Consolidation [ft^2/y]	360	730
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0

Stage: tank installation = 3 mon

Data Type	Minimum	Maximum
Total Settlement [in]	0	20.3463
Consolidation Settlement [in]	0	20.3463
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress [ksf]	0	3.34
Effective Stress [ksf]	0	5.31445
Total Stress [ksf]	0	13.1742
Total Strain	-4.39338e-005	0.0809038
Pore Water Pressure [ksf]	0	7.85974
Excess Pore Water Pressure [ksf]	-0.108363	3.1
Degree of Consolidation [%]	0	96.7498
Pre-consolidation Stress [ksf]	0.83	6.39311
Over-consolidation Ratio	1	98.9565
Void Ratio	0.930102	1.10009
Permeability [ft/y]	0.0385413	45.1198
Coefficient of Consolidation [ft^2/y]	36.5	730
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0

Stage: 50 yrs = 603 mon

Data Type	Minimum	Maximum
Total Settlement [in]	0	55.2537
Consolidation Settlement [in]	0	55.2537
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress [ksf]	0	3.34
Effective Stress [ksf]	0	6.93419
Total Stress [ksf]	0	13.1742
Total Strain	9.74262e-005	0.113636
Pore Water Pressure [ksf]	0	6.24
Excess Pore Water Pressure [ksf]	-4.98642e-010	0.0551264
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	0.83	6.91302
Over-consolidation Ratio	1	98.3266
Void Ratio	0.861365	1.0998
Permeability [ft/y]	0.0385413	45.1198
Coefficient of Consolidation [ft^2/y]	36.5	730
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0

Loads

1. Circular Load

Radius: 114 ft
Center: (164, -4.56749e-015)
Load Type: Flexible
Area of Load: 40621.2 ft^2
Load: 3.1 ksf
Depth: 0 ft
Installation Stage: tank installation = 3 mon

Embankments

1. Embankment

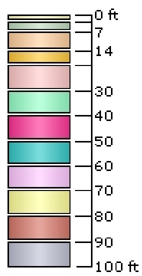
Center Line: (0, 0) to (328, 0)
Number of Layers: 2
Near End Angle: 18.43 degrees
Far End Angle: 18.43 degrees
Base Width: 323

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 mon	0	18.43	2	0.12	18.43	0
2	Stage 1 = 0 mon	0	18.43	20	0.12	18.43	0

Soil Layers

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	GS to 3	3	0	No
2	3 to 7	4	3	No
3	7 to 14	7	7	No
4	14 to 20	6	14	No
5	20 to 30	10	20	No
6	30 to 40	10	30	No
7	40 to 50	10	40	No
8	50 to 60	10	50	No
9	60 to 70	10	60	No
10	70 to 80	10	70	No
11	80 to 90	10	80	No
12	90 to 100	10	90	Yes

Ground Surface Drained: Yes



Soil Properties

Property	GS to 3	3 to 7	7 to 14	14 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
Color												
Unit Weight [kips/ft^3]	0.118	0.12	0.114	0.114	0.107	0.107	0.106	0.114	0.118	0.12	0.12	0.117
Saturated Unit Weight [kips/ft^3]	0.118	0.12	0.114	0.114	0.107	0.107	0.106	0.114	0.118	0.12	0.12	0.117
Primary Consolidation	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
Material Type	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear	Non-Linear
Cce	0.125	0.125	0.125	0.165	0.235	0.15	0.25	0.19	0.137	0.116	0.11	0.1
Cre	0.019	0.019	0.019	0.025	0.035	0.023	0.038	0.029	0.021	0.017	0.017	0.015

Pc [ksf]	0.83	2.79	2.29	2.1	2.2							
OCR						1	1	1	1	1	1	1
Cv [ft^2/y]	73	73	73	73	73	36.5	73	73	73	73	73	73
B-bar	1	1	1	1	1	1	1	1	1	1	1	1
Ch [ft^2/y]	109.5	109.5	109.5	109.5	109.5	54.75	109.5	109.5	109.5	109.5	109.5	109.5

Wick Drains

Wick Drain Region 1

Installation Stage: Stage 1 = 0 mon
Cross-Section Shape: Circular
Equivalent Drain Diameter: 0.209
Drain Spacing: 5
Drain Length: 80
Drain Pattern: Triangular
Ratio of diameter of smear zone to diameter of drain: 4.5
Ratio of undisturbed to smear zone permeability: 3.33

Coordinates

X [ft]	Y [ft]
50	0
76.6709	-73.2778
164	-114
251.329	-73.2778
278	-1.42109e-014
237.278	87.3291
164	114
84.5698	81.1767

Query Points

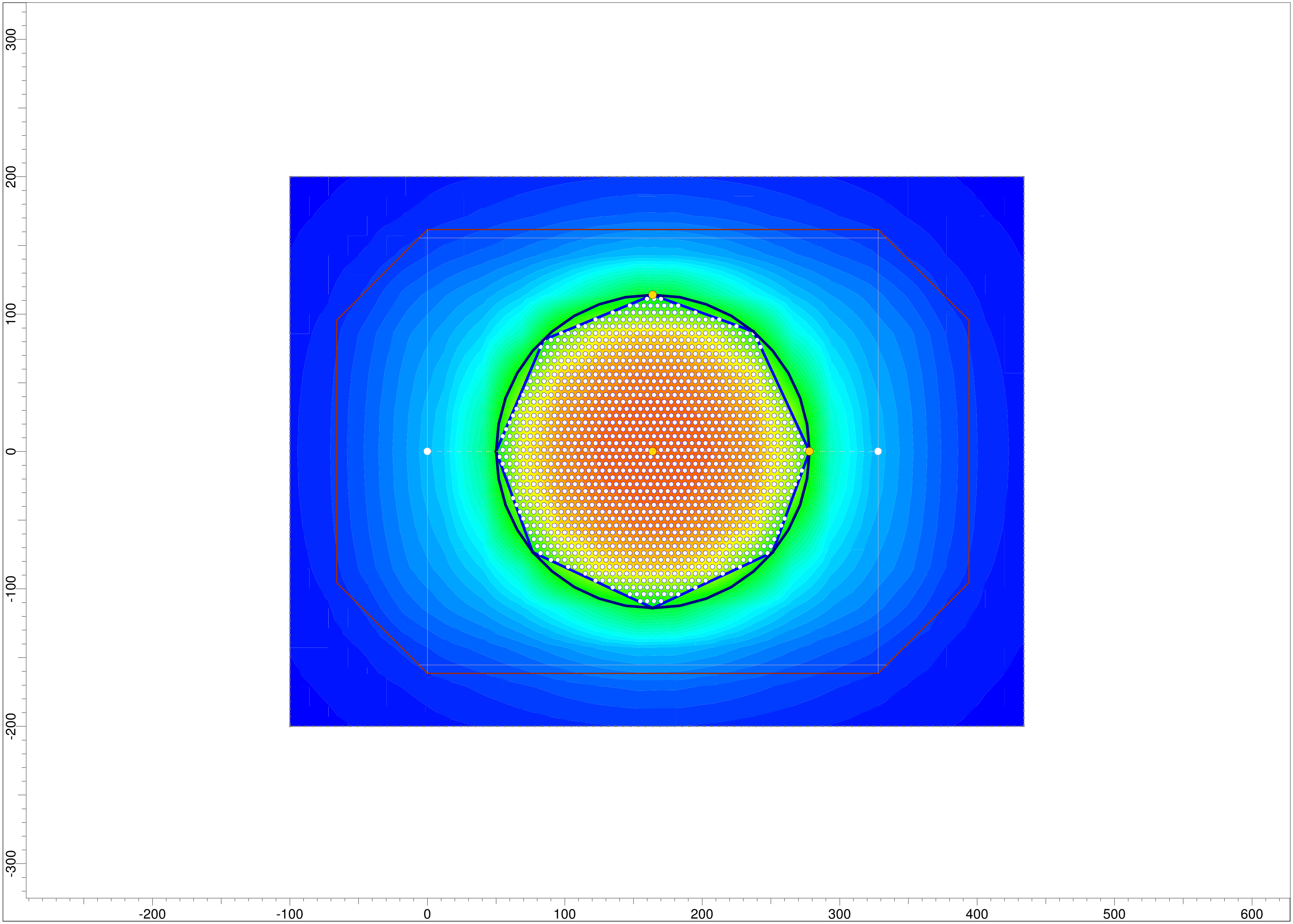
Point #	(X,Y) Location	Number of Divisions
1	164, 0	Auto: 73
2	278, -1.42109e-014	Auto: 73
3	164, 114	Auto: 73

Field Point Grid

Number of points: 300
Expansion Factor: 2

Grid Coordinates

X [ft]	Y [ft]
624.038	391.519
624.038	-391.519
-296.038	-391.519
-296.038	391.519



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VITA

Rebecca Elizabeth Scherer was born in Metairie, Louisiana on 11 January 1983, the daughter of Harold John Scherer, Jr. and Rose Beyerback Scherer. She obtained her Bachelor's of Science degree in Civil Engineering from the University of New Orleans in the Spring of2007. She joined the University of New Orleans engineering graduate program in the Fall of 2007. While earning both her undergraduate and graduate degrees, she was employed as an associate engineer with Eustis Engineering Services, L.L.C.